City of Tacoma
Environmental Services Solid Waste Management
Organics Processing Service Contract
RFI Specification No. ES21-0538F

QUESTIONS and ANSWERS

All interested parties had the opportunity to submit questions in writing by email to Dawn DeJarlais by June 23, 2021. The answers to the questions received are provided below and posted to the City's website at www.TacomaPurchasing.org: Navigate to *Current Contracting Opportunities* / *Services*, and then click *Questions and Answers* for this Specification. This information IS NOT considered an addendum. Respondents should consider this information when submitting their proposals.

Question 1: The City of Tacoma was a leader in their previous organics contract by including a compost buy-back provision. Based on legislation to support local compost manufacturing now codified in RCW 43.19A.130, does the City intend to include a buyback commitment in the new contract?

Answer 1: The City would be interested in including a buy-back provision in the contracts. We would need to consider compost quality and hauling logistics.

Question 2: We have seen success with allowing customers to use certified compostable bags in kitchens as liners, would the City be interested in including these on their accepted list?

Answer 2: At this time, we have not wanted to allow compostable bags because of the confusion that can result, potentially leading to increased contamination. We would be open to discussing the pros and cons in the future if the selected vendor or vendors supports this material being included.

Question 3: If the City adds collection of post-consumer food waste, do you have any estimates on tonnage for that stream?

Answer 3: The City has the following quantitative data related to the amound of food waste in the collected waste stream: 1) In Cecember 2014, Tacoma Solid Waste Management Organics Feasibility (pg 15 of the Exhibit A), the following estimate was included, " As of the date of this study, the City has 44, 023 residential YW customers, which result in an estimate of 5,952 tons per year or 114 tons per week of food scraps that would be diverted to the facility if it were operating today." 2) The 2015 Waste Composition Study, pg. 70, and 3) The 2017 Waste Composition Study pg 31-36 (Exhibit B).

Question 4: If the City selects two proposers, with the percentage share be allocated to each composter by month or by year? We suggest monthly to allow for effective and efficient capacity management.

Answer 4: The City would be open to allocating percentage of organics by month. The details of how the percentage would be allocated have not been finalized yet.

Exhibit A

Final Report

Tacoma Solid Waste Management Organics Facility Feasibility Study

Prepared for

City of Tacoma

December 2014

CH2MHILL®

917 Pacific Avenue
Suite 400
Tacoma, WA 98402

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Acronyms and Abbreviations

AD	Anaerobic Digestion
ASP	Aerated Static Pile
BMP	Best Management Practices
City	City of Tacoma, Washington
cm	centimeter
CNG	Compressed Natural Gas
CSA	Combined Statistical Area
DOT	Department of Transportation
EOW	every-other-week
ECS	Engineered Compost Systems
FAZ	Forecast Analysis Zones
FOG	fats, oils, and greases
Ha	hectare
Hp	horsepower
ICI	Institutional Sources
Kg	kilograms
kW	kilowatt
L&YW	Leaf and Yard Waste
M	meter
m^3	cubic meter
MODA	Multi-Objective Decision Analysis
MOR	Managed Organic Recycling
OMRI	Organic Materials Review Institute
PAW	Passively Aerated Windrow
PSRC	Puget Sound Regional Council
RAA	R. Alexander Associates, Inc.
SSO	Source Separated Organics
STA	Seal of Testing Assurance
SWMD	Solid Waste Management Division
TAGRO	“Tacoma Grows”
UV	Ultraviolet
VFD	Variable Frequency Drive
vpd	vehicles per day
vph	vehicles per hour
WWTP	wastewater treatment plants
YW	Yard Waste

Executive Summary

CH2M HILL was retained by the City of Tacoma (the City), Washington, to prepare a feasibility study that evaluated the prospect of building and operating a new large-scale organics management facility. This study was performed as part of ongoing efforts to expand the City's organics collection program. The following evaluations were conducted in 2012 and 2013 and form the basis for the recommendations in this report: feedstock analysis, technology evaluation, market study, business case cost analysis, and site evaluation.

Feedstock Analysis

During the course of the feedstock analysis, forecasts were prepared for three primary potential sources of material: residential source separated organics (SSO) (City and self-haul), material from other jurisdictions, and organics from large commercial generators and events. Out of the three potential feedstock sources, residential SSO is the only one currently under the control of the City. This source accounts for the largest amount of projected materials and is therefore the most crucial to understand in determining the capacity of the facility. Organics from other jurisdictions and commercial generators are much more uncertain and should not be relied on for the basis of design. CH2M HILL recommends providing capacity for the following tonnages:

- Minimum Requirement: City SSO of 41,022 tons per year, with a peak week of 1,450 tons
- Optional: 100 to 200 tons per week of organics (other jurisdictions and commercial generators)

Composting technologies should also be evaluated for their ability to handle approximately 200 wet tons of biosolids per week (approximately 10,000 tons per year).

Technology Evaluation

After the feedstock analysis, a technology evaluation was completed. A total of 19 potential composting and anaerobic digestion technologies were identified and screened. Ultimately, the following five composting technologies and one anaerobic digestion (AD) technology was selected to be carried forward to the next step of the evaluation process:

- Negative aerated static pile (ASP) (outdoor)
- Covered ASP (outdoor)
- Negative ASP (indoor)
- Enclosed Tunnel
- AD of suitable feedstocks from commercial sources with a high-solids-stackable system, combined with composting of the digestate and residential SSO

Market Study

Concurrent to the technology evaluation, a market study was conducted by R. Alexander Associates, Inc. (RAA) to better understand the distribution and value of the finished compost product(s). The study found that large volumes of compost are currently being successfully marketed in western Washington State and the Puget Sound region and that the area was well educated in the use of compost. The study concluded that Tacoma should concentrate its marketing efforts on wholesale, large truckload type sales, because of the volume of compost that it will be required to market. Tacoma should be able to market their product directly to horticultural professionals in tractor trailer volumes at $10 to $15 per cubic yard, picked up. If marketed to just one or two resellers/blenders, then a lower price should be expected. The study includes recommendations for Tacoma should they decide to market their compost in-house.

Business Case Cost Analysis

Following completion of the feedstock analysis and market study, a business case analysis was performed. The process used to complete the business case analysis included estimating life-cycle costs and multi-objective decision analysis (MODA) to incorporate environmental and social factors important to the City in evaluating facility options. Indoor negative ASP was selected as the preferred technology from the initial evaluation.

A second MODA evaluation was conducted for three different feedstock scenarios using that technology. The three feedstock scenarios that were considered include the following:

- SSO + Biosolids without AD
- SSO + Biosolids with AD
- SSO Only (without Biosolids)

Results of the second MODA evaluation indicate that the SSO Only and the SSO + Biosolids without AD alternatives have the highest value and least cost, respectively. The SSO + Biosolids with AD alternative was eliminated from consideration because it has a lower value MODA score and is more expensive than the SSO only alternative. Thus, should the City develop the organics facility, the choice of feedstock mix would present cost and value tradeoffs that would need to be considered.

Site Evaluation

An integral part of this feasibility study was the identification of potential sites for the organics facility. This was done in a phased approach starting with the assumption that the facility would be located within the City limits and should be designed for a minimum capacity of the 2024 projected residential SSO quantities. Conceptual layouts were prepared based on those assumptions. Next, the initial MODA evaluation used the assumption that the organics facility would be located onsite at the landfill. Following the initial MODA evaluation, an alternate site located on Marc Street was identified. A proposed layout for this site was prepared and a MODA evaluation was prepared to compare the Marc Street site with the landfill site. The Marc Street site scored slightly higher on the non-monetary aspects of the evaluation, but is estimated to be approximately 11 percent more expensive than the landfill site, mainly because of the cost of transferring material. The landfill site can accommodate future projected growth and expansion of 50 percent, whereas Marc Street can only accommodate the current 2024 design year projections. Should the City pursue development of the composting facility, it would need to evaluate this tradeoff between non-monetary value and cost when making a site selection as well as future expandability.

1. Introduction

The City of Tacoma, Washington, Solid Waste Management Division (SWMD) is committed to continuing to improve and develop its sustainable integrated waste management program. One of the target areas SWMD has identified for increasing recycling is the expansion of the organics collection program. The City of Tacoma (the City) is evaluating the various options for managing the existing and potential future organics waste materials generated in the City. As part of these efforts, CH2M HILL was retained to assess the feasibility of building and operating a new large-scale organics management facility. The feasibility study included an evaluation of the following:

- Feedstock Analysis. Analysis of organic feedstock materials including types and quantities that may be available for processing
- Technology Evaluation. Identification and evaluation of technologies that are appropriate for processing organic wastes and producing usable products.
- Market Study. A study of the local market for compost products, comprising a market survey and marketing plan.
- Business Case Cost Analysis. A business case analysis for an organic waste management facility, including life-cycle cost and revenue comparisons, risk analysis, and triple bottom line analysis.
- Site Evaluation. Development of conceptual layouts and a comparison/evaluation of the two potential sites that were identified using the preferred technology and feedstock options.

Several technical memorandums, presentations, and workshops were generated/completed during this evaluation (in 2012 and 2013). This report presents the methodologies and results of each portion of this feasibility study.

2. Feedstock Analysis

The first task that was conducted for this feasibility study was an analysis of the types and quantities of organic feedstock that may be available for processing. Initially, SSOs consisting of food waste and green waste collected from single-family residential sources and green waste self-hauled to the proposed facility are the two categories of organics that would be available. In the future, the facility may also accept materials collected from multi-family residential units and industrial, commercial, and institutional (ICI) sources, and dewatered digested biosolids generated by wastewater treatment plants (WWTPs) in the area (excluding Tacoma's own WWTP).

For the purposes of this analysis, forecasts were prepared for the following three primary potential sources of material:

1. City Yard Waste (YW) collection (including residential food scraps) and self-haul YW dropoff (that is, material collected by or delivered to the City currently and in the future).
2. Material from other jurisdictions that may be available.
3. Organic materials from large commercial generators and events.

Should the City elect to develop an organics processing facility, it will be able to count on material currently under its control, which at this time includes only the first source referenced above. Thus, this report focuses primarily on this material.

A logical strategy for developing a facility would be to size the facility for a future design year that would accommodate material the City controls. Once the facility is operational, the City could seek material from other sources as capacity is available. Further, it is always wise to design organics facilities to accommodate future expansion. The City may also want to design the facility to accommodate future infrastructure for AD with energy production for commercial food wastes and other appropriate feedstocks.

The results of this analysis provide a basis for decisions regarding sizing buildings, equipment, and related infrastructure for the proposed processing facility.

2.1 In-city Yard Waste and Residential Food Scraps

The forecast of material collected by City vehicles and self-haul YW delivered to the City was prepared on the basis of the following primary data sources:

- Daily YW deliveries from City and self-haul vehicles from 2009 through 2011.
- Estimated residential food waste diversion from the results of the City's pilot every-other-week (EOW) collection program (July 2011 to February 2012).
- City population forecasts prepared by the Puget Sound Regional Council.
- Estimates of seasonal material composition from City staff and Compost Design Services Inc.
- Material density estimates from Compost Design Services Inc.

Forecasts have been prepared for a design year of 2024, which is approximately 10 years from when an organics facility would be likely to begin operations.

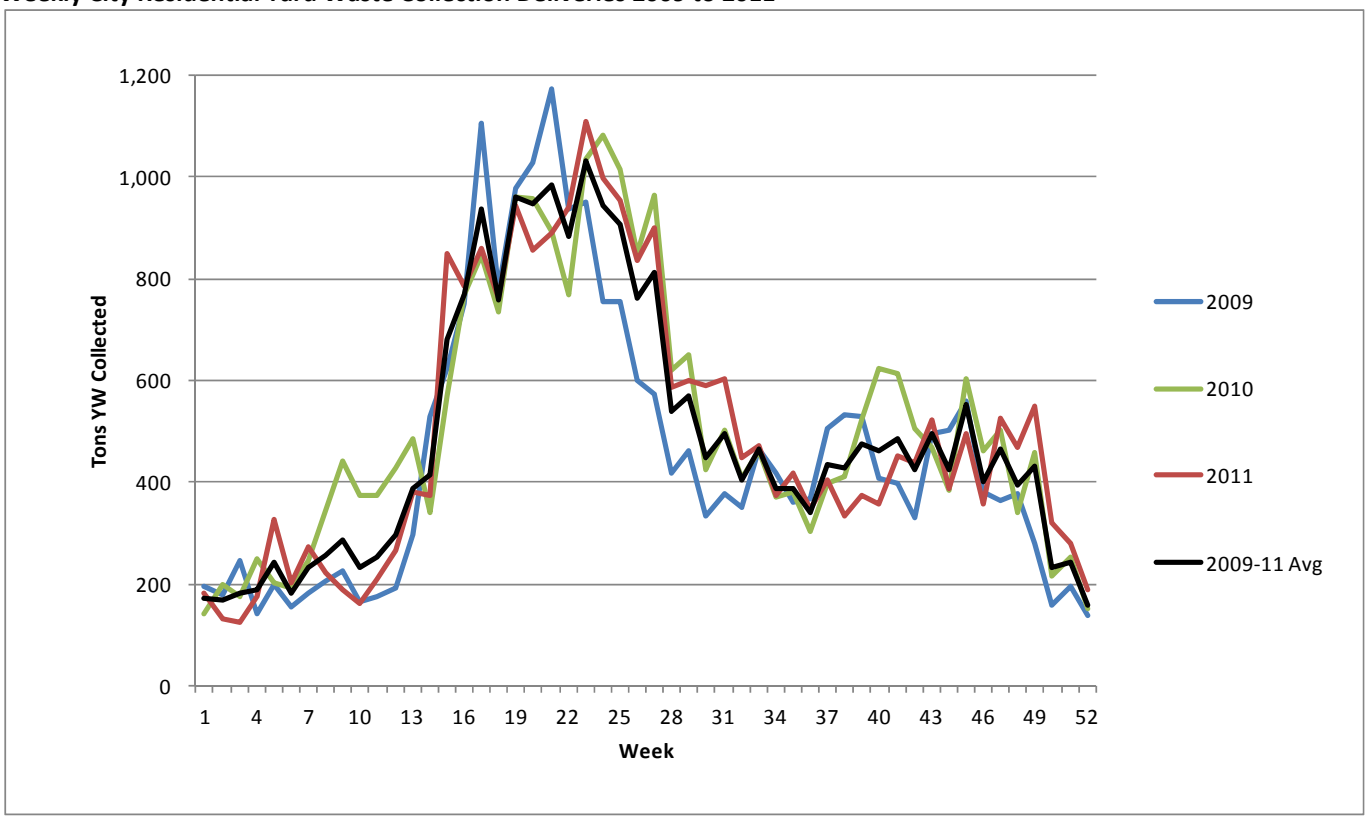
One key challenge for organics processing facilities is the seasonal flows of YW that result in extremely high peak quantities in late spring and relatively little material in winter months. Thus, we have prepared forecasts on a weekly basis to explore quantity variations throughout the year.

It is also important for facility design purposes to understand material quantities by weight and by volume. Thus, forecasts are provided in both ways. The bulk density and volumes of the fresh received materials change significantly after grinding and mixing, and are important for sizing processing equipment and composting pile capacity. The processed volumes are shown separately.

2.1.1 Historical City Yard Waste Collection

Historical weekly YW quantities collected by City collection vehicles are shown in Exhibit 1.

EXHIBIT 1
Weekly City Residential Yard Waste Collection Deliveries 2009 to 2011



Using the average of each week over the course of the 3-year time series, residential curbside YW collection averaged 489 tons per week, with a peak week of 1,032 tons and a low week of 160 tons. The ratio of peak week to average week is 2.1, which is representative of YW collection programs in the Pacific Northwest. Exhibit 1 also shows the effects of seasonal fluctuations with April, May, and June (corresponding to weeks 15 to 29) averaging significantly higher tonnages. Additionally, Exhibit 1 also shows that the quantities collected in a particular week can vary significantly from one year to the next based primarily on weather patterns.

Data for the first half of 2012 are also available, but the City began a program to divert kitchen waste in the YW cart in April 2012. Thus, 2012 data were excluded for consistency with prior years and to assist forecast accuracy. Residential food scrap diversion is addressed separately in Section 2.1.4. In total, the City's residential YW trucks collected 25,785 tons in 2011 and an average of 25,421 per year from 2009 to 2011.

2.1.2 Historical Self-haul Deliveries

Historical self-haul deliveries are shown in Exhibits 2 and 3. In viewing Exhibit 2, one notable anomaly is the unusually high deliveries that occurred in January and February 2012. This was the result of a significant wind and ice storm that occurred during the third week of January. It demonstrates the potential impact of a natural disaster on YW quantities, but is not representative of typical delivery trends. Thus, Exhibit 3, which only shows data from 2009 to 2011, presents a more common pattern of weekly flows.

EXHIBIT 2

Weekly Self-haul Yard Waste Deliveries, 2009 to 2012

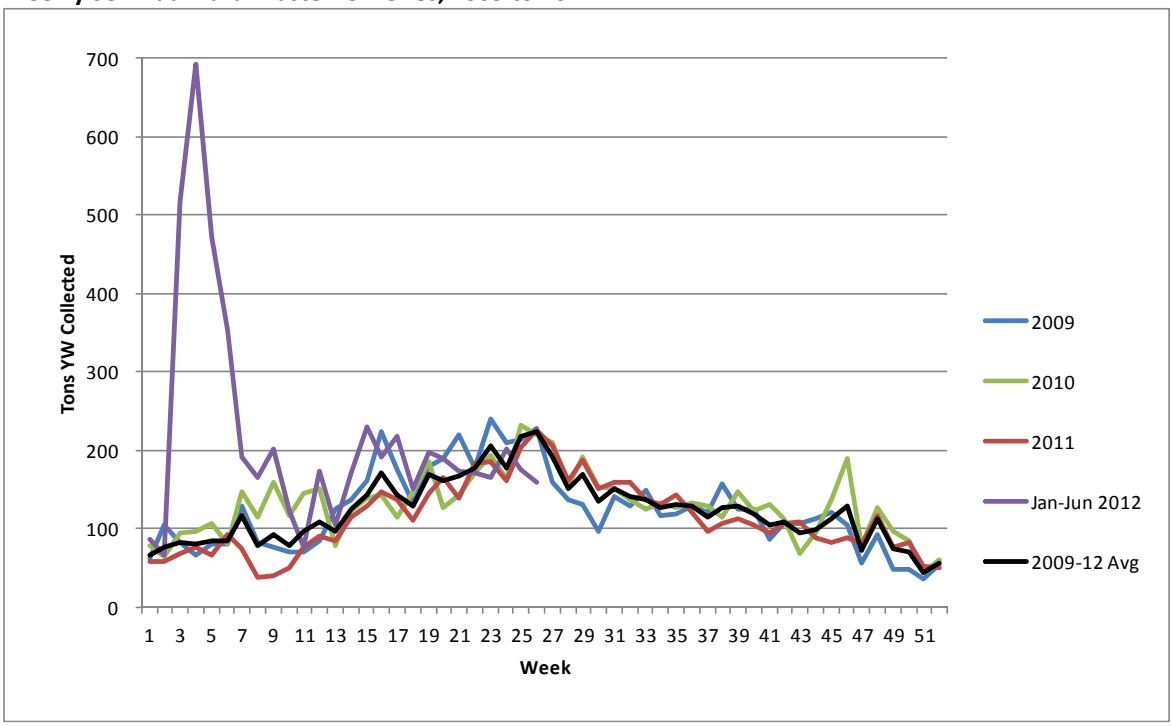
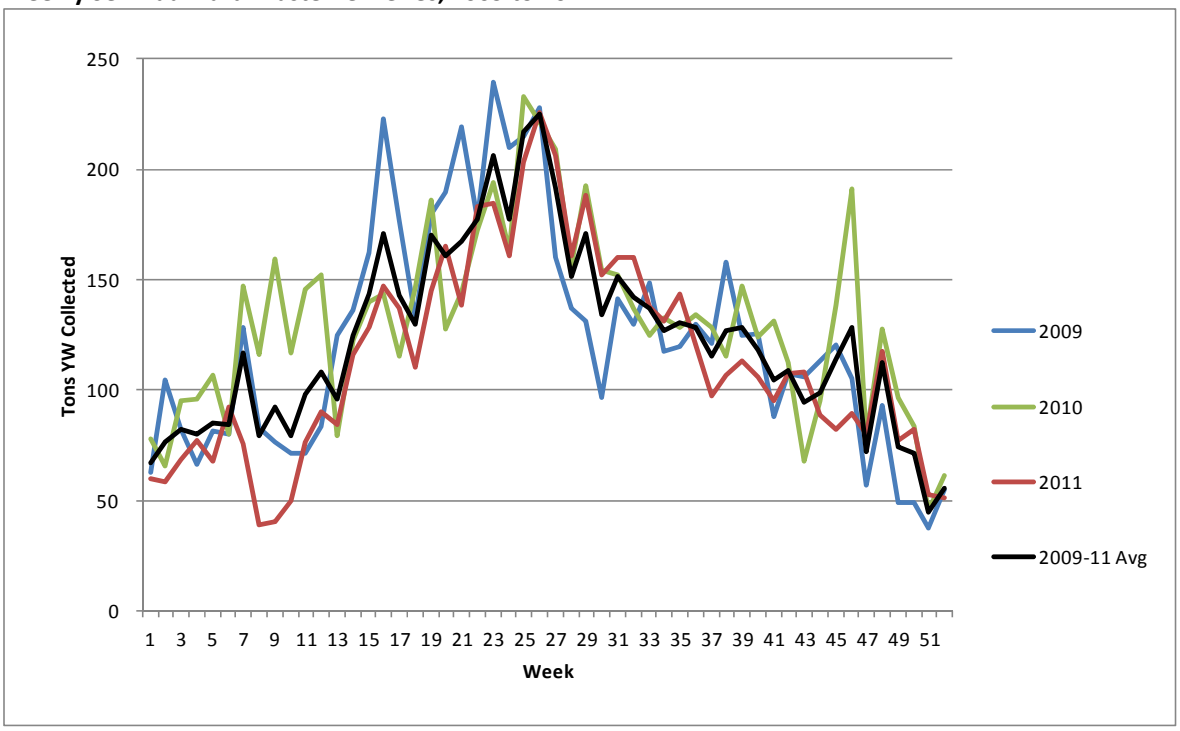


EXHIBIT 3

Weekly Self-haul Yard Waste Deliveries, 2009 to 2011

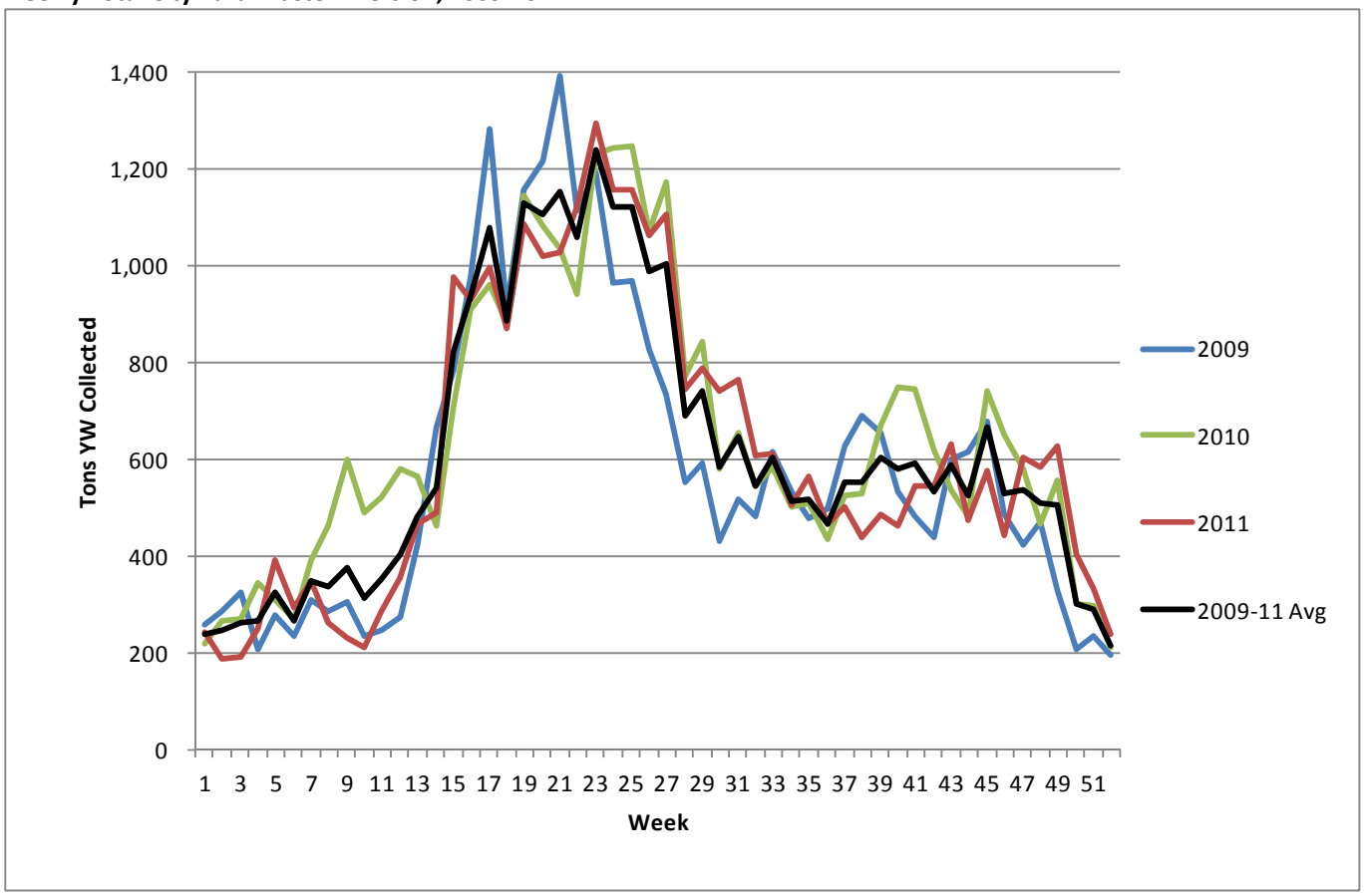


Using the average of each week over the 3-year time series, self-haul deliveries averaged 123 tons per week, with a peak week of 225 tons and a low week of 45 tons. The ratio of peak week to average week is 1.8. In total, 5,937 tons of self-haul yard waste was delivered to the City in 2011 and an average of 6,390 tons were delivered annually from 2009 to 2011.

2.1.3 Combined City Yard Waste Collection and Self-Haul

Combined residential City YW and self-haul deliveries for 2009 to 2011 are shown in Exhibit 4. Using the average of each week over the course of the 3-year time series, the combined City YW deliveries averaged 612 tons per week, with a peak week of 1,238 tons and a low week of 216 tons. The ratio of peak week to average week is 2.0. In total 31,772 tons of combined City YW collection and self-haul YW was delivered to the City in 2011 and an average of 31,812 tons were delivered annually from 2009 to 2011.

EXHIBIT 4
Weekly Total City Yard Waste Diversion, 2009-2011



2.1.4 Estimated Residential Food Scrap Diversion

In April 2012, the City began a new program that encourages residents to divert food and other kitchen wastes from the garbage and instead place them in the YW cart. In 2013, the City implemented EOW garbage collection, which provided additional incentive to divert food scraps from the garbage. At the time this evaluation was conducted, results from the full implementation of the program were not available. Results of the pilot EOW are discussed below.

The City conducted a pilot EOW garbage collection pilot program from July 2011 through February 2012. The pilot study was conducted with approximately 700 customers each in the Monday and Wednesday service areas. Customers participating in the study were provided an extra garbage container (of the same size as their former weekly garbage service) and encouraged to place food scraps into the YW container along with the YW. The YW/food scraps container was collected weekly. Customers were offered the ability to save money by shrinking the total volume of service they subscribed to.

Detailed statistics regarding material quantities were compiled and compared to a control group of Monday and Wednesday customers that did not participate in the pilot. Assuming that the pilot customers are representative of the other customers in the Monday and Wednesday areas, the difference in YW collection between the pilot

customers and non-pilot customers is assumed to be food scraps. A comparison of garbage, recycling, and YW quantities collected in the pilot and non-pilot areas are shown in Exhibit 5.

EXHIBIT 5
Pounds per Account Per Week During Pilot Program

	EOW Pilot Areas	Non-EOW Areas	Pilot Areas Percent Difference From Non-EOW Areas
Garbage	23.6	30.0	-21%
Recycling	10.1	11.2	-9%
YW/Food Waste	22.1	16.9	31%
Total	**55.9**	**58.1**	**-4%**

Source: Tacoma Public Works Department. 2012. Findings and Recommendation Report, *Every-Other-Week Garbage Collection Pilot Program*.

As shown, customers in the pilot areas delivered 5.2 pounds per household per week more in the YW/food waste containers than in the non-pilot area YW containers, which amounts to 270 pounds per household per year of food scrap diversion. In Exhibit 6, this estimate is compared to food scrap diversion estimates from some other cities. As shown, the estimate from the City's pilot EOW collection program is within the range of estimates from other communities.

EXHIBIT 6
Food Scrap Collection Estimates (pounds per household per year)

Tacoma from pilot collection program	270
Ontario Average [a]	277
Nanaimo [b]	254
Port Coquitlam, British Columbia[c]	303
Seattle, Washington - 2 years of food/yard [c,d]	288

[a.] Average of seven largest Ontario communities in 2010. Excludes Toronto, which allows diapers. From: http://www.wdo.ca/content/?path=page82+item35931.

[b.] http://www.beyondcomposting.ca/faq.asp.

[c.] Port Coquitlam and Seattle estimated by comparing to period prior to food waste introduction; Tacoma pilot estimated by comparing to control collection routes with YW only.

[d.] Various reports available at http://www.seattle.gov/util/Services/index.asp.

For the purposes of estimating incoming material flows, it is assumed that food scraps will not vary on a weekly basis. While flows will vary somewhat each day, the variations are likely to be small compared to the seasonal variation in YW trends that are expected.

As of the date of this study, the City has 44,023 residential YW customers, which result in an estimate of 5,952 tons per year or 114 tons per week of food scraps that would be diverted to the facility if it were operating today.

2.1.5 Future Growth Projections

In this report, material quantities are forecast on the basis of future population forecasts as shown in Exhibit 7. The Puget Sound Regional Council (PSRC) prepares forecasts for small areas of Puget Sound called forecast analysis zones (FAZs). The boundaries of the FAZs do not match the City boundaries exactly, but they are close. For example, the 2010 Census population for the City is 198,397 and the Tacoma area FAZs total 211,756. City population forecasts for any particular year can be prepared by applying PSRC's forecast annual growth rate to the City of Tacoma population.

EXHIBIT 7
Historical and Forecast Population

	2000	2010	2020	2030	2040
Tacoma					
Historical [a]	193,556	198,397			
Forecast			211,756	228,608	251,769
PSRC FAZ Groups [b]					
Tacoma Eastside	64,196	66,398	66,747	69,727	70,734
Tacoma South	22,095	23,351	22,957	25,761	32,402
Tacoma North End	75,677	73,884	83,304	87,431	93,189
Tacoma Central Business District	10,499	11,962	14,176	17,985	25,134
Port of Tacoma/NE Tacoma/Fife	24,889	31,326	33,670	37,526	41,127
Total	197,356	206,921	220,854	238,430	262,586
Annual Growth			0.7%	0.8%	1.0%

a. US Census Quickfacts http://quickfacts.census.gov/qfd/states/53/5370000.html

b. PSRC 2012 Draft Forecast http://psrc.org/data/forecasts/2012-forecast-products/review

Using this method, residential organics collection and self-haul YW deliveries are projected to increase at an annual rate of 0.7 percent between 2012 and 2020, and by an annual rate of 0.8 percent between 2020 and 2030.

2.1.6 Organic Waste Composition

It is important to have a basic understanding of the likely composition of organic materials that would be composted at the City's facility both for facility sizing and for appropriate carbon-to-nitrogen (C:N) ratios and porosity. The composition of organics will vary throughout the year in response to seasonal weather patterns and other factors. The estimated composition of material from the City's residential organics collection, self-haul deliveries, and food scraps on a weekly basis is shown in Exhibit 8. As indicated, these estimates were prepared on the basis of Compost Design Service Inc's operating experience in the region and the City's experience observing incoming self-haul deliveries and from its pilot woody waste chipping program.

EXHIBIT 8
Weekly Organics Material Composition Estimates

Week	City YW				Self-haul				Food Scraps	
	Brush	Grass/ Garden	Leaves/ Needles	Soil and Sod	Brush	Grass/ Garden	Leaves/ Needles	Soil and Sod	Food	Food-Soiled Paper
1	70%	10%	20%	0%	80%	7%	13%	0%	97%	3%
2	70%	10%	20%	0%	80%	7%	13%	0%	97%	3%
3	70%	10%	20%	0%	80%	7%	13%	0%	97%	3%
4	70%	10%	20%	0%	80%	7%	13%	0%	97%	3%
5	80%	10%	10%	0%	80%	10%	10%	0%	97%	3%
6	80%	10%	10%	0%	80%	10%	10%	0%	97%	3%
7	80%	10%	10%	0%	80%	10%	10%	0%	97%	3%
8	80%	10%	10%	0%	80%	10%	10%	0%	97%	3%
9	57%	30%	10%	3%	80%	14%	5%	1%	97%	3%
10	57%	30%	10%	3%	80%	14%	5%	1%	97%	3%
11	57%	30%	10%	3%	80%	14%	5%	1%	97%	3%
12	57%	30%	10%	3%	80%	14%	5%	1%	97%	3%
13	57%	30%	10%	3%	80%	14%	5%	1%	97%	3%
14	15%	70%	5%	10%	80%	16%	1%	2%	97%	3%

EXHIBIT 8
Weekly Organics Material Composition Estimates

Week	City YW				Self-haul				Food Scraps	
	Brush	Grass/ Garden	Leaves/ Needles	Soil and Sod	Brush	Grass/ Garden	Leaves/ Needles	Soil and Sod	Food	Food-Soiled Paper
15	15%	70%	5%	10%	80%	16%	1%	2%	97%	3%
16	15%	70%	5%	10%	80%	16%	1%	2%	97%	3%
17	15%	70%	5%	10%	80%	16%	1%	2%	97%	3%
18	10%	80%	5%	5%	80%	18%	1%	1%	97%	3%
19	10%	80%	5%	5%	80%	18%	1%	1%	97%	3%
20	10%	80%	5%	5%	80%	18%	1%	1%	97%	3%
21	10%	80%	5%	5%	80%	18%	1%	1%	97%	3%
22	10%	80%	5%	5%	80%	18%	1%	1%	97%	3%
23	15%	80%	2%	3%	80%	19%	0%	1%	97%	3%
24	15%	80%	2%	3%	80%	19%	0%	1%	97%	3%
25	15%	80%	2%	3%	80%	19%	0%	1%	97%	3%
26	15%	80%	2%	3%	80%	19%	0%	1%	97%	3%
27	20%	70%	7%	3%	80%	18%	2%	1%	97%	3%
28	20%	70%	7%	3%	80%	18%	2%	1%	97%	3%
29	20%	70%	7%	3%	80%	18%	2%	1%	97%	3%
30	20%	70%	7%	3%	80%	18%	2%	1%	97%	3%
31	30%	50%	14%	6%	80%	14%	4%	2%	97%	3%
32	30%	50%	14%	6%	80%	14%	4%	2%	97%	3%
33	30%	50%	14%	6%	80%	14%	4%	2%	97%	3%
34	30%	50%	14%	6%	80%	14%	4%	2%	97%	3%
35	30%	50%	14%	6%	80%	14%	4%	2%	97%	3%
36	20%	55%	20%	5%	80%	14%	5%	1%	97%	3%
37	20%	55%	20%	5%	80%	14%	5%	1%	97%	3%
38	20%	55%	20%	5%	80%	14%	5%	1%	97%	3%
39	20%	55%	20%	5%	80%	14%	5%	1%	97%	3%
40	20%	20%	55%	5%	80%	5%	14%	1%	97%	3%
41	20%	20%	55%	5%	80%	5%	14%	1%	97%	3%
42	20%	20%	55%	5%	80%	5%	14%	1%	97%	3%
43	20%	20%	55%	5%	80%	5%	14%	1%	97%	3%
44	20%	20%	55%	5%	80%	5%	14%	1%	97%	3%
45	40%	10%	50%	0%	80%	3%	17%	0%	97%	3%
46	40%	10%	50%	0%	80%	3%	17%	0%	97%	3%
47	40%	10%	50%	0%	80%	3%	17%	0%	97%	3%
48	40%	10%	50%	0%	80%	3%	17%	0%	97%	3%
49	60%	10%	30%	0%	80%	5%	15%	0%	97%	3%
50	60%	10%	30%	0%	80%	5%	15%	0%	97%	3%
51	60%	10%	30%	0%	80%	5%	15%	0%	97%	3%
52	60%	10%	30%	0%	80%	5%	15%	0%	97%	3%

Source: Compost Design Services, Inc. and CH2M HILL.

