County of Kaua‘i

Waste Characterization Study

2017 FINAL Report

CASCADIA CONSULTING GROUP

Acknowledgments

This project would not have been successful without a huge amount of support from operations staff at Kekaha Landfill, including John Bostick, Wendell (Loader Operator), Lindsay and Karen (Scalehouse Staff), and all of the other Kekaha Landfill employees who supported our study while we were onsite. We would also like to express gratitude to the County of Kaua'i employees who have been our partners in executing this study, including Allison Fraley, Troy Tanigawa, Keola Aki, and Jeanine Okuhara.

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1. Introduction & Summary

Introduction and Study Objectives

The County of Kaua'i conducted the 2016 Waste Characterization Study to collect reliable data about the waste from the County of Kaua'i that is currently disposed at the Kekaha Landfill. This study involved the hand sorting and characterization of waste that private haulers collect from commercial accounts, materials that the County collects from residential accounts, and materials that residents and others drop off at transfer stations. The study used consistent sampling procedures, sample sizes, material types, and data management processes to ensure that resulting data are representative and meaningful for long-term planning.

This section presents a project overview and a selection of key project findings. The rest of this report provides more detail about the study, including a summary of the sampling and sorting methodologies our team used to complete the characterization and detailed composition results and complete key findings.

Project Overview

During this study, our team characterized 162 samples total: 81 samples from the Private Commercial substream and 81 samples from the County Transfer Station substream (73 samples from transfer stations throughout the County and 8 samples from Country collection routes).

Field work occurred in two seasons: the first season in late July/early August 2016, and the second season in late September/early October 2016. All samples were collected and sorted at Kekaha Landfill. Our field team hand-sorted all samples collected for this study.

The project team combined the composition (percent-by-weight) data from these sorts with annual quantity (tonnage) data provided by the County of Kaua'i to create the composition and quantity estimates presented throughout this report.

Summary of Findings

Cascadia characterized and quantified two substreams for this study: Private Commercial waste and County Transfer Station waste. Results are presented in this report for the Overall County of Kaua'i waste stream, the Private Commercial waste stream, and the County Transfer Station waste stream. The project team also compared the County of Kaua'i diversion records with the overall waste composition and quantity data resulting from our study to create a picture of overall generation, and estimated diversion rates by material class and overall.

A summary of findings for this study are presented below. Findings are presented at the **Material Class** level. **Material Classes** are the broader categories that organize our material list of 71 *material types.* The eleven **Material Classes** used for this study are: **Paper**, **Glass**, **Plastic**, **Metal**, **Food**, **Other Organics**, **Inerts and Other C&D**, **Electronics and Appliances**, **Household Hazardous Waste**, **Special Waste**, and

Mixed Residue. We have bolded and capitalized them throughout this report so that it is clear when we are referencing a **Material Class**.

The **Inerts and Other C&D**, **Mixed Residue**, and **Other Organics** material classes are prevalent throughout the County of Kaua'i waste stream. Examples of material types in the **Inerts and Other C&D** class are *concrete*, *asphalt paving, asphalt roofing, clean lumber, treated lumber, other wood waste, gypsum board,* and *rock, soil, and fines.* Examples of materials in the **Mixed Residue** class are clumping kitty litter, cosmetics, partially filled containers of non-food consumer products, and bathroom waste. **Mixed Residue** also includes "fines," materials from any other material category that are less than 2" in diameter. Examples of material types in the **Other Organics** material class are *leaves and grass*, *sewage sludge*[1], *prunings and trimmings*, *branches and stumps*, *manures*, *textiles*, and *carpet***.**

The quantity of **Inerts and Other C&D** materials noticeably increased in 2016 compared to previous studies. This may be due to sampling biases or may be due to an increase in the amount of construction projects on Kaua'i , among other reasons. In particular, the demolition of the Coco Palms Resort during the first season of field work contributed to an estimated 6% increase in tons from the Private Commercial substream, and most of this tonnage was likely **Inerts and Other C&D** materials. Given the proportionally small increase in tonnage attributed to the Coco Palms project and the random sample selection method employed in this study (which reduces the possibility that Coco Palms loads were over-sampled), it is unlikely that the Coco Palms demolition alone is responsible for the estimated upswing in **Inerts and Other C&D**.

Overall Waste Composition and Diversion

- The two most prevalent material classes in the County's overall waste stream are **Inerts and Other C&D** (23.7%) and **Paper** (18.4%). Overall they make up about 42% of all disposed waste.
- The estimated diversion rates for the **Other Organics** and **Metal** material classes are the highest at approximately 64% each. The lowest diversion rate (aside from **Mixed Residue**, which has an estimated diversion rate of 0%), is for **Electronics and Appliances** (11%). Overall, the County of Kaua'i diversion rate is estimated at 44%.

Private Commercial Waste Composition

- **Inerts and Other C&D** (25.6%) and **Paper** (18.7%) are the two most common material classes in the Private Commercial waste substream. Together, they make up over 44% of the Private Commercial waste substream.

County Transfer Station Waste Composition

- **Inerts and Other C&D** (21.7%) and **Other Organics** (18.7%) are the two most prevalent materials in the County Transfer Station waste substream. Together, they make up a little over 40% of the substream. **Paper** is also a prevalent material, at 18.2% of the County Transfer Station waste substream.

[1] Note that Cascadia did not hand sort the *sewage sludge* material type, but rather used detailed County tonnage data to incorporate *sewage sludge* into the composition estimates presented in this report.

Document Map

The remainder of this report is organized in the following sections:

- **Summary of Methodology** defines the substreams included in this study and summarizes our data collection design, implementation, and analysis methodologies.
- **Study Results** presents key findings and detailed composition results for each of the substreams.
- **Appendices** follow the main body of the report. They provide definitions for all material types, a detailed explanation of the methodology, an explanation of composition calculations, examples of field forms, and a detailed genetation table.

2. Summary of Methodology

The following section summarizes the three main tasks of the study methodology: Develop Plan, Collect Data, and Analyze Data.

Develop Plan

Step 1. Coordinate with County and Landfill Staff

Prior to beginning fieldwork, Cascadia staff met by phone with County of Kaua'i and Kekaha Landfill staff to plan and coordinate study logistics such as space at the landfill, vehicle selection strategies, and assistance from landfill staff. County staff helped to coordinate pre-field work logistics like collecting tonnage data, identifying curbside carts that the field crew could borrow for the study, and finalizing material list definitions. Landfill staff helped to coordinate sample collection, sample disposal, and other details involved with the field data collection effort.

Step 2. Define Waste Streams

During project planning conversations, the project team defined the sampling universe. In this study, the universe included two substreams that our field team characterized samples from. A "substream" is determined by the particular generation, collection, or composition characteristics that make it a unique portion of the total waste stream.

In this study, Cascadia characterized the following two substreams using a hand-sort methodology:

- **Private Commercial** — waste primarily from institutional, commercial, or industrial sources that private waste hauling companies deliver to Kekaha Landfill. This material stream includes loads of municipal solid waste (MSW) as well as construction and demolition (C&D) materials.
- **County Transfer Station** — waste that the County refuse collection trucks, individual residents, and small businesses not in the business of hauling waste deliver to one of the County's four transfer stations. This material stream includes all boxes that the County delivers to the Kekaha Landfill from its four transfer stations, as well as all waste from County refuse collection trucks that deliver material directly to the Kekaha Landfill. **The majority of the material in this stream is from residential sources.**

The tonnage associated with each substream can be found in the Method to Obtain Tonnage Data section.

Step 3. Define Materials

Cascadia worked with County staff to identify material types and definitions for this study. The field crew sorted the disposed samples into 71 unique material types which are divided among eleven material classes: **Paper, Glass, Metal, Electronics and Appliances, Plastic, Food, Other Organics, Inerts and Other C&D, Household Hazardous Waste (HHW), Special Waste,** and **Mixed Residue.**

Please refer to Appendix A: Material Type Definitions for the division of material types into material classes and for material type definitions.

Step 4. Schedule Field Work and Allocate Samples

Cascadia conducted the characterization study over two seasons in order to capture differences in seasonal generation trends. Sampling for the first season took place on every weekday from July 26th through August 4th, 2016, and on Saturday, July 30th. The first season was representative of high tourist season. Sampling for the second season began on September 26th, 2016, and lasted every weekday through October 6th, 2016. An additional day of sampling took place on Saturday, October 1st. This second season was representative of low tourist season.

Table 1 below details the number of samples that the field crew planned to collect and sort by substream and the number of samples that the field crew actually sampled and sorted by substream.

Table 1. Sample Allocation by Substream and Season

Substream	Planned Samples	Actual Samples
Private Commercial (hand sort)	75-85	81
County Transfer Station (hand sort)	75-85	81
Total	**150-170**	**162**

Collect Data

Step 1. Load Selection

For this study, Cascadia selected all loads using a systematic selection methodology (selecting every n^{th} vehicle) at the landfill on each day of field work for the study. This method randomly selects individual vehicles from each substream for sampling, ensuring that the mix of sampled vehicles is representative of the private commercial, transfer station box, and County collected loads delivered to the landfill.

We used estimates for the total number of loads arriving at the facility (based on historical data provided by landfill staff) to establish a "sampling frequency" for each day of sampling. We calculated the sampling frequency by dividing the total expected number of loads for each substream by the target number of samples to determine which vehicles must be sampled—such as every third vehicle, every sixth vehicle, or every 20th vehicle. This strategy is referred to as "selecting every n^{th} vehicle." We then developed *Vehicle Selection Forms* to clearly communicate the sampling frequency required for each substream for each day at the Kekaha Landfill.

Cascadia trained scalehouse staff at the Kekaha Landfill on the vehicle selection strategy and provided them with *Vehicle Selection Forms* for each day. The scalehouse staff used these *Vehicle Selection Forms* to select vehicles for samples, with occasional instructional support from Cascadia staff when needed.

Cascadia also prepared bright pink *Sample Placards,* which Kekaha scalehouse staff placed on the windshield of vehicles that they selected. The *Sample Placards* contained information about the substream and date for each load selected. Example *Sample Placards* and *Vehicle Selection Forms* are provided in Appendix D: Example Field Forms.

Cascadia calculated the daily sampling quotas detailed on the *Vehicle Selection Forms* based on data that the County of Kaua'i provided about the average number of loads arriving at the Kekaha Landfill, backed up by the number of tons arriving at the Kekaha Landfill each year. These sampling quotas are detailed in the table below, paired with the actual number of loads selected from each stream.

Note that the substreams listed in these tables are more detailed than those listed in Step 2. Define Waste Streams. This is because we needed sampling quotas for these more detailed substreams to weight them appropriately in our analysis for each substream and overall.

Table 2. Sampling Quotas, Overall

Substream	Planned Sampling Quota	Actual Number Sampled
Privately Hauled Commercial Waste Delivered to Kekaha Landfill	80	81
County-hauled Waste Delivered Directly to Kekaha Landfill – Parks waste and household refuse collection from Kekaha on Mondays and Tuesdays	8	8
Līhu'e Transfer Station Material Delivered to Kekaha Landfill	24	24
Hanalei Transfer Station Material Delivered to Kekaha Landfill	16	16
Kapa'a Transfer Station Material Delivered to Kekaha Landfill	16	16
Hanapēpē Transfer Station Material Delivered to Kekaha Landfill	16	17
TOTAL	**160**	**162**

Step 2. Collect and Sort Samples

Cascadia field staff hand-sorted all samples collected for this study. The hand-sort methodology is summarized below. For a full description of this methodology, refer to Appendix B: Detailed Study Design.

For full list of material components and definitions used in the characterization field work, refer to Appendix A: Material Type Definitions.

Hand-Sort Methodology

Field staff hand-sorted all samples collected for this study. When a selected vehicle arrived at the landfill face, the field supervisor collected the *Sample Placard* from the windshield, verified the information noted on the *Sample Placard*, and directed the selected vehicle to the proper tipping location. After the vehicle dumped its load, the field supervisor superimposed an imaginary 16-cell grid over the dumped material, identified a sample from a pre-selected random cell (noted on the *Sample Placard*), and received assistance from the landfill's loader and operator to extract this sample from the load. Our target weight for each sample was 200 pounds. Field crew staff photographed each sample, sorted the material into 71 different material types, and recorded the weight for each sorted material type into the *Material Weight Tally Sheet*. Figure 1 provides a visual overview of this process.

The average per sample weight for this study was 232 pounds.

Figure 1. Overview of Hand-Sort Process

Analyze Data

Cascadia field staff reviewed all completed field forms daily to identify any unusual or missing entries and resolve them immediately. After field work, Cascadia staff entered all collected data into a customized database twice to prevent data entry errors and rectified any discrepancies between the two entries.

The project team developed detailed estimates of waste composition and quantities for each substream using the tonnage data the County provided and the methods described in Appendix C: Waste Characterization Calculations.