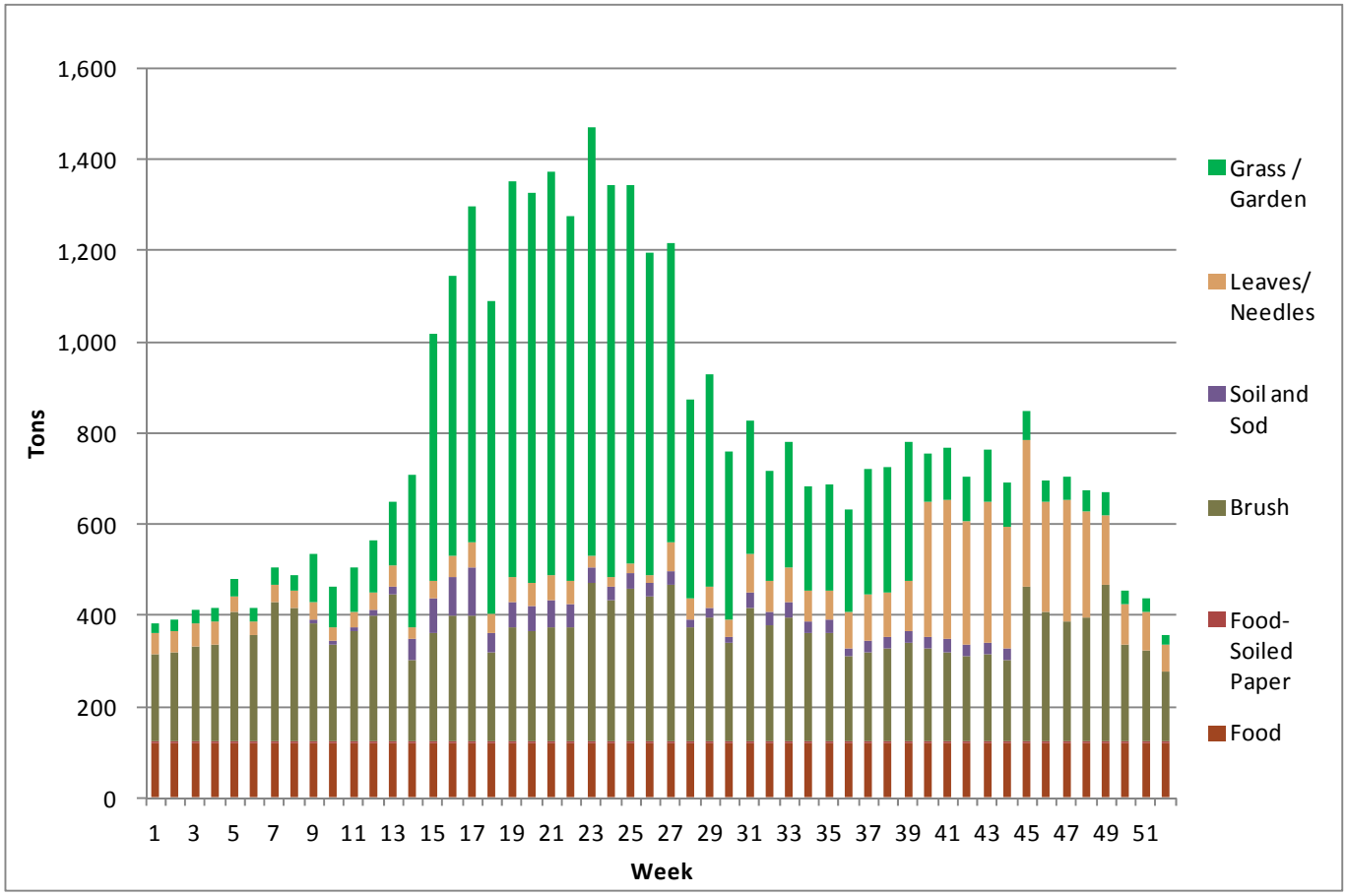
Forecast residential curbside and self-haul organics in 2024 by material type is shown in Exhibit 9. The results were prepared by multiplying 2009-2011 average weekly quantities times growth from 2012 to 2024 (using the relevant annual growth rates from Table 3) times the relevant material composition estimates from Exhibit 8.

EXHIBIT 9
2024 Residential Curbside and Self-haul Organics Forecast (tons)

Brush	12,893
Grass / Garden	15,587
Leaves/ Needles	4,857
Soil and Sod	1,219
Food	6,271
Food-Soiled Paper	194
Total	**41,022**

Forecast material quantities by week on a tonnage basis are shown in Exhibit 10. As shown, grass and garden wastes drive significant peaks in the spring and early summer.

EXHIBIT 10
2024 Forecast Weekly Residential and Self-haul Organics (tons)



The 2024 forecast in tons was converted to a volume basis using the density factors shown in Exhibit 11. As shown, estimates are provided as materials would be delivered to the receiving area, and after grinding and processing.

EXHIBIT 11
Material Density Estimates (pounds per cubic yard)

	As Delivered	After Grinding
From City Trucks		
Brush	350	850
Grass / Garden	900	950
Leaves/ Needles	750	800
Soil and Sod	1,800	1,800
Food	680	850
Food-Soiled Paper	600	800
Self-haul		
Brush	300	850
Grass / Garden	800	900
Leaves/ Needles	600	850
Soil and Sod	1,500	1,800

Source: CH2M HILL Team.

The inverse of the density factors in Exhibit 11 are multiplied by the 2024 forecast tons in 2026 resulting in a 2024 organic material forecast on a volume basis. Exhibit 12 shows that over three quarters of the forecasted volume of curbside and self-haul organics are bush and grass/garden; a large portion of which is realized in the spring and summer months. The material forecast shown in Exhibit 12 is provided on a weekly basis by material in Exhibits 13 and 14.

EXHIBIT 12
2024 Residential Curbside and Self-haul Organics Forecast (cubic yards)

	As Delivered	After Grinding
Brush	78,963	30,336
Grass / Garden	34,895	32,923
Leaves/ Needles	13,215	11,429
Soil and Sod	1,370	1,354
Food	18,446	14,756
Food-Soiled Paper	647	485
Total	**147,535**	**91,284**

EXHIBIT 13

2024 Forecast Weekly Residential and Self-haul Organics (cubic yards, as delivered)

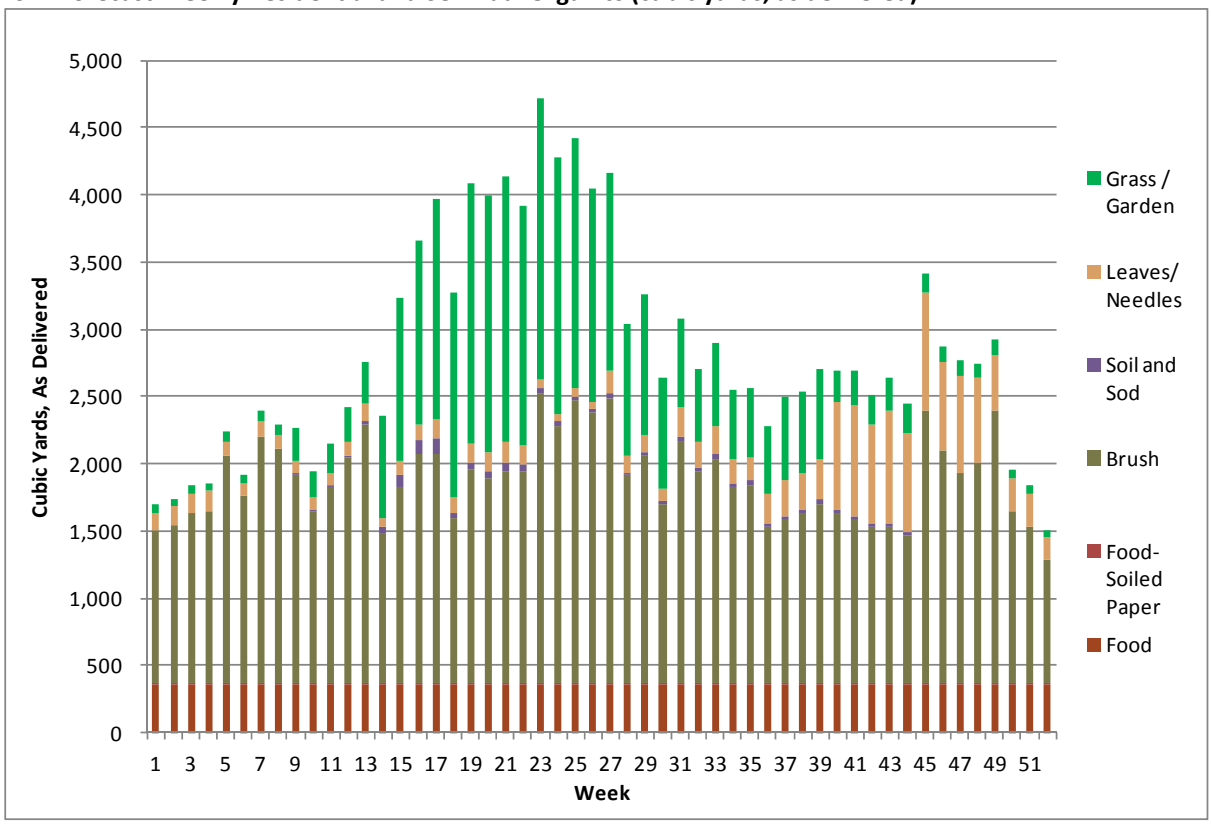
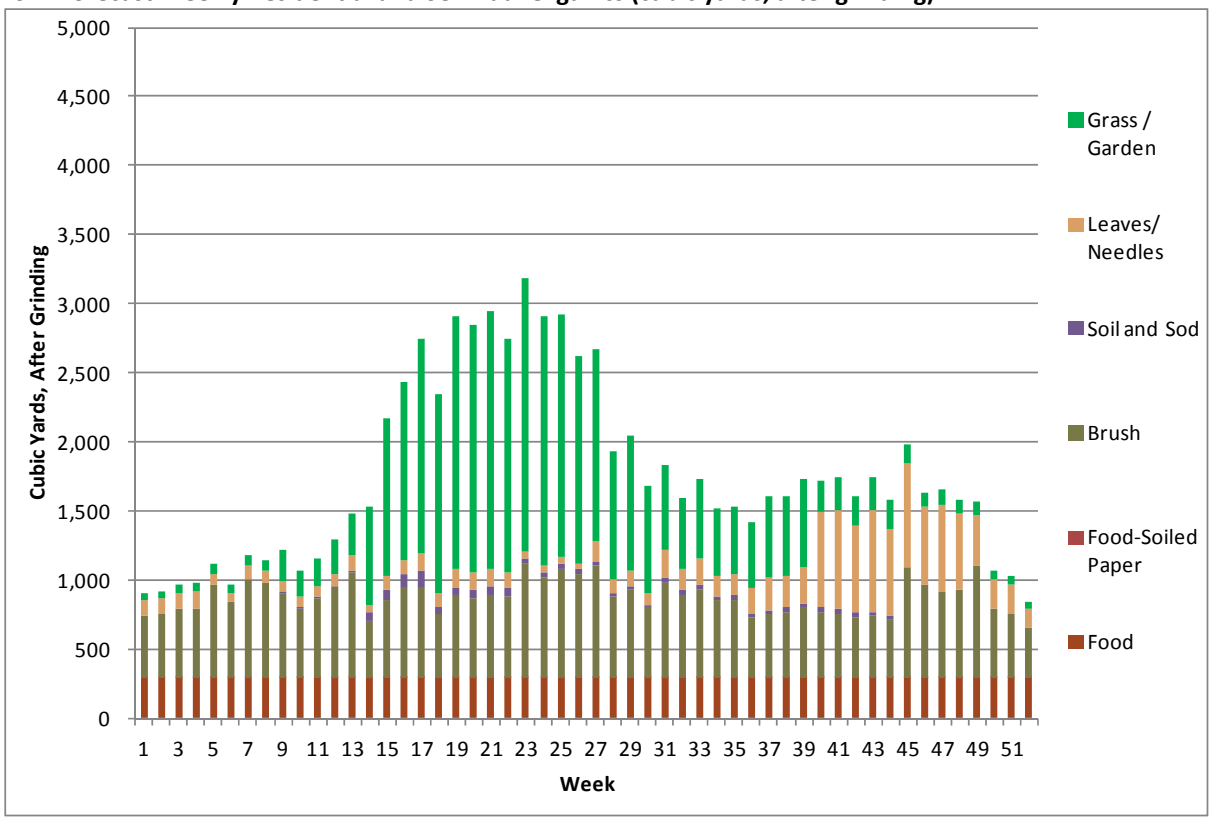


EXHIBIT 14

2024 Forecast Weekly Residential and Self-haul Organics (cubic yards, after grinding)



2.2 Potential Organic Material Available from Other Jurisdictions

CH2M HILL initially contacted Steve Wamback, Pierce County Solid Waste Administrator, and Josh Marx, King County Program Manager for Food Scraps Composting Programs, for direction on contacting local jurisdictions most likely to provide materials for a Tacoma organics management facility.

Steve Wamback informed us that all jurisdictions outside Tacoma in Pierce County have pledged all solid waste to Pierce County's program in inter-local agreements until at least 2020, with some jurisdictions locked in until 2036. Pierce County is currently going through a decision-making process for its solid waste program that includes how to handle organics. Depending on future County Council direction, the County may be able to consider cooperating with Tacoma on an organics management facility and expressed a desire to be kept informed of Tacoma's progress and decisions. Mr. Wamback did suggest we contact the solid waste manager for housing at Joint Base Lewis McChord (JBLM), which is managed by a private contract.

Josh Marx confirmed that King County cities generally franchise solid waste collection, including organics. He suggested that the jurisdictions most likely to be interested in participating in a Tacoma organics management program might be Federal Way, SeaTac, Tukwila, Enumclaw, Kent, and Auburn. We phoned the following solid waste managers for these cities and for JBLM:

- Federal Way: Rob Van Orsow – Solid Waste & Recycling Coordinator – 253-835-2770
- SeaTac : Trudy Olson – Conservation/Neighborhood Programs Coordinator 206-973-4763
- Tukwila: Rebecca Fox – Recycling Coordinator – 206-431-3683
- Enumclaw: Chris Searcy –- Public Works Director – 360-615-5721
- Kent: Gina Hungerford – Conservation Coordinator – 253-856-5549
- Auburn: Joan Nelson – Solid Waste and Recycling Coordinator – 253-931-5103
- JBLM coordinator: Ron Norton – 253-966-6452

The Auburn, Enumclaw, and the JBLM coordinator did not return our calls. Of the four who returned our calls, Federal Way expressed an interest in sending organics to Tacoma. The others said they had no plans to change contractors who were handling their wastes. Federal Way provided organic waste tonnage estimates from 2010 data: Residential – 8,800 tons, Multi-Family – 25 tons, Commercial – 60 tons, Roll-Off (varies) – 315 tons. They currently contract with Waste Management for collection of all waste but are very interested in alternatives for organics and expressed a desire to be kept informed of Tacoma's plans.

2.3 Potential Organic Material from Commercial Customers

The City has made projections of tonnages of commercial organics that could likely be captured in a City-wide collection organics collection program, based on an ongoing pilot program. Exhibit 15 presents a summary of the projections and the pilot data on which they are based. The discussion following in this section was provided by the City.

EXHIBIT 15
Commercial Organic Waste Projections by Category

Category	Restaurant	Institutional	Florist	Grocery	Other	Metro Parks	Total
# in pilot	31	6	6	16	8		67
Total # Contacted	84	18	6	24			132
% Participation	27%	33%	80%	67%			51%
Total # in Tacoma	374	79	21	63			537
Projected participation	101	26	17	42	25		211
Average est. volume (gal/wk)	71	107.5	148	467	57		851
Estimated lbs/gallon	3.75	3.75	3.75	3.75	3.75		3.75
Average est. lbs/week (pilot)	268	403	556	1,751	214		3,192
Average est. lbs/year	13,927	20,963	28,925	91,065	11,115	415,000	580,994
Total pilot tons/year	216	63	87	729	44		1,139
Total projected lbs/year	1,406,604	545,025	491,725	3,824,730	277,875		6,545,959
Total projected tons/year	703	273	246	1912	139	208	3,480

Note: Projections account for City estimates of a drop off in participation if a collection rate is implemented: the pilot program is a free service.

The projections in Exhibit 15 have been based on the experience of Jetta Antonakos, City of Tacoma, in the management and recruitment for the pilot commercial food waste program that has been operated by the City for 2 years. The pilot program maintains service to between 65 and 70 participating businesses, averaging 52 tons per month. The pilot program focuses on businesses in the North Tacoma, West End, and Downtown areas. Participating businesses are not charged for this service. Collection is two times per week. The program targets source separated organic waste, but does not allow compostable plastics or cardboards. Participants put waste in 90 gallon containers or two yard boxes.

Estimates of the weekly volumes generated by current and former participants in the pilot were based on the observations by Ms. Antonakos and the regular pilot program collection driver. The driver provided estimates of how full each business's container was on average. The estimated amount of waste in the container was converted to an approximate volume in gallons that is collected per week at each participating business. The average weight per gallon of waste was calculated by the ratio of the total estimated volume collected per week compared with the reported tons per week collected. The density of the organic waste in the containers was calculated to be 3.75 pounds per gallon. There is some variation between wet restaurant waste and drier florist waste, but this variation in density has been disregarded at this time.

Experience with the recruitment process of how many businesses contacted were willing to participate in the pilot was used to estimate the potential City-wide participation for each category of business. The lists of each category were filtered out of the lists provided by database searches by Ron Alexander, RAA. The lists were filtered to remove businesses that are no longer in business, or are located outside of the City of Tacoma limits. The following is a narrative description of the projections made for each category.

2.3.1 Restaurants

There has been good participation in the pilot program by restaurants. The recruitment process for the pilot program indicated that there are some types of restaurants that are more willing to participate than others. Some characteristics of participating restaurants include the following:

- Manager or ownership that has a strong personal ethic of waste reduction
- Smaller staff with less turn-over; such as family operations
- Space onsite for organic waste containers
- Direct control of the waste disposal contracts

Some factors that may be hindrances to participation include the following:

- Chains or corporately owned restaurants that would need to have changes to waste policy approved
- Locations in malls or shopping centers that may need approval/buy-in by landlords
- Concerns about odors and cleanliness around/in collection containers
- Concerns about the need to train staff
- Limited space for organic waste containers
- Small percentage of waste volumes are organic waste
- Desire to include paper products or other compostable plastic items such as tray liners and utensils
- The manager does not want to take on additional work for staff

Waste volumes collected from the restaurants participating in the pilot program range from 5 to 360 gallons per week, with an average of approximately 100 gallons per week. The database searches generated a list of 374 restaurant type businesses within Tacoma's City limits. The participation rate achieved in the pilot project is 37 percent. A significant portion of the restaurant participants are relatively smaller generators of organic waste. It is anticipated that when the program is expanded to a City-wide program, there will be a rate implemented that will be a hindrance to smaller producers, particularly smaller establishments. Based on this, it is anticipated that another 10 percent of the potential restaurant customers will not participate, and 27 percent of the total potential restaurants would be likely to participate. Based on this ratio, it is projected that up to 101 restaurants could be recruited to participate in a full scale commercial organics collection program, with an average of 71 gallons per week.

2.3.2 Institutional Facilities

The category of institutional facilities includes schools, hospitals, and retirement communities. These types of facilities have kitchens that serve regular meals to their resident populations. Recruitment for the pilot program found that institutional facilities had issues similar to the restaurants, including concerns about odors and cleanliness, training of staff, and the need to have policy changes approved at a corporate level. Several of these facilities started in the pilot program and then subsequently discontinued participation, or participated at a very minimal level. Concerns about the odors and cleanliness in and around the collection containers are a hindrance to full participation by the staff.

Tacoma General Hospital, which has 450 beds and serves up to 2,000 meals daily, has just recently implemented an onsite SOMAT food waste processing system that reduces waste volumes from 300 pounds/day to 25 pounds/day. The system pulps, dewaters, and then dehydrates organic wastes, sending some organic rich liquid waste to the sewer, and generates a small volume of dry, sterile, organic pellets that could be used as an additive to compost or a soil amendment. The SOMAT system equipment costs approximately $75,000, but it is anticipated to have a payback of less than 5 years.

Washington Hoyt Elementary School has participated successfully in the pilot program, thanks in large part to parent volunteers who are dedicated to making it work. Downing Elementary participated for a time, but contamination was not kept out of the waste stream well enough. The schools participating will depend on the support of the district to incorporate the food waste recycling into a broader environmental education curriculum, and will also require the support of dedicated volunteers at each location.

Some of these facilities have indicated interest in including paper and compostable plastic products in the organic waste stream.

Waste volumes ranged from 20 to 220 gallons per week, with an average of about 100 gallons per week. Estimated participation is 33 percent of the institutions, based on participation rate of those facilities contacted.

2.3.3 Florists

Florists are good candidates for commercial organic waste collection. The organic material is not as prone to odor and rodent attraction issues, and is easily separated. Six florists currently participate in that program, with quantities ranging from 20 to 360 gallons per week. It is estimated that 80 percent of florists in the City could participate in an organics collection program with an average of 150 gallons per week.

2.3.4 Grocery

The grocery category includes supermarkets, wholesale produce and meat distributers, farmers markets, and produce markets. There is some seasonal decrease over the winter, particularly from farmers markets and local produce stands.

Overall, participation by grocery stores has been good. There are some concerns from some sites about cleanliness and odor issues around the containers. Safeway stores have a corporate program for handling organic waste that has prevented Safeway stores in Tacoma from continued participation in the pilot program. It is projected that 67 percent of grocery stores could participate in an organics collection program with an average volume of 450 gallons per week.

2.3.5 Other

This category includes office buildings and food banks, and other commercial businesses that may produce organic wastes. Of the contacts made during the survey, the Metro Parks Zoo and the Metro Parks department were the most promising potential organic feedstock producers. Most of the commercial operations that touch organics and food already have identified cost effective ways of handling their organics. This includes local landscaping businesses that are currently able to dump organic wastes free of charge in Pierce County at Waste Connections facility in Puyallup. Average volumes for the participants in the “other” category are approximately 60 gallons per week. An exhaustive list of potential businesses in the “other” category has not been developed. Of the businesses contacted, Supervalu and Trident indicated they might be willing to participate. Other City facilities, such as the TMB and CUW could participate. The City estimates that there could be up to 25 businesses that fall into this category that would participate.

2.3.6 Metro Parks

The Metro Parks department is responsible for maintenance of the park grounds and also operates the Point Defiance Zoo and Aquarium (PDZA). The PDZA produces a large amount of organic wastes, comprised of manure, straw, bamboo, and other vegetation. Vegetative wastes experience seasonal variations typical of YWs. The animal bedding and manure wastes would not fluctuate as much. Metro Parks handles some organic waste through its own limited composting operations, and the bulk of its material is currently handled by LeMay with a 30-yard container that is serviced two or three times a month.

Over a 3-year period from 2009 to 2011, Metro Parks recycled an average of 208 tons per year of organic waste. Metro Parks indicated a strong interest in participating in an organics recycling program operated by the City. Previously, the City had not been able to collect the organics produced by the PDZA because of the presence of animal manure.

2.3.7 Potential Wastewater Biosolids Feedstocks from Outside Tacoma

Tacoma surveyed jurisdictions outside Tacoma for their interest in sending wastewater biosolids to be processed at a Tacoma composting facility. Chambers Creek, Gig Harbor, Karcher Creek, Puyallup, and Lakehaven all responded favorably. They all provided information on the tonnage they may wish to send, which totaled 1,979 tons/year dry solids (10,223 tons per year wet, at solids contents ranging from 17 percent to 23 percent as reported by the jurisdictions). All of the biosolids are digested. Exhibit 16 shows the results of the inquiries.

EXHIBIT 16
Biosolids Inquiry Results

Utility Name	Chambers Creek	Gig Harbor	Karcher Creek	Puyallup	Lakehaven
Would you be interested in disposing of your biosolids at an organic waste management facility run by Tacoma?	Yes	Yes	Yes	Yes	Yes
Do you currently digest your biosolids at your treatment plant or elsewhere?	At the treatment plant	At the treatment plant	At the treatment plant	At the treatment plant	At the treatment plant
How many wet tons per month of biosolids would you send to Tacoma?	45 dt per month	120 wet tons	80 wet tons	343 wet tons	24 dt per month
Does this vary throughout the year?				40% higher in spring	
Would the biosolids be digested?	Digested	Digested	Digested	Digested	Digested
Primary or Secondary?	Both	Secondary	Secondary	Secondary	Both
What is the solids content?	22%	18%	20%	17%	23%
How do you currently dispose of your biosolids?	Dried and distributed	land applied	Land Applied Fire Mountain Farms	Land Applied Tenelco	Land applied in Eastern WA (BPI)
What is the current tip fee and hauling costs for disposal?		$175/dt	$175/dt	$300/dt	
Where are your biosolids generated?	University Place	Gig Harbor	Port Orchard	Puyallup	Redondo facility (Des Moines)

2.4 Feedstock Review Conclusions and Recommendations

The design of a City organics management facility should be based primarily on the material tonnages, volumes, and variations shown in Exhibits 10 and 13. This amounts to a total projected (2024) tonnage of 41,022 tons of residential curbside and self-haul organics. These are the materials that are under the control of the City and for which there is reasonable assurance they will be available.

The potential for significant organics from other jurisdictions in Pierce or southern King County is highly uncertain. Pierce County cities' waste flows are controlled by Pierce County, which is in a long-term decision-making process on this issue as this report is finalized. Of the solid waste managers in six jurisdictions contacted in southern King County, only one expressed interest in considering sending waste to Tacoma, at a rate roughly estimated at 9,000 tons per year (175 tons per week average).

Projections of commercial organics based on pilot program data indicate that approximately 3,500 tons per year, or 65 tons per week, would likely be available if a City-wide commercial organics collection program were introduced. This material would not be expected to have as much seasonal fluctuation as the residential/self-haul organics, except for the Metro Parks contribution, which is only about 6 percent of the total commercial organics projection.

Given the potential, and the uncertainties, associated with collecting organics from commercial and other jurisdictions' sources, Tacoma should consider potentially providing system capacity for 100 to 200 tons per week in addition to the design basis derived from Exhibits 10 and 13, if it wishes to accommodate potential sources of commercial and other jurisdictions' organics, as well as potential commercial sources outside the City that have not been considered. This would allow Tacoma to begin accepting significant quantities of waste from these sources.

Composting technologies should also be evaluated for their ability to handle approximately 200 wet tons of biosolids per week (approximately 10,000 tons/year) in addition to the residential, self-haul, and commercial organic waste quantities. If this evaluation is positive for the technologies selected, then Tacoma may wish to increase the system capacity to handle this amount of biosolids.

3. Technology Evaluation

As part of the feasibility assessment, CH2M HILL undertook a screening and evaluation process to identify the composting and AD processing options that are technically suitable for application at the proposed facility. A comprehensive list of composting and AD technologies was considered including technologies available in Europe and Asia that could be imported into the United States. Potential technologies were identified based on the experience of the team members, as well as a survey of the recent editions of waste management journals and symposia and follow-up contacts regarding new technologies identified. Considerations of each technology included where it has been used, what feedstocks it can handle, and any unique characteristics.

This section discusses the technologies considered, outlines the process followed by CH2M HILL in completing the technology evaluation, and presents the evaluation results.

3.1 Description of Composting Methods and Technologies Considered

A wide range of composting methods and technologies are available that could be used at a proposed composting facility in Tacoma. Descriptions of the major methods/technologies are provided in the following sections. The technologies have been grouped into two broad groups: (1) passively aerated and turned systems and (2) aerated composting systems.

3.1.1 Passively Aerated and Turned Composting Systems

3.1.1.1 Static Pile Composting

Static pile composting (that is, no forced aeration and limited or no mechanical turning) is the simplest and generally the least expensive composting option available. However, it is generally only appropriate for feedstocks with high C:N ratios such as leaves, brush, and wood residuals. This method is not suited for processing feedstocks with low C:N ratios such as food waste and biosolids. Static pile composting is also not suited for use in urban areas since odors can be constantly emitted from the pile, and agitation of older material releases odors as the aerobic process is re-started.

The static pile method of composting involves forming the organic feedstocks into large outdoor windrows. Once built, the windrows or piles are passively aerated via convection and diffusion and decompose over a period of 2 to 3 years. Since there is little or no mixing or turning during that period, it is very important that materials initially be mixed with enough amendment to provide sufficient free air space to allow for movement of air within the pile (that is, high pile porosity).

Although larger static piles are used at some facilities, they should ideally be limited to a height of 5 metres (m). When piles are too large or there is insufficient passive aeration, anaerobic conditions can develop within static piles and odors can be generated that may affect the surrounding community. The weight of overburden materials in higher piles can also compress materials in the pile's base, which leads to further problems related to air flow, porosity, and odors.

Composting of materials using the static pile method takes much longer to complete than other methods due to the lack of agitation and the resulting lower aeration rate. The longer residence time means that a greater amount of space is required relative to other methods which compost materials more quickly.

3.1.1.2 Windrow Composting

Windrow composting is the most common composting method. It requires minimal infrastructure and has low installation and operating costs relative to many other composting methods.

At windrow composting sites, feedstocks and amendments are placed into long, low piles (windrows) that are regularly "turned" using mobile equipment (such as front-end loaders, skid steers, or farm tractors and manure spreaders) or a specially designed windrow "turner". The turning process re-establishes porosity in the material, mixes it, and reintroduces oxygen into the windrow. The oxygen is quickly consumed; in some cases, oxygen is consumed so quickly that anaerobic conditions become established in as little as 30 minutes. Thus, aeration of the

windrows is largely passive and depends on the porosity of the pile. Windrows are typically 1.5 to 3 m-high and 3 to 6 m-wide. The size of the windrow is dictated in part by the type of equipment used to turn it. A balance must be achieved between keeping a small enough cross section to maintain aerobic conditions (through passive aeration) and a large enough pile to retain heat and achieve temperatures high enough to evaporate moisture and kill pathogens.

Windrow composting is mostly done outdoors where it is exposed to precipitation. This can lead to runoff management problems. Any runoff created must be collected and treated or added to a batch of incoming feedstock to increase its moisture content. To avoid problems with runoff, piles can be placed under a roof or in a building, although this adds to the life cycle costs of the facility.

The windrows are usually situated on a firm working surface, or "pad", which is constructed to support the loads imposed by delivery vehicles and turning equipment without rutting. The pad is normally sloped (0.5 to 2 percent) to direct drain run-off towards a collection ditch or detention pond. The most common types of composting pad surfaces are concrete, asphalt, cement treated base (granular soils amended with small amounts of Portland cement), and compacted gravel.

Photo 1: Windrow composting facility in British Columbia

Every time a windrow is turned, heat, water vapor, and gases trapped in the pore spaces are released into the atmosphere. If the facility is outdoors, there is little that can be done to capture the water vapor and gases; as a result, this method of composting has the potential to release odors that can affect adjacent neighbors. Therefore, windrow turning should always be done at times when it will have the least impact. Suitable buffer zones should also be incorporated into the facility layout and design.

Composting of materials in windrows typically takes in the order of 12 to 26 weeks depending upon such factors as the type of feedstock(s), weather conditions, and the frequency of turning.

In addition to feedstock and amendment quantities, the amount of space required for windrow composting is determined by windrow size and spacing, which is determined by the type of turning equipment used. Generally, facilities that rely on straddle-type windrow turners can manage more material in the same amount of space than a site that uses front-end loaders or manure spreaders to turn the windrows.

Photo 2: Elevated face windrow turner

3.1.1.3 Turned Mass Bed Composting

Turned mass bed composting is a plug flow system that improves upon aspects of traditional windrow composting. This approach relies on a specialized windrow turner, and the use of very wide windrows or "mass beds" that have a normal length and height (for example, 30 to 100 m long, 1.8 to 2.4 m high) but are 15 m or more in width.

The original turners designed by SCAT Engineering were, and still are, used to process individual windrows. Available in both towed and self-propelled configurations, these units use an inclined conveyor to turn the compost, rather than a rotating drum as is used by most other windrow turners; as the turner travels down the length of a windrow, the inclined conveyor lifts the material and throws it straight backwards from the top of the conveyor.

To allow for a mass bed, the self-propelled turners were modified in the 1990s with the addition of a horizontal "cross conveyor" on the back of the unit. As the modified turner travels down the length of the windrow, the material is still lifted and thrown backwards by the incline conveyor; however, rather than falling straight backwards behind the turner, the horizontal conveyor catches the material and throws it to the side of the turner opposite the inclined conveyor.

The side throwing action of the modified turner allows it to work sequentially from one side of the mass bed to the other. Each time the turner makes a pass through the bed, it picks up the material to its right and throws it to the left, and in the process creates a new drive aisle to its right. The unit then backs up, moves to the right, and repeats the process down the newly created aisle. Once the mass bed has been completely turned, it will have been physically relocated 6.0 to 7.5 m to the left. Typical residence times in the bed are similar to those for turned windrow composting (that is, 12 to 26 weeks).

Photo 3: Self-propelled mass bed turner with discharge conveyor

The turned mass bed composting method can be further improved by combining it with an in-floor positive or negative aeration system, and can be situated outdoors or in a building. It can be expected that the residence time of material in an aerated turned mass bed system would be similar to a traditional ASP system (see below). Typical aeration times are 3 to 4 weeks, followed by 3 to 6 weeks of curing to produce finished compost.

Although unaerated turned mass bed systems are becoming more popular, they are still not as well known as windrow composting systems, and examples are limited. The City of Edmonton used an unaerated mass bed approach to optimize use of its 8-plus hectare (ha) outdoor curing site. Lenz Enterprises also uses this approach at its private composting facility in Stanwood, Washington.

3.1.1.4 Passively Aerated Windrow Composting

This method of composting is a hybrid of the static pile and ASP methods. In a passively aerated windrow (PAW) system, long windrows of the feedstock/amendment mixtures are constructed over a network of perforated pipes (typically 100 millimetres [mm] in diameter). The pipes are placed every 0.5 m to 1 m along the length of the windrow, and are covered with a 250-mm base layer of finished compost, straw, or wood chips. The pipes extend laterally to the outside of the windrow, and are open ended so that air can enter them and to naturally diffuse through the feedstock/amendment material without the use of aeration fans.

A 250-mm-thick layer of finished compost is normally placed over the surface of the windrow to discourage insects and help with the retention of moisture. The outer layer also helps to manage odors.

The increased amount of aeration relative to the traditional static pile method theoretically allows for quicker processing times. However, there is limited experience with this method, so it cannot be confirmed. Processing times are, therefore, generally estimated to be between 1 and 2 years.

3.1.2 Aerated Composting Systems

3.1.2.1 Outdoor Negatively Aerated Static Piles

Developed in the early 1970s, this method has been successfully used for leaf and YW, food waste, animal mortalities, animal manures, biosolids, and industrial waste composting. ASP composting offers less exposed pile surface; less agitation; and, when designed to operate using negative aeration and treatment of the off gasses, it allows for a higher level of odor control than static pile and windrow composting.

Photo 4: Typical ASP system with above-ground piping. Blowers are located behind the lock block push wall in back

Feedstocks are mixed and piled to depths of between 1.5 and 3.6 m overtop of some form of air distribution/collection network. There is no standard width or length for aerated static piles; the configuration often depends on site-specific situations, feedstocks, and land availability.

The air distribution network can consist of solid and perforated pipes laid on the ground and bedded in wood

chips, or a below-grade air system such as narrow trenches with perforated covers or buried pipes with spigots or grates at the surface. Below-grade systems are more costly to construct, but allow for quicker pile construction and tear-down and more efficient operations. They also eliminate the risk of damage and the need to replace above-ground piping.

Air is forced through the distribution network using low-pressure aeration fans. Aeration can be either positive (that is, air is blown through the piping network and into the pile) or negative (that is, air is drawn down through the pile and into the piping network).

Negative aeration generally allows for better odor control, but requires aeration fans constructed with corrosion-resistant materials. When negative aeration is used, the concentration of odorous compounds in the air removed from the pile will be much higher and some form of treatment is needed. The most common practice is to exhaust the air from the pile through a biofilter.

Air flow can be continuous or intermittent. Continuous operation of blowers allows for lower air flow rates but excessive cooling may result if the system is not carefully designed and managed. Overcooling piles can prevent the temperatures needed for pathogen destruction from being reached. Temperature control feedback to variable frequency drive fans is needed to maintain pile temperatures at desired levels with this configuration. A major benefit of continuous negative aeration is the much greater capture of fugitive pile odors for collection and treatment through biofiltration.

It is more common for blowers to be operated intermittently. Aeration fans are typically controlled by a timer, or by a computerized system that measures temperatures in the piles and turns the fans on and off – much like a home thermostat.

ASP systems are often designed based on using individual piles that are spaced 1 to 2 m apart, or individual piles that are contained within three-sided bunkers. A variation is to design an extended pile configuration where piles are built up against each other with no physical separation. This configuration allows for a greater quantity of material to be processed on a given area.

Since ASPs are not turned regularly, care must be taken during the blending of feedstocks with structural amendments to maintain adequate porosity throughout the composting period. It is important to achieve a homogeneous mixture and not compact the material with machinery while constructing the pile, so that air distribution is even and no anaerobic areas develop, resulting in sections of poorly composted material. Typical aeration times are 3 to 4 weeks, followed by 3 to 6 weeks of curing to produce finished compost.

There are many examples of outdoor negatively ASP composting systems in North America. Two of the largest facilities are the Synagro facility in Kern County, California, which processes biosolids; and Fraser-Richmond in Vancouver, British Columbia, which processes green waste and food waste.

3.1.2.2 Outdoor Covered Aerated Static Piles

The concept of using covers overtop outdoor ASP composting systems is a natural progression that has evolved over the past few decades. While there are many variations, the covers generally protect the pile from precipitation; reduce evaporative loss of water from the compost pile; contain litter that may be in the compost pile; reduce vector attraction; and, in some cases, help to control odors and volatile organic compound emissions.

Photo 5: Ag-Bag composting system in California circa 2002

One of the early adopters of covered ASP systems is Ag-Bag Forage Solutions. This system is based on the use of “compost pods” or “EcoPods” that are made from polyethylene film, and vary in lengths up to 60 m. The compost pods resemble plastic silage tubes, and are either 1.5 m or 3 m in diameter. The tubes are perforated to allow air movement and leachate drainage. Feedstocks are “injected” into the tube as it is unrolled using a

special piece of equipment that also places one or two flexible plastic aeration pipes in the bottom of the tube. When the pods are filled, the ends are sealed and the pipe(s) in the base are connected to a positive aeration system. When the composting is complete, the plastic tubes are cut open, and the materials are removed.

An Ag-Bag system has been used at the Z-Best Composting Facility in Gilroy, California for more than 10 years.

Covered ASP composting using "engineered" covers was pioneered by W.L. Gore and Associates Inc. in Europe, and was introduced to the North American market in the late 1990s. This introduction of the Gore Cover System spurred the development of additional covered systems, and renewed interest in the use of various hi-tech fabrics to cover outdoor composting systems.

The Gore Cover System is based on a positive ASP composting system. Depending upon the installation, it uses in-ground aeration trenches, or aboveground aeration piping to push air through the composting pile, and the aeration fan is controlled by temperature and oxygen sensors via a control computer. Once the composting pile is built, it is covered by a large Gore-Tex tarp that measures 10-m wide and up to 50-m long. The Gore-Tex membrane within the tarp helps to treat odorous process air as it diffuses through the tarp.

Photo 6: Gore Cover system processing biosolids in Atlantic Canada.

The composting process below the Gore-Tex tarp takes place at a much higher temperature: 80 to 90 degrees Celsius (°C) rather than the 55 to 60°C that most other composting systems operate at. Another differentiator of this composting system is its low energy requirement relative to ASP and other aerated systems. A typical full-scale pile (900 to 1,000 cubic meters [m^3]) uses only a 1.5 kilowatt (kW) (2-horsepower [hp]) aeration fan which operates intermittently (that is, 5 to 10 minutes per hour). However, these systems have a longer active composting phase (that is, 8 weeks) relative to an ASP system with higher aeration rates (typically 3 to 4 weeks).

Gore Cover systems have been installed in several locations in the United States and Canada, including Seattle, Washington; Edmonton, Alberta; Moncton, New Brunswick; Toronto, Ontario; and Wilmington, Delaware.

Engineered Compost Systems, Inc. (ECS) introduced their covered ASP system, called "AC Composter", to the marketplace in the mid-2000s. The AC Composter system is based on the negative ASP systems previously designed by ECS. It normally consists of the following major components: the AC Cover, ECS's Comptroller control and monitoring system, and a negative aeration fan system and associated aeration floor. The AC Composter can also be paired with ECS's "CompDog" pipeless above-grade aeration system, or an above-grade high density polyethylene pipe aeration system.

ECS AC Composters have been installed in Dixon, California; Silver Springs, Washington; Okeechobee, Florida; and Spokane, Washington.

Managed Organic Recycling, Inc. (MOR) sells composting systems that are based on using one of its three available covers. MOR's "Platinum Cover" consists of a breathable membrane that is laminated between two layers of polyester that provide ultraviolet and wear protection. The "Silver Cover" is marketed as providing uniform composting performance in terms of both temperature and moisture control, while also protecting composting piles from climatic influences. MOR's "Gold Cover" is a combination of the two covers, and consists of a center strip of Platinum Cover material (that sits overtop the top of the composting pile) bordered on either side by Silver Cover material (intent to cover the compost pile's sides). MOR also offers both above-grade and in-ground aeration systems.

MOR has recently installed a covered composting system to handle biosolids generated by the Central Valley Water Reclamation Facility in Salt Lake City, Utah.

Although covers on these various systems can be placed manually, mechanical "winders" are typically provided by the vendors. Weights (such as, sandbags, tires, or water-filled hoses) are used around the perimeter of the piles to seal the edges of the tarp on the ground and prevent process air from short-circuiting.

3.1.2.3 Indoor Aerated Static Piles (Positive and Negative)

Enclosed ASP composting is simply an indoor variation of the outdoor technology previously described; the processing systems are usually identical, but are housed within fabric-type or steel buildings.

Photo 7: ASP composting system inside at building in Lakeside, Arizona

The composting process can release large amounts of heat, dust, and water vapor. As a result, there is the potential for buildings that house ASP systems to have a rainforest-like environment, with interior fog obscuring visibility and condensation dripping from the ceiling interior. This is particularly true when positively aerated systems are used and in colder climates.

Due to these operating conditions, the interior environment and materials used to construct the buildings are critically important for sustaining safety and building integrity. Some enclosed facilities have proved to be inadequate with regard to corrosion protection, interior visibility, and indoor air quality. These problems are often related to low air exchange rates for the building interior, or to questionable ventilation system design.

There are many examples of ASP composting systems enclosed within buildings. One of the largest installations is the Inland Empire Regional Composting Authority's biosolids composting facility in Rancho Cucamonga, California, which is located in a former IKEA warehouse. Other examples of facilities that use indoor ASP composting systems include the City of Davenport's biosolids facility (Iowa) and Pinetop-Lakeside Sanitary District in Lakeside, Arizona. Roofed only ASP composting systems (that is, no walls) allow for natural ventilation that can prevent severe fogging problems while at the same time preventing precipitation impacts. An example of this type of operation is in Spotsylvania County, Virginia.

3.1.2.4 Enclosed Channel

A channel composting system is essentially a turned windrow that is sandwiched between two long, parallel concrete walls. The walls are typically up to 3-m high, and between 3- and 6-m apart. Unlike outdoor turned windows, which form a natural triangular cross-section, the compost fills the space between the walls, which allows for more efficient use of space.

Operationally, feedstocks are mixed with amendments, and the combined material is placed in the receiving end of the channel. The materials are subsequently moved down the length of the channel by a specialized turning machine. The turner rides along the tops of the concrete walls, and has an inclined conveyor, augers, or drum-mounted flails that extend down into the material. Every time the turner passes down the channel, materials are physically lifted and moved 3 to 4.5 m down the length of the channel. As the turner makes repeated passes down the channel over time, it gradually moves the mass of material from the receiving to the discharge end. Normally, one turner is used to service multiple channels, and is moved between channels using a carriage system at the loading or discharge end of the channels.

Photo 8: Channel composting system in Edmonton

Residence time of materials in the channels is typically between 1 and 4 weeks. The system is normally designed such that the active composting process is largely completed by the time that the compost is discharged from the end of the channel. At the end of the active composting period, the treated material is typically placed in outdoor windrows or ASPs to complete the composting process.

Photo 9: The Compost Factory near Seattle, WA uses a turned mass bed system with reversing (positive/negative) aeration inside a building

A forced aeration system in the floor of the channel, similar to that used with ASP systems, is used to provide oxygen and manage temperatures. Positive aeration systems are the most common.

3.1.2.5 Turned Mass Bed (Aerated and Enclosed)

The turned mass bed system previously described in Section 3.1.1.3 can be improved by providing an aeration system and enclosing the entire system within a building. The provision of aeration improves the performance of the system, while the building enclosure allows for increased control over odors and other nuisance conditions.

Aerated turned mass bed systems are less common than unaerated turned mass beds; only two facilities are known to use this approach. Both facilities are in the Seattle area, and are owned and operated by Pierce County Recycling, Composting and Disposal (formerly LRI). The company's Purdy facility was constructed in the 1990s near Gig Harbor, Washington and uses aerated mass beds under a roof structure. The Compost Factory was constructed in Puyallup, Washington in the early 2000s and is fully enclosed within a building.

3.1.2.6 Agitated Bed

An agitated bed composting system is similar to a turned mass bed system, except that it incorporates a much higher degree of automation. These types of systems excel in larger installations where high volumes of material are handled.

Photo 10: Agitated bay system in Lunenburg, NS viewed from discharge end of bay

The system consists of a large bed of composting material that is enclosed within a three- or four- sided bay. Perimeter walls around the bay allow for material depths in the order of 3 m. The bay is equipped with an aeration system in their floor, similar to that used with ASP and tunnel systems. Both positive and negative aeration can be used, but negative aeration is more common in North American installations.

Material in the bay is turned every 1 to 2 days using an automated system. The turner consists of an auger or flail which is suspended from a bridge crane that spans the bay. The movement of the turner along the bridge crane, combined with the bridge crane's ability to travel up and down the length of the bay, enables the turning device to access all areas of the bay. Operationally, materials are placed along the receiving side of the bay using front-end loaders or conveyor systems. The materials are subsequently moved across the bay by the turner, which follows a "serpentine path" from the bay's discharge end to its receiving end. As the turner makes a lateral pass across the bay, the augers or flails physically lift material and move it towards the discharge end. Over time, as the turner makes repeated passes through the bay, the fresh material moves completely across the bay to the discharge end and is removed from the bay using front-end loaders or conveyors.

Photo 11: Bridge crane and suspended auger turning mechanism in Edmonton, AB viewed from discharge side of bay.

Residence time of materials in the bay is typically around 3 to 4 weeks. The system is normally designed such that the active composting process is largely completed by the time that the waste is discharged from the bed. The discharged materials are typically placed in outdoor windrows to complete the curing process.

The two vendors that have installed systems in North America are Sorain Cecchini and Ebara. The latter is represented in North America by Miller Composting.

Agitated bed systems have been installed in Edmonton, Alberta; Pickering, Ontario; Halifax, Nova Scotia; and Lunenburg, Nova Scotia.

3.1.2.7 Static Containerized Systems

Static containerized systems are a type of aerated system that uses one or more modular composting vessels. These containers are very similar to the 30 m^3 roll-off containers used in North America for handling commercial solid wastes. The size of the individual containers makes them portable and they can be moved around the facility. They are also "modular", as additional containers can be added as more capacity is required.

Photo 12: Containerized composting system manufactured by Engineered Compost Systems

The containers are filled through sealable doors in the rear or roof of the container. Once filled, the containers are connected to a stationary aeration system that is capable of providing air to multiple bins. Air exhausted from the vessels may be passed through a biofilter to help mitigate odors.

After 2 to 4 weeks of composting, the containers are emptied by hoisting them onto a truck with a specialized lifting system, and tipping the material out the rear doors, much like a dump truck. This same truck is used to move empty and full containers around the site.

The residence time of material within these systems generally ranges from 2 to 4 weeks, and thus they are designed only to stabilize organic wastes. The material that is discharged from the systems must be further cured and matured before being used as a soil amendment. The curing time can take several weeks to several months, depending on the material being processed, the level of management, and external conditions.

Containerized composting system vendors include Engineered Compost Systems, Green Mountain Technologies, Stinnes, and NatureTech. Static container composting systems have been installed in Brookfield, Price Edward Island; Okotoks, Alberta; Livingston, Montana; and Gypsum, Colorado.

3.1.2.8 Agitated Container and Vessel Systems

Agitated container and vessel systems are generally stationary and operate on a continuous flow basis. Like static containers, agitated container and vessel systems tend to have smaller capacities and are modular. This makes them well suited to facilities with smaller amounts of feedstock, or facilities that will be developed and expanded over time.

The composting system manufactured by Wright Environmental Management Inc. (Wright) is a stationary container-type system that relies on a moving floor system to slowly walk materials from the unit's inlet end to its discharge end. Parameters such as temperature, moisture, and oxygen levels are monitored throughout the process. One or more sets of "spinners" are located along the length of the unit to agitate materials and break up clumps, and water can be added at these points also.

Photo 13: Wright composting system installed at a university campus.

The Wright system is available in a wide range of sizes, from 450 kilograms (kg) per day to several tonnes per day, and additional

processing capacity can be achieved by using multiple units in parallel. The size of the units varies based on capacity; smaller units can fit inside a single parking stall while larger units are typically 3- to 5-m wide and have lengths exceeding 7 m. Installations of this system are commonly designed with a retention time of 14 days; however, longer retention times are possible by lengthening the unit.

Wright composting systems have been installed in Vancouver, British Columbia and Orlando, Florida.

Photo 14: Hot Rot's mid-sized composting unit

The Hot Rot Composting System is a continuous flow system similar in concept to the Wright system; feedstocks are injected into one end of the process and are slowly moved to the discharge end. The difference is that rather than a moving floor, the Hot Rot system uses an auger that runs along the length of the vessel to move materials towards the unit's discharge end. The auger is driven by a motor and gear-box that are situated outside of the processing chamber and are therefore readily accessible for maintenance.

The Hot Rot system is available in four sizes with capacities ranging from 500 kg per day to 11.5 tonnes per day. Higher capacities can be obtained by operating multiple units in parallel. The smallest unit is approximately 8-m long and 1.5-m wide, while the largest unit is almost 22-m long and 5-m wide.

Hot Rot units are manufactured in New Zealand, and have been installed in wholesale garden markets, zoos, and municipal applications. In North America, units have been installed in Halifax, Nova Scotia; and Chico, California.

3.1.2.9 Tunnel Composting Systems

Tunnel composting systems are provided by several vendors including Gicom, Engineered Compost Systems, Christiaens, and Herhoff. The technology is similar in concept to a static container system, except that it is done on a larger scale.

Photo 15: Interior view of tunnel composting system in Banff, AB

A typical tunnel composter uses a positively aerated composting system with below-floor aeration pipes. The aeration floor and the composting pile are housed completely within a cast-in-place concrete enclosure. These enclosures are in the order of 4- to 6-m wide, 20- to 30-m long, and 6-m high; and are designed to allow front-end loaders to drive in and out of them to load and remove materials. A custom-designed door system is used to seal the front of the composting tunnel. These doors are slid manually laterally on tracks (similar to a barn door) or are hinged and operated using hydraulics. Locking mechanisms and rubber door gaskets are used to keep the tunnel sealed while in use.

Photo 16: Tunnel door at composting system in Banff, AB

Like other aerated systems, residence times are in the order of 2 to 4 weeks, and further curing of the compost is needed before it can be used.

Tunnel composting systems have been installed in Comox, British Columbia; Mariposa, California; West Yellowstone, Montana; Guelph, Ontario; Hamilton, Ontario; Ottawa, Ontario; Fort McMurray, Alberta; and Banff, Alberta.

3.1.2.10 Rotating Drum Systems

Several small-scale horizontal rotating drums systems have been developed during the past decade, modeled on the large-scale drum systems made popular for mixed-municipal solid waste (mixed-MSW) composting by Bedminster Bioconversion in the 1990s.

The small-scale drum systems typically consist of a steel drum with a diameter of 1.5 to 4.5 m, and a length of up to 10 m. The drums are positioned on a slight incline (less than 5 percent), so that gravity assists material injected into the drum's upper end in travelling to the lower end, where it is removed. Depending on the size of the drums, they are driven by large ring-gears, rubber trunions, or sprockets and chains. Large drum systems typically have diameters in the 3.6- to 4.5-m range, and lengths of up to 75 m.

Manufacturers of small-scale drum composting systems include Transform Compost Systems, X-Act Systems, and International Composting Corporation.

3.2 Description of Anaerobic Digestion Technologies Considered

The AD process can be used to break down organics materials in the absence of oxygen. As well as stabilizing organic materials and reducing their volume, the AD process results in the production of "biogas" composed predominantly of methane. Biogas can be captured and refined into boiler fuel, fuel for electrical generators, or fuel for vehicles (that is, compressed natural gas [CNG]).

There are a numerous AD systems available for processing organic components from the solid waste stream. Typically, these systems are proprietary and are provided as a technology package by vendors. Among these systems that are available are several that have not been applied successfully at full scale. Due diligence must be performed when evaluating and selecting AD systems, for they are mechanically complex and require many safety features.

AD systems vary widely in terms of the pretreatment steps involved, the amount of moisture added to the feedstock prior to digestion, operating temperature ranges, number of digestion stages, and the means of controlling specific process variables. Secondary systems for treatment of semi-solid residuals from the digestion process (called digestate) and refining of biogas into value-added products also differ, although there is not the same level of variation as with AD systems

AD systems are often categorized based on the solids content (or conversely, the water content) of the feedstocks as they are placed into the digester system, since this is the most important factor governing equipment design. There is some inconsistency in the industry regarding the exact meaning of "dry" vs. "wet" and "low solids" vs. "high solids," mainly because solid waste digester technology is continuously evolving. In keeping with the most recent applications of solid waste AD technologies, CH2M HILL has adopted the terms "high solids" and "wet" as the primary categories. The distinction between these two categories is as follows:

- High Solids: Systems with typically less than 80 percent water content (greater than 20 percent solids). Feedstocks are typically handled as a solid material with front-end loaders (high-solids-stackable systems), or processed into a slurry (high-solids-slurry systems) and handled using specialized pumping systems.
- Wet: Systems with greater than 80 percent water content (less than 20 percent solids). Feedstocks are dissolved or suspended in a liquid form and are handled as a liquid.

Exhibit 17 provides a summary of the key characteristics of the three main system types.

EXHIBIT 17
Classification of Solid Waste AD Systems

Digester Type	Moisture Content of Feedstocks within Digester	Feedstock Consistency
High-Solids-Stackable	Less than 60%	Stackable materials
High-Solids-Slurry	60 to 80%	Wet but not liquid
Wet	Greater than 80%	Liquid

A secondary means of classifying AD technologies is whether the digestion process occurs in a single vessel, or two (or more) sequential vessels. In two-stage and multi-stage AD systems, the first stage is generally operated at pH 5 to 6, which is near optimal for organisms that break down large organic molecules, but not for methane-forming bacteria that produce biogas. In the second stage and subsequent stages, the pH is raised into the 6.5 to 7.2 range to optimize the system for methane formers. In a single-stage system, both steps of the digestion process occur in the same vessel, but the conditions are not optimal for either.

Both high solids and wet systems can be configured as single- or multiple-stage digesters. Both types of systems can also be designed to operate in either the mesophilic temperature range (that is, 30 to 38°C) or thermophilic temperature range (40 to 60°C). The main distinction between these two operating temperature ranges is the speed at which the digestion process occurs and the rate at which biogas is produced. The reactions that take place during the digestion process generally occur at a faster rate at thermophilic temperatures than at mesophilic temperatures. Thus, technologies that operated at these higher temperatures allow for higher throughput and a faster rate of biogas production. However, this comes with a cost: external heat is required to maintain the higher temperatures.

Additional details on each of the three main types of AD systems used for processing solid wastes are provided in the following sections. An overview of the systems is provided in Exhibit 18.

EXHIBIT 18
Summary of Key Characteristics of Solid Waste AD Technologies

Characteristic	Digestion System Type		
	High-Solids-Stackable	**High-Solids-Slurry**	**Wet**
Waste Pretreatment/ Preparation	• Requires limited pretreatment: – Debagging, screening, and mixing – No aggressive size reduction – Needs bulking material (e.g., shredded or ground-up L&YW) to provide porosity – Particle size should be less than 20 cm	• Requires some pretreatment: – Debagging, aggressive size reduction (e.g., shredder) – No need for bulking material – Maximum particle size must be less than 5 cm to be pumpable	• Requires high level of pretreatment: – Debagging, aggressive size reduction (e.g., shredder) – Remove floatables and settleables – No need for bulking material – Particle size typically must be less than 5 cm to be pumpable
Moisture Addition	• Most SSO wastes require no water addition • Requires water content to be less than 60% • Typically requires 0.05 m^3 water per wt of waste	• Most SSO wastes require water addition • Requires water content to be 60% or greater • Typically requires 0.10 m^3 water per wt of waste	• All SSO wastes require water addition • Requires water content 80% or greater • Typically requires 0.5 m^3 water per wt of waste
Digester Design	• Typical Design Ranges: – Configuration: Concrete tunnels with tight doors – Operating Capacity: 10 000 to 100 000 wt SSO/year – Retention Time: 14-30 days • Mode of Operation: Batch	• Typical Design Ranges: – Configuration: Plug-flow or continuously stirred tank – Operating Capacity 3 000 to 250 000 wt SSO/year • Retention Time 14-30 days • Mode of Operation: Continuous or Batch	• Typical Design Ranges: – Configuration: Continuously stirred tank – Operating Capacity: 3 000 to 250 000 wt SSO/year • Retention Time: 14-40 days • Mode of Operation: Continuous

EXHIBIT 18
Summary of Key Characteristics of Solid Waste AD Technologies

Characteristic	Digestion System Type		
	High-Solids-Stackable	**High-Solids-Slurry**	**Wet**
Digestate Handling and Characteristics (Quantity and Quality)	• Digestate (solid material) removed by front-end loaders • Typical moisture of digestate between 50 and 60% water content by weight • Does not require dewatering before composting • Typically needs to be composted: – Can be added to other compost feedstocks, such as L&YW – Can be composted separately – Compost times typically reduced due to partial decomposition during digestion • Quantity: 0.85 tonnes per tonne of wet SSO processed	• Digestate pumped out of the digester • Typical moisture content of digestate prior to dewatering between 70 and 90% • Typically requires dewatering to a water content around 50% using filter/screw presses or other techniques commonly used in WWTPs for biosolids dewatering • Typically needs to be composted: – Can be composted to a humus-like condition – Compost times typically reduced due to partial decomposition during digestion – Can be dried and used as fertilizer if it contains adequate nutrients and does not contain substances harmful to plants carried over from feedstocks and not destroyed in the digestion process • Quantity: 0.85 tonnes undewatered digestate per tonne of wet SSO processed	
Effluent Characteristics (Quantity and Quality)	Effluent consists of excess percolate water *Quantity: up to 0.1 m^3 per tonne of SSO* • Almost all percolate from the digester is recirculated • With some wetter feedstocks, excess percolate may need to be disposed to a treatment facility	Effluent comes from the dewatering of the digestate *Quantity: 0.1 to 0.3 m^3 per tonne of SSO* • As much as 30% of the water fed into the digester may be discharged as effluent	Effluent comes from the dewatering of the digestate *Quantity: 0.4 to 0.7 m^3 per tonne of SSO* • As much as 45% of the water fed into the digester may be discharged as effluent
	Quality: • BOD_5 : 2000 to 5000 mg/L • SS: 50 to 5000 mg/L • Ammonia as N: 1000 to 3,000 mg/L	*Quality:* • BOD_5: 1 500 to 15 000 mg/L • SS: 50 to 5000 mg/L • Ammonia as N: 1000 to 3,000 mg/L	*Quality:* • BOD_5: 1 500 to 15 000 mg/L • SS: 50 to 5000 mg/L • Ammonia as N: 1000 to 3,000 mg/L
Unacceptable Materials	• Contaminants, such as glass, metals, and plastics present in feedstocks and removed before, during, or after digestion • Typically landfilled		
Net Energy Production (Electrical)	• 170 to 250 kWh/wt SSO	• 145 to 220 kWh/wt SSO	• 110 to 160 kWh/wt SSO
Waste Type	• Food waste mixed with YW or other bulking materials	• Food wastes, food processing wastes, shredded leaves and grass, and other liquid and semi-liquid wastes	• Wastes that are in liquid form, such as dairy manure, juices, cheese whey, spoiled milk, hydropulped SSO.

Notes:
* Net Energy Production is the electrical output minus the electrical and thermal energy consumed by the digester.

BOD5 – 5-day biological oxygen demand
cm – centimeter
kWh/t – kilowatt-hour per tonne
L – litre
L&YW – leaf and yard waste
N – nitrogen
mg/L - milligrams per liter
SS – suspended solids
t – tonne
wt – wet tonne

3.2.1 High-Solids-Stackable Digestion Systems

High-solids-stackable AD systems are a relatively recent development in AD technology that are appropriate for feedstocks with a moisture content of less than 60 percent and which can be "stacked" in piles with wheel loaders or other material handling equipment. These systems do not liquefy or submerge the feedstocks in a tank. Instead, effluent water (called percolate) is recirculated through the feedstocks. High-solids-stackable AD systems are particularly appropriate for food waste from commercial and residential sources.

Photo 17: Stacking materials for a high-solids AD system

In these systems, the feedstocks are manually placed in tunnels using front-end loaders. After loading, a gas-tight door on the tunnel is closed, and water draining from the material is recirculated to spray nozzles above the waste to carry microorganisms and nutrients through the waste mass. The material typically remains in the tunnel for 14 to 30 days, depending on the specifics of the process. At the end of this period, the solid residual (called digestate) is removed and further processed.

This AD process may be implemented as either a thermophilic or mesophilic process, and it may be implemented as a single- or two-stage process.

In a single-stage system, percolate is recirculated directly back to the tunnel where the feedstocks are held and digested rather than through a secondary digester vessel. Biogas is also collected directly from the tunnel that holds the feedstocks. The biogas in this system is being used as fuel in a combined heat and power unit, which generates electricity by burning the gas in an engine-generator set. Heat from the engine's cooling water jacket is used to heat the digester rather than being radiated to the air.

In a two-stage, high-solids- stackable AD process, the first stage occurs in the tunnel, which is operated to maintain the pH in a range of 5 to 6. Microorganisms degrade the larger organic molecules to soluble sugars and fatty acids, which are then pumped with the percolate to a second-stage, small, wet digester before being recirculated back to the tunnel. In two-stage systems, biogas is collected primarily from the second-stage digester.

High-solids-stackable AD systems that are use concrete tunnels can manage 10 000 tons per year (tpy) or more of SSO feedstocks. A typical installation includes a receiving and pre-processing facility, concrete tunnels, liquid storage tanks, and biogas storage/conversion equipment. A 30,000 tpy facility using this technology (but excluding digestate composting or other processing) would require approximately 1 acre of land. Larger facilities require more land proportion to their capacity, although some technologies optimize space utilization by employing taller storage tanks.

Some vendors offer modular high-solids – stackable AD systems that rely on smaller tunnels built from materials other than concrete. These systems are less expensive and may be cost-effective at capacities at below 10 000 tpy of feedstock input. Feasibility is dictated by project specifics considerations such as tipping fees, biogas usage and energy costs.

Screening and mixing are typically required as pre-processing steps for this technology, and the maximum feedstocks particle size should be in the 5 to 8 inch range. Food wastes must also be mixed with "structural" materials, such as shredded or ground L&YW so that the mixture has enough permeability for uniform percolation. If the feedstocks arrive in bags, debagging must be incorporated into the pre-processing step.

Fats, oils, and greases (FOG) can be added in small quantities to increase biogas production.

Exhibit 19 summarizes the key advantages and disadvantages of high-solids-stackable AD systems.

EXHIBIT 19
Advantages and Disadvantages of High-Solids- Stackable AD Systems

Advantages	Disadvantages
• Can process waste with contaminant material (plastic, metals, rocks) • Handles solid stackable wastes with little pretreatment • Produces negligible effluents • More energy efficient than other AD systems • May require no water addition	• Requires mixing with shredded L&YW or other bulking materials • Must operate as a batch system, requiring purging and opening the digester between batches • Odor potential when door is opened

3.2.2 High-Solids-Slurry Digestion Systems

Feedstocks managed using high-solids-slurry AD systems are typically reduced to a pumpable slurry (that is, 60 percent to 80 percent moisture content) through a combination of size reduction and water addition, prior to being fed into the digester vessel. Relative to wet AD systems, the conveyance equipment required to handle feedstocks in this moisture content range is generally more expensive. However, high-solids-slurry AD systems are generally more robust and better capable of handling feedstocks that contain nonbiodegradable material such as rocks, glass, metals, and plastics.

This type of digester is appropriate for a wider variety of feedstocks than high-solids-stackable AD systems: in addition to wet materials (for example, manures and food processing waste such as cheese whey and spoiled milk) it can also handle residential and commercial food wastes. Typical digester retention times are in the range of 14 to 30 days.

Prior to being introduced into the digester, feedstocks are typically shredded so the particle size is less than 2 inches. Many package systems include size-reduction equipment that has been specified specifically to work with the digestion equipment. Depending on the quality of the feedstocks, additional treatment steps may be needed to remove nonbiodegradable material. For example, some systems incorporate methods within the preparation or digester tanks to removing large pieces of plastic and other floating debris, and/or metals and grit that sink to the bottom. The level of cleanup required is somewhat dependent on the downstream digestate-handling processes and if/how that material will be used (for example, composted, or land applied versus landfill disposal).

Since feedstocks are generally wet and putrescible, the receiving and sorting/preparation areas and equipment should be enclosed in a building equipped with ventilation for air quality and odor control.

Both batch and continuous feed designs exist for this type of AD system. The design of batch digesters is relatively simple. However, biogas generation in a batch system peaks at a certain point during the process and decreases thereafter as the digestion process progresses. In a continuous feed design, the biogas generation rate is more consistent. Continuously fed digesters are typically a better fit for larger AD systems that aim to maximize energy recovery. These types of digesters often also have an “inoculum loop” that recycles a portion of the material from the discharge end of the digester vessel to its feed end to help rapidly establish the required microorganisms populations in the incoming feedstock.

Single-stage batch processes are typically used in small- and large-scale applications. Very few high-solids-slurry AD systems are configured as two-stage or multi-stage systems. Most high-solids-slurry digesters are also designed to operate in the thermophilic temperature range.

Digester tanks can be oriented vertically or horizontally. Vertical silo-type digester package systems are more efficient from a space utilization perspective, but may be limited by local height ordinances. Materials generally are feed into the top of the vertical digester and move downwards in a plug-flow manner as a result of gravity. Horizontal digestion systems are typically cylindrical and use internal paddles or rotors to move the digesting

material through the system. In both cases, biogas generated is collected and piped to storage before being delivered to the biogas utilization system.

The processing capacities of commercially available for high-solids-slurry AD systems range from approximately 3,000 to in excess of 250,000 tpy. The footprint for a large-scale facility that processes in the order of 150,000 to 200,000 tpy of SSO would be approximately 12 acres. This includes the space required for all processing facilities as well as access roadways and staff/administrative facilities, but does not include buffer zones, space for further processing of digestate (for example, composting) or space for extensive pre-processing for SSO contaminated with high amounts of contaminants. As noted, vertical silo digesters save some footprint space compared to horizontal digesters, but project-specific layouts are required to quantify the difference.

The advantages and disadvantages of high-solids-slurry AD systems are summarized in Exhibit 20.

EXHIBIT 20
Advantages and Disadvantages of High-Solids-Slurry AD Systems

Advantages	Disadvantages
• Can process waste with contaminants (plastic, metals, rocks)	• Slurry typically is not completely mixed, so can cause uneven digestion if not carefully managed
• Handles wastes that are in a liquid or slurry condition upon arrival	• Produces more effluent than high-solids stackable digestion
• Produces less effluent than wet low-solids digestion	• Less energy-efficient than high-solids stackable digestion
• More energy-efficient than wet low-solids systems	• May require water addition to make the feedstocks pumpable
• Entirely contained system (high level of odor control)	

3.2.3 Wet (Low-Solids) Digestion Systems

In wet AD systems, water is added to the organic solid wastes so the resulting mixture has a moisture content of 80 percent or more. Alternatively, effluents are recycled from latter stages of the AD process and added to the feedstocks to raise their moisture content. This allows the feedstock to be handled with pumps, and to be continuously stirred and mixed within the digester vessel(s).

Wet AD systems are most appropriate for feedstocks with a very low solids content such as dairy manure and select food processing wastes (for example, juices, cheese whey, spoiled milk). Organic feedstocks with a higher solids content, such as food waste, must be mixed with low-solids feedstocks, water, or recycled effluents so they can be effectively processed.

Wet AD systems can be operated under mesophilic or thermophilic temperatures and be arranged as single-, two, or multistage digesters. Retention times of materials in the digester vessels are between 14 and 40 days. The designs of wet AD systems for solid waste streams are similar to the digesters historically used in WWTPs to stabilize biosolids. In fact, some of the first wet AD system designs were direct derivatives of biosolids digester systems.

Wet AD systems rely on a much higher level of pretreatment than high-solids AD systems. For example, in continuously stirred wet AD systems, feedstocks must typically be processed to remove large, fibrous materials that would otherwise wrap around or interfere with the mixing and stirring mechanisms. This higher level of pretreatment generally introduces a higher degree of complexity in the system.

As with high-solids-slurry systems, wet AD systems are commercially available in capacities ranging from 3,000 to in excess of 250,000 tpy. The footprint for a facility processing in the order of 150,000 to 200,000 tpy of SSO would be approximately 10 acres. This includes the space required for all processing facilities as well as access roadways and staff/administrative facilities. This does not include space for digestate composting or buffer zones.

The advantages and disadvantages of wet AD systems are summarized in Exhibit 21.

EXHIBIT 21
Advantages and Disadvantages of Wet AD Systems

Advantages	Disadvantages
• Handles wastes that are in a liquid or slurry condition upon arrival • Takes advantage of existing, unused capacity in WWTP digesters, increasing their cost-effectiveness and energy efficiency • Entirely contained system (high level of odor control)	• Cannot generally handle waste with contaminant material (plastic, metals, rocks) • Requires significant pretreatment and operational care to avoid exceeding capacity or "upsetting" digestion of biosolids • Solids in SSO may form a floating mat in WWTP digester where microbes cannot easily digest them • Produces more effluent than the other two digester types. Less energy-efficient than the other two digester types

3.3 Review of Environmental Permit Requirements

As part of this project, CH2M HILL identified environmental permit requirements that are applicable to compost and AD technologies as of mid-2013. This includes state and local environmental permits, state solid waste facility permits, land development permits, grading and drainage, wastewater, air emissions, and other pre-construction and environmental permits. Building department and construction approvals are not included.

The expected requirements for preparing permit applications, recommendations for preliminary meetings with agencies, and approximate time frames for preparation of permit applications are summarized in Exhibit 22. This information was used as a basis for the secondary evaluation of processing technologies.

EXHIBIT 22
Potential Environmental Permit Requirements

	Permit Application Requirements	Preliminary Agency Meetings and Content	Time Frames for Application Processing	Notes
Environmental Operating Permits				
Solid waste facility permits	Solid waste facility operating permit application is required Provide permit application submittal to the Tacoma Pierce County Health Department Required review by Washington Department of Ecology (Ecology) per WAC 173-350-710, Solid Waste Handling Standards	Meeting 1: Initial meeting with Tacoma Pierce County Health Department and Ecology Content: • Review the project preliminary design concept, location, and operations. • Review project schedule. • Review ongoing Ecology rule-making process WAC 173-350 specifically for changes to solid waste permit application, design, operating, and closure requirements for compost facilities and anaerobic digesters. Meeting 2: Follow-up technical meetings as needed to provide project details and reach agreement on permit application submittal components.	Review by Tacoma Pierce County Health Department within 90 days of submittal– *"Every solid waste permit application shall be approved or disapproved within ninety days after its receipt by the jurisdictional health department."* Review by Ecology within 45 days of receiving complete application from Health Department *"Recommend for or against the issuance of each permit by the jurisdictional health department within forty-five days of receipt of a complete application."* Solid waste permit issuance – Review by Ecology within 30 days of receiving issued solid waste permit from Health Department *"Jurisdictional health departments shall file all issued permits with the appropriate regional office of the department no more than seven days after the date of issuance."* *(d) The department shall review the permit in accordance with RCW 70.95.185 and report its findings to the jurisdictional health department in writing within thirty days of permit issuance.*	Solid waste permit application requirements: • For the site considered at the current Tacoma landfill – the existing solid waste permit for landfill operation may have additional or different permit submittal conditions for a major modification to the site for the compost facility. The permit should be reviewed for requirements. Ongoing Ecology rule-making for WAC 173-350, Solid Waste Handling Standards • Public comment period closes November 2, 2012 • Proposed amendments in the draft rule including construction completion determination by Health Department prior to operational startup, revised requirements for compost facilities, and new permit application requirements for Anaerobic Digesters (Excerpts from the Ecology draft rule-making) • *Facilities ((shall)) not ((commence operation)) until the jurisdictional health department has determined that the construction was completed in accordance with the approved engineering report((/)), plans, and specifications and has approved the construction documentation in writing.* • *(9) Anaerobic digester - Permit application contents (permit requirements). The owner or operator of an anaerobic digestion facility not exempt under subsection (2) of this section must obtain a solid waste permit from the jurisdictional health department. All applications for permits must be in accordance with the procedures established in WAC 173-350-710. In addition to the requirements of WAC 173-350-710 and 173-350-715, each permit application must contain:* *(a) Engineering reports, plans, and specifications that* *address the design standards of subsection (4) of this section;* *(b) A plan of operation that addresses the requirements of* *subsection (5) of this section; and* *(c) A closure plan meeting the requirements of subsection (7) of this section.* • *(10) Anaerobic digester - Construction records (permit requirements). Facilities must not start operation until the jurisdictional health department has determined that the construction was completed in accordance with the approved engineering report, plans, and specifications and has approved the construction documentation in writing and issued a permit. Within thirty days of completing construction, the owner or operator of an anaerobic digestion facility must provide the following materials to the jurisdictional health department and the department:* • *Ecology notes in the rule-making fact sheet that the goal is to ""*Encourage development of small facilities through expansion of conditional permit exemptions.*" and "Adopt permit exemptions for qualified anaerobic digesters"*
Land Use Permit Applications				
Land Use Permit Application Form	Land use permit application is required since an environmental checklist will be submitted. Land use permit applications cover the following areas: General Variance Application Wetland/Stream Exemption Application Wetland/Stream Inspection Application Environmental Checklist Joint Aquatic Resource Permits(JARPA) Provide permit application form submittal to the City of Tacoma Building and Land Use Services (BLUS) Division	Refer to Environmental Checklist and Grading, Excavation and Erosion Control Permit.	Land Use Permit application review: At this time, it is assumed that a land use permit (conditional use, variance, shoreline, boundary line adjustment) will not be needed however; the form will need to be completed. The 2-page form provides general description of site development project and will be completed for submittal with the environmental checklist and grading permit applications.	