Method to Obtain Tonnage Data

Cascadia requires annual tonnage information to complete the analysis. The County of Kaua'i provided Cascadia with tonnage information from fiscal year 2016 for each detailed substream that this study considered. Table 3 details the tons that the County provided.

Table 3. FY 2016 Annual Quantities

Detailed Material Stream	FY 2016 Annual Tons, rounded
Privately Hauled Commercial Waste Delivered to Kekaha Landfill	42,324
County Hauled Waste Delivering Directly to Kekaha Landfill	938
Līhu'e Transfer Station Material Delivered to Kekaha Landfill	17,079
Hanalei Transfer Station Material Delivered to Kekaha Landfill	5,957
Kapa'a Transfer Station Material Delivered to Kekaha Landfill	4,870
Hanapēpē Transfer Station Material Delivered to Kekaha Landfill	9,350
Residential Hauled to Kekaha Landfill[2]	3,222
TOTAL	**83,740**

[2] This study did not sample from Residential Hauled to Kekaha Landfill, a detailed material stream that includes residents who self-haul their garbage and recycling to the Kekaha Landfill. However, we have included this tonnage in the County Transfer Station Waste Stream, since that Waste Stream encompasses resident self-hauled material at all other transfer stations in the County.

3. Study Results

Interpreting the Results

This report presents characterization results in three ways:

- First, a pie chart and a bar chart present an overview of composition by **Material Class**. **Material Classes** are the broader categories that organize our material list of 71 *material types* into sections. The eleven **Material Classes** utilized for this study are: **Paper**, **Glass**, **Plastic**, **Metal**, **Food, Other Organics**, **Inerts and Other C&D**, **Electronics and Appliances**, **Household Hazardous Waste**, **Special Waste**, and **Mixed Residue**. We have bolded and capitalized them throughout this results presentation so that it is clear when we are referencing a **Material Class**.
- Next, the ten most prevalent individual *material types*, by weight, are shown in a table. *Material types* are the detailed categories that our field crew used to sort samples for this study. There were 71 *material types* for this study, numbered and defined in Appendix A: Material Type Definitions. We have italicized them and presented them in lower case throughout this results presentation so that it is clear when we are referencing a *material type*.
- Finally, a detailed table lists the full composition and quantity results for the 71 *material types* used in the study.

For the Overall Waste Composition and Quantity results presentation, we have also prepared a table that compares disposal and diversion tonnages by material class, calculates total generation, and estimates a diversion rate for each material class and overall. The disposal tonnage data are the result of this characterization study, and the diversion tonnage data are from the County of Kaua'i internal records.

Rounding

When interpreting the results presented in the tables and figures in this report, it is important to consider the **effect of rounding**.

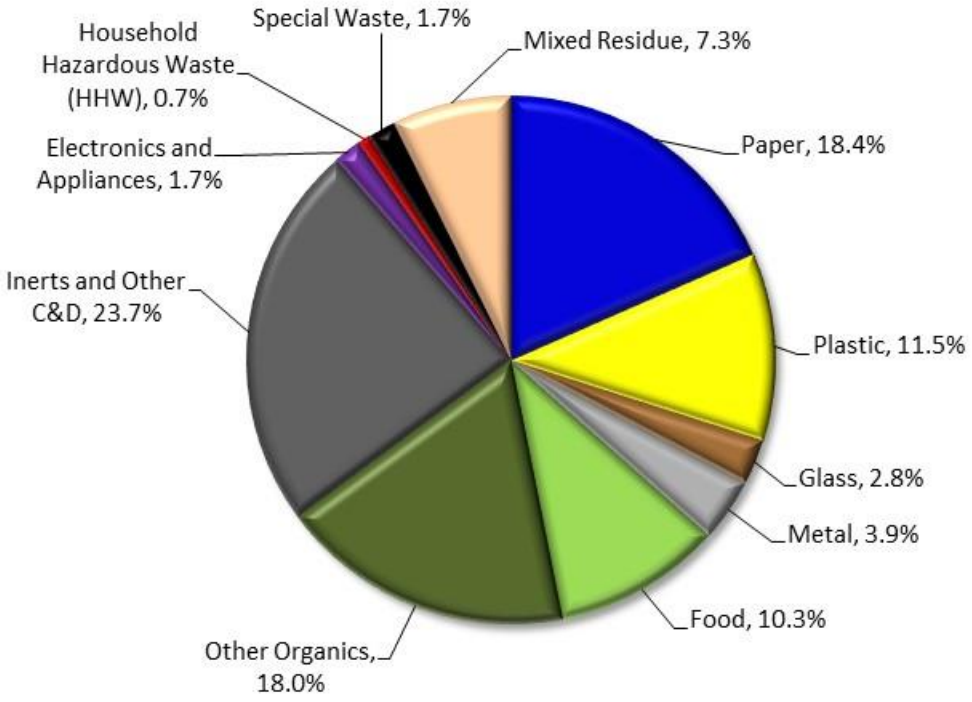
To keep the composition tables and figures readable, estimated tonnages are rounded to the nearest ton, and estimated percentages are rounded to the nearest tenth of a percent. Likewise, text references to the tables round the estimated percentages to the nearest percent. Due to this rounding, the **tonnages**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

It is important to recognize that the tons throughout the report were calculated using the non-rounded percentages. Therefore, using the rounded percentages from the tables to calculate tonnages may yield tonnages that are slightly different than those shown in the report.

Overall Waste Composition and Generation

The overall waste composition is based on 162 samples of waste generated in the County of Kaua'i and collected for this study; this figure reflects all samples collected and sorted for this study. As shown in Figure 2, 23.7% of the County's waste stream is made up of **Inerts and Other C&D**, the largest portion of the County's disposed waste stream. **Paper** (18.4%), **Other Organics** (18.0%), **Plastic** (11.5%), and **Food** (10.3%) also make up significant portions of the overall disposed waste stream.

Figure 2. Composition by Material Class,
Overall Kaua'i Countywide Waste Composition, 2016



The ten most prevalent material types can be found in Table 4. As shown, *mixed residue* (7.3%)*, other wood waste* (6.2%), and *clean lumber* (5.0%) are the three most prevalent material types; together they represent over 18% of the overall County waste stream.

Table 4 and Table 5 provide data about percent composition by material type, as well as tonnage estimates by material type, for the County of Kaua'i waste stream overall. Cascadia arrived at these tonnage estimates by applying the fiscal year 2016 tonnage provided by the County of Kaua'i (83,740 tons for the County overall) to the percent compositions listed in both tables. For example, as shown in Table 4, *mixed residue* makes up an estimated 7.3% of the overall Kaua'i waste stream. Applying this 7.3% estimate to the overall tonnage figure of 83,740 results in the estimate of 6,089 tons attributed to *mixed residue*.

The figure 83,740 tons includes privately hauled commercial waste delivered to Kekaha Landfill; County-hauled waste delivering directly to Kekaha Landfill; and Lihue, Hanalei, Kapa'a, and Hanapepe transfer

station materials hauled to Kekaha Landfill in transfer trailers. The analytical calculations are detailed in Appendix C: Waste Characterization Calculations.

Table 4. Ten Most Prevalent Material Types, Overall Kaua'i Countywide Waste Composition, 2016

Material	Estimated Percent	Cumulative Percent	Estimated Tons
Mixed Residue	7.3%	7.3%	6,089
Other Wood Waste	6.2%	13.4%	5,157
Clean Lumber	5.0%	18.4%	4,167
Sewage Sludge	4.8%	23.2%	3,985
Compostable Paper	4.4%	27.6%	3,711
Uncoated Corrugated Cardboard	4.4%	32.0%	3,674
Unpackaged Food - Non-Meat	4.3%	36.3%	3,597
Leaves and Grass	4.3%	40.6%	3,579
Mixed Paper	4.1%	44.7%	3,472
Non-Recyclable Film Plastic	4.1%	48.8%	3,407
Subtotal	***48.8%***		***40,841***
All other materials	51.2%		42,899
Total	**100.0%**		**83,740**

The detailed composition of the overall County waste stream is shown in Table 5.

Table 5. Detailed Composition, Overall Kaua'i Countywide Waste Composition, 2016

Material	Estimated Percent	Estimated Tons	Material	Estimated Percent	Estimated Tons
Paper	**18.4%**	**15,441**	**Other Organics**	**18.0%**	**15,107**
Uncoated Corrugated Cardboard	4.4%	3,674	Leaves and Grass	4.3%	3,579
Kraft Paper Bags	1.4%	1,149	Prunings and Trimmings	1.9%	1,585
Newspaper	0.8%	629	Branches and Stumps	0.1%	64
White Ledger Paper	1.3%	1,096	Manures	0.0%	0
Mixed Paper	4.1%	3,472	Textiles	3.0%	2,525
Aseptic and Gable Top Containers	0.4%	323	Carpet	0.6%	508
Compostable Paper	4.4%	3,711	Sewage Sludge	4.8%	3,985
Non-Recyclable Paper	1.7%	1,386	Non-Recyclable Organic	3.4%	2,861
Plastic	**11.5%**	**9,595**	**Inerts and Other C&D**	**23.7%**	**19,815**
PETE Containers - HI-5	0.4%	375	Concrete	1.3%	1,072
PETE Containers - Non-HI-5	0.3%	246	Asphalt Paving	0.0%	3
HDPE Containers - HI-5	0.1%	122	Asphalt Roofing	1.9%	1,566
HDPE Containers - Non-HI-5	0.5%	430	Clean Lumber	5.0%	4,167
Plastic Containers #3-#7	1.1%	958	Treated Lumber	2.9%	2,467
Plastic Grocery and Other Merchandise Bags	0.0%	41	Other Wood Waste	6.2%	5,157
Agricultural Film Plastic	0.1%	80	Gypsum Board	3.4%	2,821
Other Clean Film	0.5%	385	Rock, Soil and Fines	1.7%	1,395
Non-Recyclable Film Plastic	4.1%	3,407	Non-Recyclable Inerts and Other	1.4%	1,166
Durable Plastic Items	1.9%	1,605			
Expanded Polystyrene Food Serviceware	0.4%	364	**Electronics and Appliances**	**1.7%**	**1,446**
Other Expanded Polystyrene	0.3%	236	Covered Electronic Devices	0.2%	138
Non-Recyclable Plastic	1.6%	1,345	Non-Covered Electronic Devices	0.5%	387
			Major Appliances	0.0%	0
Glass	**2.8%**	**2,332**	Small Appliances	1.1%	921
Glass Bottles and Containers - HI-5	0.9%	761			
Glass Bottles and Containers - Non-HI-5	1.3%	1,083	**Household Hazardous Waste (HHW)**	**0.7%**	**626**
Non-Recyclable Glass	0.6%	488	Paint	0.0%	38
			Empty Aerosol Containers	0.1%	70
Metal	**3.9%**	**3,240**	Vehicle and Equipment Fluids	0.0%	0
Tin/Steel Cans	0.5%	438	Used Oil	0.0%	2
Bi-Metal Cans HI-5	0.1%	69	Batteries	0.1%	109
Other Ferrous	1.3%	1,060	Mercury-Containing Items - Not Lamps	0.0%	0
Aluminum Cans - HI-5	0.3%	228	Lamps - Fluorescent and LED	0.0%	8
Aluminum Cans - Non-HI-5	0.1%	78	Remainder/Composite Household Hazardous	0.5%	399
Other Non-Ferrous	0.6%	530			
Remainder/Composite Metal	1.0%	838	**Special Waste**	**1.7%**	**1,415**
			Ash	0.2%	130
Food	**10.3%**	**8,635**	Treated Medical Waste	0.0%	4
Retail Packaged Food - Meat	0.5%	432	Bulky Items	0.4%	335
Retail Packaged Food - Non-Meat	2.8%	2,361	Tires	0.0%	9
Unpackaged Food - Meat	0.9%	787	Remainder/Composite Special Waste	1.1%	937
Other Packaged Food - Meat	0.6%	522			
Unpackaged Food - Non-Meat	4.3%	3,597	**Mixed Residue**	**7.3%**	**6,089**
Other Packaged Food - Non-Meat	1.1%	936	Mixed Residue	7.3%	6,089
			Totals	**100.0%**	**83,740**
			Samples	**162**	

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

Table 6 below presents data about total tons disposed, total tons diverted, and total tons generated for the County of Kaua'i. The tons disposed data are the result of this waste characterization study, based on fiscal year 2016 tonnages. The tons diverted data are from County of Kaua'i diversion documentation for fiscal year 2016. The total generation is the sum of tons disposed and tons diverted. The diversion rate is the tons diverted divided by the total tons generated.

The estimated diversion rates for the **Other Organics** and **Metal** material classes are the highest at approximately 64% each. The lowest diversion rate (aside from **Mixed Residue**, which has an estimated diversion rate of 0%), is for **Electronics and Appliances** (11%). Overall, the County of Kaua'i diversion rate is estimated at 44%.

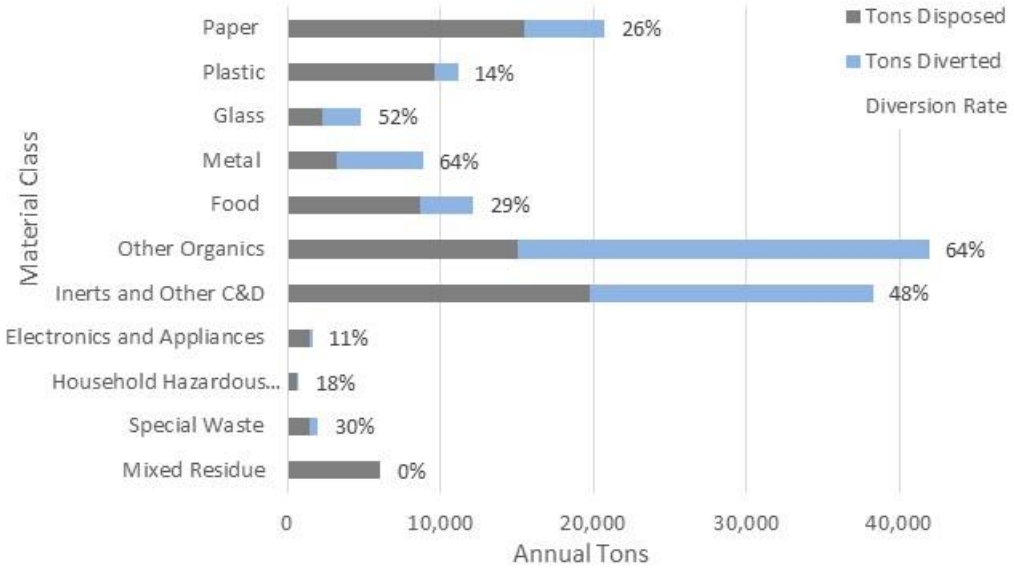
Appendix E: Detailed Total Generation presents a more detailed version of this table: Total Generation by *material type*, with diversion rate estimates for each *material type*. This table also includes detailed information about the methodology that Cascadia used to combine the County's diversion data with the characterization study disposal data to estimate total generation for each *material type*.

Table 6. Total Generation by Material Class

Material	Tons Disposed	Tons Diverted	Total Generation	Diversion Rate
Paper	15,441	5,320	20,760	26%
Plastic	9,595	1,580	11,175	14%
Glass	2,332	2,504	4,835	52%
Metal	3,240	5,646	8,886	64%
Food	8,635	3,541	12,175	29%
Other Organics	15,107	26,818	41,925	64%
Inerts and Other C&D	19,815	18,436	38,251	48%
Electronics and Appliances	1,446	173	1,619	11%
Household Hazardous Waste	626	141	767	18%
Special Waste	1,415	609	2,024	30%
Mixed Residue	6,089	0	6,089	0%
TOTAL	83,740	64,767	148,507	44%

Figure 3 below visualizes the data from Table 6 above. Total tons disposed are indicated in black, total tons diverted are indicated in blue, and total tons generated are the combination of the blue and black bar for each material class.

Figure 3. Total Tons Diverted and Disposed by Material Class

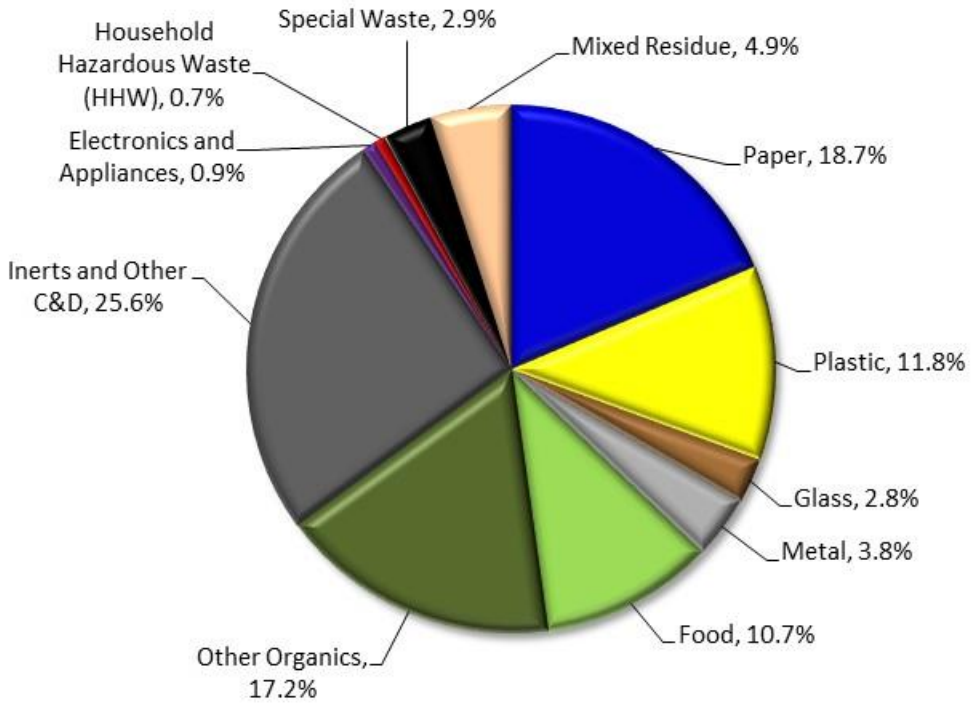


Private Commercial Waste Composition

The project team hand-sorted 81 samples of Private Commercial waste. Private Commercial waste is material primarily from institutional, commercial, or industrial sources that private waste hauling companies deliver to Kekaha Landfill. This material stream includes loads of municipal solid waste (MSW) as well as construction and demolition (C&D) materials.

As shown in Figure 4, 25.6% of the Private Commercial waste substream is **Inerts and Other C&D**. **Paper** is the second largest material class, making up 18.7% of the substream. **Other Organics** (17.2%), **Plastic** (11.8%), and **Food** (10.7%) also make up large portions of this substream.

Figure 4. Composition by Material Class, Private Commercial Waste, 2016



The ten most prevalent material types can be found in Table 7. As shown, *sewage sludge*[3] (9.4%), *other wood waste* (7.0%), and *clean lumber* (6.9%) are the three most prevalent material types; together they represent over 23% of the Private Commerical waste substream.

Table 7 and Table 8 provide data about percent composition by material type, as well as tonnage estimates by material type, for privately hauled commercial waste delivered to Kekaha Landfill. Cascadia arrived at these tonnage estimates by applying fiscal year 2016 tonnage provided by the County of Kaua'i (42,324 tons for privately hauled commercial waste) to the percent compositions listed in both tables. For example, as shown in Table 7, *sewage sludge* makes up an estimated 9.4% of the privately

[3] Note that Cascadia did not hand sort the *sewage sludge* material type, but rather used detailed County tonnage data to incorporate *sewage sludge* into the composition estimates presented in this report.

hauled commercial waste stream. Applying this 9.4% estimate to the overall tonnage figure of 42,324 results in the estimate of 3,985 tons attributed to *sewage sludge*.

The figure 42,324 tons includes only privately hauled commercial waste delivered directly to Kekaha Landfill. The analytical calculations are detailed in Appendix C: Waste Characterization Calculations.

Table 7. Ten Most Prevalent Material Types, Private Commercial Waste, 2016

Material	Estimated Percent	Cumulative Percent	Estimated Tons
Sewage Sludge	9.4%	9.4%	3,985
Other Wood Waste	7.0%	16.4%	2,943
Clean Lumber	6.9%	23.2%	2,899
Gypsum Board	5.2%	28.4%	2,204
Unpackaged Food - Non-Meat	5.0%	33.4%	2,096
Mixed Residue	4.9%	38.3%	2,091
Compostable Paper	4.5%	42.9%	1,925
Uncoated Corrugated Cardboard	4.3%	47.2%	1,834
Mixed Paper	4.0%	51.2%	1,699
Non-Recyclable Film Plastic	3.7%	54.9%	1,576
Subtotal	***54.9%***		***23,252***
All other materials	45.1%		19,072
Total	**100.0%**		**42,324**

The detailed composition of the Private Commercial waste substream is shown in Table 8.

Table 8. Detailed Composition, Private Commercial Waste, 2016

Material	Estimated Percent	Estimated Tons	Material	Estimated Percent	Estimated Tons
Paper	**18.7%**	**7,908**	**Other Organics**	**17.2%**	**7,262**
Uncoated Corrugated Cardboard	4.3%	1,834	Leaves and Grass	1.4%	610
Kraft Paper Bags	1.4%	572	Prunings and Trimmings	1.5%	629
Newspaper	0.6%	271	Branches and Stumps	0.1%	37
White Ledger Paper	1.7%	702	Manures	0.0%	0
Mixed Paper	4.0%	1,699	Textiles	1.7%	716
Aseptic and Gable Top Containers	0.5%	193	Carpet	0.2%	99
Compostable Paper	4.5%	1,925	Sewage Sludge	9.4%	3,985
Non-Recyclable Paper	1.7%	712	Non-Recyclable Organic	2.8%	1,187
Plastic	**11.8%**	**5,010**	**Inerts and Other C&D**	**25.6%**	**10,829**
PETE Containers - HI-5	0.5%	221	Concrete	0.4%	152
PETE Containers - Non-HI-5	0.3%	117	Asphalt Paving	0.0%	3
HDPE Containers - HI-5	0.1%	59	Asphalt Roofing	1.3%	536
HDPE Containers - Non-HI-5	0.5%	193	Clean Lumber	6.9%	2,899
Plastic Containers #3-#7	1.2%	502	Treated Lumber	2.9%	1,212
Plastic Grocery and Other Merchandise Bags	0.1%	27	Other Wood Waste	7.0%	2,943
Agricultural Film Plastic	0.1%	61	Gypsum Board	5.2%	2,204
Other Clean Film	0.8%	319	Rock, Soil and Fines	0.4%	184
Non-Recyclable Film Plastic	3.7%	1,576	Non-Recyclable Inerts and Other	1.6%	695
Durable Plastic Items	2.3%	957			
Expanded Polystyrene Food Serviceware	0.3%	134	**Electronics and Appliances**	**0.9%**	**380**
Other Expanded Polystyrene	0.4%	166	Covered Electronic Devices	0.2%	65
Non-Recyclable Plastic	1.6%	678	Non-Covered Electronic Devices	0.1%	62
			Major Appliances	0.0%	0
Glass	**2.8%**	**1,167**	Small Appliances	0.6%	253
Glass Bottles and Containers - HI-5	0.9%	378			
Glass Bottles and Containers - Non-HI-5	1.4%	591	**Household Hazardous Waste (HHW)**	**0.7%**	**288**
Non-Recyclable Glass	0.5%	198	Paint	0.0%	5
			Empty Aerosol Containers	0.1%	33
Metal	**3.8%**	**1,616**	Vehicle and Equipment Fluids	0.0%	0
Tin/Steel Cans	0.4%	157	Used Oil	0.0%	0
Bi-Metal Cans HI-5	0.1%	33	Batteries	0.0%	14
Other Ferrous	1.1%	476	Mercury-Containing Items - Not Lamps	0.0%	0
Aluminum Cans - HI-5	0.2%	102	Lamps - Fluorescent and LED	0.0%	1
Aluminum Cans - Non-HI-5	0.1%	24	Remainder/Composite Household Hazardous	0.6%	235
Other Non-Ferrous	0.7%	311			
Remainder/Composite Metal	1.2%	514	**Special Waste**	**2.9%**	**1,243**
			Ash	0.0%	0
Food	**10.7%**	**4,531**	Treated Medical Waste	0.0%	0
Retail Packaged Food - Meat	0.3%	145	Bulky Items	0.7%	300
Retail Packaged Food - Non-Meat	2.8%	1,184	Tires	0.0%	5
Unpackaged Food - Meat	1.2%	499	Remainder/Composite Special Waste	2.2%	937
Other Packaged Food - Meat	0.5%	224			
Unpackaged Food - Non-Meat	5.0%	2,096	**Mixed Residue**	**4.9%**	**2,091**
Other Packaged Food - Non-Meat	0.9%	382	Mixed Residue	4.9%	2,091
			Totals	**100.0%**	**42,324**
			Samples	**81**	