EXHIBIT 22
Potential Environmental Permit Requirements

	Permit Application Requirements	Preliminary Agency Meetings and Content	Time Frames for Application Processing	Notes
Environmental Checklist	An environmental checklist is required to be prepared for the following types of projects – all or some of which could be elements of the compost facility project: • Construction or demolition of a building – greater than 12,000 square feet • Construction of a parking lot – more than 20 vehicles • Fill or excavation – more than 500 cubic yards • Installation or removal of impervious tanks – capacity of more than 10,000 gallons • Stormwater, water, and sewer utilities – 8 inches or more in diameter Environmental checklist required to be submitted to BLUS – • 14 page BLUS form covering environmental elements (earth, air, water, plants, animals, environmental health, energy, land and shoreline use, housing, aesthetics, light/glare, transportation, public services, and utilities.)	Meeting 1: Pre-application meeting required with BLUS Division prior to environmental checklist submittal. Content: • Review the project preliminary design concept, location, and operations. • Review project schedule. • Confirm forms to be submitted – Environmental Checklist, Land Use form	Environmental Checklist /SEPA review: If no land use permit - 6 week review and determination timeframe as follows including the required public review process: • 2 week comment period after preliminary environmental determination is made by a Land Use Planner • 3 week appeal period after final determination is made	SEPA Checklist - Before any permits are issued, review under the State Environmental Policy Act (SEPA) must occur. SEPA review is usually conducted by the local government planning or permitting department. At the City of Tacoma, this review is conducted by BLUS.
Joint Aquatic Resources Permit Application (JARPA)	JARPA is assumed to not be required for the following reasons based on the two currently identified potential site locations: • No shoreline substantial development permit or conditional use permit assumed needed • No in water work required for construction • No wetlands on the site are present or will be impacted	None	N/A	JARPA is used for the following permit applications: • U.S. Army Corps of Engineers (Corps): Section 10 and Section 404. • U.S. Coast Guard: General Bridge Permit and Private Aids to Navigation (PATON). • Washington Department of Ecology: 401 Water Quality Certification. • Washington Department of Fish and Wildlife: Hydraulic Project Approval. • Washington Department of Natural Resources: Aquatic Use Authorization. • Shoreline Substantial Development Permit. • Shoreline Conditional Use Permit. • Shoreline Variance. • Shoreline Exemption. • Shoreline Revision.
Site Development Permits				
Grading, Excavation, and Erosion Control Permit	Grading permit is assumed to be required since it is likely the following conditions would be met requiring a permit for construction based on the two currently identified potential site locations: • 50 cubic yards of soil or more are moved, or • if an area 7,000 square feet or greater is grubbed, or • If any amount of soil or a significant amount of vegetation is moved or disturbed within a critical area. Grading in excess of 500 cubic yards or in a critical area requires a grading plan prepared by a civil engineer. Grading Permit Application required to be submitted to BLUS – 2 page form	Meeting 1: Content and requirements for the grading permit should be discussed during the pre-application meeting required with BLUS Division prior to environmental checklist submittal.	Not published but assumed to be similar to the environmental checklist review schedule.	Potential additional conditions: • Work in critical areas are subject to the requirements in TMC 13.11 • Additional reports and information may be required depending on the project per TMC 2.02.370 and other applicable codes • Stormwater mitigation may be required. Refer to the City of Tacoma Surface Water Management Manual (SWMM) for requirements
Right of Way Permits	Right of Way permits would be required for work in the city street or alley right of way for utility connection, access roads Permit issued by Public Works Department.	None	Obtained as needed from Public Works Department permit intake center.	
Side Sewer Permits	Side Sewer Permit required for connection of the sanitary sewer to the City of Tacoma sewer system. Permit issued by Public Works Department.	None	Obtained as needed from Public Works Department permit intake center.	

EXHIBIT 22
Potential Environmental Permit Requirements

	Permit Application Requirements	Preliminary Agency Meetings and Content	Time Frames for Application Processing	Notes
Wastewater and Stormwater				
Construction stormwater permit	A construction stormwater permit is required since the currently identified potential sites range in size from 8-15 acres. It is assumed that the soil disturbing activities for construction of the compost facility would be greater than 1 acre disturbed, and stormwater will be discharged to receiving water directly or to storm drains that discharge to a receiving water.	None.	Application is required to be submitted at least 60 days before the requested start of discharge. <u>Ecology permit application submittal review –</u> • 30 day public comment period after publication two weeks in a row in local newspaper. • Coverage begins on day 31 after the required public notice period.	Reference: City of Tacoma 2012 Stormwater Management Manual
Industrial Pretreatment Discharge Permit	Application for discharge of wastewater to the City of Tacoma sewer system is required. It is unclear at this point if the compost facility will require an industrial pretreatment discharge permit.	Meeting 1: Pre-application meeting with BLUS prior to permit application submittal. Content: • Review the project preliminary design concept, location, and operations. • Review project schedule.	Application is required to be submitted at least 30 days before the requested discharge date to the sewer system.	From City of Tacoma website – Fees are based on the amount and the strength of the discharged wastewater as well as a fixed administrative fee of $200-$650.
Industrial Stormwater Discharge Permit	Application to ecology for discharge of stormwater to surface water. Complete Ecology Notice of Intent form. Compost facilities are specifically identified as requiring permit coverage if discharge of stormwater is to surface water.	None.	Application is required to be submitted at least 60 days before the requested start of discharge. <u>Ecology permit application submittal review –</u> • Within 30 days of application submittal–Ecology will review for completeness • Coverage begins on day 31 or day 61 if there is a required public notice period.	
Ponds – Dam Construction Permit	At this time, it is unknown if leachate from the compost operation will be handled in tanks or ponds. If ponds are considered, WAC 173-175 Dam Safety may be applicable if the pond can impound a volume of 10 acre-feet or more of water. The Dam Safety regulations do not apply to concrete or steel water storage tanks. The Dam Safety regulations require submission of application for construction permit.	Meeting 1: Pre-application meeting with Ecology Dam Safety Office prior to permit application submittal. Content: • Review the project preliminary design concept, location and operations. • Review project schedule.		
Air emissions				
PSCAA Notice of Construction (NOC)	Puget Sound Clean Air Agency has established requirements for permitting of emissions from compost facilities. The following permit application forms will be required: • General information for (Form P) • Additional NOC application form for Composting • Biofilter form • SEPA Environmental Checklist (SEPA Environmental Checklist completed determination from City of Tacoma may be provided to PSCAA and does not require a separate process.)	Meeting 1: Pre-application meeting with PSCAA prior to permit application submittal. Content: • Review the project preliminary design concept, location and operations. • Review project schedule.	<u>PSCAA NOC permit application submittal review –</u> • Within 30 days of application submittal–PSCAA will review for completeness • Within 60 days of receipt of complete application – issue Order of Approval or deny permit application • 30 day public notice period likely required which would be in addition to the 90 days listed above.	Subsequent to NOC completion and Order of Approval issuance, the annual Registration program will be required. Excerpt from PSCAA's website: *PSCAA regulates "commercial" composting operations through its Notice of Construction (NOC) permit application process and through the Registration program. The NOC program is a preconstruction review which may lead to an Order of Approval with site specific conditions for the approved operations. The <u>Registration program is an annually renewable status</u> which supports the compliance staff efforts to ensure actively registered sources are in compliance with all applicable permit approval conditions and Agency regulations* NOC application fee is $1,150 filing fee (nonrefundable).
PSCAA Order of Approval	An Order of Approval will be required prior to construction of the compost facility and is issued at the completion of the NOC review process. An Operations and Maintenance Plan is required once the Order of Approval is issued.	None.	Order of Approval is issued at the completion of the NOC review process and contains site specific conditions for the approved operations.	Annual registration fee required.

EXHIBIT 22
Potential Environmental Permit Requirements

	Permit Application Requirements	Preliminary Agency Meetings and Content	Time Frames for Application Processing	Notes
Other				
Diesel generators	If diesel generators are to be an element of the compost facility, the PSCAA General Order of Approval for Rich-Burn, Spark Ignition, Gaseous Fossil Fuel-Powered Emergency Electrical Generators will be required to be applied for or evaluated as not applicable.	Meeting 1: Pre-application meeting with PSCAA prior to permit application submittal. Content: • Review the project preliminary design concept, location, and operations. • Review project schedule.	PSCAA review schedule: • The applicant will receive a Coverage Order within 30 days after the complete application has been received. • For those units that do not qualify for coverage, the applicant will receive a letter from Ecology within 30 days after the application was received. The letter will state why the unit does not qualify for coverage under this General Order of Approval.	Fee - $500.
Aboveground Storage Tank Permit	City of Tacoma Fire Department application for above ground storage tanks construction, operation, and closure.	Meeting 1: Pre-application meeting with Fire Marshall prior to permit application submittal. Content: • Review the project preliminary design concept, location, and operations. • Review project schedule. • Determine permit application and plan submittal requirements.		

Notes:
1. Department of Ecology WAC 173-350 rule-making reference: http://www.ecy.wa.gov/programs/swfa/organics/
2. Assumes no wetlands on the property.
3. Assumes no demolition on existing property.
4. Assumes no conditional Use Permit is required by Tacoma Municipal Code (TMC) Title 13, Land Use Regulations.
5. Future expansion by possibly 50 percent is not addressed in these requirements.
6. Table does not include building permits.

3.4 Evaluation of Processing Technologies

To identify the most appropriate processing technology(s) for use in Tacoma from a technical perspective, CH2M HILL undertook a two-step evaluation process. The first step was a "fatal flaw analysis" that was based on several pass/fail criteria. The second step was a qualitative analysis based on a number of technical criteria developed by CH2M HILL and reviewed by City personnel. Composting and AD technologies were both subjected to the same evaluation process but were evaluated separately.

The analysis process is discussed further in the following sections. Also discussed are a set of basic assumptions that were made related to the proposed facility's basis of design. These assumptions are identified as they have a bearing on the results of the evaluation process.

3.4.1 Basic Assumptions

3.4.1.1 Residential SSO Composition and Characteristics

The choice of processing technology depends, in part, on the types and quantities of materials to be processed. For example, windrow composting may be appropriate for processing small quantities of L&YW, whereas more sophisticated technologies, such as aerated static piles, may be more appropriate for larger quantities of L&YW. Still more sophisticated technologies may be appropriate when biosolids and/or food waste are added to the operation. The quantities of materials available for processing will depend on the choice of collection system and mix of policies adopted to encourage and enforce participation in the organics program.

For the purposes of this evaluation, it was assumed that the City's residential SSO collection program would involve food waste being collected together with green waste in a single rolling cart. The estimated projected (to year 2024) tonnage of the SSO is 41,022 tons. Additional information regarding the composition and specific quantities is discussed in detail in Section 2.

In addition to feedstocks from the City's residential program, there is the potential for residential SSO to be accepted from programs in adjacent jurisdictions. For the purpose of this evaluation, is has been assumed that this material is similar in composition to the SSO from the Tacoma program.

3.4.1.2 Commercial Sector SSO

Based on an ongoing pilot program, the City has estimated that an additional 3,480 tons per year of SSO could potentially be captured from commercial sources if a City-wide collection program were implemented.

3.4.1.3 Dewatered Biosolids Quantities and Characteristics

In addition to SSO feedstocks from the City and adjacent jurisdictions, there is also the potential that the facility may manage digested biosolids from WWTPs in the area.

For this evaluation, it has been assumed that biosolids accepted at the facility would be dewatered prior to delivery using centrifuges. Key characteristics of the dewatered biosolids that have been assumed are summarized in Exhibit 23.

EXHIBIT 23
Assumed Biosolids Characteristics

Parameter	Value
% Solids	22%
% Nitrogen	4.6%
% Carbon	41.2%
Carbon: Nitrogen Ratio	~9:1
Bulk Density	1,650 lb/yd^3
Volatile Solids	75%

3.4.1.4 Fats, Oils, and Greases

FOG is not typically considered to be part of the municipal waste stream, but this material may be appropriate for acceptance at organic waste processing facilities. For the purpose of this evaluation, FOG has been excluded from the facility feedstocks.

3.4.1.5 Feedstock Quantities

Based on the analysis of organic feedstock types and availability discussed in Section 2, CH2M HILL recommends that the design of a City organics management facility should be based primarily on the material tonnages, volumes, and variations from the City's residential curbside and self-haul programs as outlined in Section 2. These materials are under the control of the City, and therefore there is reasonable assurance they will be available.

Given the potential, and the uncertainties, associated with collecting organics from commercial and other jurisdictions' sources, CH2M HILL also recommends the City consider providing system capacity for 100 to 200 tons per week (5,200 to 10,400 tons per year) extra capacity in addition to the capacity required to handle materials from the residential curbside and self-haul programs. This will accommodate potential sources of commercial and other jurisdictions' organics, as well as potential commercial sources outside the City that have not been considered. This would allow Tacoma to begin accepting significant quantities of waste from these sources. The land area selected should also allow future expansion of at least 50 percent, to be able to respond to opportunities for accepting additional commercial or other jurisdictions' waste that may occur if initial acceptance and processing from these sources are successful.

There is also the potential to manage dewatered biosolids at the processing facility, and it has been recommended that the processing technologies be evaluated for their ability to handle approximately 200 wet tons of biosolids per week (approximately 10,000 tons/year) in addition to the residential, self-haul, and commercial organic waste quantities. Section 5 covers the alternatives selected for further evaluation, and the results of the evaluations.

3.4.1.6 Enclosed Receiving Building

It has been assumed that the facility will include fully enclosed receiving and preprocessing buildings to minimize odors at the critical initial phases of the process.

3.4.1.7 Compost Product Quality and Use Assumptions

The quantities and proposed uses of the final product(s) produced by a composting facility should be reflected in the facility's design and the selection of technologies.

The primary markets envisioned for the compost produced at the composting facility are internal landscaping uses in City parks, boulevards, and sports fields; professional landscapers and retail landscape supply companies; and as a component for soil blenders to use in manufactured topsoil and garden soil blends.

On the basis of these expectations, it will be necessary to produce compost products that are both stable and mature. Stability is a measure of the stage of decomposition of the organic material and is measured by tests such as reheating (for example, Dewar Flask) or carbon dioxide respirometry. Maturity is affected by stability, but also measures the compost's impacts to plant germination and development. Germination and growth tests with cucumbers or other species, and ammonia concentration tests are commonly used to measure maturity. The industry-accepted stability and maturity requirements in Exhibit 24 have been adopted and used to guide the evaluation process.

EXHIBIT 24
Product Stability/Maturity Criteria

Criteria	Method	Criteria
Stability Criteria:		
Reheat	TMECC 5.08-D	<10°C
CO_2 Respiration	TMECC 5.08-B	<4 mg CO_2/g OM/day
Maturity Criteria:		
Emergence/Growth (Cucumber)	TMECC 5.05-A	90%
Ammonia Concentration	TMECC 4.02-C	<500 ppm (dry wt)

Notes:
CO2 – Carbon Dioxide
CO2/g OM/d – Carbon Dioxide per gram organic matter per day
dry wt – dry weight
mg – milligram
ppm – parts per million
TTMECC – Test Methods for the Examination of Composting and Compost

3.4.1.8 Biogas Utilization Assumptions

Biogas production will be similar for all of the AD technologies considered, and the rate of production will depend on the throughput of SSO. Biogas from all technologies can be used for electricity production, CNG, or cleaned up for sale as pipeline quality gas. For the purposes of facility footprint sizing in this evaluation, it is assumed that cleanup to CNG for vehicle fuel will be used.

3.4.1.9 Facility Siting Assumptions

For the purposes of this analysis CH2M HILL has assumed that the facility will be located on a property in an urban setting within the boundaries of the City, and suitability for use in an urban environment is one of the criteria used to evaluate the alternative technologies.

3.4.2 Initial Screening Analysis

A set of initial screening criteria for the processing technologies was established as part of the evaluation process. These screening criteria were applied on a pass/fail basis to establish a short list of technologies for further consideration. If a processing method or technology failed to meet any one or more of these criteria, it was excluded from further consideration.

The screening criteria were reapplied to the processing technologies described in Sections 3.1 and 3.2 of this report, and the corresponding assumptions outlined in Section 3.4. The analysis results for composting technologies are presented in Exhibit 25. The analysis results for AD technologies are presented in Exhibit 26.

EXHIBIT 25
Initial Screening of Composting Technologies

	Processing Method/Technology	Available in United States	Proven at Commercial Scale	Appropriate to Feedstock Types & Quantities (~45K tpy)	Appropriate to Urban Setting at ~45K tpy Capacity	Pass/Fail
Composting	Static Pile (outdoor facility)	Yes	Yes	No	No	Fail
	Passively Aerated Static Pile (outdoor facility)	Yes	No	No	No	Fail
	Windrow (outdoor facility)	Yes	Yes	Yes	No	Fail
	Turned Mass Bed (unaerated, outdoor facility)	Yes	Yes	Yes	No	Fail
	Positively Aerated Static Pile (outdoor facility)	Yes	Yes	Yes	No	Fail
	Negatively Aerated Static Pile (outdoor facility)	Yes	Yes	Yes	Yes	Pass
	Covered Aerated Static Pile (outdoor facility)	Yes	Yes	Yes	Yes	Pass
	Turned Mass Bed (aerated, indoor facility)	Yes	Yes	Yes	Yes	Pass
	Positively Aerated Static Pile (indoor facility)	Yes	Yes	Yes	Yes	Pass
	Negatively Aerated Static Pile (indoor facility)	Yes	Yes	Yes	Yes	Pass
	Channel (indoor, positive aeration)	Yes	Yes	Yes	Yes	Pass
	Static Containers/Vessels (indoor receiving and preprocessing)	Yes	Yes	No	Yes	Fail
	Agitated Containers/Vessels (indoor receiving and preprocessing)	Yes	Yes	No	Yes	Fail
	Enclosed Tunnel (indoor receiving and preprocessing)	Yes	Yes	Yes	Yes	Pass
	Agitated Bed (indoor, negative aeration)	Yes	Yes	Yes	Yes	Pass
	Rotating Drum (indoor receiving and preprocessing)	Yes	Yes	No	Yes	Fail

EXHIBIT 26
Initial Screening of Anaerobic Digestion Technologies

	Processing Method/Technology	Available in United States	Proven at Commercial Scale	Appropriate to Feedstock Types & Quantities (<10K tpy)	Appropriate to Urban Setting at <10K tpy Capacity	Pass/Fail
Anaerobic Digestion	Wet Digestion	Yes	Yes	No	Yes	Fail
	High Solids - Slurry Digestion	Yes	Yes	Yes	Yes	Pass
	High Solids - Stackable Digestion	Yes	Yes	Yes	Yes	Pass

Exhibits 25 and 26 show the following:

- The initial screening resulted in 9 of the 19 technologies being eliminated from further consideration.
- Four of the composting methods (that is, static pile, passively-aerated static pile, windrow, outdoor turned mass bed) were eliminated primarily due to the higher potential for offsite odor impacts when sited in an urban setting.
- Although an outdoor positively ASP system has inherently better odor and nuisance control than passive methods, it was considered to be inappropriate to an urban setting at the scale being considered by the City, and was eliminated from further consideration.
- Static and agitated containerized composting systems and rotating drum composting systems were not considered to be logistically feasible for a facility of this magnitude (that is, too many containers would be required that would introduce a high degree of complexity to the facility), and were eliminated from further consideration on this basis.
- Wet anaerobic digestion systems were eliminated from further consideration since they have severe disadvantages compared to other AD technologies for less than 10,000 tons per year of high-solids organics.

Secondary Analysis

To provide a relative comparison of the remaining technology options, a secondary analysis was conducted using a set of criteria developed by CH2M HILL. The evaluation criteria were based on performance requirements that are common to the organic processing industry as a whole, and on specific issues of importance to Tacoma. The secondary criteria included space requirements, odor control, water consumption, leachate and surface water quality, worker health and safely, and additional processing requirements required to meet product maturity requirements.

The evaluation criteria were applied to each of the remaining technologies based on the project team members' experience, and each was evaluated as low, low to moderate, moderate, moderate to high, or high. A five-point scoring system was then used to translate these results to a numerical value (that is, 1 through 5), with a lower number indicating a more preferable outcome. In completing this evaluation and scoring, no weighting factors were applied to the evaluation criteria.

The evaluation took into consideration supporting infrastructure that would be required along with the composting technologies (for example, buildings, heating, ventilation, and air-conditioning systems, curing pads, weigh scales, surface water ditches, ponds and other controls, curing facilities) so that all technologies would meet a consistent performance specification. This approach is necessary to provide a balanced evaluation of the technologies.

Exhibits 27 and 28 summarize the results from the secondary analysis and the relative scoring of each technology.

EXHIBIT 27

Secondary Evaluation of Composting Technologies

	Processing Method/Technology	Pass/Fail	Secondary Evaluation Criteria: Operational Considerations: Pre-processing Requirements	Post-processing Requirements	Equipment Reliability	Maintenance Requirements	Req'd Level of Technical & Process Training	Total Processing Period	Worker Exposure to Poor Air Quality	Odours and Nuisances: Inherent Odour Control	Potential for offsite dust impacts	Potential for offsite litter impacts	Residuals: Leachate and Contaminated Surface Water Quantity	Leachate and Contaminated Surface Water Strength	Secondary Evaluation Criteria: Resource Consumption: Potable Water Consumption	Power Consumption	Fuel Consumption	Land Requirements	Financial: Relative Construction Costs per ton of annual capacity	Relative O&M Costs per ton of feedstock	Development Considerations: Startup Schedule	Solid Waste Permitting Difficulty	Air Quality Permit Difficulty	Relative Score
Composting	Static Pile (outdoor facility)	Fail																						Fail
	Passively Aerated Static Pile (outdoor facility)	Fail																						Fail
	Windrow (outdoor facility)	Fail																						Fail
	Turned Mass Bed (unaerated, outdoor facility)	Fail																						Fail
	Positively Aerated Static Pile (outdoor facility)	Fail																						Fail
	Negatively Aerated Static Pile (outdoor facility)	Pass	Shredding/Mixing	Curing	High	Low	Moderate	7-8 weeks	Low to Moderate	Moderate to High	Moderate to High	Moderate to High	Moderate	Low to Moderate	Low to Moderate	Moderate	Low	Low to Moderate	Moderate	Low to Moderate	Low to Moderate	Moderate	Low	48
	Covered Aerated Static Pile (outdoor facility)	Pass	Shredding/Mixing	Curing	High	Low	Moderate	8-11 weeks	Low to Moderate	Moderate to High	Low	Low	Moderate	Low to Moderate	Low	Moderate	Low	Low to Moderate	Moderate	Low to Moderate	Low to Moderate	Moderate	Low to Moderate	42
	Turned Mass Bed (aerated, indoor facility)	Pass	Shredding	Curing	High	Moderate	Moderate	5-6 weeks	High	High	Low	Low	Low	Low to Moderate	Low to Moderate	Moderate	High	Low	Moderate to High	Moderate	Moderate	Low	Low	46
	Positively Aerated Static Pile (indoor facility)	Pass	Shredding/Mixing	Curing	High	Low	Moderate	7-8 weeks	High	High	Low	Low	Low	Moderate	Low to Moderate	Moderate	Low	Low to Moderate	Moderate to High	Moderate to High	Moderate	Low	Low	45
	Negatively Aerated Static Pile (indoor facility)	Pass	Shredding/Mixing	Curing	High	Low	Moderate	5-6 weeks	Low to Moderate	High	Low	Low	Low	High	Low to Moderate	Moderate	Low	Low to Moderate	Moderate to High	Moderate	Moderate	Low	Low	42
	Channel (indoor, positive aeration)	Pass	Shredding	Curing	Moderate to High	Moderate	Moderate to High	5-6 weeks	Moderate to High	High	Low	Low	Low	Moderate	Low to Moderate	Moderate to High	Low	Low to Moderate	High	Moderate to High	Moderate	Low	Low	48
	Static Containers/Vessels (indoor receiving and preprocessing)	Fail																						Fail
	Agitated Containers/Vessels (indoor receiving and preprocessing)	Fail																						Fail
	Enclosed Tunnel (indoor receiving and preprocessing)	Pass	Shredding/Mixing	Curing	High	Moderate	Moderate to High	7-8 weeks	High	High	Low	Low	Low	High	Low	Moderate	Low	Low	High	Moderate	High	Low	Low	50
	Agitated Bed (indoor, negative aeration)	Pass	Shredding	Curing	Moderate to High	Moderate to High	High	6-7 weeks	Low to Moderate	High	Low	Low	Low	High	Low to Moderate	Moderate to High	Low	Low	High	Moderate to High	High	Low	Low	52
	Rotating Drum (indoor receiving and preprocessing)	Fail																						Fail

EXHIBIT 28

Secondary Evaluation of Anaerobic Digestion Technologies

		Pass/Fail	Secondary Evaluation Criteria: Operational Considerations: Pre-processing Requirements	Post-processing Requirements	Equipment Reliability	Maintenance Requirements	Req'd Level of Technical & Process Training	Total Processing Period	Worker Exposure to Poor Air Quality	Odours and Nuisances: Inherent Odour Control	Potential for offsite dust impacts	Potential for offsite litter impacts	Residuals: Leachate and Contaminated Surface Water Quantity	Leachate and Contaminated Surface Water Strength	Secondary Evaluation Criteria: Resource Consumption: Potable Water Consumption	Power Consumption	Fuel Consumption	Land Requirements	Financial: Relative Construction Costs per ton of annual capacity	Relative O&M Costs per ton of feedstock	Development Considerations: Startup Schedule	Solid Waste Permitting Difficulty	Air Quality Permit Difficulty	Relative Score
Anaerobic Digestion	Wet Digestion	Fail																						Fail
	High Solids - Slurry Digestion	Pass	Shredding/Mixing	Dewatering, Composting, Curing	Moderate to High	Moderate to High	High	7-10 weeks	Low	High	Low	Low	Moderate	High	Moderate	High	Low	Low to Moderate	High	High	High	Moderate	Low to Moderate	63
	High Solids - Stackable Digestion	Pass	Mixing	Composting and Curing	Moderate to High	Moderate to High	High	7-10 weeks	Moderate to High	High	Low	Low	Low	High	Low	High	Low	Low to Moderate	High	High	High	Moderate	Low to Moderate	60

As shown in Exhibit 27, of the compost technologies evaluated, the following have the highest applicability to the Tacoma situation based on the assumptions that have been made at this point:

- Indoor negative ASP composting
- Covered outdoor ASP composting
- Indoor positive ASP composting

As shown in Exhibit 28, of the three types of AD technologies reviewed, the high-solids-stackable system has the greatest applicability for implementation in Tacoma. Typically, an AD system such as this is used in combination with a composting system; the composting system is used to further process digestate or to handle feedstocks that cannot be digested or temporary surges in feedstock deliveries which exceed the AD system's capacity.

3.4.3 Conclusions

Based on the results from this evaluation, the following processing technologies passed the secondary evaluation:

- Negative ASP (outdoor)
- Covered ASP(outdoor)
- Turned Mass Bed (indoor)
- Positive ASP (indoor)
- Negative ASP (indoor)
- Channel (indoor)
- Enclosed Tunnel
- Agitated Bed
- High Solids Stackable AD
- High Solids Slurry AD

The high solids stackable AD scored the best out of the three AD technologies evaluated; however, all of the composting technologies scored better, and therefore it was only carried forward to be evaluated as a processing technology for only ICI organics in combination with a compost technology used as the primary processing technology.

In meetings with the City, the list was refined for further consideration. Positively aerated, uncovered composting technologies were excluded from further consideration because of the potential for odors if outdoors and potential safety issues if indoors. After exclusion of these technologies, the best-ranking composting technologies were retained for further evaluation. Processing technologies that were carried forward to the next step of the evaluation were as follows:

- Negative ASP (outdoor)
- Covered ASP(outdoor)
- Negative ASP (indoor)
- Enclosed Tunnel
- AD of suitable feedstocks from commercial sources with a high-solids-stackable system, combined with composting of the digestate and residential SSO

Scenarios were developed to evaluate these technologies considering market conditions, detailed cost estimates, and non-monetary factors as described in Section 5.

At the end of the technology evaluation, CH2M HILL prepared several preliminary site layouts to determine the approximate total facility size required for candidate sites. Based on these layouts, it was determined that a facility size of at least 10 acres would be required for the smallest footprint of the four technologies above (negative ASP, indoor) and at least 15 acres for the largest footprint of the four (covered ASP, outdoor). These sizes did not include allowance for future expansion. These sizes were provided for use by the City in identifying potential alternative sites for a composting facility. Site selection is discussed in Section 6, which include more detailed layouts developed during the business case evaluation (see Section 5) that superseded the layouts produced at the end of the technology evaluation.

4. Market Study

4.1 Methodology/Objectives

As part of this feasibility study, RAA was retained to complete market research to better understand the distribution and value of the finished compost product(s).The feedstock design basis is 41,000 tons per year of residential curbside source-separated organics, with 3,500 tons per year of commercial food waste and 10,000 tons per year of out-of-jurisdiction biosolids (CH2M HILL, 2012). RAA assumed that approximately 60,000 to 90,000 cubic yards of compost would be produced in 2024, and half that amount in 2014.

To complete the work effort, RAA completed the following tasks:

- Program and Data Collection – production volume data, anticipated processing methods, and feedstock and product analytical data were considered
- Startup Meeting – spoke with project team to discuss marketing program goals, revenue requirements, and potential marketing strategies
- Detailed Market Research – including various Tacoma departments and staff
- Report and Compost Marketing Plan Development

Throughout the project, RAA interfaced with Tacoma and CH2M HILL staff to obtain background data on the prospective facility and feedstocks, as well as input pertaining to related program goals and concepts.

RAA completed market research within the regional horticultural, agricultural, and environmental industries. Uniform data collection was completed using a standard survey device. Surveying was completed to obtain valuable qualitative and quantitative marketing data. Surveying was completed through the telephone using only staff experienced in data collection and/or compost sales. Then, to improve data collection and long-term market development efforts, a series of companies were surveyed in-person (face-to-face). Market research databases were provided by RAA, using Info USA, and these databases were provided to Tacoma under separate cover. The list of companies surveyed during the project can be found in Appendix A.

Further, industry market demographics were analyzed within a “truckable” distance, and a “distance to market” analysis was completed. Other aspects of the market research included the following:

- Identifying competing compost producers in the southern Puget Sound region, and obtaining product and marketing data regarding their programs
- Identifying and interviewing potential partners and end users who may assist in long-term market development efforts
- Evaluating internal City uses for the products
- Interviewing representatives of the TAGRO (short for “Tacoma Grows”) program to discuss the possible usage of the compost product, and other synergies
- Identifying product registration/certification options for the product(s)
- Evaluating the costs of developing an in-house marketing team

4.2 The Market Area

Tacoma is included in the Seattle metropolitan area, which also includes the City of Seattle, King County, Snohomish County, and Pierce County within the Puget Sound region. The United States Census Bureau officially defines the metropolitan area as the *Seattle–Tacoma–Bellevue, WA Metropolitan Statistical Area*, with an estimated population of 3,500,026, which is more than half of Washington's population as of 2012, making it the fifteenth largest metropolitan statistical area in the United States. Tacoma is the second-largest city in the Puget

Sound area and the third largest in the state. Tacoma also serves as the center of business activity for the South Sound region that has a population of around 1 million people. Based on commuting patterns, the adjacent metropolitan areas of Olympia, Bremerton, and Mount Vernon, along with a few smaller satellite urban areas, are grouped together in a wider labor market region known as the *Seattle–Tacoma–Olympia Combined Statistical Area (CSA)*, commonly known as the Puget Sound region. The population of this wider region is 4,269,349—almost two-thirds of Washington's population—as of 2012. The Seattle CSA is the twelfth largest CSA and the thirteenth largest primary census statistical area in the country. The large urban/suburban population base is largely "environmental" (green) in nature, and has been using yard trimmings compost for over 20 years.

Data pertaining to the population and drive distances to regional population bases can be found in Exhibit 29, within this section. Although the surrounding region has had a rich agricultural base for many generations, the region has become much more urban in nature. This, of course, benefits the sale of compost into horticultural or "ornamental" applications (for example, landscaping, turf care). Because of the population density, there is a great concentration of horticultural businesses within the region. The greatest concentration of these businesses are in the more populous counties, as would be expected. The numerically largest potential market segment of end users for compost is landscapers, followed by resellers (combined garden centers, landscape supply, and topsoil companies), golf courses, and nurseries. The large number of potential end users is an excellent reflection on the overall size of the lawn and garden industry.

EXHIBIT 29
Population and Drive Distances

City	County	Distance Miles	Drive Time (Hours: Minutes)	City Population	County Population
Tacoma	Pierce	-	-	198,397	795,225
Aberdeen	Grays Harbor	79	1:48	16,896	72,797
Bellevue	King	36	0:50	122,363	1,931,249
Bellingham	Whatcom	122	2:21	80,885	201,140
Bremerton	Kitsap	35	0:57	37,729	251,133
Everett	Snohomish	62	1:21	103,019	713,335
Longview	Cowlitz	97	1:50	36,648	102,410
Olympia	Thurston	30	0:41	46,478	252,264
Renton	King	26	0:39	90,927	1,931,249
Seattle	King	34	0:46	608,660	1,931,249
Vancouver (WA)	Clark	135	2:20	161,791	425,363
Yakima	Yakima	156	2:32	91,067	243,231

Tacoma, Washington has a Mediterranean climate with dry warm summers and mild winters. The area within 25 miles of the local weather station is covered by forests (67 percent), oceans and seas (17 percent), built-up areas (11 percent), and croplands (4 percent). Over a year, the temperature typically varies from 38°F to 76°F and is rarely below 31°F or above 85°F. Average annual precipitation is 39 inches, mostly in the cold season, and it rains on average on 149 days annually (WeatherSpark Beta, 2012).

Potential professional end users are categorized by their primary business type, as can be seen in Exhibit 30, using Info USA data. However, when evaluated along with other contact lists (yellow pages), it is obvious that horticultural businesses often operate more than one distinct function (business). For instance, landscape suppliers can also act as garden centers (retail sales) and also operate landscape or other horticultural businesses. This same cross-over can also be found in the other market segments surveyed during the market research process. This illustrates the vertical integration of companies throughout different facets of the horticultural industry. This integration is common and is based upon the needs of the local industry or specific goals of individual companies.

EXHIBIT 30
Professional Market Demographics

	Horticulture									
County	**Landscape Designers**	**Landscape Contractors**	**Nurseries**	**Green-Houses**	**Golf Courses**	**Ldsp. Eqt.& Suppliers**	**Topsoil**	**Mulches**	**Garden Centers**	**Totals**
King	231	540	29	8	69	22	35	1	49	984
Kitsap	29	105	7	2	16	13	19	0	7	198
Mason	4	21	0	0	5	6	10	0	4	50
Pierce	31	167	8	6	31	13	18	0	15	289
Snohomish	25	209	18	0	20	19	24	1	11	327
Thurston	34	92	6	6	15	11	13	0	12	189
TOTALS	**354**	**1134**	**68**	**22**	**156**	**84**	**119**	**2**	**98**	**2,037**

	Agriculture				
County	**Farms-Prim. Crop**	**Sod**	**Vineyards**	**Orchards**	**Totals**
King	10	2	3	1	16
Kitsap	2	0	1	2	5
Mason	2	0	0	0	2
Pierce	2	0	0	2	4
Snohomish	5	4	1	0	10
Thurston	6	2	0	0	8
TOTALS	**27**	**8**	**5**	**5**	**45**

The Puget Sound Region possesses only a small amount of crop acreage, compared to other areas of the state. The primary agricultural products produced in the region are livestock (animals) and nursery / greenhouse crops. Further, although certified organic farming continues to grow in Washington State, in 2008, 63 percent of certified organic farms and 71 percent of organic acreage were located in counties east of the Cascade Crest (WSU Ag Bulletin). The soils in western Washington are generally between 3 and 5 percent organic matter, but a number exist outside that range (both high and low). Soils are generally either glacier till or river bottoms (generally sandy loams to silty loams, and clayey loams). Since landscaping project sites often have their native soil removed, compost has been found to be very beneficial to the soils actually left on the site for landscape and lawn establishment.

4.3 Research Findings

The data within this section was obtained through data collection during the surveying process and will be discussed in three subsections: end-user demographics (and contact), compost experience, and opportunity/value.

4.3.1 End-user Demographics

As mentioned earlier, the Puget Sound region of Washington State has a large urban population which is being serviced by an expanding horticulture industry. Since these "ornamental" end users typically pay the greatest price for compost products, they were concentrated on during the market research. In saying that, agricultural and environmental applications (reclamation of disturbed soils, erosion control, surface water protection) were also appropriately investigated. During the market research itself, the following entities were contacted: 18 landscape supply (including soil blending) companies, 10 landscapers, 6 nurserymen/garden centers, 5 golf courses, several Tacoma departmental end users, and others (for technical background on the region and compost usage) for surveying. Potential end users were initially selected and surveyed randomly, then other pertinent (and non-random) contacts were made based on more specific market data obtained during the research process. The contact numbers are somewhat skewed in that several related agricultural and environmental contacts were made during the project, however these contacts were not considered to be potential buyers.

4.3.2 Compost Experience

A great amount of experience exists in the Tacoma (and Puget Sound) region regarding compost and compost use. Almost 98 percent of the companies contacted stated that they were familiar with compost (and its benefits) and over 83 percent stated that they have or are currently using compost. This over 80 percent penetration rate figure is considered to be a characteristic of a mature market area and is an excellent overall rate. Those entities possessing limited compost experience are primarily golf courses and greenhouses, which are very conservative buyers. The region has also been very forward-minded in compost utilization, being early adopters in topsoil manufacturing, erosion control, and stormwater management using compost. Research with industry experts also confirmed that compost was not being used regionally in reclamation and very little was being used in commercial agriculture (although a couple of composters are trying to develop agricultural markets). The compost benefits most commonly mentioned during surveying were: improves soil quality (supplies organic matter, aerates soil, makes soil more workable, holds water), adds nutrients, and feeds and supplies soil microbes. Keep in mind much of the education of end users has been done through the Soils for Salmon, and other related, programs. Further, the market-place has benefited from Washington State University's (WSU) long-term research efforts with compost.

The high familiarity and usage rate for compost is a very beneficial market characteristic to Tacoma (and other composters) because much of the market has already been educated about compost. Of the companies indicating that they are currently using compost the overwhelming majority purchase it in bulk form. Garden centers and mass merchants are the professional end users primarily purchasing and reselling compost in bagged form. This existing market experience with bulk compost means that Tacoma does not have to "start from scratch" with education, they can create a message specific to the requirements of its own particular operation. Tacoma will need to educate new potential end users, such as general contractors (for example, Soils for Salmon ordinance), which have not used compost in the past, as well as promote expanded usage by Tacoma departments and specification by landscape architects. Education pertaining to biosolids may also be necessary if Tacoma chooses to include it in the compost feedstock mix.

Several large trucking and bulk material companies exist in the region that act as compost brokers for existing producers. Tacoma should easily be able to work with one of these companies as long as the compost is of high quality.

Further, Tacoma staff or its surrogate must also be prepared to promote the differences between its composts, and others, as well as educate them about new potential environmental applications (for example, rain garden media). Tacoma's greatest organizational allies in this endeavor will likely be the Environmental Services Department, which specifies compost usage in various environmental applications, and the Tacoma Public Works Department, which operates the TAGRO program.

The most popular feedstock of compost in the marketplace is yard trimmings. There are also manure (SteerCo) and biosolids (for example, GroCo) composts available, as well as some bark materials being used. There are significant volumes of compost available in the regional marketplace, and much of this product is high quality.

Therefore, Tacoma will need to commit to producing a high quality compost for it to comfortably market its product. Compost has become a staple within the landscaping industry, with landscapers and soil blenders primarily purchasing compost in bulk form, while the garden centers purchase primarily in bagged form. Although these buying habits are common, there are always opportunities to cross sell bagged compost to landscapers and sell more bulk compost to garden centers (resellers).

Horticulture – Landscapers and resellers (including topsoil blenders) are the most familiar with compost, while golf courses and nurseries are less so. These are typical market characteristics in several locations throughout the US. Resale of compost in bulk and bagged form to homeowners is a popular market for compost. Some existing composters even own their own resale yards and application equipment. Blended soils containing compost are also very popular in the region, and may even be more popular than "straight" (unblended) compost to landscapers and homeowners. The Puget Sound region of Washington State has an established bulk materials infrastructure, which allows both landscapers and homeowners to purchase compost (and related or blended products) from bulk materials yards at a lower price than garden centers. Many regions of the US do not have such a well-established bulk material supply network. This benefits the large-scale distribution of compost. Compost is typically used in landscape bed installation, turf establishment projects, and some as mulch. It is most popularly used during the spring season, with the fall being the secondary season. However, soil blenders and resellers are purchasing it throughout the year. It is applied along with soil or blended in with it before application.

Agriculture – Potential agricultural markets for the use of compost were evaluated using various methods. Western Washington agricultural statistics were gathered and farm specialists and composters (trying to sell to farmers) were interviewed. Land bases in agricultural crop production have shrunk significantly in the Puget Sound over the past 20 years, as population and urban sprawl has increased. While animal production is still significant in the region, like many other population bases, nursery and greenhouse production has eclipsed food crop production. Although some crop production land does exist within a truckable distance, their ability to pay a realistic price for the product is unlikely. If no biosolids are added to the feedstock mix, a properly manufactured yard trimmings and food waste compost could possibly be marketed to certified organic farmers, but again, the economics of usage would prove somewhat problematic, as they compare compost to nitrogen fertilizer. Further, there are also a number of large chicken producers that produce a non-composted product that is difficult to compete with on price and nitrogen content.

Environmental – The use of compost in reclamation practices is not typical in the Puget Sound region. The most likely historic reason for this is economic constraint - higher paying compost markets (for example, horticulture) were developed first in the region and markets have been large enough to absorb all of the supply. With that said, there are thousands of brownfield sites within the Puget Sound region as identified by the Washington State Department of Ecology. This market could potentially be developed over time, but would require additional research and a determination of how sites are contaminated, in order to determine if compost could be used to reclaim them. Little data was available from the Department of Ecology regarding compost usage in reclamation. A good example of this type of program was the City of Philadelphia's involvement in abandoned mine reclamation with its compost and biosolids management program.

The use of compost in erosion control and soil manufacturing (for surface water protection) has greatly expanded, with great advances being made through the Soils for Salmon program (where construction site soils must be amended with organic matter to improve stormwater percolation) and the Washington State Department of Transportation (DOT). The Washington State DOT may even be the largest user of compost in the state. Further, the Tacoma Environmental Services Department would like Tacoma compost to be used in the rain garden mixes that they promote. Tacoma must help to educate the marketplace and 'push' Tacoma contractors to use compost on their internal projects to further expand compost markets. The erosion control market can be significant, but will require a coarsely graded product to be produced which is free of inert contamination. Other 'green' applications, such as stormwater management techniques (for example, rain gardens, creating soil that absorb and percolate stormwater) hold great promise, and political initiatives are already in place to expand them.

Tacoma Departments – Metro Parks generates yard trimmings that they used to passively compost themselves; before state regulations made it difficult for them to continue. They produced 3,000 cubic yards of compost at

their peak (included zoo doo). Now the Department mulches the grass and leaves on project sites, and the tree wood goes to the City's composter. Metro uses tree chips for mulching landscape beds and trees, and for trails, which they get for free. They still do some chipping themselves at their project sites, which they then use onsite. Metro tried TAGRO mixed with sand as a top dressing in the past on some sand-based ball fields. However, they thought that the product provided too much fertilization and it smelled of ammonia. They also used some Cedar Grove compost in the past. They own a 4 cubic yard spreader that they use for topdressing sand. However, topdressing is problematic because the time in which the fields are not in use. When they are not on use, they are too wet to topdress. Metro does have its own greenhouse operation (and conservatory) which buys bulk growing media. Some compost may be able to be used in this mix, but they purchase the media pre-made. There are initiatives in place to reduce chemical fertilizer and pesticide applications. They could use both compost and mulch if it was provided by Tacoma's composting operation, but manpower to apply it is still an issue. Their operation is fiscally constrained. Metro manages three sports field complexes and a 27-hole golf course. They do need to lime on occasion. Metro also operates a habitat restoration program (establishing natives), but they do not typically amend the soil.

The Streets Department does the maintenance of roads and right of ways; including landscaping, mowing, irrigation system maintenance, tree trimming, and slope management. They also maintain 26 parks, but have not been pushed to reduce fertilizers or pesticides. The Streets Department chip and reuse tree wood generated at project sites but send the other yard trimmings to the Solid Waste Department (which sends them to LRI) to manage. They do not purchase much mulch, and do not do many new landscapes (maybe some minor installations). The Streets Department does do some aeration and topdressing and some hydroseeding. Like the Parks Department, all new construction is contracted out, and this is probably the area in which the majority of compost could be used. However, stormwater management, both quantity and quality, is an issue, and they follow Washington State DOT specs for construction, which allow compost usage. Realistically, all City landscaping, and related, specifications should be reviewed and modified to include compost, where feasible. Often, this will require project construction standards and specifications to be reviewed, and education to major contractors be completed.

The Environmental Services Department stated that Best Management Practice (BMP) 63, which requires that the Soil for Salmon standards be used, are actively being used (specified) by their Department. The BMPs guarantee proper soil management (permeable soil be created on most projects), which promotes compost usage, and allows compost for use in erosion control. They are being asked to specify a rain garden mix to landscapers and homeowners, and would like to spec an approved product which Tacoma could manufacture using products that it produces. They have been doing research with TAGRO in a rain garden mix, but it may provide too much nutrition. The Department is very supportive of compost usage. Severe slopes were evaluated along Marine View Drive. These eroding slopes could be better managed using compost filter socks and a trial could be completed.

The TAGRO program, which is operated by the Tacoma Public Works Department, uses Class A dewatered biosolids to manufacture soil mixes. They used to produce a potting soil, mulch and mix (blended soil), but no longer produce the mulch (because the woody ingredient is no longer available). The program has been very successful, marketing almost 30,000 cubic yards of product per year to smaller landscapers and homeowners. They also operate their own fleet of trucks, thereby controlling delivery. The TAGRO program managers would consider using the Tacoma compost in some of their mixes and would like to see if the compost screening overs could be used (or reprocessed and used) to re-create their past mulch product. They also would be willing to discuss a joint marketing arrangement. This should be explored, but would likely require additional staff to do so. TAGRO staff is familiar with biosolids. Additional data on the TAGRO program can be found in Appendix A.

Exhibit 31 lists the most significant competitors to a Tacoma compost product. Aside from these nine facilities, there are also several small municipal composters that exist in the marketplace, as does a supply of mushroom soil (typically less stabilized product).

EXHIBIT 31
Larger Compost Competitors

Organization	Location	Feedstocks	Volume (per year)	Product Type(s)	Primary Form
Cedar Grove	Seattle (facilities in Maple Valley and Everett)	Yard trimmings and food waste	350,000 CY	Compost and various mixes	Bulk and bags
Emu Composting & Topsoil	Poulsbo (facility in Kingston)	Yard trimmings and biosolids	600-800CY/wk	Topsoil (#1), compost	Bulk
Lenz Enterprises, Inc.	Stanwood	Yard trimmings and food waste	Under 40,000 CY	Compost, erosion control compost, soil blending	Bulk
North Mason Fiber Company	Belfair	Fish compost, yard trimmings compost	40,000 CY	Compost	Bulk and bags
Pacific Topsoil, Inc.	Everett (facility in Woodinville)	Yard trimmings	130,000 CY	Compost, topsoil, other soil mixes	Bulk
Pierce Cty. Recycling, Composting & Disposal (Waste Connections)	Puyallup	Yard trimmings and food waste	80,000 tons (Purdy facility – 55,000tons)	Compost	Bulk
Riverside Topsoil, inc.	Snohomish	Yard trimmings	N/A	Compost, soil mixes	Bulk
Sawdust Supply	Seattle	Yard trimmings, biosolids, manure – separate products	N/A	Compost, soil mixes	Bulk
Silver Springs Organics, LLC	Rainier	Yard trimmings and food waste	Not re-opened yet, Licensed for 140,000 tons incoming, likely 78-80,000 tons	Compost	Bulk

N/A - not available

All of the large composters market primarily in bulk form, however Cedar Grove and North Mason Fiber Company also sell packaged (bagged) product. Cedar Grove is the largest composter in the region and is probably the most well diversified in their marketing approach. The predominant markets in which the composters distribute to are: landscapers/contractors, homeowners, resellers, and the Washington State DOT. Much of their compost is used in creating soil blends and selling to municipal and other 'green' projects.

4.3.3 Opportunity/Value

Tacoma has an excellent opportunity to market its compost products throughout the region. As mentioned earlier, significant volumes of compost currently are being generated regionally, so producing a high quality compost will be important to the success of the marketing program. The most significant product quality and attitudinal concerns identified during the market research regarding compost were the following:

- Yard trimmings-based compost – possible inert contamination, weed seeds/pesticide residual content
- Food waste-based compost – possible inert contamination (trash), 'will it attract rodents?
- Biosolids-based compost – possible heavy metal and/or medication (drug) residuals contamination, 'will my customers accept it?'

Interestingly, approximately 25 percent of those responding had some type of concern regarding biosolids compost. This was surprising because biosolids compost has been marketed in the region for many years. With that said, RAA still believes that any of the existing biosolids concerns are manageable through education. Regional buyers were not really knowledgeable about any compost certification programs at this point, with only one mentioning the Washington State certified organic product certification and one the Washington State DOT specification. Tacoma should consider certifying their compost through the US Composting Council's Seal of Testing Assurance (STA) Program. Selling compost to the Washington State DOT requires STA certification, and this same specification is trickling down to county and local landscaping specs.

Regarding desirable and undesirable compost characteristics, potential end users want a compost with the following characteristics (listed in descending order):

- Desirable characteristics: loose/well draining, well aged, finely screened, consistent, clean, dark/nice appearance, dry, rich in organic matter.
- Undesirable characteristics: possessing inert contamination (man-made [plastic], rocks, clay), is coarse/chucky, light colored, odorous, or possessing weeds (weed seeds).

Manufacturing compost that meets the product quality requirements of the marketplace will be a key aspect to the success of the Tacoma compost marketing program; especially since it will be one of the larger composters over time. One key aspect will be to educate waste generators (homeowners and professionals) that inert contamination will not be tolerated. Even the Washington State DOT stated that they are having problems receiving contaminated compost; more so now that food waste is being processed. When potential end users were asked what would get them to buy larger volumes of compost, the most common responses were (in descending order): better pricing, better quality, improved availability (golf courses), and more information.

The greatest short-term market opportunity lies within the following areas:

- Horticultural sectors of landscaping and topsoil blending, as well as other bulk resellers (for example, landscape materials yards)
- Large public and private construction projects, public entities
- Environmental applications of erosion control, topsoil manufacturing, and stormwater management (mixes)

These markets will purchase appropriately priced, high quality compost. Marketing to the soil blenders and resellers (landscape supply yards) will be important, as they are the largest volume buyers within the 'value' market sector. The largest of the soil blenders (for example, Corliss Resources, Randle's Sand & Gravel), as well as certain truckers (for example, Holman Trucking) may be able to contract purchase all of the Tacoma compost. Typical wholesale prices for compost (sold to professional end users such as the landscapers) are $14.00 to $28.00 per cubic yard, picked up; with tractor trailer load and larger volumes being $11.00 to $18.50 per cubic yard, picked-up. Further, to market its significant volumes, creating blended soils containing Tacoma compost will be a helpful step, as blended soils appear be as or more popular than straight compost. Working with existing topsoil companies, if Tacoma sells their product 'directly' (using in-house staff) to make this happen will be important.

Tacoma should consider branding its compost, perhaps along with the TAGRO product, since various other branded products already exist in the marketplace. Although much education has been completed in the marketplace, Tacoma will have to continue these efforts, as well as conducting sales activities to secure their place within the market. The same could be said for erosion control and storm water management applications. Nursery and golf course applications should be considered secondary markets, as they are smaller and much slower to develop.

Short-term markets do not exist within the agricultural or reclamation sectors, and significant effort would be required to develop these markets. In-City horticultural markets could be developed, but do not appear to be as significant in size as the environmental markets. Obviously, a well thought out sales and marketing plan must also be implemented (see Section 5) and sales staff must be hired. The most popular products in the region are Cedar Groves and Pierce County Recycling composts (most mentioned), and while significant competition exists, Tacoma should be able to carve out a market. Interestingly, the Puget Sound compost market has creative composters

within it. They produce various compost blends, some own their own resale yards, some package, and some provide application services.

4.3.4 Pricing

Tacoma must concentrate its marketing efforts on wholesale, large truckload type sales, because of the volume of compost that it will be required to market. Tacoma should be able to market their product directly to horticultural professionals in tractor trailer volumes at $10.00 to $15.00 per cubic yard, picked up. If marketed to just one or two resellers/blenders, then a lower price should be expected. A Tacoma pricing structure must allow for sales to professional end users that can purchase in large truckload volumes, using sliding scale pricing structure that decreases with volume. It should also allow for a contracted price where large end users can buy the product in blocks. Again, producing a high quality product will be important to gain a foothold within the marketplace. If jointly marketed through TAGRO then other pricing arrangements would be required.

4.4 Marketing Plan Options and Opportunities

There are two primary methods for distributing compost. They are either through the use of an in-house staff or through a contracted broker (or distributor). In an in-house sales scenario, Tacoma manages the program and hires an in-house sales person; perhaps teaming with TAGRO. This scenario requires more upfront investment, and staff training, but yields the greatest sales revenues. This scenario also leaves Tacoma in control of all aspects of the composting program (also making them responsible for all aspects too). It is expected that some of the in-house marketing effort could be reduced by heavily involving local resellers in the distribution program. Marketing costs typically are reduced over time, however an outside consultant may be required to train and assist in-house staff in getting the marketing program up and running.

In a contracted broker scenario, Tacoma would have to identify and hire an outside company to be responsible for sales. This organization should be able to guarantee the distribution and sale of the entire production capacity of the facility. In Western Washington, brokerage can be done through a distributor which contracts to buy all or some of the compost. This scenario requires little investment in marketing from Tacoma, but also yields the least net revenue. If a brokerage arrangement is considered, due diligence must be taken to identify and contract with a reputable company familiar with compost (the same soil blenders and truckers mentioned in Section 4.3). In some ways, a brokerage scenario also takes an important component of the program out of Tacoma's control. Exhibit 32 illustrates the realistic economics of the two marketing scenarios.

EXHIBIT 32
Marketing Scenario Economics

Parameter	In-House Sales	Broker Sales
Staffing Cost*	$80,000	$10,000
Assistant*	$40,000	$0
Marketing Budget Cost**	$40,000	$10,000
Consulting Assistance	$30,000	$5,000
Estimated sales income [a] (at 75,000 CY production)	$750,000 (average wholesale price of $10/CY)	$375,000 (broker price of $5/CY)
Total Revenue	$560,000	$350,000

* It was estimated by Tacoma management that a sales person and vehicle would cost approximately $80,000 and assistant will cost half that price

** Costs are based on the use of a variety of options and the development of various tools (e.g., literature, promotions)

[a.] Estimated sales income is based on realistic compost prices paid throughout Washington State

4.5 Market Development

Within this section, a series of marketing suggestions have been provided which can be used for a short-term compost marketing implementation plan. A preliminary marketing plan for the Tacoma compost product is also enclosed. The marketing plan addresses five major areas of concern; production, research, promotion, education, and sales/distribution.

4.5.1 Marketing Suggestions

A. Focus marketing efforts in the southern Puget Sound region, avoiding higher transportation costs and several large volume competitors. Expanding sales efforts north only as necessary. The entire Puget Sound region could be serviced by a Tacoma composting facility. Compost is often shipped 100 miles or more, but the goal should be to distribute it within a 50-mile radius.

B. Focus marketing efforts towards the most receptive and easy to access markets – these markets segments are landscapers and resellers (including topsoil dealers). Tacoma may also simply consider marketing through one of the compost distributors already operating in the region. Undoubtedly, interest will exist within the nursery and golf course industries, but these should be considered as secondary markets because they are conservative in their buying habits and slow to change. Agricultural and reclamation markets should not be aggressively approached, unless horticultural and environmental (specifically, erosion control and stormwater management) markets cannot absorb all of the product supply.

C. Effort should be made to expand In-City uses for the compost, as discussed above. Excellent opportunity exists to work with the TAGRO program, and stormwater and erosion control markets.

D. If marketing through in-house staff, consider branding the product. Again, this could be done through or along with the TAGRO product and program. The goal would be to promote the brand name and work to build a reputation around it. This will help to increase product value and stave off competition (because of brand loyalty). Tacoma's in-house media staff should be able to greatly assist in this effort.

E. Consider developing a bulk sales distribution chain for the product. This distribution chain would have the ability to market less than truckload quantities to both small professionals within the horticultural industry and to homeowners. This would allow Tacoma to concentrate on tractor-trailer load quantity sales. Once established, this distribution chain will stay loyal to the Tacoma product, as long as it is a profitable product for them to carry and the compost quality stays consistently good. It is also a long-term approach to market development which will allow for less manpower to operate the marketing program in the long-term. Of course, because of the profit incentive, resellers will also help Tacoma establish the brand name, so they may sell more product and make more money. Develop brochures for the resellers and give them preference when product supply is short. Supply them with a finely screened product which is not odorous and contains no inert contamination. Topsoil blenders would also be a part of this distribution chain. Cedar Grove Composting operates a similar type of program.

F. Concentrate sales efforts on bulk sales in larger truckload quantities. Minimum truckload orders could be as low as 20 cubic yards, but should realistically be 40-50 cubic yards. Marketing in these volumes keeps you from competing with the resellers, and reduces the number of trucks that have to be loaded by Tacoma staff. However, the product will have to be sold at a lower price in this marketing scenario. Avoid marketing on a retail level, because of time pressures it will place on your operations staff and it will disincentive resellers to carry the product.

G. Tacoma should be able to market their compost in individual truckload volumes (40 to 50 CY) at a price of between $10.00 and $15.00 per cubic yard, pick-up. If Tacoma would sell in less than truckload quantities then its price would improve by approximately $3.00 to $9.00 per cubic yard. If distributed through a third party distributor, a significantly lower price should be expected.

H. It will be important to produce high quality compost, since significant competition exists in the region, and also one that is 'clean' (minimal inert contamination). As stated earlier, the marketplace is experiencing dirtier compost now that more household collected food waste is being composted. Therefore, the concept of

producing both a biosolids and yard trimmings/SSO compost should be further developed. By producing separate products, there are more options in the marketplace and those that will not use biosolids compost will have another option. However, biosolids compost is known for being very clean (low in inert contamination), whereas the yard trimming/SSO product may be more contaminated. So, managing the products separately, may offer Tacoma some additional comfort as far as producing clean product. Further, diversify product screen sizing to allow for varying applications (for example, coarse product for use in erosion control, topdressing). However, a base screening size of 3/8" will be required. Consider reprocessing options for clean compost overs for potential usage by the TAGRO program.

4.5.2 Marketing Plan Outline

The following outline has been provided to assist Tacoma in the development of an actual compost marketing plan. It describes the key facets of a compost marketing plan. Activities follow the assumption that Tacoma will use in-house staff to market the product.

Production

A. Product characteristics must match customer needs.
   1. Clean, well stabilized product must be produced.
   2. Produce and market both a biosolids and yard trimmings/SSO compost.
   3. Produce products that meet the Washington State DOT specifications (in Appendix A).

B. Maintain quality control through on-going testing.
   1. Consider participating in the US Composting Council's Seal of Testing Assurance Program.
   2. Consider listing the yard trimmings/SSO compost with Organic Materials Review Institute (OMRI) (for organic certification).

Research

A. Literature search/access
   1. Access research/articles on compost usage for educational and market development purposes.

B. Demonstration plots
   1. Consider development of demonstration plots at local parks, prominently placing signage promoting the product name.
   2. Develop demonstration plots (trial) with well-known and influential end users (also promotional activity).
   3. Get all Tacoma Departments to test the compost in the field.

C. Product and market research
   1. Determine if one of the composts can be used as an ingredient to the TAGRO products, and determine if the overs can be used to help them produce their mulch product.
   2. Determine if an erosion control compost for Washington State DOT's specifications can be produced.

Promotion

A. Develop a marketing/promotional budget, whether marketing in-house or out.

B. Consider developing and promoting a regionally based trade name.

C. Pursue promotion/public education through local newspaper articles about the program. This would be helpful in promoting the product to the local horticultural industry and to residents.

D. Develop promotional literature
   1. Landscape, turf, and erosion control pieces will be required at startup. Develop a primary product label (landscape and turf uses) and a bulk distributor piece.
   2. Consider developing a compost training piece to assist resellers get educated.
   3. Consider developing banners/signage for distributors.

E. Attend landscape and turf shows as necessary (others). This has proven to be one of the most effective methods of promoting compost to professional end users. Engage the industry in a coordinated fashion.

F. Technical data

   1. Provide customers with technical product use assistance.
   2. Provide customers with USCC Seal of Testing Assurance analytical data.
   3. Register the products, as necessary, with the State Department of Agriculture.

Education

A. Public sector

B. Write newspaper articles and/or obtain newspaper advertisements.

C. Consider having an Open House at Facility – Earth Day, Compost Awareness Week.

   1. Get Tacoma Communications staff involved.

D. Professionals

   1. Specifiers – educate area specifiers about compost (for example, landscape architects, engineers) because they specify which soil amendments landscape companies can use on particular projects.

      a. Promote the Soils for Salmon ordinance, stormwater, erosion control, and 'Green Building' applications

E. End-Users – educate (and promote) the benefits of compost, and soil containing it.

F. Educate about the purchase of manufactured topsoil with compost.

G. Promote resale locations to general public.

H. Push usage with landscapers, turf, and perhaps erosion control applications.

I. Trade Show Attendance – exhibit where possible, educate and promote.

   1. Consider obtaining compost spreading equipment for In-City and others usage.

J. Employees

K. Promote the composting facility as a manufacturing facility.

L. Train staff in product quality and production.

M. Train staff in compost sales and end use.

   1. Promote cleanliness and product quality within the facility.

Sales/Distribution

A. Concentrate sales efforts on target markets

B. Start in the southern region of the Puget Sound with landscapers and resellers (including soil blenders).

C. Sales efforts to other markets should be pragmatic and long-term (to guarantee the distribution of the facility's capacity and better manage inventory, before chasing slower to develop markets).

   1. Promote In-City Departmental and TAGRO usage.

D. Develop marketing strategy

E. Determine if In-City staff will be marketing compost or if it will be done through a distributor/broker.

F. Consider a wholesale price of $10.00 - $15.00/CY (picked-up) in bulk form and in 40 to 50 CY loads.

G. Sell primarily in truckload quantities only (for example, 40-50 CY loads). Develop distribution chain to sell compost in small quantities.

H. Focus direct sales efforts on professional customers.

   1. Focus on efforts that will enhance name recognition.

I. Develop delivery infrastructure for product so wholesale customers can more easily obtain the product.

J. Provide end users access to technical assistance.

4.6 Market Study Conclusions

Tacoma is currently using LRI to compost their yard trimmings, but has considered the development of an expanded composting program that will also process food waste and biosolids. Further, the City has considered internal operation of the composting facility, through which they will produce both biosolids and yard trimmings/SSO composts. Large volumes of compost are currently being marketed in western Washington State and the Puget Sound region. Composts of various feedstocks are being successfully marketed and much of the product is of high quality. Further, excellent market development and educational efforts have been completed for compost, and that has led to expanded horticultural and environmental markets. Use of compost by the Washington State DOT and the establishment of the Soils for Salmon ordinance have also assisted market expansion and expanded usage by a variety of government entities, as well as private companies.

The Marketing Plan Outline discussed above should be followed and honed over time (with additional data), if Tacoma is to market their compost in-house. Tacoma will need to decide who will market its compost, since a variety of plausible options exist. Whether marketing in-house (with or without TAGRO's assistance), or working through a distributor/broker, prospects for market development are promising. However, a high quality compost must be produced and substantial marketing efforts will be required (if marketing with in-house staff) to compete with existing products.

5. Business Case Cost Analysis

5.1 Introduction

A business case analysis was performed for an organic waste management facility that included estimating life-cycle costs and MODA to incorporate environmental and social factors important to the City in evaluating facility options. The process included three workshops and a number of follow up meetings. A description of the approach taken for this business case analysis is provided below along with a description of the results.

The initial workshop was held November 1, 2012, at which project objectives were identified, an objectives hierarchy was developed, and potential alternatives were discussed. Participants in the workshop provided relative value weights for each of the objectives selected. Based on this information a draft MODA evaluation was prepared for four alternative technologies. Initial MODA results were reviewed with participants at the second workshop held November 20, 2012.

A refined MODA evaluation was presented at the third workshop on December 18, 2012. For this evaluation, it was assumed that the composting facility would be located at the landfill site. After viewing the results, indoor negative ASP was selected as the preferred technology from this evaluation, and a second MODA evaluation was conducted for three different feedstock scenarios, including indoor ASP with and without biosolids and the addition of an AD system to treat SSO feedstocks from commercial sources that could be collected unmixed with YW. Results of this analysis were presented in a meeting with the City on February 28, 2013. The results confirmed the selection of an indoor negative ASP without AD as the preferred technology. Details of the analyses that led to these conclusions are presented below.

For each of the MODA evaluations, the business case was conducted by comparing the environmental , socioeconomic, and operational aspects of each alternative, expressed as a total MODA score to its life cycle cost, the net present value of capital and ongoing revenues and operations and maintenance costs for a 30-year operating period.

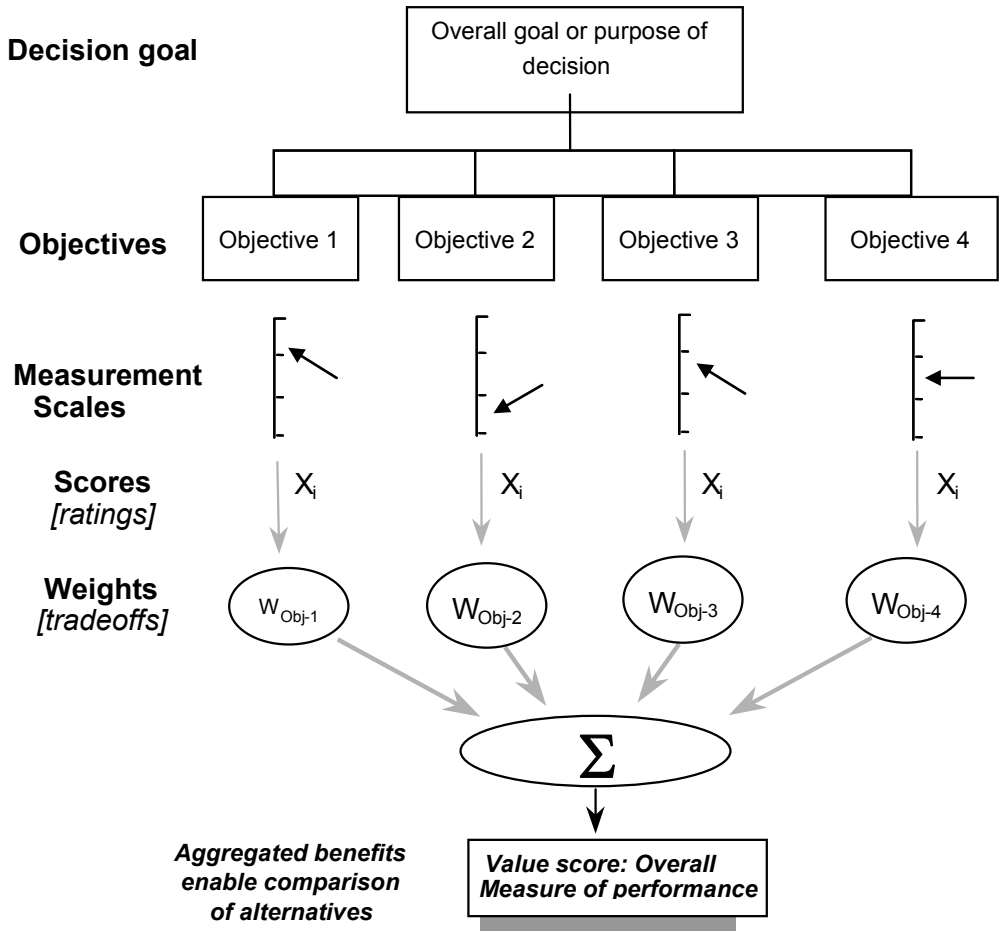
Once the technology and feedstock alternatives were selected a similar process was used to evaluate a potential alternative location in the tide flats. This evaluation is described in Section 6.

5.2 Multi-Objective Decision Analysis

MODA is a quantitative technique for making decisions that involve multiple financial, environmental, and social objectives. MODA proceeds through a series of defined steps. The following steps are illustrated in Exhibit 33 and described in this section:

- Establish the decision goal
- Identify and specify fundamental objectives
- Develop performance measures to assess project performance against objectives
- Add technical detail to the performance measures and assign scores to the performance measures
- Assign weights to the objectives
- Score alternatives
- Calculate total value scores and conduct sensitivity analysis

EXHIBIT 33
Generalized Representation of MODA



5.2.1 Decision Goal

The decision goal is the overall purpose of the evaluation. It is what will be accomplished by making a decision. It should clarify what is included and excluded from the scope of the evaluation.

The following decision goals were determined for the business case cost analysis:

- Evaluate alternatives for composting food and YW from residential and self-haul sources, and evaluate AD of commercial food waste compared to composting.
- Evaluate composting SSO, composting SSO and biosoilds, and composting SSO and biosolids with AD of commercial SSO at the City landfill site.

5.2.2 Evaluation Criteria

Achieving the decision goal typically involves meeting a set of objectives, or evaluation criteria, which are typically classified into a hierarchical structure in which a main criterion might have a series of subcriteria. In this analysis we refer to evaluation criteria instead of objectives, but the terms are functionally equivalent. The set of criteria and subcriteria developed for the business case evaluations are shown in Exhibit 34. The evaluation criteria were developed by CH2M HILL in consultation with City staff based on an understanding of the City's critical success factors for this project and our experience working on similar projects.

EXHIBIT 34
Evaluation Criteria

I. Minimize Long-term Life Cycle Cost (including capital, maintenance, replacement, operating, and revenues from compost, electricity, biogas, other)

II. Maximize non-monetary value resulting from alternatives

A. Minimize Environmental Impacts or Benefits
1. Protect air from pollution
   a. Minimize air pollution from vehicles and equipment (PM10, NOx) or other sources
   b. Minimize GHG emissions (CO2e) from process/operation, and/or end use materials accounting for biogas recovery/renewable energy benefits
2. Protect water resources
   a. Minimize the use of potable water as a process input
   b. Maximize the quality of any process water effluent
3. Protect and enhance land resources
   a. Minimize developable City land required for processing

B. Minimize Socioeconomic Impacts on Tacoma Residents and Businesses
1. Minimize the negative effects of traffic
2. Minimize the negative effects of noise from operations
3. Minimize the negative effects of localized odors from operations
4. Minimize the negative visual effects of process infrastructure
5. Minimize the negative effects of dust/debris from operations
6. Maximize local job creation (processing facility, transportation)

C. Confirm Facility is Reliable and Able to Respond to Future Uncertainties
1. Modular to allow for expansion to accommodate increased future diversion or other customers
2. Adaptable to beneficial future technologies and opportunities, and future regulations
3. Provides reliable and resilient operations (e.g., not mechanically complex and/or if a component breaks down, you can still operate or parts are easy to obtain)

D. Achieve Simplicity and Safety during Operations and Maintenance
1. Relatively easy and desirable to operate by City staff for operating labor continuity
2. Relatively easy to maintain, for maintenance labor continuity
3. System promotes operational worker safety

5.2.3 Measurement Scales

After establishing the evaluation criteria, measurement scales were developed to determine how well alternatives perform against each criterion. The measures of performance may be quantitative or qualitative, depending on the objective and the availability of data for each measure.

Each measure of performance is transformed linearly to a scale of zero-to-one. For example, if a cost scale ranging from $1,000 to $2,000 were converted to a zero-to-one scale, then $1,000 would rate a one on the new scale, $2,000 would rate a zero, and $1,500 would rate a 0.5. This zero-to-one scale implies a linear relationship between cost and value. This means that increasing cost from $1,000 to $1,500 is as important as increasing cost from $1,500 to $2,000. The two incremental changes are of equivalent value. In this analysis all scales are linear.

Exhbiit 35 presents the measurement scales used for this evaluation. For those criteria scored on a 1 to 5 scale, it was assumed that existing conditions would receive a score of 3. Changes that were beneficial were scored greater than 3, while changes that were not beneficial were scored less than 3. There will always be an option with a score of 1 and an option with a score of 5. The options did not always differ significantly for some criteria; thus, scores are clustered around the midpoint of the range (that is, scores of 3).

EXHIBIT 35
Measurement Scales

Evaluation Criteria	Measurement Scale
I. Minimize Long-term Life Cycle Cost (including capital, maintenance, replacement, operating, and revenues from compost, electricity, biogas, other)	**Levelized Life-cycle Cost Index, Low Cost Alternative = 100**
II. Maximize non-monetary value	
A. Minimize Environmental Impacts or Benefits	
1. Protect air from pollution	
a. Minimize air pollution from vehicles and equipment (PM10, NOx) or other sources	NPV of fuel consumed (gallons)
b. Minimize GHG emissions (CO2e) from process/operation, and/or end use materials accounting for biogas recovery/renewable energy benefits	NPV of reduction in CO2eq (tons)
2. Protect water resources	
a. Minimize the use of potable water as a process input	1-5 scale for added process water requirements
b. Maximize the quality of any process water effluent	1-5 scale for changes in effluent water quality
3. Protect and enhance land resources	
a. Minimize developable City land required for processing	Developable land requirements (acres)
B. Minimize Socioeconomic Impacts on Tacoma Residents and Businesses	
1. Minimize the negative effects of traffic	1-5 scale for changes in truck trips for organics, and/or end use products
2. Minimize the negative effects of noise from operations	1-5 scale for offsite noise levels that exceed existing operations
3. Minimize the negative effects of localized odors from operations	1-5 scale for likelihood of noticeable odors
4. Minimize the negative visual effects of process infrastructure	1-5 scale for new facilities that would result in visual degradation for any resident
5. Minimize the negative effects of dust/debris from operations	1-5 scale for likelihood of offsite dust during construction or operation
6. Maximize local job creation (processing facility, transportation)	Net new FTE jobs in the City of Tacoma from processing and transportation
C. Confirm Facility is Reliable and Able to Respond to Future Uncertainties	
1. Modular to allow for expansion to accommodate increased future diversion or other customers	1-5 scale reflecting relative modularity
2. Adaptable to beneficial future technologies and opportunities, and future regulations	1-5 scale reflecting relative adaptability
3. Provides reliable and resilient operations (e.g., not mechanically complex and/or if a component breaks down, you can still operate or parts are easy to obtain)	1-5 scale for reducing likelihood of major failure or difficulty in obtaining parts
D. Achieve Simplicity and Safety during Operations and Maintenance	
1. Relatively easy and desirable to operate by City staff for operating labor continuity	1-5 scale reflecting operational simplicity
2. Relatively easy and desirable to maintain by City staff, for maintenance labor continuity	1-5 scale reflecting maintenance simplicity
3. System promotes operational worker safety	1-5 scale reflecting inherent worker risks

Notes:
NPV – net present value

Costs are measured as long-run life-cycle costs over a 30-year operating period from 2014 to 2043. The cost estimates include the present value cost of construction, debt service on major capital expenditures, operations and maintenance (O&M), revenues, and long-term replacement.

Impacts to air quality were also evaluated as the NPV of fuel consumed, which serves as a proxy for criteria air contaminants including NOx and PM_{10}. Because of concerns regarding the relationship between greenhouse gas (GHG) emissions and climate change, a separate analysis was performed for the major sources of GHGs for each alternative. The calculations for the GHG evaluation are shown in Appendix B.

5.2.4 Alternatives

As discussed in Section 3, a comprehensive list of composting and AD technologies suitable for the Tacoma project were identified and then subjected to a two-step evaluation process. The first step was a fatal flaw analysis that was based on several pass/fail criteria. The second step was a qualitative analysis based on a number of technical criteria developed by CH2M HILL and reviewed by City personnel.

After the two-step evaluation was complete, the following technologies were selected as alternatives:

1. Negative ASP, Outdoor
2. Covered ASP
3. Negative ASP, Indoor
4. Enclosed Tunnel

For the evaluation of feedstock options, the following alternatives were evaluated:

1. SSO and Biosolids
2. SSO and Biosolids with AD
3. SSO without Biosolids

5.2.5 Relative Value Weights

Based on the value system of the decision-maker(s), some objectives may be more or less important than other objectives. For example, minimizing traffic impacts might be more or less important to a particular decision-maker in a specific context than minimizing operational risk. Obviously, different stakeholders faced with the same problem may have different underlying value systems, and, therefore, may have a different sense of what's most important in the given problem.