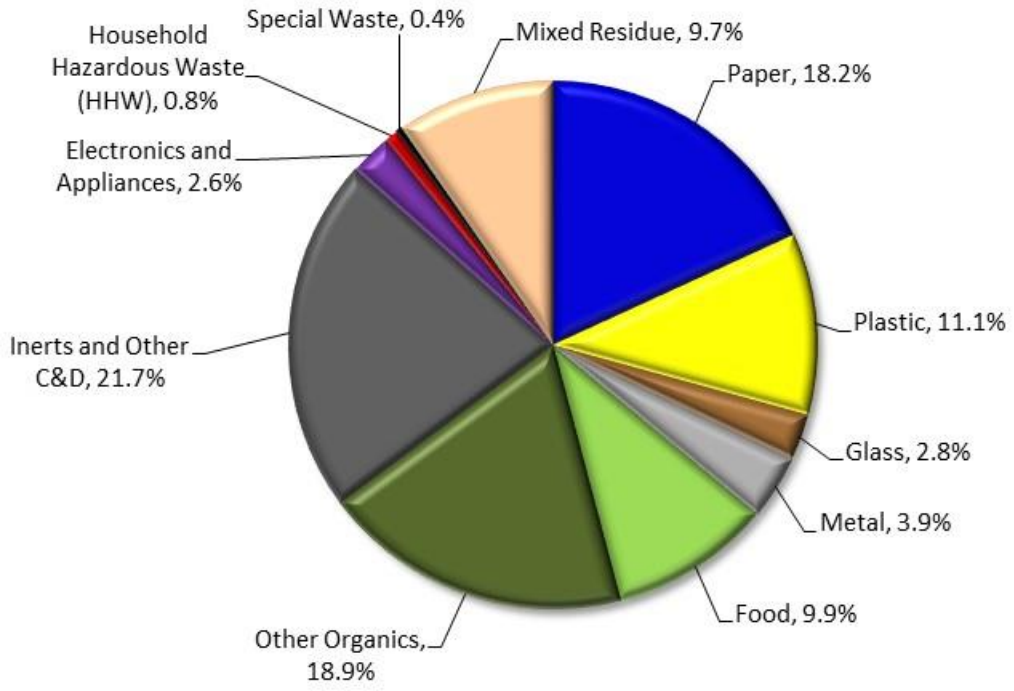
Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

County Transfer Station Waste Composition

The project team hand-sorted 81 samples of waste from the County Transfer Station substream. The samples collected from this substream are waste that the County refuse collection trucks, individual residents, and small businesses not in the business of hauling waste deliver to one of the County's four Transfer Stations. This material stream also includes waste from County refuse collection trucks that deliver material directly to the Kekaha Landfill. **The majority of the material in this stream is from residential sources.**

As shown in Figure 5, 21.7% of the County Transfer Station waste substream is **Inerts and Other C&D**. **Other Organics** made up 18.9% of the substream, followed by **Paper** (18.2%), **Plastic** (11.1%), and **Food** (9.9%).

Figure 5. Composition by Material Class, County Transfer Station Waste, 2016



The ten most prevalent materials can be found in Table 9. As shown, *mixed residue* (9.7%)*, leaves and grass* (7.2%), and *other wood waste* (5.3%) are the three most prevalent material types; together they represent 22.2% of the County Transfer Station waste substream.

Table 9 and Table 10 provide data about percent composition by material type, as well as tonnage estimates by material type, for County transfer station waste. Cascadia arrived at these tonnage estimates by applying fiscal year 2016 tonnage provided by the County of Kaua'i (41,416 tons for County transfer station waste) to the percent compositions listed in both tables. For example, as shown in Table 9, *mixed residue* makes up an estimated 9.7% of the County transfer station waste stream. Applying this 9.7% estimate to the overall tonnage figure of 41,416 results in the estimate of 3,998 tons attributed to *mixed residue*.

The figure 41,416 tons includes County-hauled waste delivering directly to Kekaha Landfill; and Lihue, Hanalei, Kapa'a, and Hanapepe transfer station materials hauled to Kekaha Landfill in transfer trailers. The analytical calculations are detailed in Appendix C: Waste Characterization Calculations.

Table 9. Ten Most Prevalent Material Types, County Transfer Station Waste, 2016

Material	Estimated Percent	Cumulative Percent	Estimated Tons
Mixed Residue	9.7%	9.7%	3,998
Leaves and Grass	7.2%	16.8%	2,970
Other Wood Waste	5.3%	22.2%	2,214
Uncoated Corrugated Cardboard	4.4%	26.6%	1,840
Non-Recyclable Film Plastic	4.4%	31.0%	1,831
Textiles	4.4%	35.4%	1,810
Compostable Paper	4.3%	39.7%	1,787
Mixed Paper	4.3%	44.0%	1,773
Non-Recyclable Organic	4.0%	48.0%	1,675
Unpackaged Food - Non-Meat	3.6%	51.7%	1,501
Subtotal	***51.7%***		***21,399***
All other materials	48.3%		20,017
Total	**100.0%**		**41,416**

The detailed composition of the County Transfer Station waste substream is shown in Table 10.

Table 10. Detailed Composition, County Transfer Station Waste, 2016

Material	Estimated Percent	Estimated Tons	Material	Estimated Percent	Estimated Tons
Paper	**18.2%**	**7,533**	**Other Organics**	**18.9%**	**7,846**
Uncoated Corrugated Cardboard	4.4%	1,840	Leaves and Grass	7.2%	2,970
Kraft Paper Bags	1.4%	577	Prunings and Trimmings	2.3%	956
Newspaper	0.9%	358	Branches and Stumps	0.1%	27
White Ledger Paper	1.0%	395	Manures	0.0%	0
Mixed Paper	4.3%	1,773	Textiles	4.4%	1,810
Aseptic and Gable Top Containers	0.3%	130	Carpet	1.0%	408
Compostable Paper	4.3%	1,787	Sewage Sludge	0.0%	0
Non-Recyclable Paper	1.6%	673	Non-Recyclable Organic	4.0%	1,675
Plastic	**11.1%**	**4,584**	**Inerts and Other C&D**	**21.7%**	**8,986**
PETE Containers - HI-5	0.4%	155	Concrete	2.2%	920
PETE Containers - Non-HI-5	0.3%	128	Asphalt Paving	0.0%	0
HDPE Containers - HI-5	0.2%	63	Asphalt Roofing	2.5%	1,029
HDPE Containers - Non-HI-5	0.6%	237	Clean Lumber	3.1%	1,268
Plastic Containers #3-#7	1.1%	456	Treated Lumber	3.0%	1,256
Plastic Grocery and Other Merchandise Bags	0.0%	14	Other Wood Waste	5.3%	2,214
Agricultural Film Plastic	0.0%	19	Gypsum Board	1.5%	617
Other Clean Film	0.2%	66	Rock, Soil and Fines	2.9%	1,211
Non-Recyclable Film Plastic	4.4%	1,831	Non-Recyclable Inerts and Other	1.1%	471
Durable Plastic Items	1.6%	649			
Expanded Polystyrene Food Serviceware	0.6%	230	**Electronics and Appliances**	**2.6%**	**1,066**
Other Expanded Polystyrene	0.2%	70	Covered Electronic Devices	0.2%	74
Non-Recyclable Plastic	1.6%	667	Non-Covered Electronic Devices	0.8%	324
			Major Appliances	0.0%	0
Glass	**2.8%**	**1,165**	Small Appliances	1.6%	668
Glass Bottles and Containers - HI-5	0.9%	383			
Glass Bottles and Containers - Non-HI-5	1.2%	492	**Household Hazardous Waste (HHW)**	**0.8%**	**338**
Non-Recyclable Glass	0.7%	290	Paint	0.1%	33
			Empty Aerosol Containers	0.1%	37
Metal	**3.9%**	**1,624**	Vehicle and Equipment Fluids	0.0%	0
Tin/Steel Cans	0.7%	281	Used Oil	0.0%	2
Bi-Metal Cans HI-5	0.1%	36	Batteries	0.2%	96
Other Ferrous	1.4%	584	Mercury-Containing Items - Not Lamps	0.0%	0
Aluminum Cans - HI-5	0.3%	126	Lamps - Fluorescent and LED	0.0%	7
Aluminum Cans - Non-HI-5	0.1%	54	Remainder/Composite Household Hazardous	0.4%	164
Other Non-Ferrous	0.5%	218			
Remainder/Composite Metal	0.8%	325	**Special Waste**	**0.4%**	**172**
			Ash	0.3%	130
Food	**9.9%**	**4,104**	Treated Medical Waste	0.0%	4
Retail Packaged Food - Meat	0.7%	286	Bulky Items	0.1%	34
Retail Packaged Food - Non-Meat	2.8%	1,177	Tires	0.0%	3
Unpackaged Food - Meat	0.7%	287	Remainder/Composite Special Waste	0.0%	0
Other Packaged Food - Meat	0.7%	298			
Unpackaged Food - Non-Meat	3.6%	1,501	**Mixed Residue**	**9.7%**	**3,998**
Other Packaged Food - Non-Meat	1.3%	554	Mixed Residue	9.7%	3,998
			Totals	**100.0%**	**41,416**
			Samples	**81**	

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

Appendix A: Material Type Definitions

Cascadia sorted each sample from the 2016 County of Kaua'i Waste Characterization Study into the categories named and defined below.

Paper

1. **Uncoated Corrugated Cardboard** means old unwaxed/uncoated corrugated container (OCC) boxes. Corrugated cardboard means a paper laminate usually composed of three layers. The center wavy layer is sandwiched between the two outer layers. It does not have any wax coating on the inside or outside. Examples include entire cardboard containers, such as shipping and moving boxes, computer packaging cartons, and sheets and pieces of boxes and cartons. This type also includes very clean (no food residue and only lightly stained) pizza boxes.

2. **Kraft Paper Bags** means bags and sheets made from kraft paper. Kraft paper bags are bags and sheets made from kraft paper. The paper may be brown (unbleached) or white (bleached). Examples include paper grocery bags, clean fast food bags, department store bags, and heavyweight sheets of kraft packing paper.

3. **Newspaper** means paper used in newspapers. Examples include newspaper and glossy inserts found in newspapers, and all items made from newsprint, such as free advertising guides, election guides, plain news packing paper, stapled college schedules of classes, and tax instruction booklets.

4. **White Ledger Paper** means bleached, uncolored bond, rag, or stationery grade paper, without ground wood fibers. It may have colored ink on it. When the paper is torn, the fibers are white. Examples include white paper used in photocopiers and laser printers, and letter paper.

5. **Mixed Paper** means other types of recyclable paper. This type includes other office paper like colored ledger, computer paper, manila folders, manila envelopes, index cards, white envelopes, white window envelopes, white or colored notebook paper, ground wood computer paper, junk mail, and carbonless forms. This type also includes magazines, catalogs, whole or damaged phone books, and other miscellaneous types of mixed paper, like cereal and cracker boxes, unused paper plates and cups, frozen food boxes, self-adhesive notes, and hard cover and soft cover books.

6. **Aseptic and Gable Top Containers** means aseptic and gable top cartons. Aseptic containers means multi-layered packaging that contains shelf-stable food products such as apple juice, soup, soy/rice milk, etc. "Gable top" cartons means cartons with a gable top used to contain non-refrigerated items such as granola and crackers and refrigerated items such as milk, juice, egg substitutes, etc.

7. **Compostable Paper** means items made mostly of paper that could be composted, that do not fit into any of the other paper types. Paper may be combined with minor amounts of other materials such as wax or glues. Examples include pulp paper egg cartons, unused pulp paper plant pots, molded paper packing materials, some berry trays, some take-out food containers, dirty molded

paper plates, waxed corrugated cardboard, waxed paper, napkins, tissue, paper towels, fast food wrappers, food-soiled paper and moisture-soiled paper, all pizza boxes (unless at least 95 percent clean), and shredded paper.

8. **Non-Recyclable Paper** means items made mostly of paper but combined with large amounts of other materials. These are items that do not fit into any other categories, are not generally compostable or recyclable, and are not food and beverage cartons. Examples include blueprints, sepia, carbon paper, photographs, paper frozen juice cans, ice cream cartons, and sheets of paper stick-on labels, and paper mailing envelopes lined with bubble wrap or plastic.

Glass

9. **Glass Bottles and Containers – HI-5** means glass beverage containers that display the HI-5 notification. Examples include whole or broken clear and colored soda, beer, and fruit juice bottles, and whole or broken wine cooler bottles.

10. **Glass Bottles and Containers – Non-HI-5** means glass containers that do not display the HI-5 notification. Examples include wine bottles, mayonnaise jars, and jam jars.

11. **Non-Recyclable Glass** means glass that cannot be put in any other type, and items made mostly of glass but combined with other materials. Examples include Pyrex, Corningware, crystal and other glass tableware, mirrors, non-fluorescent light bulbs, auto windshields, laminated glass, glass window panes, doors and table tops, flat automotive window glass (side windows), safety glass, and architectural glass.

Metal

12. **Tin/Steel Cans** means rigid containers made mainly of steel. These items will stick to a magnet and may be tin-coated. These are used to store food, beverages, paint, and a variety of other household and consumer products. Examples include canned food and beverage containers, and bimetal containers with steel sides and aluminum ends.

13. **Bi-Metal Cans – HI-5** means any beverage container that is made of a combination of steel and aluminum that displays the HI-5 notification. Examples include coconut water, coffee, tea, or alcohol.

14. **Other Ferrous** means any iron or steel that is magnetic or any stainless steel item. This type does not include tin/steel cans. Examples include structural steel beams, metal clothes hangers, metal pipes, stainless steel cookware, security bars, used oil filters, empty metal paint cans, and scrap ferrous items.