This leads to the concept of "weighting" objectives, resulting in relative value weights. Assigning relative value weights to objectives is a subjective exercise based on the values of the stakeholder(s). In this project, weights were established in a workshop setting where a CH2M HILL facilitator worked with six City staff members. During the workshop, participants had an opportunity to think clearly about the relative importance of different values. Weighting was done after the measurement scales were developed so that participants could consider the variability of each measurement scale when establishing relative value weights. Technically, the weight assigned to an objective is a measure of its relative contribution to the decision goal as it is varied from the lower end of its measurement scale to the upper end of that scale, a concept known as "swing weighting". These weights are then converted to a 0-1 scale regardless of the method used to obtain weights.

Exhibit 36 presents the weights developed for the evaluation criteria. Weights were developed by having workshop participants rank each sub-criterion within each of the four main criteria with the criterion having the highest value receiving a weight of 100. The other criteria were assigned numbers that reflected the relative value of that criterion to the one with 100, that is, a criterion with a weight of 50 would be perceived of having half the value of the criterion with 100.

After weighting the sub-criteria, workshop participants did the same approach with the four main criteria. As shown, minimizing socioeconomic impacts was selected as the criterion with the largest relative value and the other criteria were weighted proportionally to that criterion. The group then discussed the weights provided and developed a consensus set of weights to be used in the analysis.

The percentage weights are derived first by determining the percentage of each criterion of the total weights over all four criteria. For example, environmental receives a weight of 26 percent, which is its weight of 90 divided by 340 (the sum over all criteria). The percentage of each main criterion is allocated to its sub-criteria using the same calculations.

EXHIBIT 36
Consensus Value Weighting Results

Evaluation Criteria	Relative Importance Weight	% of Total
II. Maximize non-monetary value resulting from alternatives		
A. Minimize Environmental Impacts or Benefits	90	26%
1. Protect air from pollution		
a. Minimize air pollution from vehicles and equipment (PM10, NOx) or other sources	100	8.5%
b. Minimize GHG emissions (CO2e) from process/operation, and/or end use materials accounting for biogas recovery / renewable energy benefits	100	8.5%
2. Protect water resources		
a. Minimize the use of potable water as a process input	20	1.7%
b. Maximize the quality of any process water effluent	35	3.0%
3. Protect and enhance land resources		
a. Minimize developable City land required for processing	50	4.2%
B. Minimize Socioeconomic Impacts to Residents and Businesses	100	37%
1. Minimize the negative effects of traffic	50	4.7%
2. Minimize the negative effects of noise from operations	80	7.5%
3. Minimize the negative effects of localized odors from operations	100	9.4%
4. Minimize the negative visual effects of process infrastructure	55	5.2%
5. Minimize the negative effects of dust/debris from operations	80	7.5%
6. Maximize local job creation (processing facility, transportation)	25	2.4%
C. Confirm Facility is Reliable and Able to Respond to Future Uncertainties	80	20%
1. Modular to allow for expansion to accommodate increased future diversion or other customers	85	6.4%
2. Adaptable to beneficial future technologies and opportunities, and future regulations	85	6.4%
3. Provides reliable and resilient operations (e.g., not mechanically complex and/or if a component breaks down, you can still operate or parts are easy to obtain)	100	7.5%
D. Achieve Simplicity and Safety during Operations and Maintenance	70	17%
1. Relatively easy and desirable to operate for operating labor continuity	80	5.3%
2. Relatively easy to maintain for maintenance labor continuity	80	5.3%
3. System promotes operational worker safety	100	6.6%

Sensitivity analysis can be used to evaluate which objectives had the most impact on the final value score. Weighting values from individual participants can also be compared against the consensus weightings allowing individuals to better understand how their value weighting compare with others. It is also possible to explore how results would differ if individual value weightings were used in place of consensus weightings.

5.2.6 Alternative Scores

Rating or scoring alternatives is the process by which the performance measurement scales are applied to the alternatives. Each alternative is scored to determine the extent to which that alternative meets each objective. The performance scores for a criterion will have uncertainty associated with them. Typically, models use the best estimate available for each criterion on each alternative, but models can be built with uncertain performance scores. The scores for each objective are normalized to a 0-1 scale. The measurement scales for each objective are shown in Exhibit 36.

The scores for each of the composting technology alternatives are presented in Exhibit 37. Scoring for the feedstock alternatives are shown in Exhibit 38. Costs are presented as an index of levelized costs (per ton of organic material) over the full life of the project where the low cost alternative is scored 100, and the other alternatives are scored proportional to that low cost alternative. The following seven main cost components were estimated:

- Construction cost. Order-of-magnitude cost opinions were developed for each alternative.
- Compost Sales. Estimated on the basis of information obtained during the market study.

- Commercial Tip Fee. Estimated on the basis of current market pricing (at the time of this study) in the Puget Sound region.
- Annual O&M reduction. An estimate prepared by CH2M HILL of the reduction in the City's current cost of transferring organics that would no longer be required with this option.
- Annual O&M. Estimated on the basis of a high-level operating plan and specific equipment needs for each alternative.
- Equipment Replacement. The estimated cost of replacing equipment during the 30-project life.
- Facility Expansion/Upgrades. The estimated cost of expansion and/or upgrades that are assumed to be required after 10 years of operations.

EXHIBIT 37
Scoring for Alternative Technologies

Evaluation Criteria	Negative ASP, Outdoor	Covered ASP	Negative ASP, Indoor	Enclosed Tunnel
I. Minimize Long-term Life Cycle Cost (including capital, maintenance, replacement, operating, and revenues from compost, electricity, biogas, other), with Low Cost = 100	**100**	**110**	**121**	**127**
II. Maximize non-monetary value resulting from alternatives				
A. Minimize Environmental Impacts or Benefits				
1. Protect air from pollution				
a. Minimize air pollution from vehicles and equipment (PM10, NOx) or other sources	1,318,000	1,318,000	1,318,000	1,318,000
b. Minimize GHG emissions (CO2e) from process/operation, and/or end use materials accounting for biogas recovery/renewable energy benefits	(136,000)	(137,000)	(135,000)	(136,000)
2. Protect water resources				
a. Minimize the use of potable water as a process input	5	5	5	5
b. Maximize the quality of any process water effluent	3	4	5	5
3. Protect and enhance land resources				
a. Minimize developable City land required for processing	7.0	11.5	7.0	6.0
B. Minimize Socioeconomic Impacts to Residents and Businesses				
1. Minimize the negative effects of traffic	5	5	5	5
2. Minimize the negative effects of noise from operations	3	3	4	4
3. Minimize the negative effects of localized odors from operations	3	3	4	4
4. Minimize the negative visual effects of process infrastructure	3	3	4	4
5. Minimize the negative effects of dust/debris from operations	3	3	4	4
6. Maximize local job creation (processing facility, transportation)	2.5	2.5	2.5	2.5
C. Confirm Facility is Reliable and Able to Respond to Future Uncertainties				
1. Modular to allow for expansion to accommodate increased future diversion or other customers	5	5	5	4
2. Adaptable to beneficial future technologies and opportunities, and future regulations	5	4	4	3
3. Provides reliable and resilient operations (e.g., not mechanically complex and/or if a component breaks down, you can still operate or parts are easy to obtain)	4	4	4	3
D. Achieve Simplicity and Safety during Operations and Maintenance				
1. Relatively easy and desirable to operate for operating labor continuity	4	4	4	3
2. Relatively easy and desirable to maintain, thus ensuring maintenance labor continuity	4	4	4	3
3. System promotes operational worker safety	4	4	3	2

EXHIBIT 38
Scoring for Alternative Feedstock Alternatives

Evaluation Criteria	SSO+Bio-solids	SSO+Bio-solids+AD	SSO only
I. Minimize Long-term Life Cycle Cost (including capital, maintenance, replacement, operating, and revenues from compost, electricity, biogas, other), with Low Cost = 100	**100**	**112**	**110**
II. Maximize non-monetary value resulting from alternatives			
A. Minimize Environmental Impacts or Benefits			
1. Minimize air pollution from vehicles and equipment (PM10, NOx) or other sources	1,318,000	1,318,000	1,318,000
2. Minimize GHG emissions (CO2e) from process/operation, and/or end use materials accounting for biogas recovery / renewable energy benefits	(132,000)	(152,000)	(137,000)
3. Minimize the use of potable water as a process input	5	5	5
4. Maximize the quality of any process water effluent	5	5	5
5. Minimize developable City land required for processing	10.3	9.5	9.4
B. Minimize Socioeconomic Impacts to Residents and Businesses			
1. Minimize the negative effects of traffic	4.5	4.5	5
2. Minimize the negative effects of noise from operations	4	4	4
3. Minimize the negative effects of localized odors from operations	4	4	4
4. Minimize the negative visual effects of process infrastructure	4	4	4
5. Minimize the negative effects of dust/debris from operations	4	4	4
6. Maximize local job creation (processing facility, transportation)	2.5	2.5	2.5
C. Confirm Facility is Reliable and Able to Respond to Future Uncertainties			
1. Modular to allow for expansion to accommodate increased future diversion or other customers	5	5	5
2. Adaptable to beneficial future technologies and opportunities, and future regulations	4	4	4
3. Provides reliable and resilient operations (e.g., not mechanically complex and/or if a component breaks down, you can still operate or parts are easy to obtain)	4	3	4
D. Achieve Simplicity and Safety during Operations and Maintenance			
1. Relatively easy and desirable to operate for operating labor continuity	4	4	4
2. Relatively easy and desirable to maintain for maintenance labor continuity	4	4	4
3. System promotes operational worker safety	3	2	3

For both tables, the air pollution scoring is based on fuel consumed (gallons) that is identical for each of the alternatives since each of the alternatives is located at the same location and would process the same quantity of organic matter. The calculations for fuel consumption (gallons), as well as GHG emissions (CO2e tons), are included in Appendix B. The developable land required for processing is measured in acres. The remaining scores are expressed as scaled numerical values based on performance measures and consensus value weighting.

5.2.7 Calculating Total Value Scores and Sensitivity Analysis

The total value score for each alternative is calculated as a weighted averaging process in which the normalized scores are multiplied by the value weights and summed for each alternative. Typically, the result is multiplied by 100 so that scores are reported as ranging between 0 and 100 rather than as decimals.

Sensitivity analysis can be conducted to test the sensitivity of the results to changes in weights. It is often applied to test the sensitivity of the results to different sets of weights that might represent the views of different stakeholders, or to test which criteria weights, if varied, might lead to the choice of a different alternative. In this study, sensitivity results were calculated and shown to workshop participants. The MODA results were relatively insensitive to changes in weights. The rank order of the alternatives changed little regardless of the weights specified.

5.2.8 Results

The results of MODA are best regarded and applied as decision aids. Results should inform rather than dictate the decision. A MODA evaluation results in two key outputs. A stacked bar graph is used to show the total value scores for each alternative. The height of the colored bars show the reasons why one alternative performs better or worse than another. A scatter diagram comparing total value scores on the y-axis against monetary value on the x-axis (for example, monetary value is shown as the net present value of each alternative) allows decision makers to quickly determine which alternatives provide the most value at least cost, and determine the added cost of selecting an alternative that may provide additional value.

Results from the evaluation of technology alternatives as well as for the feedstock alternatives analysis are shown below in Exhibits 39 to 42. Exhibit 39 presents a comparison of non-monetary values for the technology alternatives evaluated. Negative ASP, Indoor had the highest value score of 81.2. This alternative was distinguished from the next two alternatives due to a higher score for the "Minimize Social Impacts" criteria, because it performs well on minimizing odor, noise, and visual impacts. Although the enclosed tunnel also scored well in this category, it had a lower score for "Operational Simplicity and Safety."

Exhibit 40 provides the scatter diagram with total value on the y-axis and a life cycle cost index on the x-axis. As shown, there is a tradeoff between the Indoor Negative ASP and Outdoor Negative ASP. The Indoor alternative provides higher value at a cost of about 20 percent more than the Outdoor alternative. After discussion and reflecting on these results, the City felt that the added cost of the Indoor system was worth paying because of the added reduction in risk of odors and other community impacts.

EXHIBIT 39

Contribution to Total Non-Monetary Value for Technology Alternatives

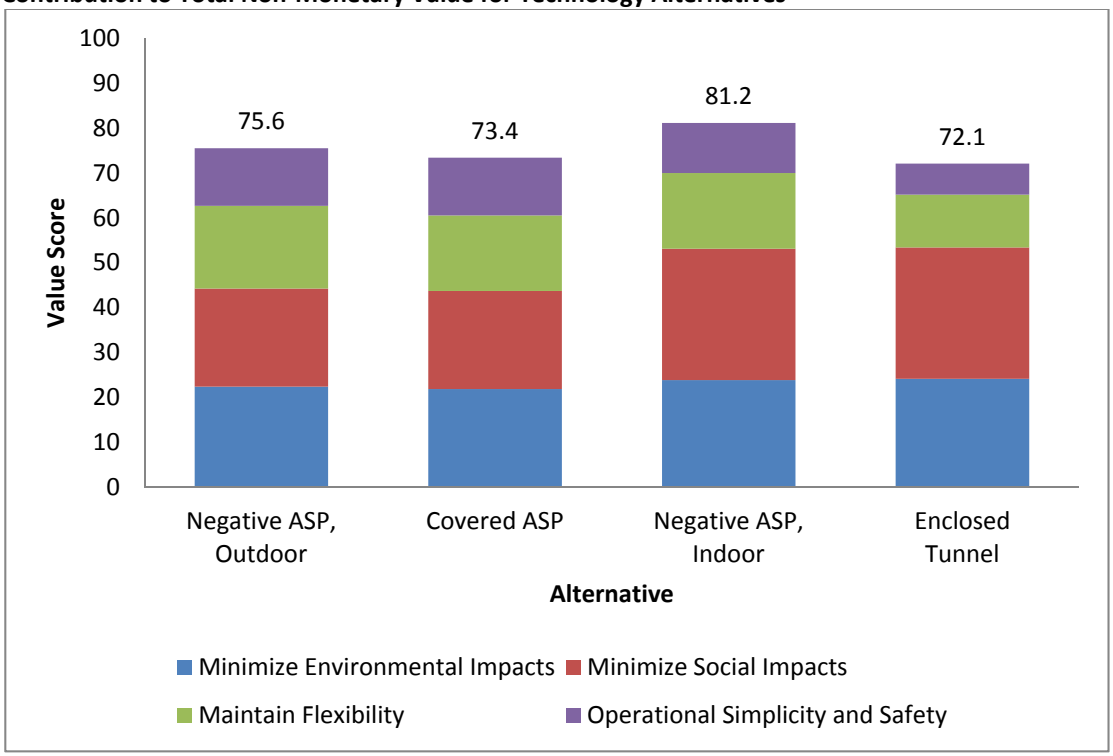
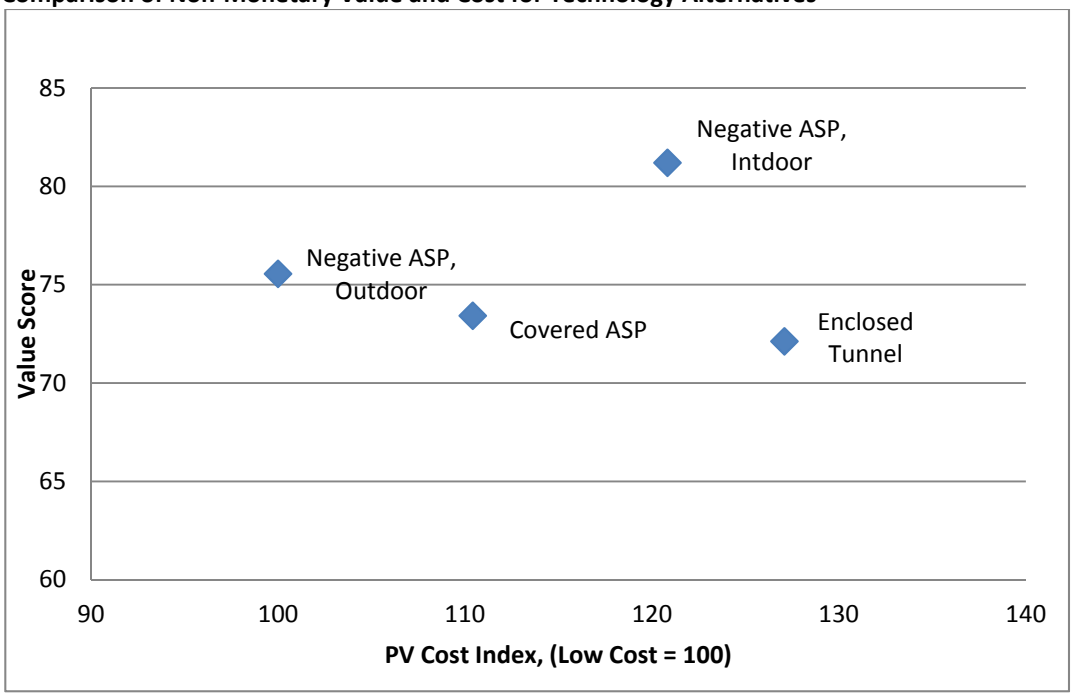


EXHIBIT 40

Comparison of Non-Monetary Value and Cost for Technology Alternatives



The results of the evaluation of feedstock options are shown in Exhibits 41 and 42. As shown, Alternative 3 (SSO Only) has the highest score of 74.4, and "Minimize Environmental Impacts" criterion has the largest effect on the overall score, mainly because of the environmental effects associated with the added transportation of biosolids.

As shown in Exhibit 42, the least option cost is Alternative 1 (SSO + Biosolids without AD), which was assigned an index score of 100. Alternative 3 (SSO only) costs about 10 percent more than Alternative 1, but provides significantly higher value. Alternative 2 (SSO + Biosolids with AD) could be eliminated from consideration based on the fact that it has a lower value score and is more expensive than Alternative 3. Thus, should the City develop the organics facility, the choice of feedstock mix would present cost and value tradeoffs that would need to be considered.

EXHIBIT 41

Contribution to Total Non-monetary Value for Feedstock Alternatives

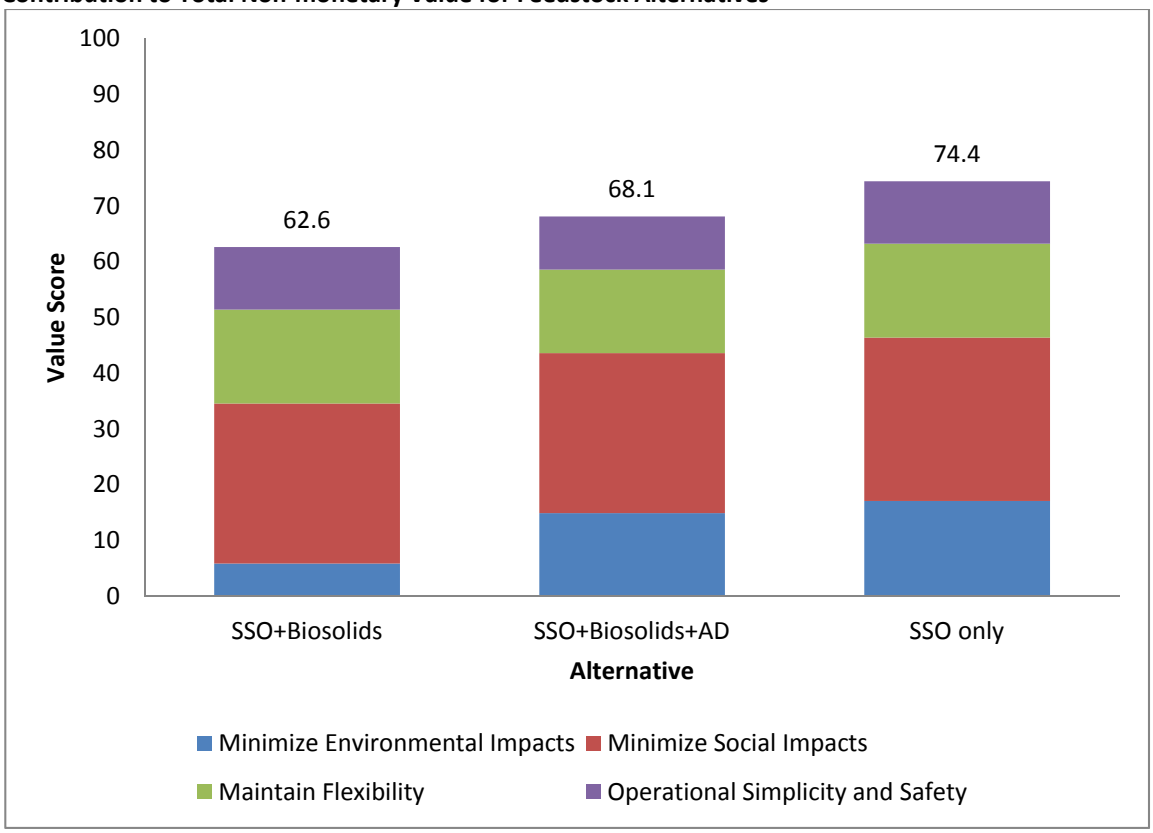
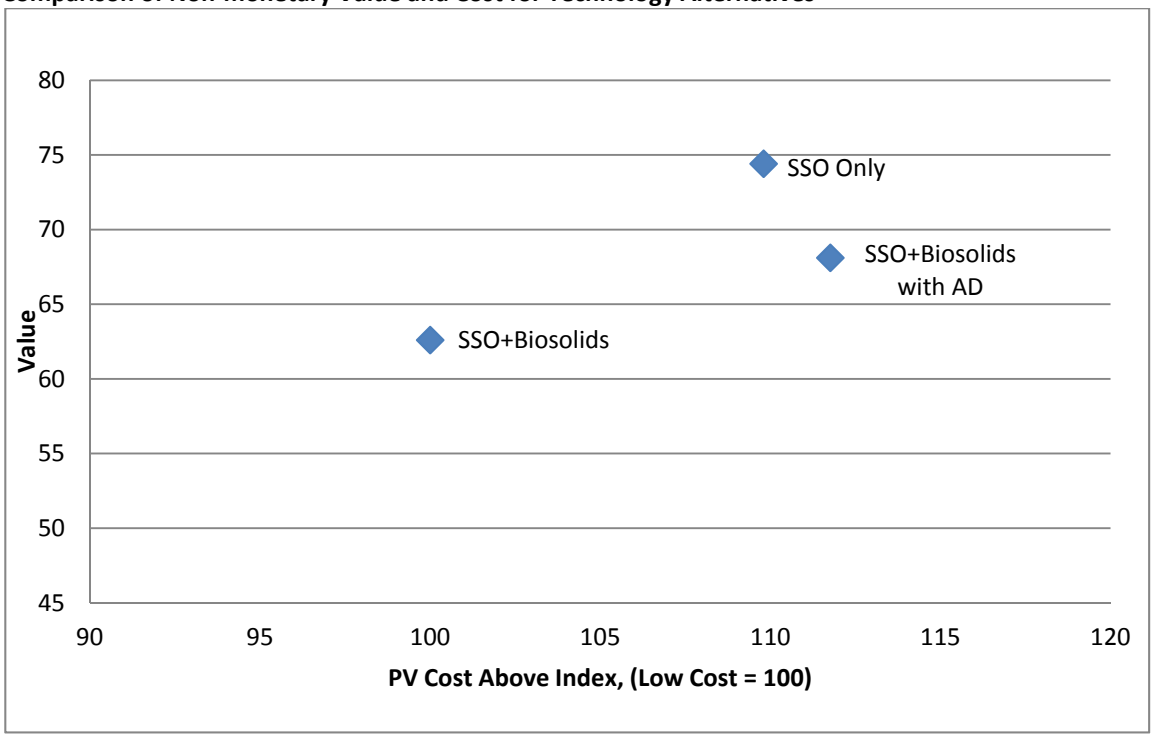


EXHIBIT 42

Comparison of Non-monetary Value and Cost for Technology Alternatives



5.3 Conclusions of Business Case Analysis

Based on proceedings of the initial workshop, held November 1, 2012, a draft MODA evaluation was prepared for four alternative technologies. Initial MODA results were reviewed with participants at the second workshop held November 20, 2012. A refined MODA evaluation was presented at the third workshop on December 18, 2012. For this evaluation, it was assumed that the composting facility would be located at the landfill site. After viewing the results, Indoor Negative ASP was selected as the preferred technology from this evaluation, and a second MODA evaluation was conducted for three different feedstock scenarios using that technology. The three feedstock scenarios that were considered include: “SSO + Biosolids without AD”, “SSO + Biosolids with AD”, and “SSO Only” (without biosolids).

Results of the second MODA evaluation indicate that the SSO Only alternative has the highest score of 74.4. The alternative that has the least option cost is the SSO + Biosolids without AD alternative, which is about 10 percent less than SSO Only alternative, however the SSO only alternative provides significantly higher value. The SSO + Biosolids with AD alternative was eliminated from consideration based on the fact that it has a lower value score and is more expensive than the SSO only alternative. Thus, should the City develop the organics facility, the choice of feedstock mix would present cost and value tradeoffs that would need to be considered. These results were presented in a meeting with the City on February 28, 2013. The results confirmed the selection of an indoor negative ASP without AD as the preferred technology.

6. Site Evaluation

An integral part of this feasibility study was the identification of potential sites for the organics facility. This was done in a phased approach starting with the assumption that the facility would be located within the City limits. Technologies were screened using that siting assumption. Next, conceptual layouts were prepared based on the composting technologies that were selected as outlined in Section 3.4. These conceptual layouts were prepared to provide guidance to the City in relation to identifying suitable host sites for the facility. To carry forward the evaluation, the initial MODA evaluation used the assumption that the organics facility would be located onsite at the landfill. Following the initial MODA evaluation (conducted during the business case analysis), an alternate site was identified. A proposed layout for the alternate site was prepared.

This section discusses the assumptions used by CH2M HILL to prepare the conceptual layouts and provides a layout for the alternative site that was identified after the business case analysis.

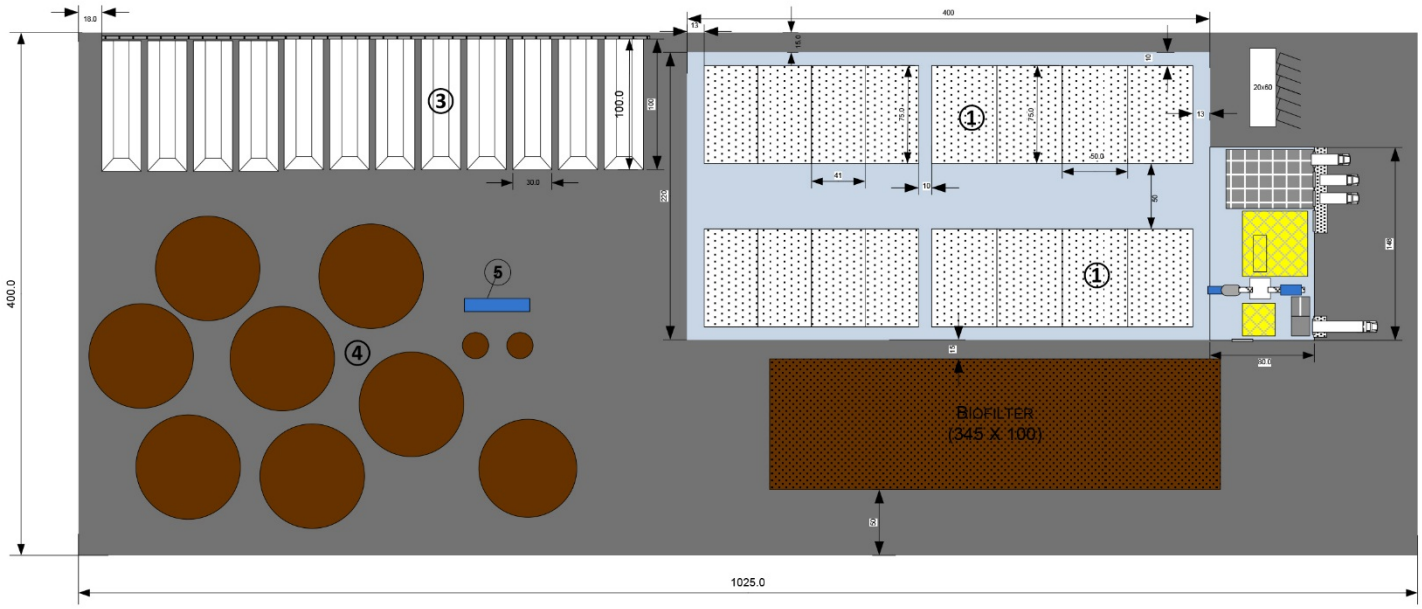
6.1 Conceptual Site Layouts

CH2M HILL prepared several preliminary site layouts to determine the approximate total facility size required and to provide guidance to the City in relation to identifying suitable host sites for the facility. The layouts were based on the composting technologies that were selected in the evaluation process outlined in Section 3.4 and include: covered ASP, negative ASP, and enclosed tunnel. Out of the technologies selected, the smallest footprint required (10 acres) was for the negative ASP, indoor alternative. The largest footprint required was for the covered ASP, outdoor alternative (15 acres). These sizes did not include the original requirement of allowing for 50 percent future expansion and should be used as the minimum requirement only. The underlying assumptions used by CH2M HILL to prepare these layouts are outlined in the following section.

Additional conceptual site layouts were prepared for the preferred scenarios discussed in Section 5, based on design assumptions developed during preparation of the business case analysis. The layouts are presented in Exhibits 43 to 45. Design assumptions for the layouts are presented in the following subsection.

EXHIBIT 43

1. SSO Composting System
3. Curing Area
4. Screening and Storage Area
5. Screen



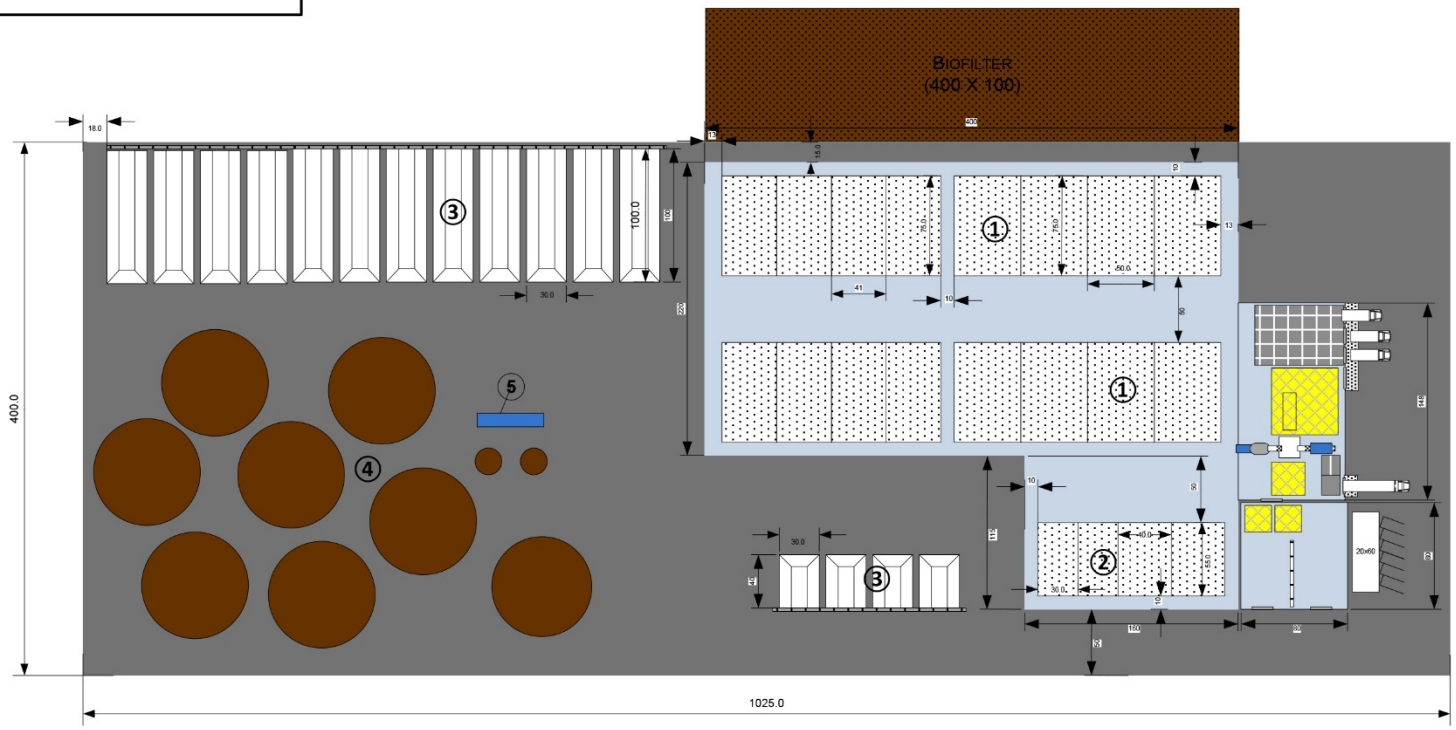
9.4 acres total area incl biofilter

CH2MHILL

Landfill Site Layout
Indoor Negative ASP Technology (SSO Only)
(dimensions in feet)

EXHIBIT 44

1. SSO Composting System
2. Biosolids Composting System
3. Curing Area
4. Screening and Storage Area
5. Screen



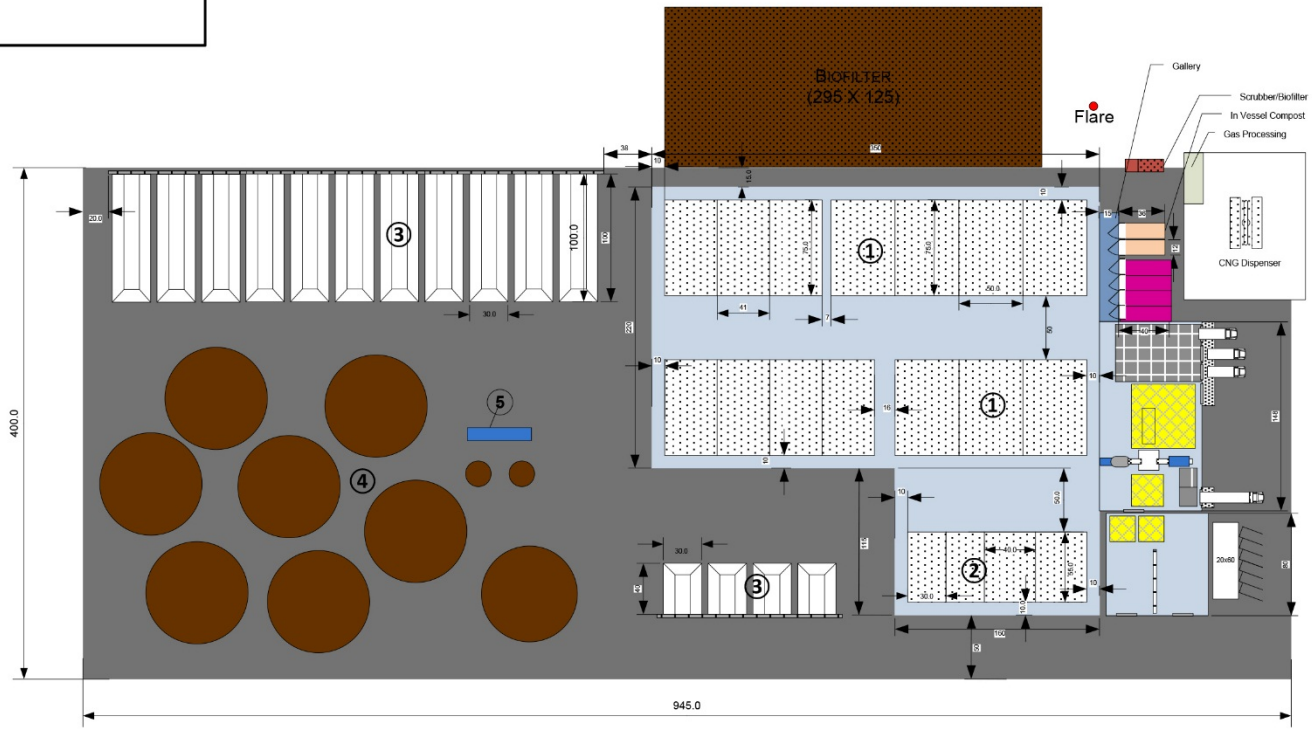
10.3 acres total area incl biofilter

CH2MHILL

Landfill Site Layout
Indoor Negative ASP Technology (SSO + Biosolids)
(dimensions in feet)

EXHIBIT 45

1. SSO Composting System
2. Biosolids Composting System
3. Curing Area
4. Screening and Storage Area
5. Screen



9.5 acres total area incl biofilter

CH2MHILL

Landfill Site Layout
Indoor Negative ASP & AD Technology (SSO + Biosolids)
(dimensions in feet)

6.1.1 Facility Sizing and Layout Assumptions

6.1.1.1 Facility Capacity

For the purposes of sizing the processing technologies and developing initial site layouts, it has been assumed the facility will initially be sized to manage approximately 41,000 tons per year (with a peak weak of 1,450 tons) of SSO materials from single-family sources. This is based on the 2024 projected peak weekly amount as discussed in Section 2.

The facility would also be sized so that it is capable of managing 200 wet tons per week (10,400 wet tons per year) of digested and dewatered biosolids. It is assumed that this material would be processed separately from the SSO feedstocks, and that a biosolids-based compost would be produced and marketed in conjunction with the SSO-based compost.

6.1.1.2 Traffic Levels

Traffic levels related to SSO deliveries to the facility were approximated based on the estimates of peak residential and commercial SSO quantities during 2024 (that is, 1,450 tons/week) and the assumption that feedstock deliveries are evenly distributed over each day of the week and the average truck payload is 10 tons. The peak daily traffic level was estimated to be in the order of 21 vehicles per day (vpd). The peak hourly traffic level was estimated to be 5 to 6 vehicles per hour (vph), which his approximately 24 percent of the peak daily level.