15. **Aluminum Cans – HI-5** means any or beverage container that is made mainly of aluminum and that displays the HI-5 notification. Examples include containers for soda, water, juice, coffee, tea, or alcohol. Dairy containers do not pay a deposit and are not included in this material type.

16. **Aluminum Cans – Non-HI-5** means any food or beverage container that is made mainly of aluminum and that does not display the HI-5 notification. Examples include some pet food and meat cans, and cans that have contained dairy.

17. **Other Non-Ferrous** means any metal item, other than aluminum cans, that is not stainless steel and that is not magnetic. These items may be made of aluminum, copper, brass, bronze, lead, zinc, or other metals. Examples include aluminum window frames, aluminum siding, copper wire, shell casings, brass pipe, and aluminum foil.

18. **Remainder/Composite Metal** means metal that cannot be put in any other type, specifically items that are metal combined with other materials, containing less than 50% metal. This type includes items made mostly of metal but combined with other materials Examples include motors, insulated wire, and finished products that contain a mixture of metals, or metals and other materials, whose weight is derived significantly from the metal portion of its construction.

Electronics and Appliances

19. **Covered Electronic Devices** are electronics covered under the State of Hawai'i Electronic Waste and Television Recycling and Recovery Law which requires manufacturer responsibility for recycling specified items**.** Electronic devices covered under this law include: all computers, computer printers, computer monitors, and portable computers with screen size greater than four inches measured diagonally. Televisions covered under this law include devices that are capable of receiving broadcast, cable, or satellite signals and displaying television or video programming. Including, without limitation, any direct view or projection televisions with viewable screen sizes of nine inches or larger with display technology based on cathode ray tube, plasma, liquid crystal on silicon, silicon crystal reflective display, light emitting diode, or similar technology.[4]

20. **Non-Covered Electronic Devices** are electronics that are not covered under the State of Hawai'i Electronic Waste and Television Recycling and Recovery Law. Electronics in this category include: personal digital assistants (PDA), cell phones, phone systems, phone answering machines, computer games and other electronic toys, portable CD players, camcorders, digital cameras, cell phone chargers and other electronic device chargers, and other electronic devices. Other examples include stereos, VCRs, DVD players, large radios, keyboards, and mice.

21. **Major Appliances** means discarded major appliances of any color. These items are often enamel-coated. Examples include washing machines, clothes dryers, hot water heaters, stoves, and refrigerators. This type does not include electronics, such as televisions and stereos.

22. **Small Appliances** means all small non-electronics appliances such as toasters, hair dryers, coffee makers, hair dryers, fans, and vacuum cleaners.

[4] http://health.hawaii.gov/ewaste/files/2013/06/consumer.pdf

Plastic

23. **PETE Containers – HI-5** means clear or colored PET beverage containers that display the HI-5 notification. When marked for identification, it bears the number "1" in the center of the triangular recycling symbol and may also bear the letters "PETE" or "PET." The color is usually transparent green or clear. A PET container usually has a small dot left from the manufacturing process, not a seam. It does not turn white when bent. Examples include soda, beer, juice and water bottles.

24. **PETE Containers – Non-HI-5** means clear or colored PET containers that do not display the HI-5 notification. When marked for identification, it bears the number "1" in the center of the triangular recycling symbol and may also bear the letters "PETE" or "PET." The color is usually transparent green or clear. A PET container usually has a small dot left from the manufacturing process, not a seam. It does not turn white when bent. Examples include non-HI-5 juice or water bottles, some liquor bottles, cooking oil containers, food jars, pastry jars, frozen food or other trays, clamshell packaging, and aspirin bottles.

25. **HDPE Containers – HI-5** means natural and colored HDPE beverage containers that display the HI-5 notification. This plastic is usually either cloudy white, allowing light to pass through it (natural) or a solid color, preventing light from passing through it (colored). When marked for identification, it bears the number “2” in the triangular recycling symbol and may also bear the letters “HDPE.” Examples include some small juice bottles.

26. **HDPE Containers – Non-HI-5** means natural and colored HDPE containers that do not display the HI-5 notification. This plastic is usually either cloudy white, allowing light to pass through it (natural) or a solid color, preventing light from passing through it (colored). When marked for identification, it bears the number “2” in the triangular recycling symbol and may also bear the letters “HDPE.” Examples include milk jugs, detergent bottles, some hair-care bottles, some margarine and yogurt tubs, clamshell packaging, empty motor oil, empty antifreeze, and other empty vehicle and equipment fluid containers.

27. **Plastic Containers #3-#7** means plastic containers that do not display the HI-5 notification that are made of types of plastic other than HDPE or PET. Items may be made of PVC, PP, or PS. When marked for identification, these items may bear the number “3,” “4,” “5,” “6,” or “7” in the triangular recycling symbol. This subtype also includes plastic containers that do not have the triangular recycling symbol. Examples include hardware and fastener packaging, food containers such as bottles for salad dressings and vegetable oils, flexible and brittle yogurt cups, syrup bottles, margarine tubs, microwave food trays, and clamshell-shaped fast food containers. This type also includes some shampoo containers, vitamin bottles, foam egg cartons, and clamshell-like muffin containers.

28. **Plastic Grocery and Other Merchandise Bags** means plastic shopping bags used to contain merchandise to transport from the place of purchase, given out by the store with the purchase. This type includes dry cleaning bags intended for one-time use. Does not include produce bags.

29. **Agricultural Film Plastic** means film plastics used in various farming and growing applications, such as silage greenhouse films, mulch films, and wrap for hay bales. This material is being recycled in Kaua'i.

30. **Other Clean Film** includes clean film plastic used for large-scale packaging or transport packaging, like shrink-wrap, mattress bags, furniture wrap, and film bubble wrap.

31. **Non-Recyclable Film Plastic** means dirty film in any film category and film plastic that is typically non-recyclable. Examples include plastic sheeting used as drop cloths, and building wrap. Other materials in this category include plastic bags sold for use as trash bags, for both residential and commercial use, including garbage, kitchen, compactor, can-liner, composting, yard, lawn, leaf, and recycling bags. This category also includes plastic pouches made of thicker, multi-layer flexible material, thicker than potato chip bags and frozen vegetable bags; plastic coffee bags like Starbucks and Peets; Capri Sun pouches; baby food pouches – may have plastic screw top; soup pouches; salad dressing pouches; wine pouches; backpacking meals in pouches; soap refill pouches; laundry detergent pouches; and other similar items. Finally, this category includes other types of plastic bags (sandwich bags, zipper-recloseable bags, newspaper bags, produce bags, frozen vegetable bags, bread bags), food wrappers such as candy-bar wrappers, potato chip bags, mailing pouches, bank bags, X-ray film, metallized film (such as balloons), and plastic food wrap

32. **Durable Plastic Items** means plastic items other than containers or film plastic, that are large (generally larger than a soccer ball) rigid plastic bulky items. These items are made to last for more than one use. Examples include: crates, buckets (including 5-gallon buckets), baskets, totes, large plastic garbage cans, large tubs, large storage tubs/bins (usually with lids) that don't have sharp corners, flexible (non-brittle) flower pots of 1 gallon size or larger, lawn furniture, large plastic toys, tool boxes, first aid boxes, and some sporting goods. Examples include CDs, plastic housewares such as dishes, cups, and cutlery. This type also includes building materials such as house siding, window sashes and frames, housings for electronics such as computers, televisions and stereos, fan blades, and plastic pipes and fittings.

33. **Expanded Polystyrene Food Serviceware** means materials used for eating and drinking that are made of expanded polystyrene (EPS). Examples include EPS drinking cups, plates, and bowls.

34. **Other Expanded Polystyrene** is materials made of expanded polystyrene (EPS) that is not used for eating and drinking directly. Examples include foam meat and pastry trays, foam packing blocks, and foam packing peanuts.

35. **Non-Recyclable Plastic** means plastic that cannot be put in any other type. These items are usually recognized by their optical opacity. This type includes items made mostly of plastic but combined

with other materials. Examples include auto parts made of plastic attached to metal, plastic drinking straws, cookie trays found in cookie packages, plastic strapping, plastic lids, some kitchen ware, some toys, window blinds, plastic lumber, insulating foam, imitation ceramics, handles and knobs, plastic string (such as used for hay bales), plastic rigid bubble/foil packaging (as for medications), small (less than 1 gal) plant containers such as nursery pots and plant six-packs, and new Formica, new vinyl, or new linoleum.

Food

Food means food material resulting from the processing, storage, preparation, cooking, handling, or consumption of food. This type includes material from industrial, commercial, or residential sources. Examples include discarded meat scraps, dairy products, egg shells, fruit or vegetable peels, and other food items from homes, stores, and restaurants. This type includes grape pomace and other processed residues or material from canneries, wineries, or other industrial sources.

Packaged Food means any food described in the definition of food in the above list that is enclosed in glass, plastic, paper, or other original packaging as sold or distributed.

36. **Retail Packaged Food – Meat** means any meat that is packaged. Meat includes any poultry, pork, beef, veal, fish, or other flesh of an animal consumed as food, including composite meat products like hot dogs.
37. **Retail Packaged Food – Non-Meat** means any non-meat food that is packaged. Non-meat includes all food that is not meat.

Unpackaged Food means any food described in the definition of **Food** in the above list that is **not** enclosed in glass, plastic, paper, or other original packaging as sold or distributed.

Unpackaged Food – Meat means any meat that is **not** packaged. Meat includes any poultry, pork, beef, veal, fish, or other flesh of an animal used as food, including composite meat products like hot dogs.

38. **Unpackaged Food – Meat** means any unpackaged meat that is not contaminated with material (including paper, glass, plastic, and all other non-food materials) that is not other food.
39. **Other Packaged Food– Meat** means any unpackaged meat that is contaminated with material (including paper, glass, plastic, and all other non-food materials) that is not other food. This includes any meat in packaging that it was not originally sold or distributed in, such as Ziploc bags or Tupperware.

Unpackaged Food – Non-Meat means any non-meat food that is packaged. Non-meat includes all food that is not meat.

40. **Unpackaged Food – Non-Meat** means any unpackaged non-meat that is not contaminated with material (including paper, glass, plastic, and all other non-food materials) that is not other food.

41. **Other Packaged Food – Non-Meat** means any unpackaged non-meat that **is** contaminated with material (including paper, glass, plastic, and all other non-food materials) that is not other food. This includes any non-meat in packaging that it was not originally sold or distributed in, such as Ziploc bags or Tupperware.

Other Organics

42. **Leaves and Grass** means plant material, except woody material, from any public or private landscape. Examples include leaves, grass clippings, plants, and seaweed. This type does not include woody material or material from agricultural sources.

43. **Prunings and Trimmings** means woody plant material up to 4 inches in diameter from any public or private landscape. Examples include prunings, shrubs, and small branches with branch diameters that do not exceed 4 inches. This type does not include stumps, tree trunks, branches exceeding 4 inches in diameter, or material from agricultural sources.

44. **Branches and Stumps** means woody plant material, branches, and stumps that exceed 4 inches in diameter, from any public or private landscape.

45. **Manures** means manure and soiled bedding materials from large domestic, farm, or ranch animals. Examples include manure and soiled bedding from animal production operations, race tracks, riding stables, animal hospitals, and other sources. Does not include feces from small household pets such as dogs and cats.

46. **Textiles** means items made of thread, yarn, fabric, or cloth. Examples include clothes, fabric trimmings, draperies, and all natural and synthetic cloth fibers. This type does not include cloth covered furniture, mattresses, leather shoes, leather bags, or leather belts.

47. **Carpet** means flooring applications consisting of various natural or synthetic fibers bonded to some type of backing material. This type does not include carpet padding or woven rugs with no backing.

48. **Non-Recyclable Organic** means organic material that cannot be put in any other type. This type includes items made mostly of organic materials, but combined with other material types. Examples include leather items, cork, hemp rope, garden hoses, rubber items, hair, carpet padding, cigarette butts, diapers, feminine hygiene products, small wood products (such as Popsicle sticks and tooth picks), sawdust, agricultural crop residues, and animal feces from small household pets such as dogs and cats.

Inerts and Other C&D

49. **Concrete** means a hard material made from sand, aggregate, gravel, cement mix and water. Examples include pieces of building foundations, concrete paving, and concrete/cinder blocks. This category includes concrete with a steel internal structure composed of reinforcing bars (re-bar) or metal mesh.

50. **Asphalt Paving** means a black or brown, tar-like material mixed with aggregate used as a paving material.

51. **Asphalt Roofing** means composite shingles and other roofing material made with asphalt. Examples include asphalt shingles and attached roofing tar and tar paper.

52. **Clean Lumber** means unpainted new or demolition dimensional lumber, engineered wood, or pallets/crates. This includes materials such as 2 x 4s, 2 x 6s, 2 x 12s, plywood, particleboard, wafer board, oriented strand board, wood pallets, crates, and packaging made of lumber/engineered wood, and residual materials from framing and related construction activities. May contain nails or other trace contaminants.

53. **Treated Lumber** means lumber treated with a chemical preservative for protection against pests and environmental conditions. Includes all lumber types discussed in the **Clean Lumber** category, but treated with creosote, arsenic, chromium, copper, or pentachlorophenol – typically identified by "staple marks" by which chemical was injected into the wood, a characteristic green color, and/or presence of obvious crystals. Also includes painted or stained lumber.

54. **Other Wood Waste** means wood waste that cannot be put into any other material type. This type may include untreated/unpainted scrap from production of prefabricated wood products such as wood furniture or cabinets, and untreated or unpainted wood roofing and siding.

55. **Gypsum Board** means interior wall covering made of a sheet of gypsum sandwiched between paper layers. Examples include used or unused, broken or whole sheets. Gypsum board may also be called sheetrock, drywall, plasterboard, gypboard, gyproc, or wallboard. Includes painted gypsum board.

56. **Rock, Soil, and Fines** means rock pieces of any size and soil, dirt, and other matter. Examples include rock, stones, sand, clay, soil and other fines. This type also includes non-hazardous contaminated soil.

57. **Non-Recyclable Inerts and Other** means inerts and other material that cannot be put in any other type. This type may include items from different types combined, which would be very hard to separate. Examples include brick, ceramics, tiles, toilets, sinks, dried paint not attached to other materials, and fiberglass insulation. This type may also include demolition debris that is a mixture of items such as plate glass, wood, tiles, gypsum board, synthetic counter tops, fiber or composite acoustic ceiling tiles, and aluminum scrap.

Household Hazardous Waste (HHW)

58. **Paint** means containers with paint in them. Examples include latex paint, oil based paint, and tubes of pigment or fine art paint. This type does not include dried paint, empty paint cans, or empty aerosol containers.

59. **Empty Aerosol Containers** means empty spray paint and other aerosol containers, where the contents of the containers are under pressure.

60. **Vehicle and Equipment Fluids** means containers with fluids used in vehicles or engines, except used oil. Examples include used antifreeze and brake fluid. This type does not include empty vehicle and equipment fluid containers.

61. **Used Oil** means the same as defined in Health and Safety Code section 25250.1(a). Examples include spent lubricating oil such as crankcase and transmission oil, gear oil, and hydraulic oil.

62. **Batteries** means any type of battery including both dry cell, rechargeable, and lead acid. Examples include car, flashlight, small appliance, watch, and hearing aid batteries.

63. **Mercury-Containing Items - Not Lamps** means items other than lamps that are readily identifiable as containing mercury such as thermostats and thermometers.

64. **Lamps - Fluorescent and LED** means both compact and tube-style fluorescent lights, and LED lights.

65. **Remainder/Composite Household Hazardous** means household hazardous material that cannot be put in any other type. This type also includes household hazardous material that is mixed. Examples include household hazardous waste which if improperly put in the solid waste stream may present handling problems or other hazards, such as pesticides and caustic cleaners; sharps (needles), medications, and supplements.

Special Waste

66. **Ash** means a residue from the combustion of any solid or liquid material. Examples include ash from fireplaces, incinerators, biomass facilities, waste-to-energy facilities, and barbecues. This type also includes ash and burned debris from structure fires.

67. **Treated Medical Waste** means medical waste that has been processed in order to change its physical, chemical, or biological character or composition, or to remove or reduce its harmful properties or characteristics, as defined in Section 25123.5 of the Health and Safety Code.

68. **Bulky Items** means large hard to handle items that are not defined elsewhere in the material types list, including furniture, mattresses, and other large items. Examples include all sizes and types of furniture, box springs, and base components.

69. **Tires** means vehicle tires. Tires may be pneumatic or solid. Examples include tires from trucks, automobiles, motorcycles, heavy equipment, lawn mowers, and bicycles.

70. **Remainder/Composite Special Waste** means special waste that cannot be put in any other type. Examples include asbestos-containing materials such as certain types of pipe insulation and floor

tiles, auto fluff, auto bodies, trucks, trailers, truck cabs, untreated medical waste (such as tubes, oxygen masks, medical instruments), and artificial fireplace logs.

Mixed Residue

71. **Mixed Residue** means material that cannot be put in any other type or category. This category includes mixed residue that cannot be further sorted. Examples include clumping kitty litter, cosmetics, partially filled containers of non-food consumer products, and residual material from a materials recovery facility or other sorting process that cannot be put in any other material type, including remainder/composite types. This material type also includes "fines," materials from any other material category that are less than 2 inches in diameter.

Appendix B: Detailed Study Design

This appendix includes the study design **as it was written prior to beginning field work**.

Study Objectives

The County of Kaua'i is conducting the 2016 Waste Characterization Study to collect reliable data about the waste from the County of Kaua'i that is currently disposed at the Kekaha Landfill. This study will involve the characterization of waste that Private haulers collect from commercial accounts, materials that the County collects from residential accounts, and materials that residents and others drop off at transfer stations. The study will use consistent sampling procedures, sample sizes, material types, and data management processes to ensure that resulting data are representative and meaningful for long term planning.

Cascadia has identified the subtreams and number and allocation of samples necessary to support this study and yield results to best serve the County of Kaua'i. The sections that follow define the substreams that the study will include, and the number and allocation of samples between each substream.

Sampling Universe and Substreams

The first step in planning a waste characterization study is to identify and carefully define the waste streams that will be studied, or the "universe" of waste. In this study, the universe includes two substreams that our field team will characterize. A "substream" is determined by the particular generation, collection, or composition characteristics that make it a unique portion of the total waste stream.

In this study, Cascadia will characterize the following two substreams using a hand sort methodology:

- **Private Commercial** — waste primarily from institutional, commercial, or industrial sources that private waste hauling companies deliver to Kekaha Landfill. This material stream includes loads of municipal solid waste (MSW) as well as construction and demolition (C&D) materials.
- **County Transfer Station** — waste that the County refuse collection trucks, individual residents, and small businesses not in the business of hauling waste deliver to one of the County's four Transfer Stations. This material stream includes all boxes that the County delivers to the Kekaha Landfill from its four Transfer Stations, as well as County refuse collection trucks that deliver material directly to the Kekaha Landfill.

Sampling Calendar and Substream Allocations

Cascadia will conduct the characterization study over two seasons in order to capture differences in seasonal generation trends. Sampling for the first season will begin on July 26, 2016, and will last every weekday through August 4, 2016 and Saturday, July 30th. Sampling for the second season will begin on September 27, 2016, and will last every weekday through October 6th, 2016, and Saturday, October 1st.

In each season, our field crew will sample and sort a total of 75 to 85 samples over eight days, split evenly between the two substreams. We will plan to capture 85 samples per season, but allow for ranges to accommodate circumstances beyond our control, like truck breakdowns, fewer loads arriving than usual, etc. Our sampling plan is summarized in Table 1 below.

Table 11: Sample Allocation by Substream and Season

Substream	High Visitor Season July-August 2016	Low Visitor Season Sept-Oct 2016	Total Samples
Private Commercial (hand sort)	38-43	37-42	75-85
County Transfer Station (hand sort)	37-42	38-43	75-85
Total	**75-85**	**75-85**	**150-170**

Obtaining and Sorting Samples

This section describes Cascadia's approach to obtaining and sorting samples for the County of Kaua'i 2016 Waste Characterization Study.

Load Selection

The first step in obtaining samples is to construct a random selection protocol for loads. For this study, we will select all loads using a systematic selection methodology (selecting every n^{th} vehicle) at the landfill on each day of field work for the study.

The Cascadia team will use a systematic selection method to randomly select individual vehicles from each stream for sampling. The systematic selection method ensures that the mix of sampled vehicles is representative of the private commercial and transfer station box loads delivered to the landfill. We use the total number of loads arriving at the facility (based on historical data provided by landfill staff) to establish a "sampling frequency" for each day of sampling at each site. The sampling frequency is calculated by dividing the total expected number of loads for each sector by the target number of samples to determine which vehicles must be sampled—such as every third vehicle, every sixth vehicle, or every 20^{th} vehicle. This strategy is referred to as "selecting every n^{th} vehicle." The *Vehicle Selection Forms* are used to clearly communicate the sampling frequency required for each day at the Kekaha Landfill.

Cascadia will train Kekaha landfill staff on the vehicle selection strategy. The landfill staff will be responsible for selecting vehicles for samples, with instructional support from Cascadia staff as needed.

Cascadia has calculated daily sampling quotas and frequencies based on data that the County of Kaua'I provided about the average number of loads arriving at the Kekaha Landfill, backed up by the annual number of tons arriving at the Kekaha Landfill each day. These sampling quotas and frequencies are detailed in the tables below. Note that the substreams listed in these tables are more detailed than those listed at the beginning of this design. This is because we need sampling quotas and frequencies for these more detailed substreams to weight them appropriately in our analysis.

Table 12. Daily Sampling Quotas by Substream, Season 1

Substream	7/26	7/27	7/28	7/29	7/30	8/1	8/2	8/3	8/4	TOTAL
Privately Hauled Commercial Waste Delivered to Kekaha Landfill	5	5	5	5	5	5	5	5	N/A – will be a day off unless catch up needed	40
County Hauled Waste Delivering Directly to Kekaha Landfill – Parks waste and household refuse collection from Kekaha on Mondays and Tuesdays[5]	1	0	1	1	0	1	0	0	N/A – will be a day off unless catch up needed	4
Līhu'e Transfer Station Material Delivered to Kekaha Landfill	1	2	1	1	2	1	2	2	N/A – will be a day off unless catch up needed	12
Hanalei Transfer Station Material Delivered to Kekaha Landfill	1	1	1	1	1	1	1	1	N/A – will be a day off unless catch up needed	8
Kapa'a Transfer Station Material Delivered to Kekaha Landfill	1	1	1	1	1	1	1	1	N/A – will be a day off unless catch up needed	8
Hanapēpē Transfer Station Material Delivered to Kekaha Landfill	1	1	1	1	1	1	1	1	N/A – will be a day off unless catch up needed	8
TOTAL	10	10	10	10	10	10	10	10	0	80

The table that follows includes sampling frequencies for each substream. The systematic sampling strategy that Cascadia will use for this study calls for "selecting every n^{th} vehicle." In the table below, where n=1, Cascadia will select the first vehicle in the substream that arrives at the landfill each day.

[5] Cascadia will take the Kekaha parks/household refuse loads on 7/26 and 8/1, and other County hauled loads on 7/28 and 7/29.

Where n=4 (for the Privately Hauled Commercial Waste substream), Cascadia will select the 4th, 8th, 12th, 16th, and 20th vehicle entering the Kekaha Landfill each day.

We will assemble vehicle selection sheets for Kekaha Landfill staff to guide them through sample collection using these sampling frequencies.

Table 13. Sampling Frequencies by Substream, Season 1 and Season 2

Substream	n=
Privately Hauled Commercial Waste Delivered to Kekaha Landfill	4
County Hauled Waste Delivering Directly to Kekaha Landfill – Parks waste and household refuse collection from Kekaha on Mondays and Tuesdays	1
Līhu'e Transfer Station Material Delivered to Kekaha Landfill	1st and 2nd load, on days when sampling quota is 2
Hanalei Transfer Station Material Delivered to Kekaha Landfill	1
Kapa'a Transfer Station Material Delivered to Kekaha Landfill	1
Hanapēpē Transfer Station Material Delivered to Kekaha Landfill	1

Sorting and Sampling Procedures

Cascadia staff will hand sort all samples selected for this study using the methods outlined below. Cascadia's health and safety plan to ensure that our field workers and the people that we interact with during this study are safe is included in Cascadia's Health and Safety Plan.

Collect Samples from Selected Vehicles

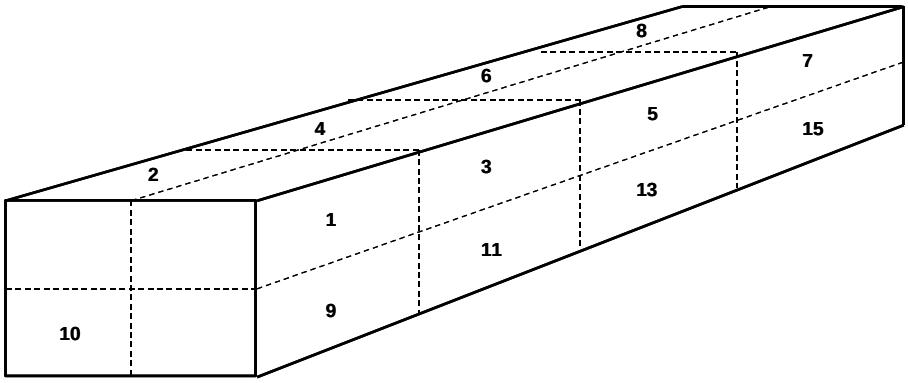
The Cascadia field crew will extract 200 to 250-pound samples from selected commercial and transfer station box loads for sorting at Kekaha Landfill. Since only a few transfer station box loads are expected to arrive at the landfill from each transfer station each day, we will select up to four samples from each transfer station box.