6.1.1.3 Enclosed Receiving and Pre-processing Building

In all layouts considered, it has been assumed that the facility would include an engineered steel-frame building for receiving of SSO. This receiving building would be fully enclosed to assist with the control of odors and vector attraction, and the ventilation system would be integrated into the design of the overall odor capture and treatment system.

The receiving building would contain separate areas for receiving SSO and biosolids. One SSO truck unloading bay would be required in the receiving building to handle the expected peak hourly traffic, based on an assumed unloading time of 10 minutes per vehicle. However, to account for both future growth in SSO quantities beyond the 2024, and unexpected situations (for example, vehicle breakdown during unloading), three unloading bays have been provided in the site layouts. The SSO area has further been sized to provide floor temporarily space to store 900 yd^3 of SSO feedstocks. This is equivalent to one day's worth of SSO deliveries material during the peak summer. It was assumed that the feedstocks would be stacked to a maximum height of 15 feet using a wheel loader.

It has been assumed that biosolids would be received in tandem-axle end dump trucks or similarly sized units. A single truck bay has been included inside the receiving building for this purpose. This bay is adjacent to but separate from the truck bays designated for SSO receiving. Biosolids delivery trucks would discharge their contents into a recessed storage pit in the floor so that the biosolids are contained. The biosolids would subsequently be removed from the storage pit and handled using a wheel loader.

Amendments for biosolids would be stored in a cold-storage building adjacent to the receiving building. This amendment building would be connected to the receiving building via an overhead door so that the wheel loader can travel between the two buildings without having to travel outside.

6.1.1.4 Pre-Processing

Pre-processing equipment for the SSO and biosolids feedstocks would be located within the receiving building.

Pre-processing for the SSO is assumed to consist of size reduction and mixing. This will be achieved using a single manually loaded shredder unit. The shredder would discharge onto a common conveyor belt that would transfer the material to a temporary storage bunker. Material in this storage bunker would be manually loaded into the composting system using a wheel loader.

Pre-processing of biosolids is assumed to consist of mixing only (that is, it is assumed that wood would be ground prior to delivery to the amendment storage area). The biosolids would be mixed with wood amendments and screening overs using a manually loaded vertical auger mixer. The unit would be equipped with scales to allow for proper metering of materials and adherence to the final mix design. The biosolids/amendment mixture would be

discharged from the mixing unit onto a conveyor system that would transfer it to a temporary storage bunker. Material in this storage bunker would be manually loaded into the composting system using a wheel loader.

6.1.1.5 Active Composting Systems

The conceptual facility layouts were prepared using the technologies recommended in Section 3.4. It was assumed that the residence time for materials in the composting systems would be 4 weeks. The numbers of composting piles/vessels in each scenario were based on this assumed residence time, the peak weekly amount of feedstocks that are accepted at the facility, and the associated amendment requirements. All composting systems were sized based on volumetric capacities.

As previously outlined, it has been assumed that SSO and biosolids would be composted separately.

6.1.1.6 Odor Treatment

Odor treatment will be a key component of the processing facility. An allowance has been included in each of the site layouts for one or more biofilters, which is the assumed odor treatment method.

The sizes of the biofilters shown in each of the layout drawings have been based on the size of the corresponding active composting systems. The biofilters are also sized to process air collected from receiving and composting buildings.

In addition to biofiltration, process air from the biosolids composting operation will be routed through an acid scrubber to reduce ammonia concentrations in the airstream. The scrubber systems will be located upstream of the biofilter system.

6.1.1.7 Compost Curing Assumptions

It will be necessary to produce compost products that are both stable and mature. The industry-accepted stability and maturity requirements in Exhibit 46 have been adopted and used to guide the technology evaluation process.

It has been assumed for all evaluated composting technologies that curing would be completed over a 3-week period using a positively aerated system that is located below an open-sided roof structure. The size of the curing operation for each scenario has been based around the use of discrete curing piles that are 15 feet high.

6.1.1.8 Compost Screening and Product Storage Area

Due to market demand cycles, it may be necessary to temporarily store compost produced during the winter months. The layouts include an allowance for storage of finished compost in 20 feet high stockpiles.

6.1.1.9 Administration and Staff Facility

An allowance has been included for a combined administration and staff facility. This space would be located immediately adjacent to the composting facility but would be accessible from a public road network (that is without having to pass through the landfill scale system).

A footprint of 50 feet by 65 feet has been assumed for this facility. It is assumed that this would be a single-story structure that contains reception area and offices, meeting rooms, lunch room, change room with showers, control room, and onsite laboratory.

6.1.2 Alternate Location

As a follow up to the business case cost analysis, a site evaluation was conducted for an alternate location to the landfill site using the preferred technology and feedstock options. The alternate site, located in the Tide Flats at 2014 Marc Street with dimensions as shown in Exhibit 46. A conceptual layout for the site is shown in Exhibit 47.

MODA was used as a methodology to compare the two sites. A discussion of the MODA evaluation conducted for siting follows. In comparing the two sites, it was assumed the indoor ASP technology would be used and the facility would handle both SSO and biosolids, but that AD would not be implemented.

EXHIBIT 46

Marc Street Site Dimensions

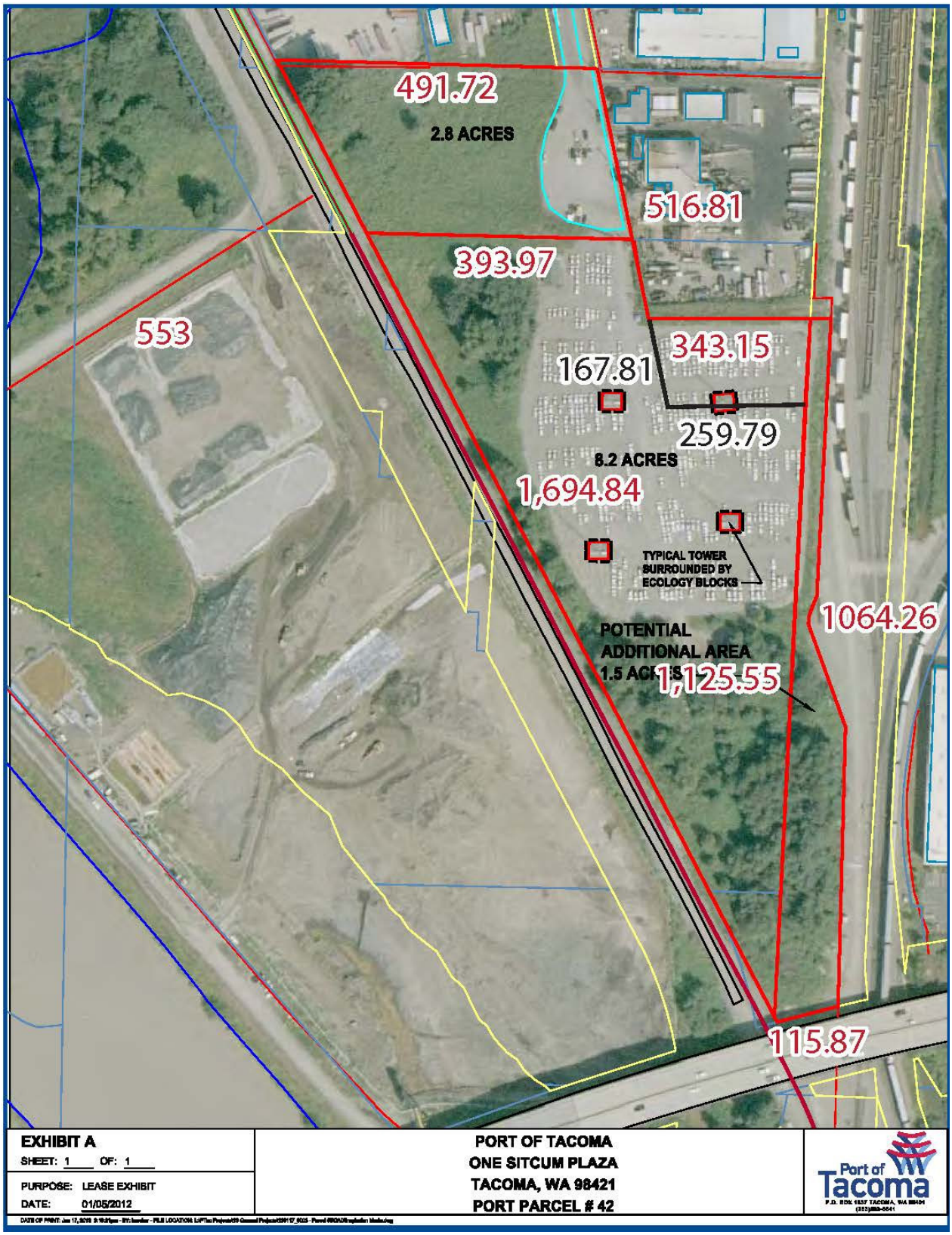
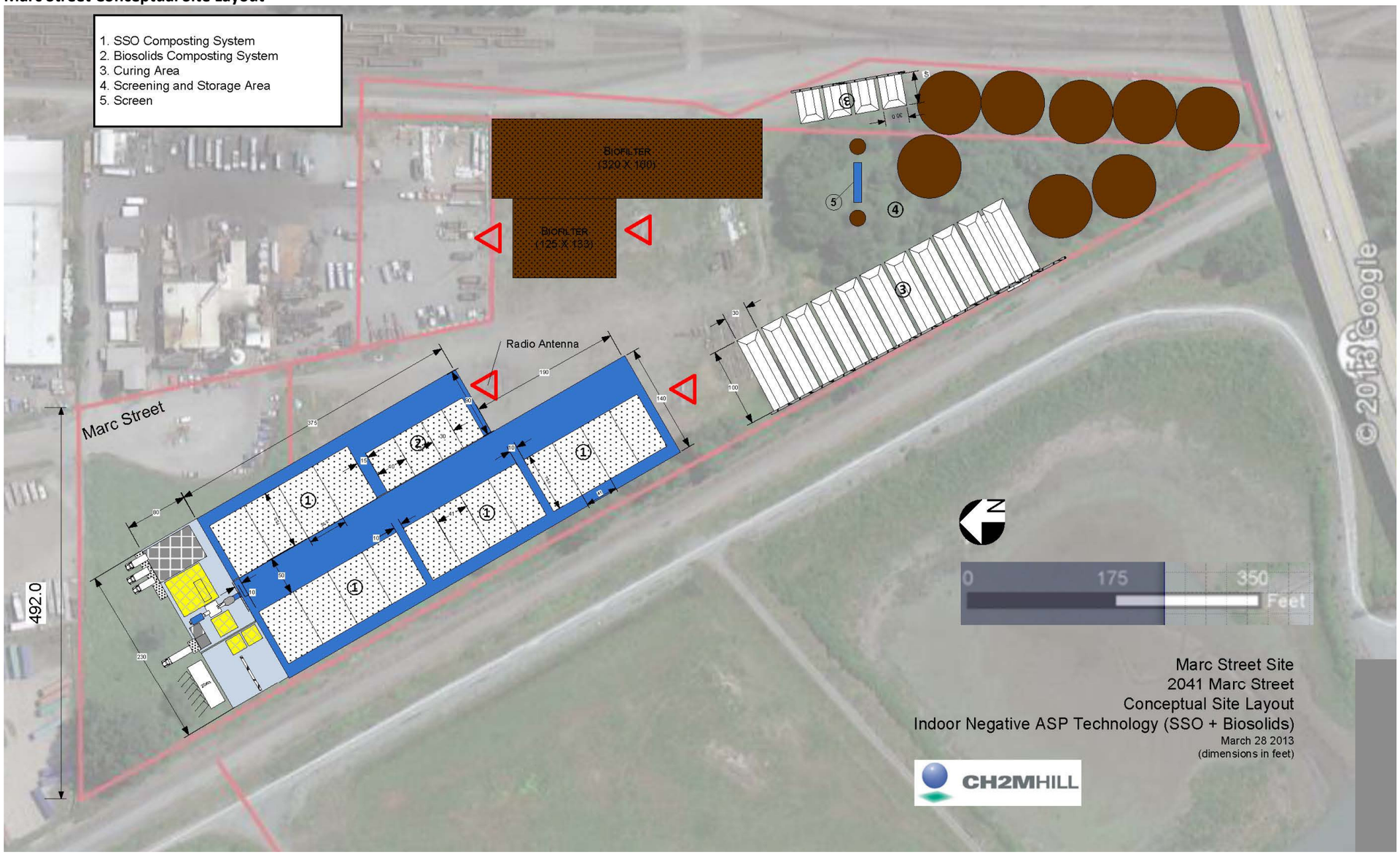


EXHIBIT 47

Marc Street Conceptual Site Layout



6.1.3 Evaluation Criteria

CH2M HILL developed a proposed set of evaluation criteria based on prior siting evaluations and our understanding of the City's objectives. The criteria used for the siting evaluation is presented in Exhibit 48. Similarly to the technology evaluations, the MODA evaluation included two primary criteria: cost and non-monetary objectives.

EXHIBIT 48
Siting Criteria

I. Minimize life-cycle costs (acquisition, site demolition and development, permitting, capital, operating, maintenance, collection, transportation), Low Cost = 100	
II. Maximize Ability to Achieve the City's Non-monetary Objectives	
1	Potential for environmental constraints (wetlands, wildlife, fish, surface waters)
2	Consistency with neighboring land uses (e.g., Port plans)
3	Truck access/egress
4	Operational flexibility (larger site is better)
5	Likelihood of impacts to persons living or working near the facility (residences, schools, urban areas)
6	Potential for truck route to affect persons or businesses
7	Preservation of economic benefits by not using land that would otherwise be readily developable

6.1.3.1 Measurement Scales

The measurement scales used to evaluate the siting criteria are presented in Exhibit 49. All sub-criteria evaluated under the non-monetary objectives were evaluated on a 1-5 scale. As with the business case evaluation, life-cycle costs were calculated over a 30-year operating period from 2014 to 2043. The cost estimates include the present value cost of construction, debt service on major capital expenditures, O&M, revenues, and long-term replacement.

EXHIBIT 49
Performance Measures for Site Evaluation

	Siting Criteria	Measurement Scale
I. Minimize life-cycle costs (acquisition, site demolition and development, permitting, capital, operating, maintenance, collection, transportation)		
II. Maximize Ability to Achieve the City's Non-monetary Objectives		
1	Potential for environmental constraints (wetlands, wildlife, fish, surface waters)	1-5 scale reflecting likelihood of environmental constraints
2	Consistency with neighboring land uses (e.g., Port plans)	1-5 scale reflecting land use consistency
3	Truck access/egress	1-5 scale reflecting ease of truck access/egress
4	Operational flexibility (larger site is better)	1-5 scale reflecting acreage of land available and its implication for operations
5	Likelihood of impacts to persons living or working near the facility (residences, schools, urban areas)	1-5 scale reflecting the proximity of sensitive receptors
6	Potential for truck route to affect persons or businesses	1-5 scale reflecting potential for dramatic increase in truck traffic en route to the facility
7	Preservation of economic benefits by not using land that would otherwise be readily developable	1-5 scale reflecting economic potential foregone

6.1.3.2 Relative Value Weights

Relative value weights were provided by City staff using an email survey. Consensus weights, shown in Exhibit 50, were the average of the responses received.

EXHIBIT 50
Consensus Value Weighting Results for Site Evaluation

	Siting Criteria	Relative Importance Weight	Percent of Total
1	Potential for environmental constraints (wetlands, wildlife, fish, surface waters)	78	14.1%
2	Consistency with neighboring land uses (e.g., Port plans)	72	13.0%
3	Truck access/egress	83	15.0%
4	Operational flexibility (larger site is better)	90	16.2%
5	Likelihood of impacts to persons living or working near the facility (residences, schools, urban areas)	100	18.0%
6	Potential for truck route to affect persons or businesses	76	13.7%
7	Preservation of economic benefits by not using land that would otherwise be readily developable	56	10.1%

6.1.3.3 Alternative Scores

The scores for each of the site evaluation alternatives are presented in Exhibit 51. The two locations had identical scores for four of the criteria. The Landfill Site scored better in two categories, while the Marc Street site scored better in the criteria relating to likelihood of impacts to persons living or working near the facility.

EXHIBIT 51
Scoring for Siting Alternative

	Siting Criteria	Landfill	Marc St
1	Potential for environmental constraints (wetlands, wildlife, fish, surface waters)	3.0	2.0
2	Consistency with neighboring land uses (e.g., Port plans)	3.0	3.0
3	Truck access/egress	5.0	5.0
4	Operational flexibility (larger site is better)	5.0	4.0
5	Likelihood of impacts to persons living or working near the facility (residences, schools, urban areas)	2.0	5.0
6	Potential for truck route to affect persons or businesses	5.0	5.0
7	Preservation of economic benefits by not using land that would otherwise be readily developable	5.0	4.0

6.1.3.4 Life Cycle Cost Estimates

The life cycle cost of the landfill site is estimated to be less than that of the Marc Street site, with the Marc Street site estimated to be about 11 percent higher than the landfill site. The cost elements estimated are the same as those described above for the evaluation of the four composting technologies with one difference. For siting, the cost of transporting material to the Marc Street site was considered. Information about current collection and transfer practices were obtained from the City and it was assumed that 20 percent of organics is from self-haul customers and 80 percent is from collection vehicles. All of the self-haul material and 60 percent of the material from collection vehicles would be transferred from the landfill site to the Marc Street site.

6.1.4 Results

Results from the site evaluation are shown in Exhibits 52 and 53. As shown, the Marc Street scores slightly higher on the non-monetary aspects of the evaluation, primarily because of the landfill site's proximity to residences. However, the Marc Street site is estimated to be approximately 11 percent more expensive than the landfill site mainly because of the cost of transferring material. Should the City elect to pursue development of the

composting facility, it would need to evaluate this tradeoff between non-monetary value and cost when making a site selection. Additionally, the landfill site can accommodate a future expansion of 50 percent, whereas the Marc Street site cannot.

EXHIBIT 52
Contribution to Non-monetary Value for Two Siting Options

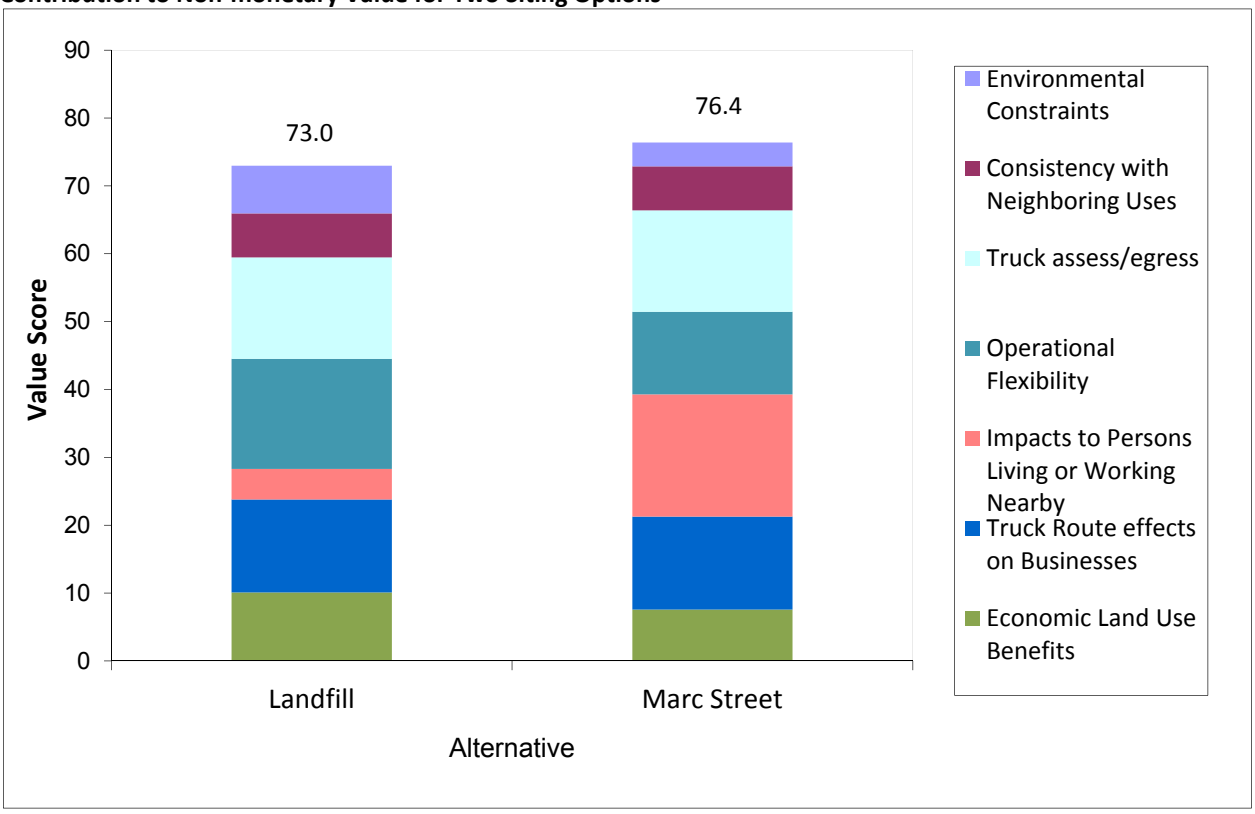
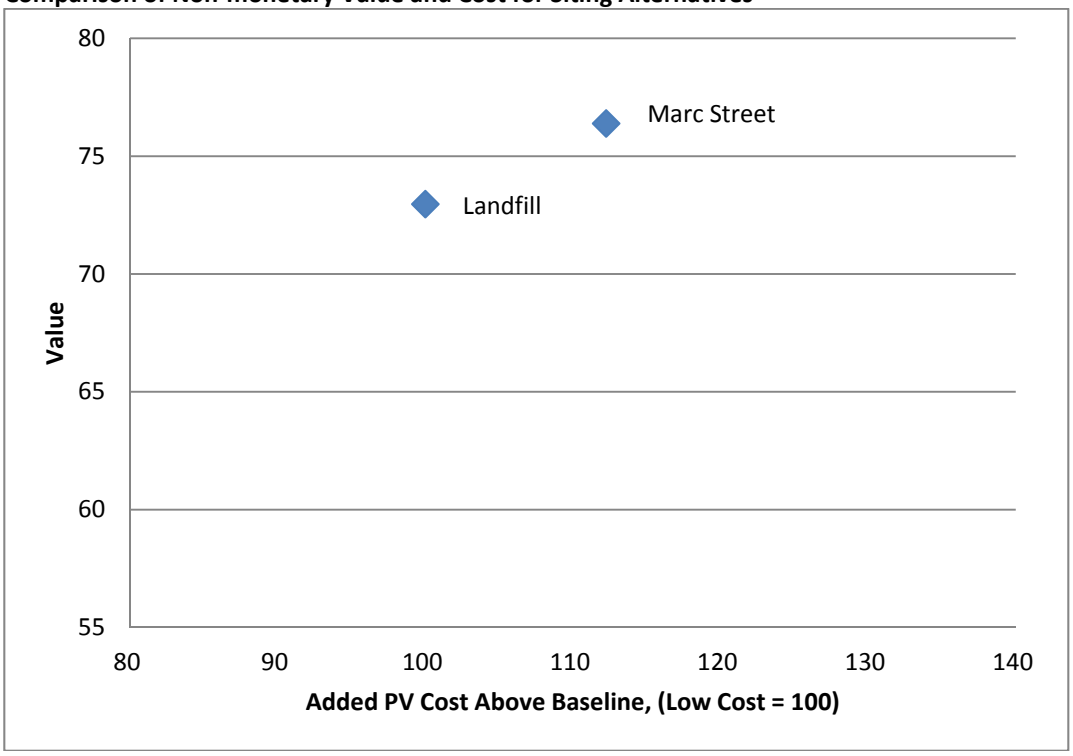


EXHIBIT 53
Comparison of Non-monetary Value and Cost for Siting Alternatives



7. Summary and Conclusions

CH2M HILL was retained by the City of Tacoma Washington to prepare a feasibility study that evaluated the prospect of building and operating a new large-scale organics management facility. This feasibility study presents the findings of the following activities: feedstock analysis, technology evaluation, market study, business case cost analysis, and site evaluation. These activities took place in 2012 and 2013.

Based on the results of the feedstock analysis, the City should design the organics management facility to accommodate 41,022 tons per year (peak weak of 1,450 tons) of residential SSO. The City might also plan for an additional 100 to 200 tons per week for organics that may be available from other jurisdictions and commercial generators. Additionally, composting technologies should also be evaluated for their ability to handle approximately 200 wet tons of biosolids per week (approximately 10,000 tons per year).

After the feedstock analysis, a technology evaluation was completed. A total of 19 potential composting and AD technologies were identified and screened. Ultimately, four composting technologies and one AD technology was selected to be carried forward to the next step of the evaluation process.

Concurrently a market study was performed that found the Washington State and the Puget Sound region currently has large volumes of successfully marketed compost, has several potential end users, and is comprised of population that is well versed on the benefits and uses of compost.

The next step of the evaluation was to perform a business case analysis (including multiple MODA evaluations) of the four recommended composting technologies and the one AD technology. Based on this analysis, indoor negative ASP was selected as the preferred technology from the initial evaluation. A second MODA evaluation was conducted for three different feedstock scenarios using that technology. Results of the second MODA evaluation indicate that the SSO Only and the SSO + Biosolids without AD alternatives have the highest value and least cost, respectively. The SSO + Biosolids with AD alternative was eliminated from consideration based on the fact that it has a lower value score and is more expensive than the SSO only alternative. Thus, should the City develop the organics facility, the choice of feedstock mix would present cost and value tradeoffs that would need to be considered.

An integral part of this feasibility study was the identification of potential sites for the organics facility. Conceptual layouts were prepared based on the assumption that the facility would be located within the City limits. Next, a specific site was needed for completion of the initial MODA evaluation. To meet this requirement, CH2M HILL assumed that the organics facility would be located onsite at the landfill. Following the initial MODA evaluation, an alternate site located on Marc Street was identified. A proposed layout for this site was prepared and a MODA evaluation was prepared to compare the Marc Street site with the landfill site. The Marc Street scored slightly higher on the non-monetary aspects of the evaluation, but is estimated to be approximately 11 percent more expensive than the landfill site, mainly because of the cost of transferring material. The landfill site can accommodate a future expansion of 50 percent and the Marc Street site cannot. Should the City elect to pursue development of the composting facility, it would need to evaluate this tradeoff between non-monetary value and cost and future expandability when making a site selection.

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Appendix A
Supplementary Market Assessment Materials

Survey Responses/Contact List

P/V	#	Company Name	City	Phone	Contact
Ldsp. Suppliers					
P	1	Holman Trucking	Renton	(206) 612-2853	Ray Holman
P	2	Lenz Enterprises	Stanwood	(360) 336-1642	Taylor Brown
V	3	Burien Sand & Gravel	Seatac	(206) 246-7000	Nathan Ward
P	4	West Sound Landscape Supplies	Port Orchard	(253) 857-3378	Steve Littleton
V	5	Corliss Resources	Sumner	(253) 891-6680	Sam Martinson
P	6	H & B Topsoil	Tacoma	(253) 472-1252	Eric Sylstad
P	7	Allen Shearer Trucking-Lndscp	Belfair	(360) 275-3465	Antonette Huggins
P	8	Purdy Topsoil & Gravel Llc	Gig Harbor	(253) 857-5850	Rick Mondoux
P	9	Asbury S Topsoil Inc	Silverdale	(360) 692-8393	Rich Hendericks
P	10	Red E Topsoil	Redmond	(425) 868-6500	Steve Steiger
V	11	River Road Ldspg Supplies	Puyallup	253-841-1125	Pat Herbert
V	12	Corliss Resource Retail	Puyallup	206-510-7104	Sam Martinson
V	13	Randles Sand & Gravel	Puyallup	253-531-6800	
V	14	Puyallup Bark Supply, Inc	Puyallup	253-548-3000	
V	15	Pacific Topsoils -Issaquah Yard	Issaquah	425-337-2700	
V	16	Sunset Materials	Renton	425-226-4140	Trevor
V	17	E-Green Ldsp Supply / Ldspg	Seattle	206-763-7625	
V	18	Pierce County Recycling	Puyallup	253-377-2963	Don Taylor
Golf Course					
P	19	Capitol City Golf Club	Olympia	(360) 491-5111	Don Firestone
P	20	Snoqualmie Falls Golf Course	Fall City	(425) 222-6440	Lee Baldwin
P	21	Intrawest Golf	Redmond	(425) 836-1432	Greg Matz
P	22	Golf Club At Newcastle	Newcastle	(425) 793-5566	Scott Phelps
P	23	Fort Lewis Golf Course	McChord Field	(253) 967-6522	Terry Beck
Landscaper					
P	24	New Dimension Lawn & Ldsp	Puyallup	(253) 922-1184	Tabitha Stewart
P	25	Uyeta Nursery Ldsp & Design	Renton	(253) 859-8589	Mike Hilsenkopf
P	26	Sauro Landscaping	Lake Tapps	(253) 862-6590	Thomas Sauro
P	27	Ralph Wells Ldspg & Rckrs	Fall City	(425) 372-7776	Ralph Wells
P	28	Pro Grass Inc	Tacoma	(253) 539-0092	Bret Bryan
P	29	Glenbrook Services	Lake Stevens	(425) 334-0700	Cindy Bond

P	30	Borealls Landscape & Design	Snohomish	(206) 679-6576	Gil Schieber
P	31	Casey S Landscaping & Mntnc	Tenino	(360) 956-1536	Richard Casey
P	32	Evergreen Landscape Mgt.	Shoreline	(425) 489-3435	Forrest Lemme
P	33	Williamson Landscape Arch.	Seattle	(206) 784-7996	William Williamson
Nursery / Garden Center					
V	34	Star Lake Greenhouse	Auburn	(253) 852-3523	Todd Nakamura
P	35	Van Klaveren S Nursery	Lake Stevens	(360) 659-5560	Jack Van Klaveren
P	36	Harnden S Tree Nursery	Snohomish	(360) 568-6568	Dave Harnden
P	37	Eatonville Nursery-Greenhouse	Eatonville	(360) 832-4345	Dave Schactler
V	38	Alpine Nursery	Renton	(425) 255-1598	Josh Potter
V	39	Alpine Nursery & Landscape	Puyallup	253-847-7078	Bret Ratfield
Other					
P	40	WA DOT	Olympia	360-705-7260	Mark Maurer
P	41	WA DOT	Olympia	360-705-7245	Sandy Salisbury
P	42	WSU Puyallup	Puyallup	253-445-4512	Craig Cogger

TAGRO Program	City of Tacoma – Tacoma, Washington Dan Thompson, John Wells, and Tom Amundson
PROCESS	**1. Biosolids treatment method used to achieve Class A:** Dual digestion: aerobic/thermophilic and temperature phase/aerobic ('these processes have really reduced the odor of the biosolids' / 22 day treatment). **2. Soil amendment process description:** dewatered biosolids (20-24% dm) > pre-blended with FELs on blending pad > stacked > shredded with soil shredder (Royer 466) > stockpiled. **3. Biosolids volume generated and managed:** 4,000 dty / 85% being managed through the TAGRO program. **4. Startup date of soil amendment program:** 1992, small program that gave product away. 2003, stopped give aways. **5. Staffing:** 13, which includes truckers **6. Equipment utilized:** 2 FEL's, large soil shredder. **7. Site description:** Small blending pad, with 1.5-2 acre manufacturing and storage area. **8. Operational difficulties/potential improvements:** Few difficulties. Had some minor product odor issues in past (but none since digester upgrade). **9. Successes/failures:** Having excellent success selling their product for a set price. Have obtained more commercial scale accounts (because slow Spring sales to residents, attributed to rain and related storage issues, forced them to expand their marketing efforts). Always difficult to manage labor force vs. work load, as well as product stockpile sizes vs. available storage space. Have to run all price changes (up/down) through City Council, which is cumbersome. **10. Processing cost:** See attached table of manufacturing costs. When transportation and other overhead costs are included, they estimate a per CY profit of $12.99 for potting soil and a loss of $2.42(-$2.42) for the mix.
PRODUCT/ MARKETING	**11. Finishing equipment:** No screener. **12. Types of products produced:** Potting soil and mix (soil type soil amendment). Also, used to produce a mulch product. Stopped producing mulch because they didn't have enough room on site for storage, and the source of their mulch feedstock (woody) became problematic. At its peak, 4,000 CY/yr of 'mulch' were sold. They need more room for product storage and new product development *(could be an opportunity to team with City composting facility)*.

PRODUCTS	Formula	Sale Price (picked-up)	2011 Sales
Potting Soil	20% sawdust, 60% bark, 20% dewatered biosolids	$30 CY	4,000 CY
Mix	25% sawdust, 25% sand, 50% dewatered biosolids	$8-10 CY	24-25,000 CY

13. Volumes of finished products and marketing/distribution: See table above. Would like to produce mulch product again *(could potentially be produced with woody fraction of compost).* 10-15% of the product is given away to farmers and additional material is given to community gardens. Homeowners are the largest buyers, by far, with landscapers a distant second. Landscaper usage is even slower since the downturn in the economy. Homeowners can come to site and get the 'mix' product for 'free' if they shovel it themselves. There are always loading and delivering charges applied.

14. Quality control program: Test for 503 metals and pathogens for State and Federal regulation, also test every 1,000 CY through A&L Great Lakes Laboratory for agronomic parameters.

15. Marketing effort: Have developed product literature and a website (www.tagro.com). They are also members of regional landscape organizations and attend a regional lawn/garden show (booth), as the budget allows. They sometimes advertise the products on the radio.

16. Marketing strategies: Market locally, concentrating on residents and professional landscapers. Trying to 'push' sales to professional landscapers, but aggressive sales have not been done. Could see a joint marketing program with the composting facility working.

17. Public acceptance: It is manageable. They get an occasional e-mail about heavy metals, but have master gardeners who work for them. They are sent into the 'field' to assist end users and answer questions.

18. Transportation: Have a small fleet of trucks that are used for the majority of the hauling (5 – 15CY, 2 – 10 CY and 2 – 3 CY truck). They place a 1 CY minimum for deliveries within the City and a 3 CY minimum for orders delivered outside the City. Because the City Council controls pricing, they can only charge a $1.50/loaded mile delivery charge, even though it is costing well above that.

19. Types of large customers: In the past, Washington State DOT purchased 4,000 CY of mix for landscape planting projects, but not anymore. Sell primarily to small customers now.

Washington State Department of Transportation Compost Specifications

9-14.4(8) Compost

The second paragraph is revised to read:

Compost production and quality shall comply with WAC 173-350 and for biosolids composts, WAC 173-308.

The third paragraph is to read:

Compost products shall meet the following physical criteria:

1. Compost material shall be tested in accordance with U.S. Composting Council Testing Methods for the Examination of Compost and Composting (TMECC) 02.02-B, "Sample Sieving for Aggregate Size Classification".

Fine compost shall meet the following gradation:

Sieve Size	Percent Passing	
	Minimum	Maximum
1"	100	
5/8"	90	100
¼"	75	100

Note Maximum particle length of 4 inches.

Medium compost shall meet the following gradation:

Sieve Size	Percent Passing	
	Minimum	Maximum
1"	100	
5/8"	85	100
¼"	70	85

Note Maximum particle length of 4 inches. Medium compost shall have a carbon to nitrogen ration (C:N) between 18:1 and 35:1. The carbon to nitrogen ration shall be calculated using dry weight of "Organic Carbon" using TMECC 04.01A divided by the dry weight of "Total N" using TMECC 04.02D.

Coarse compost shall meet the following gradation:

Sieve Size	Percent Passing	
	Minimum	Maximum
2"	100	
1"	90	100
¾"	70	100
¼"	40	60

Note

1. Maximum particle length of 6 inches. Coarse compost shall have a carbon to nitrogen ratio (C:N) between 25:1 and 35:1. The carbon to nitrogen ratio shall be calculated using the dry weight of "Organic Carbon" using TMECC 04.01A divided by the dry weight of "Total N" using TMECC 04.02D.
2. The pH shall be between 6.0 and 8.5 when tested in accordance with U.S. Composting Council TMECC 04.11-A, "1:5 Slurry pH".
3. Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 1 percent by weight as determined by U.S. Composting Council TMECC 03.08-A "Classification of Inerts by Sieve Size".
4. Minimum organic matter shall be 40 percent by dry weight basis as determined by U.S. Composting Council TMECC 05.07A "Loss-On-Ignition Organic Matter Method (LOI)".
5. Soluble salt contents shall be less than 4.0 mmhos/cm when tested in accordance with U.S. Composting Council TMECC 04.10 "Electrical Conductivity."
6. Maturity shall be greater than 80 percent in accordance with U.S. Composting Council TMECC 05.05-A, "Germination and Root Elongation".
7. Stability shall be 7-mg CO2–C/g OM/day or below in accordance with U.S. Composting Council TMECC 05.08-B "Carbon Dioxide Evolution Rate".

8. The compost product shall originate from organic waste as defined in WAC 173 350 as “Type 1 Feedstocks”, “Type 2 Feedstocks”, and/or “Type 3 Feedstocks”. The Contractor shall provide a list of feedstock sources by percentage in the final compost product.
9. The Engineer may also evaluate compost for maturity using U.S. Composting Council TMECC 05.08-E “Solvita® Maturity Index”. Fine compost shall score a number 6 or above on the Solvita® Compost Maturity Test. Medium and coarse compost shall score a 5 or above on the Solvita® Compost Maturity Test.

9-14.4(8)A Compost Approval

This section’s title is revised to read:

9-14.4(8)A Compost Submittal Requirements

The first sentence in this section up until the colon is revised to read:

The Contractor shall submit the following information to the Engineer for approval:

Item No. 2 in the first paragraph is revised to read:

2. A copy of the Solid Waste Handling Permit issued to the manufacturer by the Jurisdictional Health Department in accordance with WAC 173-350 (Minimum Functional Standards for Solid Waste Handling) or for biosolid composts a copy of the Coverage Under the General Permit for Biosolids Management issued to the manufacturer by the Department of Ecology in accordance with WAC 173-308 (Biosolids Management).