Our field crew will work with the driver of each vehicle and the loader operator at the landfill to secure a sample from each selected load by extracting a randomly-selected portion from the tipped load using the following procedure:

1. Once the vehicle arrives at the area designated for sorting during the study, the Field Manager will verify the vehicle load's description, interview the driver to collect any additional

information that may be required (this interview is short, 10-20 seconds at most), and direct the driver to a pre-determined location to dump their load.

2. The vehicle driver will dump the selected load in an elongated pile. The Sampling Manager will select a sample from this pile using an imaginary 16-cell grid (shown below) superimposed over the dumped material. The Sampling Manager will use a randomly-generated number (1-16) that is pre-printed on the S*ample Placard* to determine from which cell to extract a sample.



3. The Kekaha Landfill loader operator will extract a sample from the selected cell under direction from the Sampling Manager, and will deposit the sample on a clean tarp for sorting.

Hand Sort Procedure

The Cascadia field crew will hand sort all samples for this study. Our process for hand-sorting waste includes the following steps:

1. A member of the field crew will take photographs of the sample using a digital camera. The *Sample Placard* identifying the sample will be positioned to be visible in each photo.
2. The field crew will sort the sample into the material types and store separated materials in plastic laundry baskets. Individual members of the sorting crew typically specialize in groups of materials, such as papers or plastics. The crew manager will monitor the homogeneity of material in the baskets as they accumulate, rejecting any materials that are improperly classified. The material list and definitions that will guide this sorting are presented in Appendix A: Material Type Definitions.
3. The Field Manager will then visually inspect the purity of each material as it is weighed in its basket using a pre-calibrated scale, and will record each material weight on the *Material Weight Tally Sheet*.

Contacts and Communication Protocol

Allison Fraley (Kaua'i side) and Jessica Coe (Cascadia side) will be primary point of contact for formal communications, documents data needs, etc. Cascadia's Field Manager (Stefan Moedritzer for the first season and Jessica Coe for the second season) will be primary point of contact for field work needs.

If anything happens onsite at the Kekaha Landfill that the Cascadia team needs assistance with, Cascadia's Field Manager will contact John, John, or Ian for assistance first, and then follow up with Allison later to keep her in the loop. The issues that we might contact John or John for include:

- Coordinating the site visit on July 25th 2016.
- If trucks aren't coming.
- If we need to get into the facility outside of our regular schedule for any reason.
- If there is an emergency.

John and John will lend the Cascadia team a radio for ease of communication with the whole team, including the loader and scalehouse personnel.

Cascadia will sign in and sign out at the Waste Management offices every day.

The following contact list captures the County of Kaua'i personnel involved in this study, and their responsibilities:

Name	Title / Role	email
Keola Aki	Recycling Specialist Assisting with C9381 Management	kaki@kauai.gov
John Bostick	Temporary Landfill Worksite Supervisor Manages Landfill and Scale House Attendants	landfillsupervisor@kauai.gov
Allison Fraley	SW Program Coordinator Contract 9381 Manager	afraley@kauai.gov
Jeanine Okuhara	SW Accounting Technician Operates Weigh Master Tracking System	jokuhara@kauai.gov
Mike Olivas	Refuse Collection Supervisor Provides Information on Residential Collection	molivas@kauai.gov
Rick Renaud	Solid Waste Superintendent Oversees all Refuse Transfer Stations, Landfill Operations, and Refuse Collection	rrenaud@kauai.gov
John Ruiz	District Manager Waste Management of Hawai'i Manages Kekaha Landfill	jruiz6@wm.com
Troy Tanigawa	Environmental Services Manager Chief of SW Division	ttanigawa@kauai.gov

Analysis

Cascadia requires annual tonnage information to complete the analysis. County of Kaua'i staff have already provided the tonnage information necessary to complete this analysis, which includes fiscal year 2016 tonnage for the following detailed substreams:

- Privately Hauled Commercial Waste Delivered to Kekaha Landfill
- County Hauled Waste Delivering Directly to Kekaha Landfill
- Līhu'e Transfer Station Material Delivered to Kekaha Landfill
- Hanalei Transfer Station Material Delivered to Kekaha Landfill
- Kapa'a Transfer Station Material Delivered to Kekaha Landfill
- Hanapēpē Transfer Station Material Delivered to Kekaha Landfill

Additionally, since Cascadia is sampling one weekend day per season, we will require total tonnage from the transfer stations as a whole for 2016, for Saturdays and Sundays combined. We would subtract this from the overall annual tonnage, and weight the weekend samples accordingly.

Appendix C: Waste Characterization Calculations

Estimating Waste Composition

Waste composition estimates were calculated using a method that gave equal weighting or "importance" to each sample within a given stratum.

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 stream or substream of the waste stream; and
- *n* denotes the number of samples in the particular group that is being analyzed at that step.

Estimating the Composition

For a given stratum (that is, for the samples belonging to the same generator type collected by the same hauler type such as the privately hauled commercial waste), 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 of the selected samples belonging to a given stratum and dividing by the sum of the total weight of waste for all of 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; and
- 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 component *carpet* are shown.

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

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

To find the composition estimate for the component *carpet*, 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 *carpet*. This finding is then projected onto the stratum being examined in this step of the analysis.

Estimating the Composition of Kaua'i's Overall Disposed Waste Stream

Composition results for all strata were combined, using a weighted averaging method, to estimate the composition of Kaua'i's entire waste stream. The relative tonnages associated with each strata served as the weighting factors. The calculation was performed as follows:

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

where:

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

The following scenario illustrates the above equation. This example involves the component *carpet* in three strata.

	Strata 1	**Strata 2**	**Strata 3**
Ratio of *carpet* (*r*)	0.05	0.10	0.15
Proportion of Tonnage (*p*)	50%	25%	25%

$$O_{Carpet} = (0.50 * 0.05) + (0.25 * 0.10) + (0.25 * 0.15) = 0.0875$$

So, it is estimated that 0.0875 or 8.75% of the entire waste stream is composed of *carpet*.

The variance of the weighted average was calculated as follows:

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

Appendix D: Example Field Forms

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

- Example Vehicle Selection Sheet
- Example Sample Placard
- Example Material Weight Tally Sheet

Figure 6. Example Vehicle Selection Sheet

County of Kaua'i 2016 Waste Characterization Study
Vehicle Selection Sheet

Site: Kekaha Landfill **Substream:** Privately Hauled Commercial Waste

Date: July 26th, 2016 **Goal:** **5 Samples Total**

Each number represents an expected vehicle based on the available data.

Cross off one number for each vehicle entering the landfill.

When you reach the number circled, place a pink placard in the windshield and ask this vehicle to go to the sorting area.

Privately Hauled Commercial Waste: **NEED** 5 **TOTAL**

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										

(expect 30)

Figure 7. Example Sample Placard

Sample ID:

Lihue TS 1

Date: 7/26/2016

Cell #:
9

Figure 8. Example Material Weight Tally Sheet

2016 Kaua'i Waste Composition Study

SAMPLE #:	DATE:	TIME:
Notes:		

PAPER	Uncoated Corrugated Cardboard				
	Kraft Paper Bags				
	Newspaper				
	White Ledger Paper				
	Mixed Paper				
	Aseptic and Gable Top Containers				
	Compostable Paper				
	Non-Recyclable Paper				
PLASTIC	PETE Containers – HI-5				
	PETE Containers - Non-HI-5				
	HDPE Containers - HI-5				
	HDPE Containers - Non-HI-5				
	Plastic Containers #3-#7				
	Plastic Grocery and Other Merchandise Bags				
	Agricultural Film Plastic				
	Other Clean Film				
	Non-Recyclable Film Plastic				
	Durable Plastic Items				
	Expanded Polystyrene Food Servicew are				
	Other Expanded Polystyrene				
	Non-Recyclable Plastic				
METAL	Tin/Steel Cans				
	Bi-Metal Cans HI-5				
	Other Ferrous				
	Aluminum Cans - HI-5				
	Aluminum Cans - Non-HI-5				
	Other Non-Ferrous				
	Remainder/Composite Metal				
ELEC + APPS	Covered Electronic Devices				
	Non-Covered Electronic Devices				
	Major Appliances				
	Small Appliances				

ORGANICS	Packaged Food - Meat				
	Packaged Food - Non-Meat				
	Clean Unpackaged Food – Meat				
	Clean Unpackaged Food – Non-Meat				
	Contaminated Unpackaged Food – Meat				
	Contaminated Unpackaged Food – Non-Meat				
	Leaves and Grass				
	Prunings and Trimmings				
	Branches and Stumps				
	Manures				
	Textiles				
	Carpet				
	Non-Recyclable Organic				
INERTS AND OTHER C&D	Concrete				
	Asphalt Paving				
	Asphalt Roofing				
	Clean Lumber				
	Treated Wood				
	Other Wood Waste				
	Gypsum Board				
	Rock, Soil, and Fines				
	Non-Recyclable Inerts and Other				
HOUSEHOLD HAZARDOUS	Paint				
	Empty Aerosol Containers				
	Vehicle and Equipment Fluids				
	Used Oil				
	Batteries				
	Mercury-Containing Items - Not Lamps				
	Lamps - Fluorescent and LED				
	Remainder/Composite Household Hazardous				
SPECIAL WASTE	Ash				
	Treated Medical Waste				
	Bulky Items				
	Tires				
	Remainder/Composite Special Waste				
MF	**Mixed Residue**				
GLASS	Glass Bottles and Containers – HI-5				
	Glass Bottles and Containers - Non-HI-5				
	Non-Recyclable Glass				

If found, please call Cascadia Consulting (206) 343-9759, Reward Offered

Appendix E: Detailed Total Generation

Table 14 below provides total generation data by material type, material class, and overall.

The Tonnage Allocation Notes column includes information for each individual material type about the methodology that Cascadia used to combine the County's diversion data with the disposal data that the characterization study produced to estimate total generation.

Table 14. Total Generation by Material Type

Material	Tons Disposed	Tons Diverted	Total Generation	Diversion Rate	Tonnage Allocation Notes
Paper	**15,441**	**5,320**	**20,760**	**25.62%**	
Cardboard	3,674	4,495	8,170	55.02%	Tons disposed includes only the *Uncoated Corrugated Cardboard* material type tons from the characterization study results. Tons diverted includes diversion tons that County of Kaua'i (COK) tracks under the Cardboard material type name in their records. County staff noted that waxed cardboard is not included in their diversion records for Cardboard.
Mixed Paper	5,717	691	6,408	10.78%	Tons disposed includes the *Kraft Paper*, *White Ledger Paper*, and *Mixed Paper* material type tons from the characterization study results in whole, and 5% of the *Compostable Paper* material type tons from the characterization study results to account for pulp egg cartons, unused pulp paper plant pots, and shredded paper that COK reported as included in their definition of Mixed Paper diverted. Tons diverted includes diversion tons that COK tracks under the Mixed Paper material type name. According to COK, "Our mixed paper includes your definition (for the *Mixed Paper* material type used in the characterization study), plus kraft paper, white ledger paper, some compostable paper (pulp egg cartons, unused pulp paper plant pots, and shredded paper)."

Material	Tons Disposed	Tons Diverted	Total Generation	Diversion Rate	Tonnage Allocation Notes
Newspaper	629	134	763	17.57%	Tons disposed includes the *Newspaper* material type tons from the characterization study results. Tons diverted includes diversion tons that COK tracks under the Newspaper material type name in their records.
Aseptic and Gable Top Containers	323	0	323	0.00%	Tons disposed includes the *Aseptic and Gable Top Containers* material type tons from the characterization study results. COK did not report any tons of this material type diverted.
Compostable Paper	3,711	0	3,711	0.00%	Tons disposed includes 95% of the *Compostable Paper* material type tons from the characterization study results. The diversion amounts for compostable paper (about 5% of compostable paper generated - pulp egg cartons, shredded paper, and unused pulp paper plant pots) are reflected in the Mixed Paper accounting above, per the COK's records. COK did not report any additional tons of this material type diverted.
Non-Recyclable Paper	1,386	0	1,386	0.00%	Tons disposed includes the *Non-Recyclable Paper* material type tons from the chracterization study results. COK did not report any tons of this material type diverted.
Plastic	**9,595**	**1,580**	**11,175**	**14.14%**	
Non-HI5 Plastic	675	70	745	9.39%	Tons disposed includes the *PETE Containers - Non-HI-5* and the *HDPE Containers - Non-HI-5* material type tons from the chracterization study results. Tons diverted includes diversion tons that COK tracks under the Non-HI5 Plastic material type name in their records. COK notes that tons diverted only includes #1 and #2 plastics as accepted on the island via the Kaua'i Recycles Program.
HI5 Plastic	497	385	882	43.65%	Tons disposed includes the *PETE Containers - HI-5* and the *HDPE Containers - HI-5* material type tons from the characterization study results. Tons diverted includes diversion tons that COK tracks under the HI5 Plastic material type name in their records.

Material	Tons Disposed	Tons Diverted	Total Generation	Diversion Rate	Tonnage Allocation Notes
Plastic Irrigation Plastic	80	325	405	80.19%	Tons disposed includes the *Agricultural Film Plastic* material type tons from the characterization study results. Tons diverted includes diversion tons that COK tracks under the Plastic Irrigation Plastic material type name in their records.
Plastic Film	385	800	1,185	67.50%	Tons disposed includes the *Other Clean Film* material type tons from the characterization study results. Tons diverted includes diversion tons that COK tracks under the Plastic Film material type name in their records
Plastic Containers #3-#7	958	0	958	0.00%	Tons disposed includes the *Plastic Containers #3-#7* material type tons from the characterization study results. COK did not report any tons of this material type diverted.
Plastic Grocery and Other Merchandise Bags	41	0	41	0.00%	Tons disposed includes only the *Plastic Grocery and Other Merchandise Bags* material type tons from the characterization study results. COK did not report any tons of this material type diverted.
Non-Recyclable Film Plastic	3,407	0	3,407	0.00%	Tons disposed includes only the *Non-Recyclables Film Plastic* material type tons from the characterization study results. COK did not report any tons of this material type diverted.
Durable Plastic Items	1,605	0	1,605	0.00%	Tons disposed includes only the *Durable Plastic Items* material type tons from the characterization study results. COK did not report any tons of this material type diverted.
Expanded Polystyrene Food Serviceware	364	0	364	0.00%	Tons disposed includes only the *Expanded Polystyrene Food Serviceware* material type tons from the characterization study results. COK did not report any tons of this material type diverted.
Other Expanded Polystyrene	236	0	236	0.00%	Tons disposed includes only the *Other Expanded Polystyrene* material type tons from the characterization study results. COK did not report any tons of this material type diverted.

Material	Tons Disposed	Tons Diverted	Total Generation	Diversion Rate	Tonnage Allocation Notes
Non-Recyclable Plastic	1,345	0	1,345	0.00%	Tons disposed includes only the *Non-Recyclable Plastic* material type tons from the characterization study results. COK did not report any tons of this material type diverted.
Glass	**2,332**	**2,504**	**4,835**	**51.78%**	
Non-HI5 Glass	1,083	859	1,942	44.23%	Tons disposed includes the *Glass Bottles and Containers - Non-HI-5* material type tons from the characterization study results. Tons diverted includes diversion tons that COK tracks under the Non-HI5 Glass material type name in their records.
HI5 Glass	761	1,645	2,406	68.38%	Tons disposed includes the *Glass Bottles and Containers - HI-5* material type tons from the characterization study results. Tons diverted includes diversion tons that COK tracks under the HI5 Glass material type name in their records.
Non-Recyclable Glass	488	0	488	0.00%	Tons disposed includes only the *Non-Recyclable Glass* material type. COK did not report any tons of this material type diverted.
Metal	**3,240**	**5,646**	**8,886**	**63.54%**	
Non-HI5 Aluminum/Tin	78	0	78	0.37%	Tons disposed includes the *Aluminum Cans - Non-HI-5* material type tons from the characterization study results. Tons diverted includes diversion tons that COK tracks under the Non-HI5 Aluminum/Tin material type name in their records.
HI5 Aluminum	228	317	545	58.22%	Tons disposed includes the *Aluminum Cans - HI-5* material type tons from the characterization study results. Tons diverted includes diversion tons that COK tracks under the HI5 Aluminum material type name in their records.
HI5 Bi-metal	69	17	85	19.43%	Tons disposed includes the *Bi-Metal Cans HI-5* material type tons from the characterization study results. Tons diverted includes diversion tons that COK tracks under the HI5 Bi-metal material type name in their records.

Material	Tons Disposed	Tons Diverted	Total Generation	Diversion Rate	Tonnage Allocation Notes
Steel Cans	438	48	486	9.79%	Tons disposed includes the *Tin/Steel Cans* material type tons from the characterization study results. Tons diverted includes diversion tons that COK tracks under the Steel Cans material type name in their records.
Scrap Metal + Non-Ferrous	1,590	5,265	6,854	76.81%	Tons disposed includes the Other Ferrous and Other Non-Ferrous material type tons from the characterization study results. Tons diverted includes diversion tons that COK tracks under the "Scrap Metal" and "Non-Ferrous" material type name in their records. The "Non-Ferrous" material type name includes tons of metals accepted for recycling as reported by COK.
Remainder/ Composite Metal	838	0	838	0.00%	Tons disposed includes only the *Remainder/Composite Metal* material type tons from the characterization study results. COK did not report any tons of this material type diverted.
Food	**8,635**	**3,541**	**12,175**	**29.08%**	
Food Dispursed	2,793	860	3,652	23.54%	Tons disposed includes the *Retail Packaged Food - Meat* and *Retail Packaged Food - Non-Meat* material types from the characterization study results. Tons diverted includes diversion tons that COK tracks under the Food Dispursed material type name in their records.
Pig Farmers + Home Composting (Food)	5,842	2,404	8,246	29.15%	Tons disposed includes the *Unpackaged Food - Meat*, *Unpackaged Food - Non-Meat*, *Other Packaged Food - Meat*, and *Other Packaged Food - Non-Meat* material type tons from the characterization study results. Tons diverted includes all of the Pig Farmer tonnages reported by the County and 1/2 of the Home Composting tonnages (assuming that half of home composting is food).
Commercial Greasetrap	0	277	277	N/A	The waste characterization study did not include grease in our material list for the disposed stream, so we do not have a disposed number for grease.

Material	Tons Disposed	Tons Diverted	Total Generation	Diversion Rate	Tonnage Allocation Notes
Other Organics	**15,107**	**26,818**	**41,925**	**63.97%**	
Green Waste + Home Composting (Green Waste)	5,228	26,818	32,046	83.69%	Tons disposed includes the *Leaves and Grass*, *Prunings and Trimmings*, and *Branches and Stumps* material type tons from the characterization study results. Tons diverted includes tons COK reported as diverted in the Green Waste category in whole, and in half of the Home Composting category (assuming that about half of home composting is green waste).
Manures	0	0	0	N/A	The waste characterization study did not find any *Manures*, and COK did not report diverting any manure.
Textiles	2,525	0	2,525	0.00%	Tons disposed includes only the *Textiles* material type tons from the characterization study results. COK did not report any tons of this material type diverted.
Carpet	508	0	508	0.00%	Tons disposed includes only the *Carpet* material type from the characterization study results. COK did not report any tons of this material type diverted.
Sewage Sludge	3,985	0	3,985	0.00%	Tons disposed includes only the *Sewage Sludge* material type from the County of Kaua'i detailed tonnage records. Cascadia did not hand-sort this material, but rather relied on County of Kaua'i tonnage numbers for this material.
Non-Recyclable Organic	2,861	0	2,861	0.00%	Tons disposed includes only the *Non-Recyclable Organic* material type tons from the characterization study results. COK did not report any tons of this material type diverted.

Material	Tons Disposed	Tons Diverted	Total Generation	Diversion Rate	Tonnage Allocation Notes
Inerts and Other C&D	**19,815**	**18,436**	**38,251**	**48.20%**	
Concrete and Asphalt	1,075	17,886	18,961	94.33%	Tons disposed includes the *Concrete* and *Asphalt Paving* material type tons from the characterization study results. Tons diverted includes diversion tons that COK tracks under the Concrete and Asphalt material type name in their records. To the County's knowledge, asphalt that they track as diverted is only from recycled roads projects, and does not include asphalt roofing.
Clean Lumber, Including Pallets	4,167	550	4,717	11.66%	Tons disposed includes the *Clean Lumber* material type tons from the waste composition study results. The compostition study counted pallets as *Clean Lumber* while sorting. Tons diverted includes diversion tons that COK tracks under the Pallets material name in their records. Please note that the waste characterization study did not separate clean pallets for consideration, so we do not have a way to track the diversion rate specific to pallets. The actual diversion rate for clean pallets may be much higher than this.
Asphalt Roofing	1,566	0	1,566	0.00%	Tons disposed includes only the *Asphalt Roofing* material type tons from the characterization study results. COK did not report any tons of this material type diverted.
Treated Lumber	2,467	0	2,467	0.00%	Tons disposed includes only the *Treated Lumber* material type tons from the characterization study results. COK did not report any tons of this material type diverted.
Other Wood Waste	5,157	0	5,157	0.00%	Tons disposed includes only the *Other Wood Waste* material type tons from the characterization study results. COK did not report any tons of this material type diverted.

Material	Tons Disposed	Tons Diverted	Total Generation	Diversion Rate	Tonnage Allocation Notes
Gypsum Board	2,821	0	2,821	0.00%	Tons disposed includes only the *Gypsum Board* material type tons from the characterization study results. COK did not report any tons of this material type diverted.
Rock, Soil, and Fines	1,395	0	1,395	0.00%	Tons disposed includes only the *Rock, Soil, and Fines* material type tons from the characterization study results. COK did not report any tons of this material type diverted.
Non-Recyclable Inerts and Other C&D	1,166	0	1,166	0.00%	Tons disposed includes only the *Non-Recyclable Inerts and Other C&D* material type tons from the characterization study results. COK did not report any tons of this material type diverted.
Electronics and Appliances	**1,446**	**173**	**1,619**	**10.70%**	
eWaste	525	173	699	24.81%	Tons disposed includes the *Covered Electronic Devices and Non-Covered Electronic Devices* material type tons from the characterization study results. Tons diverted includes diversion tons that COK tracks under the eWaste material type name in their records. According to the COK, "Most of [the material in this category] is covered, we did start tracking our new recycler who takes both types, but for the most part this should be covered electronics."
Major Appliances	0	0	0	100.00%	The waste study did not find any *Major Appliances*, but COK reports that they divert all *Major Appliances, so we have listed this as 100% diversion.*
Small Appliances	921	0	921	0.00%	Tons disposed includes only the *Small Appliances* material type tons from the characterizations study results. COK did not report any tons of this material type diverted.

Material	Tons Disposed	Tons Diverted	Total Generation	Diversion Rate	Tonnage Allocation Notes
Household Hazardous Waste	**626**	**141**	**767**	**18.36%**	
Batteries (Lead Acid)	109	116	225	51.42%	Tons disposed includes the *Batteries* material type tons from the characterization study results. Tons diverted includes only lead acid battery diversion reported by the COK. Note that this comparison is not completely accurate, but is the closest comparison feasible given available data. For the waste characterization study, we defined batteries as "any type of battery including both dry cell, rechargeable, and lead acid. Examples include car, flashlight, small appliance, watch, and hearing aid batteries." The tons reported as diversion here include only lead acid batteries.
HHW	80	71	151	47.01%	Tons disposed includes the *Empty Aerosol Containers*, *Vehicle and Equipment Fluids*, *Used Oil*, *Mercury-Containing Items - Not Lamps*, and *Lamps - Fluorescent and LED* material type tons from the characterization study results. Tons diverted includes diversion tons that COK tracks under the HHW material type name in their records and 53 tons of used motor oil collected through a different program.
Paint	38	7	45	15.64%	Tons disposed includes only the *Paint* material type tons from the characterization study results. Tons diverted includes 7 tons of oil-based paint collected during HHW collection events that the COK provides. During these events, COK will accept oil-based paint, but not latex paint.
Remainder/ Composite Household Hazardous	399	0	399	0.00%	Tons disposed includes only the *Remainder/Composite Household Hazardous* material type tons from the characterization study results. COK did not report any tons of this material type diverted.

Material	Tons Disposed	Tons Diverted	Total Generation	Diversion Rate	Tonnage Allocation Notes
Special Waste	**1,415**	**609**	**2,024**	**30.09%**	
Tires and Commercial tires (unitek)	9	609	617	98.62%	Tons disposed includes the *Tires* material type tons from the waste composition study results. Tons diverted includes the Tires and Commercial Tires (Unitek) categories from the County's diversion records.
Ash	130	0	130	0.00%	Tons disposed includes only the *Ash* material type tons from the compostion study results. COK did not report any tons of this material type diverted.
Treated Medical Waste	4	0	4	0.00%	Tons disposed includes only the *Treated Medical Waste* material type tons from the characterization study results. COK did not report any tons of this material type diverted.
Bulky Items	335	0	335	0.00%	Tons disposed includes only the *Bulky Items* material type tons from the characterization study results. COK did not report any tons of this material type diverted.
Remainder/ Composite Special Waste	937	0	937	0.00%	Tons disposed includes only the *Remainder/Composite Special Waste* material type tons from the characterication study results. COK did not report any tons of this material type diverted.
Mixed Residue	**6,089**	**0**	**6,089**	**0.00%**	
Mixed Residue	6,089	0	6,089	0.00%	Tons disposed includes only the *Mixed Residue* material type tons from the characterization study results. COK did not report any tons of this material type diverted.