Appendix B
Greenhouse Gas Estimation

Introduction

Greenhouse gas (GHG) emissions were calculated as part of the life cycle analysis for each of the technology and feedstock alternatives evaluated in the Business Case Cost Analysis. GHG emissions, expressed in tons of carbon dioxide equivalents (CO2e), were included as part of the MODA evaluation.

Composting results in GHG emissions from electricity and diesel use during operations; and there is a reduction in GHG emissions from the composting process when compared to landfill disposal. The reduction in GHG emissions associated with composting is a result of the reduction in methane associated with decomposition of organic materials under conditions present in a landfill. Methane has a potency of around 21 times that of CO2[1].

The total impact on GHG emissions is calculated as the sum of GHG emissions from operations minus the GHG reduction inherent in composting[2]. Calculations were conducted using defined parameters and assumptions, as well as professional judgment based on experience with similar projects.

Input Assumptions

Input parameters used in the evaluation of technology and feedstock alternatives, are shown in Table B-1.

Three primary sources of GHG emissions were identified:

1. Electricity usage in operations
2. Diesel usage during operations
3. Transportation of Biosolids to the Landfill Site

GHG calculations were based on an operation period beginning in 2014 and continuing through 2043. Quantities of organic material from residential sources were assumed to increase at a rate of approximately 1 percent annually. Biosolids added to the composting facility were assumed to originate from the Tacoma Central Wastewater Treatment Plant (CWWTP) beginning in 2015 with quantities ramping up and then leveling off after 2018.

Electricity use estimates for each of the alternatives were based on project experience and review of literature for similar operations. Electricity use has relatively low corresponding GHG emissions due to the high proportion of renewable energy used by Tacoma Power. Diesel use in composting operations was assumed to be proportionate to quantity of organic material processed.

As part of the feedstock analysis, the impact of adding an anaerobic digestion (AD) system to process commercial source separated organics (SSO) was assessed. Biogas was assumed to be collected and used to run equipment with excess biogas converted to CNG to be used as a fuel source for City vehicles. Leakage of methane gas from this system was counted as a source of GHG emissions.

Results

The results from GHG evaluation of technology and feedstock alternatives are presented in Exhibits B-2 and B-3, respectively. For the technology alternatives analysis, the reduction of GHG emissions resulting from landfill diversion is much greater than the increase in GHG emissions from material transportation and facility operations. For the feedstock analysis, the generation and use of biogas, which displaces fossil fuels that would otherwise be used, contributed to an estimated net GHG reduction that was approximately 13 percent greater than the alternatives that did not include AD. .

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[1] http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results

[2] Morris et al. 2012. Review and meta-analysis of 82 studies on end-of-life management methods for source separated organics. *Waste Management.* www.elsevier.com/locate/wasman

EXHIBIT B-1

Input Assumptions for GHG Emission Calculations

Input	Units	Input Value
Annual Growth Rate of Organic Material	%	1%
Payload per Truck	tons	20
Fuel Use	mpg	4.03
GHG per gal fuel Biodiesel (B20)	kg CO2e/gal	9.46
Distance from transfer station to Landfill (Alt 2)	miles	9
CO2e reduction per ton compost feedstock [a]	tons CO2e/tons compost	-0.21
CO2e reduction per ton anaerobic digester feedstock [a]	tons CO2e/tons compost	-0.25
Annual Energy use, Indoor ASP	kw-hr/yr	5,107,510
Annual Energy use, Outdoor ASP	kw-hr/yr	2,852,609
Annual Energy use, Covered ASP	kw-hr/yr	1,182,070
Annual Energy use, Indoor tunneling	kw-hr/yr	2,927,555
Biogas produced by AD per ton SSO	scf/ton	3,842
Methane leakage	%	1%
Diesel use	gal/yr	65,903
GHG per gal diesel	kg CO2e/gal	10.15

Notes:
Trucks are assumed to run on biodiesel (B20) fuel.
[a.] Morris et al. 2012. Review and meta-analysis of 82 studies on end-of-life management methods for source separated organics. *Waste Management* 33(3):545-51.

EXHIBIT B-2

GHG Emissions from Composting Technology Alternatives

Technology	NPV CO2e (Tons)				
	Transportation	Compost Emissions	Facility Operation Electricity	Facility Operation Diesel	Total
Negative ASP,Outdoor	293	(151,324)	1,683	14,031	(135,316)
Covered ASP	293	(151,324)	697	14,031	(136,302)
Negative ASP, Indoor	293	(151,324)	3,013	14,031	(133,986)
Enclosed Tunnel	293	(151,324)	1,727	14,031	(135,272)

EXHIBIT B-3

GHG Emissions from Differing Feedstocks and Anaerobic Digestion

Feedstock Alternative	Transportation	Emissions Reduction from Composting + AD	Facility Operation Electricity	Facility Operation Diesel	Emissions from Methane Leakage	Emission Reduction - CNG Generation	Total
SSO with biosolids	293	(151,324)	3,285	15,298	0	0	(132,448)
SSO with biosolids and AD	293	(163,530)	3,494	15,298	967	(8,531)	(152,009)
SSO only	0	(151,324)	2,595	12,085	0	0	(136,643)

Exhibit B

Volume 2 Waste Stream Composition Study

Sustainable Materials Management Plan

2015

City of Tacoma
WASHINGTON

CASCADIA
CONSULTING GROUP

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Executive Summary

Objective

In 2015, the City of Tacoma commissioned Cascadia Consulting Group (Cascadia) to conduct a characterization study that examined the materials in the city's disposed waste and organics material streams. Cascadia has performed similar studies for the City of Tacoma in the past. In 2009, Cascadia conducted a characterization study for the disposed waste stream (before an organics collection program was available to residents). The objective of the study was to assess how the disposed waste stream has changed since the 2009 study, inform Tacoma's sustainable materials management plan and the assessment of Material Recovery facility (MRF) options, and collect residential organics set-out and composition data to assist the City in planning for increased organics diversion.

This report includes a summary of Cascadia's methodology for completing the study, and discusses both summary level and detailed study results.

Methodology

Cascadia's methodology for conducting this characterization study included the following steps:

Step 1. Develop a sampling plan.

- Cascadia collaborated with city staff to define the "study universe." For this study, the universe included all disposed waste received at the Tacoma Recovery & Transfer Center and all organics from single-family curbside collection programs in the City of Tacoma. After defining the study universe, Cascadia:
  - Divided Tacoma's disposed waste stream into substreams—residential, commercial, self-haul, and construction and demolition **(C&D)** materials. We divided each of these substreams further to provide more precise composition results:
    - **Residential:** Single-family, multifamily
    - **Commercial (non-C&D):** Commercial packer, commercial roll-off, and school waste
    - **Self-haul (non-C&D):** Residential, commercial
    - **Construction and Demolition Materials (C&D):** Commercial roll-off, residential self-haul, and commercial self-haul
  - Defined 85 material types (for example, *newspaper*, *pizza boxes*, etc.) for characterizing disposed waste and 23 material types for characterizing organics.
  - Scheduled sampling events over three seasons—spring, summer, and fall of 2015.

Step 2. Collect composition data.
Over three sampling events, Cascadia staff:

- Hand-sorted 163 samples of residential and commercial (non-C&D) waste.

- Visually characterized 255 samples of commercial C&D and self-haul (both non-C&D and C&D) waste.
- Hand-sorted 180 samples of residential organics.

Step 3. Analyze data and produce a report documenting study methodology and findings.

Results

This section summarizes results from the study, in terms of both quantification and composition for waste and organics.

Disposed Waste Quantities

Table ES-1 depicts each substream's estimated contribution to the overall waste stream, by weight.

Table ES-1. Estimated Tons of Disposed Waste by Substream

Substream	Tons	Percent of Total
Residential	46,625	30%
Commercial (non-C&D)	60,647	38%
Self-haul (non-C&D)	30,103	19%
C&D	20,449	13%
Total	**157,824**	**100%**

Disposed Waste Composition Results

Figure ES-1 summarizes the composition results for Tacoma's overall waste stream by **material class**. Each *material type* identified for the study is assigned to a more general **material class**: for example, the *material type newspaper* is assigned to the **Paper material class**.

Figure ES-2 summarizes the recoverability of Tacoma's waste. Cascadia arrived at these recoverability estimates by collaborating with the City of Tacoma to assign each *material type* (for example, *newspaper*, *pizza boxes*) to a recoverability category. Recoverability categories for this study included curbside recyclables, recyclable paper, compostable, recyclable C&D and wood, potentially recoverable, and non-recoverable. Recoverability category assignments for each *material type* were based on the availability of recycling or composting opportunities in the Puget Sound area for each *material type*. Potentially recoverable materials are materials with recycling and composting opportunities that are not readily available. The assignment of *material types* to recoverability categories is shown in **Table 3-1**.

Figure ES-1. Overview of Overall Disposed Waste

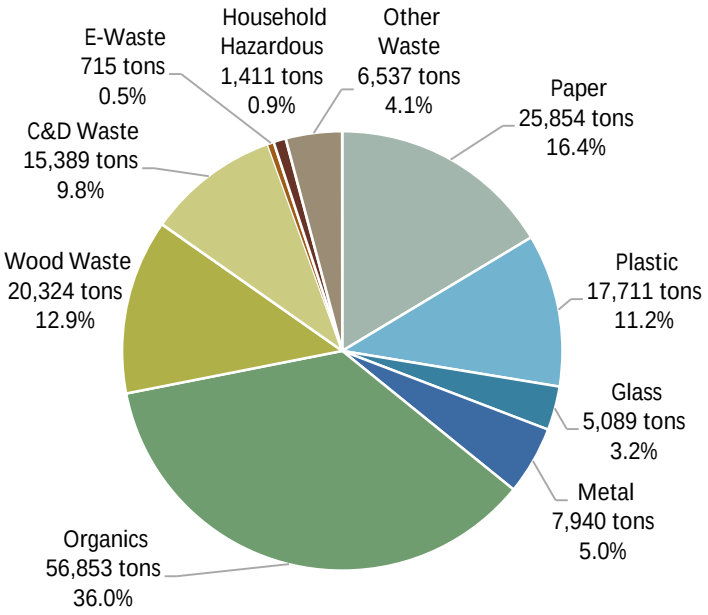
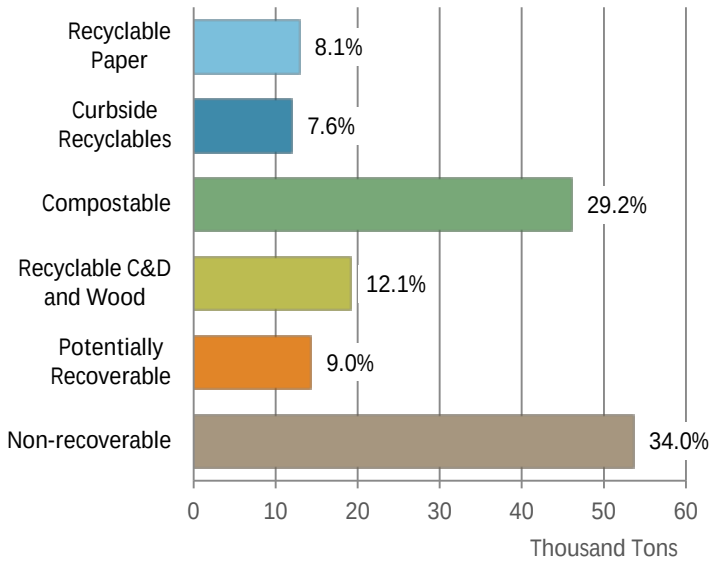


Figure ES-2. Summary of Recoverability of Overall Disposed Waste



Organics (36.0%), **Paper** (16.4%), **Wood Waste** (12.9%), and **Plastic** (11.2%) are the most prevalent **material classes** in the overall disposed waste stream for Tacoma. Together, they make up over 75 percent of the stream.

In terms of recoverability, the most prevalent recoverability category is Non-Recoverable (34.0%) followed by Compostable (29.2%). Compostable materials represent the largest diversion opportunity, followed by Recyclable C&D and Wood (12.1%), Potentially Recoverable materials (9.0%), and Recyclable Paper (8.1%).

Key Findings

This section discusses the high level findings from this study. Detailed results that support these key findings are presented in the Findings section.

Overall Disposed Waste

- **Organics, Paper,** and **Wood Waste** accounted for almost two thirds (65.3%) of overall waste disposed in Tacoma in 2015. **Organics** was the most prevalent **material class** and made up more than one third of the total waste disposed.
- Two thirds (66%) of the overall disposed waste stream was Recoverable or Potentially Recoverable.
- The most prevalent recoverability category was Compostable (29.2%). A large portion of the Compostable recoverability category was made up of *food waste, vegetative* and *other food*.

- *Dimensional lumber, leaves and grass,* and *compostable/soiled paper* were also prominent *material types* in the disposed waste stream.

Residential Waste

- Over half of the residential disposed waste stream was composed of **Organics**.
- Recoverable or Potentially Recoverable materials accounted for almost two thirds (65.1%) of disposed residential waste.
- The Compostable recoverability category made up a large portion of the materials considered recoverable. About three quarters of the materials in this recoverability category were *food waste, vegetative* and *other food*. Recyclable Paper and Curbside Recyclables accounted for almost one fifth (20%) of residential disposed waste.
- More than one fifth (21.8%) of residential waste was *animal excrement/litter* or *disposable diapers.*

Commercial Waste (non-C&D)

- **Paper**, **Plastic**, and **Organics** made up approximately 75 percent of Tacoma's commercial waste.
- Recoverable or Potentially Recoverable materials constituted about 70 percent of commercial waste.
- Compostable material was almost 36 percent of the commercial waste substream; a large portion of this material was *food waste, vegetative; other food;* and *compostable/soiled paper*.
- Some of the most prevalent recoverable materials in the disposed commercial waste stream included *low-grade paper, leaves and grass*, and *uncoated OCC/Kraft paper.*

Self-haul (non-C&D)

- **Organics** (24.9%) and **Wood Waste** (18.8%) were the largest **material classes** in non-C&D self-haul waste.
- Recoverable or Potentially Recoverable materials accounted for approximately 65 percent of non-C&D self-haul waste, about half of which was Compostable material or Recyclable C&D and Wood.
- The most prevalent *materials types* in non-C&D disposed self-haul waste were *furniture, leaves and grass,* and *prunings and trimmings.*

C&D

- Tacoma's C&D waste stream consisted primarily of **Wood Waste** (42.6%) and **C&D Waste** (40.6%).
- Recoverable or Potentially Recoverable materials accounted for almost 60 percent of disposed C&D, most of which was Recyclable C&D and Wood.
- The most prevalent recoverable materials in the Disposed C&D stream were *dimensional lumber*, *pallets and crates,* and *engineered wood.* Other *material types* that were present in

large percentages, but are not recoverable materials, included *remainder/composite construction materials* and *painted wood*.

Single-family Curbside Organics Quantity and Composition

The City of Tacoma collected approximately 26,000 tons of organics through the single-family curbside collection program in 2015.

- The single-family residential organics waste stream consisted primarily of Yard Waste (91.7%), specifically *leaves, grass, prunings, and trimmings* (91.2%).
- Food waste accounted for less than five percent of the single family residential organics stream (3.7% was *food waste, vegetative* and 0.9% was *other food waste*)
- Approximately three percent of the single-family residential organics stream was contaminant (non-compostable) material.

1. Introduction and Objectives

The City of Tacoma has provided solid waste services to residents and businesses since 1929, when it became clear that the city's 18,000 residents needed a safer way to dispose of its ever growing municipal waste stream. Over the years, Tacoma's Solid Waste Management Division has gone beyond simply offering reliable garbage collection and disposal services, and now offers customers innovative ways to reduce, reuse, and recycle. In 1990, the Solid Waste Management Division implemented residential, commercial, and multifamily curbside recycling collection and residential yard waste collection. Currently, the city provides these services to about 50,000 single-family residential homes. They also provide garbage and recycling collection services to about 2,000 commercial customers and over 1,000 multifamily buildings. In April 2012, foodwaste was added to the single family curbside yardwaste "organics" program. May 1, 2015, yard and food waste pickup was offered to commercial customers. The residential curbside organic waste is taken to a composting facility. Commercial food waste is ground and transported to the central treatment plant via sewage lines as part of a pilot organics to energy program.

In 2015, the City of Tacoma commissioned Cascadia Consulting Group (Cascadia) to conduct a characterization study that examined the materials in the city's disposed waste and single family curbside organics material streams. In 2009, Cascadia conducted a characterization study for the disposed waste stream (before an organics collection program was available to residents). The objective of this study was to assess how the disposed waste stream has changed since the 2009 study, inform Tacoma's sustainable materials management plan and the assessment of MRF options, and collect single-family residential organics set-out and composition data to assist the City in planning for increased organics diversion.

Specifically, this composition study was designed to provide estimates of the composition of the City of Tacoma's overall disposed waste stream, as well as specific compostion estimates for disposed waste generated by the residential, commercial, and self-haul sectors.[1] The study also expanded upon the 2009 study by including a characterization of the organics set out by single-family residents for curbside collection. Cascadia Consulting Group partnered with Sky Valley Associates to conduct all field work.

Section 2 of this report summarizes the methodology Cascadia and Sky Valley used to conduct the composition study, and Section 3 presents key findings and waste composition results for each of the substreams analyzed. The appendices that follow the main body of the report provide additional detail on the study, including definitions of waste categories, an explanation of composition calculations, a complete explanation of the methodology, detailed composition results, and examples of field forms.

2. Summary of Methodology

Cascadia's approach to characterizing the City of Tacoma's disposed waste and single-family curbside residential organics streams consisted of the following three steps:

[1] This study only assessed material going to the Tacoma Recovery & Transfer Center and did not include loads delivered directly to LRI Landfill, such as hospital, hard-to-handle, and certain industrial loads.

- **Develop a sampling plan** to ensure a statistically sound and efficient approach for meeting the city's objectives.
- **Collect composition data** through hand-sort and visual characterization methods.
- **Analyze data and provide a report** to document findings of the study.

Each step of the study is summarized below. More detail on the study methodology is provided in **Appendix B: Sampling Methodology** and an explanation of the calculations used in the analysis is included in **Appendix C: Waste Composition Calculations.**

Develop Plan

Before starting field work, a sampling plan was developed that defined the material streams included in the study and characterization methods for each. The steps to developing a sampling plan are described in detail below.

Step 1: Identify Universe

The first step in planning a materials characterization study is to identify and carefully define the streams that will be studied. For the disposed waste portion of this study, the "universe" of waste included all loads of municipal solid waste (MSW) and contruction and demolition (C&D) materials entering the Tacoma Recovery & Transfer Center, including waste materials hauled by Tacoma Solid Waste Management and self-haul customers. For the "Organics" portion of this study, the "universe" included organic material that single-family residents placed in yard waste carts for curbside collection in the City of Tacoma.

Step 2: Define Material Substreams

Disposed Waste

When characterizing waste, dividing the universe of waste into substreams based on particular generation, collection, or geographic characteristics provides more detailed and accurate results. This study divided Tacoma's disposed waste stream into ten substreams as shown below:

Substreams	
Residential—waste generated from single-family homes and multifamily buildings that is collected and transported by the City of Tacoma.	**Single-family**—waste generated from single-family dwellings and duplexes.
	Multifamily—waste generated from residential buildings with three or more dwelling units, including large apartment or condo buildings.
Commercial—waste generated by businesses, industries (e.g., factories, farms), institutions, and government (e.g., highways, parks) that is collected and transported by City of Tacoma garbage collection trucks.	**Commercial Packer (MSW)**—waste generated by a business or industry that is generated from a non-construction activity and hauled by the City of Tacoma in a front load, side load, or rear load packer truck.
	Commercial Roll-off (MSW)—waste generated by a business or industry that is generated from a non-construction activity and hauled by the City of Tacoma in an open-top or compacted roll-off box.
	School Waste—waste generated and hauled by the Tacoma Public Schools.
Self-haul—waste that is a) generated at residences as well as businesses and institutions, and b) hauled by the household or business that generated the waste.	**Residential Self-haul (MSW)**—waste that is generated from a non-construction activity and hauled to the Tacoma Recovery and Transfer Center by a resident.
	Commercial Self-haul (MSW)—waste that is generated from a non-construction activity and hauled to the Tacoma Recovery and Transfer Center by a commercial enterprise (such as a landscaper), including waste from residential dwellings.
C&D—waste generated from a construction or demolition activity at a commercial site or residence that is self-hauled or collected by the City of Tacoma.	**Commercial Roll-off (C&D)**—Waste generated by a business or industry that is generated from a construction activity at a business or residence and hauled by the City of Tacoma in open top roll-off boxes.
	Residential Self-haul (C&D)—waste that is generated from a construction activity and hauled to the Tacoma Recovery and Transfer Center by a resident.
	Commercial Self-haul (C&D)—waste that is generated from a construction activity and hauled to the Tacoma Recovery and Transfer Center by a commercial enterprise (such as a contractor), including waste from residential dwellings.

Single Family Curbside Organics

The organics characterization study only covered one substream: single-family residential organics. This substream is defined as organics set out by single-family residents in yard waste containers for curbside collection by the City of Tacoma.

Step 3: Classify Disposed Waste and Single-family Curbside Organics

For sorting purposes, the study established 85 standard *material types* for the disposed waste stream that are listed and defined in **Appendix A: Definitions of Material Types**. The material list was designed to be comparable to the 2009 study; the current study includes additional paper and plastic material types to more clearly distinguish compostable, potentially compostable, and non-compostable materials in the disposed waste stream. The *material types* were organized into ten **material classes: Paper, Plastic, Glass, Metal, Organics, Wood, Construction Materials, E-Waste, Household Hazardous/Special Waste,** and **Other.**

For the single-family curbside organics stream, the study established 23 standard *material types* that are listed and defined in **Appendix A: Definitions of Material Types**. These were organized into three **material classes**: **Organics, Other Compostables,** and **Other Non-compostables**.

Step 4: Allocate Samples

This study was designed to provide composition estimates for each of the ten waste substreams, and the one single-family organics substream described above. **Table 2-1** and **Table 2-2** show the planned allocation of samples to each substream compared to the actual number of samples collected, sorted, and analyzed.

Table 2-1. Planned vs. Actual Waste Samples by Substream

Waste Substream	Planned Number of Samples	Actual Number of Samples	Difference (+/-)
Residential	**90**	**91**	**1**
Single-family	60	61	1
Multifamily	30	30	0
Commercial	**72**	**72**	**0**
Commercial packer	30	31	1
Commercial roll-off (MSW)	30	28	-2
School waste	12	13	1
Self-haul	**130**	**131**	**1**
Residential self-haul (MSW)	80	80	0
Commercial self-haul (MSW)	50	51	1
Construction & Demolition	**110**	**124**	**14**
Commercial roll-off (C&D)	40	38	-2
Residential self-haul (C&D)	20	36	16
Commercial self-haul (C&D)	50	50	0
Total	**402**	**418**	**16**

Table 2-2. Planned vs. Actual Organics Samples by Substream

Organics Substream	Planned Number of Samples	Actual Number of Samples	Difference (+/-)
Residential Single-family	180	180	0

Step 5: Determine Sampling Calendar

To capture seasonal variations in waste and organics generation and to correspond to the prior study, data collection was spread across three sampling events, each in a different season and consisting of six days of sampling. The three sampling events occurred on the following dates:

- **Spring**—May 11 to 16, 2015
- **Summer**—August 16 to 21, 2015
- **Fall**—November 2 to 7, 2015

Samples were distributed evenly between events, and between each day of the week.

Collect Data

Implementing the sampling plan to collect data required coordinating with waste haulers, organics haulers, and facility staff, collecting samples and characterizing samples into the defined material types.

Step 1: Coordinate with Staff and Drivers

Before the scheduled fieldwork, the consultant team met with key staff at the Tacoma Recovery and Transfer Center to coordinate the sample collection, drop-off, and capture strategies and all other logistics involved with the field data collection effort. During each sampling event, route managers provided information used in route selection. Scalehouse staff assisted with the study by selecting self-haul vehicles for sampling and by collecting data on C&D loads.

Step 2: Collect and Characterize Samples

The sample selection and collection methods for both waste and organics samples are described in detail in **Appendix B: Sampling Methodology**. The sampling crew used either a hand-sorting procedure or a visual characterization procedure to sort samples. Hand-sorting is the preferred method for loads that tend toward homogeneity (residential and commercial MSW), whereas visual characterization is more effective when heavy, bulky, and highly variable materials are expected (self-haul and C&D loads). Utilizing these two methods in parallel leads to a more representative characterization of each load and, therefore, the waste stream as a whole.

Table 2-3 below shows which sampling procedure—hand-sorting or visual estimating—we applied to the various substreams.

Table 2-3: Sampling Procedure by Substream

Waste Substreams		Hand Sort	Visual Estimate
RESIDENTIAL	Single Family	x	
	Multifamily	x	
COMMERCIAL	Commercial Packer MSW	x	
	Commercial Roll-off MSW	x	
	School Waste	x	
SELF-HAUL	Residential MSW Self-haul		x
	Commercial MSW Self-haul		x
C&D	Commercial Roll-off C&D		x
	Residential C&D Self-haul		x
	Commercial C&D Self-haul		x
Organics Substreams		**Hand Sort**	**Visual Estimate**
RESIDENTIAL	Single Family	x	

Hand-sort Municipal Solid Waste

A total of 163 samples of residential, commercial (non-C&D), and school waste were characterized using a hand-sorting method. The field crew worked with facility staff to extract samples weighing approximately 200 pounds from selected loads, and sorted each sample into 85 *material types*. The field supervisor recorded the weight for each sorted *material type* and reviewed forms for accuracy. A full description of the hand-sorting procedure is included in **Appendix B: Sampling Methodology**.

Visually Characterize C&D and Self-Haul Waste

An additional 255 samples of C&D and self-haul waste were visually characterized. In the visual sampling method, a sample consisted of the entire load of materials delivered by the selected vehicle. This method is an efficient way to identify materials that may be present in large quantities, characterize waste loads that contain bulky items, and characterize waste streams in which materials are often not distributed evenly throughout individual vehicle loads (for example a construction load may be composed of wood in the front of the vehicle and roofing materials in the back, so a sample of only part of the load would not accurately represent the entire load).

The trained visual estimator first measured the volume of waste in each sample, then recorded the estimated percentage of the load corresponding to each of the 10 major material classes, and finally recorded the estimated percentages for each of the 85 *material types*. The visual sampling method is described in greater detail in **Appendix B: Sampling Methodology**.

Hand-sort Curbside Single-family Organics

A total of 180 samples of single-family residential organics were characterized using a hand-sorting method. A sample consisted of the entire contents of a randomly selected curbside organics cart. A sampling crew sorted samples into 23 *material types*. The field supervisor recorded the weight for each

sorted *material type* and reviewed the completed forms for accuracy. The hand sorting procedure used is the same as that for municipal solid waste samples.

Analyze and Draft Report

This section summarizes the analysis and reporting steps that occurred following the completion of field work.

Step 1: Determine Waste Quantities

The City of Tacoma provided information on the total tons of waste disposed annually at the Tacoma Recovery and Transfer Center and estimates for the specific tons of single-family, multifamily, commercial packer, and school waste disposed. Tonnage estimates for the remaining six substreams were derived by conducting vehicle surveys at the scalehouse and recording daily tons disposed in roll-off containers using tickets collected by the route supervisors. Refer to **Table 3-4** for a detailed list of substreams, including the tons associated with each substream.

Step 2: Enter and Analyze Data

Following the sampling event for each season, all data recorded on field forms was entered into a customized database and reviewed for data entry errors. Cascadia then calculated waste composition estimates using the methods described in **Appendix C: Waste Composition Calculations**.

Step 3: Draft Report

The final composition results and study methodology were documented and summarized in this report for the City of Tacoma. The findings from the disposed waste and curbside single-family organics study are provided in the section that follows.

3. Findings

Interpreting Results

The Disposed Waste Composition Results section presents characterization results for Tacoma's overall disposed waste stream as well as for the commercial, residential, self-hauled, and C&D substreams. The Organics Composition Results section presents characterization results for Tacoma's single-family curbside organics stream. Results by seasons and for single-family collection districts are presented in **Appendix D: Additional Composition Results**.

Disposed Waste characterization data are presented in four ways:

- A pie chart presents an overview of material composition by **Material Class**.
- A bar chart depicts a summary of material composition by six recoverability categories: recyclable paper, curbside recyclables, compostable, recyclable C&D and wood, potentially recoverable, and non-recoverable. *Material types* were assigned to recoverability categories based on the availability of recycling or composting opportunities in the Puget Sound area. The assignment of waste *material types* to recoverability categories is shown in **Table 3-1**. Estimates for total recoverable materials are derived by summing composition estimates for Recyclable Paper, Recyclable C&D and Wood, Other Recyclables, and Compostable categories.
- A table shows the ten most prevalent *material types* by weight.
- A detailed table lists the full composition and quantity results for the 85 *material types*.

Material Designations

For the sake of clarity, broad classes such as **Paper**, **Glass**, and **Metal** are bolded and capitalized while material types such as *newspaper*, *clear glass containers*, and *tin food cans* are italicized.

Single-family Curbside Organics characterization data are similarly presented in four ways:

- A pie chart presents an overview of material composition by **Material Class**.
- A bar chart depicts a summary of the composition by six recoverability categories: Food Waste, Yard Waste, Compostable Paper, Compostable Plastic, Other Compostable, and Contaminants. The assignment of organic *material types* to recoverability categories is shown in **Table 3-2**.
- A table shows the five most prevalent *material types* by weight.
- A detailed table lists the full composition and quantity results for the 23 *material types*.

Please refer to **Appendix A: Definitions of Material Types** for detailed descriptions and definitions of each *material type*.

Table 3-1. *Material Types* by Recoverability Categories – Waste[1] [2]

See page 21 for Table 3-1.

[1] *(N)* indicates which *material types* were added for the 2015 study and were not included in the 2009 study.

[2] The project team considered current recycling markets when evaluating the *material types* at the start of the 2015 study and reclassified many as *potentially recoverable* instead of recyclable or *non-recoverable* instead of *potentially recoverable*.

Recoverability Category	Material Type
Curbside Recyclables	#1 PET Bottles
	#2 HDPE Bottles
	#1-#7 Other Containers
	Clean Shopping/Dry Cleaning Bags
	Clear Glass Containers
	Green Glass Containers
	Brown Glass Containers
	Aluminum Beverage Cans
	Aluminum Foil/Containers
	Other Non-ferrous
	Tin Food Cans
	Empty Aerosol Cans
	Other Ferrous
	Dry-cell Batteries
Recyclable C&D and Wood	Dimensional Lumber
	Pallets and Crates
	Engineered Wood
	Other Untreated Wood
	Concrete
	Clean Drywall
	Asphalt Paving
	Asphalt Shingles
	Soil, Rocks, and Sand
	Ceramics and Brick
Potentially Recoverable	Expanded Polystyrene Non-food Grade
	Other Clean PE Film
	Major Appliances
	Oil filters
	Remainder/Composite Metal
	Textiles and Clothing
	Carpet
	Carpet Padding
	Televisions and CRTs
	Computers and Flat Monitors
	Computer Peripherals
	Other Consumer Electronics
	Fluorescent Lighting
	Paints, Solvents, and Adhesives
	Wet-cell Batteries
	Motor Oil
	Tires
	Mattresses

Recoverability Category	Material Type
Recyclable Paper	Newspaper
	Uncoated OCC/Kraft Paper
	High-grade Paper
	Low-grade Paper
Compostable	Waxed OCC (N)
	Pizza Boxes (N)
	Compostable/Soiled Paper
	Pot. Comp. Single-use Food Service Paper (N)
	Pot. Comp. Single-use Food Service Plastic (N)
	Food Waste, Vegetative
	Other Food Waste
	Leaves and Grass
	Prunings and Trimmings
	Branches and Stumps
Non-recoverable	Non-comp. Single-use Food Service Paper (N)
	Remainder/Composite Paper
	Expanded Polystyrene Food grade
	Non-comp. Single-use Food Service Plastic (N)
	Other Film
	Durable Plastic Products
	Remainder/Composite Plastics
	Plate Glass
	Remainder/Composite Glass
	Disposable Diapers
	Animal Excrement/Litter
	Remainder/Composite Organic
	Painted Wood
	Treated Wood
	Remainder/Composite Wood
	Other Drywall
	Other Asphalt Roofing
	Insulation
	Remainder/Composite Construction
	Pesticides and Herbicides
	Asbestos
	Gasoline/Kerosene
	Vehicle and Equipment Fluids
	Medical Wastes
	Pharmaceuticals
	House Cleaners and Chemicals
	Other Potentially Hazardous
	Furniture
	Non-distinct Fines

Table 3-2. *Material Types* by Recoverability Categories – Single-family Curbside Organics

Recoverability Category	Material Type
Food Waste	Food Waste, Vegetative Other Food Waste
Yard Waste	Leaves, Grass, Prunings and Trimmings Branches and Stumps
Compostable Paper	Waxed Corrugated Cardboard Pizza Boxes Compostable Paper Newspaper Pot. Comp. Single-use Food Service Paper
Compostable Plastic	Pot. Comp. Single-use Food Service Plastic

Recoverability Category	Material Type
Other Compostable	Other Compostable Organics
Contaminants	Uncoated Corrugated Cardboard/Kraft Paper Mixed Recyclable Paper Recyclable Polycoated Paper Non-comp. Single-use Food Service Paper Recyclable Plastic Non-comp. Single-use Food Service Plastic Clean Shopping/Dry Cleaning Bags Other Non-compostable Film Recyclable Glass Recyclable Metal Animal Excrement And Litter Other Materials

Means and Error Ranges

Cascadia statistically analyzed the data from the sorting process to provide two pieces of information for each of the *material types*:

- The estimated percent-by-weight composition of waste represented by the samples examined in this study.
- The error ranges (+/-) of our composition estimates.

All error ranges (+/-) were calculated at the 90 percent confidence level. The equations used in these calculations appear in Appendix C: Waste Composition Calculations and were also applied to estimate the composition and error range of organics.

The example in **Table 3-3** below illustrates how the results can be interpreted. The best estimate of the amount of *compostable/soiled paper* present in the overall disposed waste stream is 4.2 percent. The figure 0.5 percent reflects the precision of the estimate. When calculations are performed at the 90 percent confidence level, we are 90 percent certain that the true mean for *compostable/soiled paper* is between 4.2 percent plus 0.5 percent and 4.2 percent minus 0.5 percent. In other words, we are 90 percent certain that the true mean lies between 3.7 percent and 4.7 percent.

Table 3-3. Example Percentage Composition and Error Range

Material	Est. Percent	+ / -
Compostable/Soiled Paper	4.2%	0.5%

Error Range (+/-)

An error range is used to measure the spread of values in a collection of data. For instance, if the quantities of *newspaper* were found to be nearly the same in each of the 418 waste samples collected for this study, then this would result in a very narrow error range. By contrast, if some samples are 75% *newspaper* and others have 0% *newspaper*, there will be a much broader error range.

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 waste composition tables and figures readable, estimated tonnages are rounded to the nearest ton, and estimated percentages are rounded to the nearest tenth of a percent. Due to this rounding, the tonnages presented in the report, when added together, may not exactly match the subtotals and totals shown. Similarly, the percentages, when added together, may not exactly match the subtotals or totals shown. Also, percentages less than 0.05 percent are rounded to 0.0 percent even though there may be weights associated with the material.

Waste Study

The results from the 2015 City of Tacoma waste characterization study are presented below. First, an overview of the tonnages of waste by substream is provided. Then, detailed characterization data for the overall waste and for the residential, commercial, self-haul, and C&D substreams are provided.

Waste Quantities

The Tacoma Recovery and Transfer Center received a total of 157,824 tons of waste in 2015. The allocation of disposed tonnage to substreams appears in **Table 3-4**. As shown, commercial waste was the largest substream, disposing of 38 percent of Tacoma's waste, followed by residential (30%) and self-haul (19%). C&D waste made up 13 percent of Tacoma's disposed waste during the study period.

Table 3-4. Estimated Tons of Disposed Waste by Substream

Substream	Tons	Percent of Total
Residential	**46,625**	**30%**
Single-family	*35,169*	*22%*
Multifamily	*11,456*	*7%*
Commercial	**60,647**	**39%**
Commercial packer	*23,186*	*15%*
Commercial roll-off (MSW)	*34,992*	*22%*
School waste	*2,468*	*2%*
Self-haul	**30,103**	**19%**
Residential self-haul (MSW)	*12,564*	*8%*
Commercial self-haul (MSW)	*17,540*	*11%*
C&D	**20,449**	***12%***
Commercial roll-off (C&D)	*6,494*	*4%*
Residential self-haul (C&D)	*2,287*	*1%*
Commercial self-haul (C&D)	*11,667*	*7%*
Total	**157,824**	**100%**

Disposed Waste Composition Results

This section presents composition results for Tacoma's overall disposed municipal waste stream. Results are also provided for the residential, commercial, self-haul, and C&D substreams overall, and for the groups within each substream as listed in **Table 3-5** below.

Table 3-5. Waste Composition Results Presented

Substream	
Residential	Single-family and multifamily
Commercial	Commercial packers (MSW), commercial roll-off (MSW), and school waste
Self-haul	Residential self-haul (MSW) and commercial self-haul (MSW)
C&D	commercial roll-off (C&D), residential self-haul (C&D), and commercial self-haul (C&D)

Additional detailed composition data by season and for single-family collection districts are presented in **Appendix E: Analysis of Results among Single-family Collection Districts**.

Overall Disposed Waste

Composition estimates by material class for the overall waste stream are presented in **Figure 3-1**. **Organics**, **Paper**, and **Wood Waste** accounted for nearly two thirds (65.3%) of the total.

Figure 3-2 shows the composition according to recoverability categories. Two thirds (66.0%) of the overall waste stream was estimated to be recoverable or potentially recoverable. The largest recoverable portion, Compostable materials, constituted approximately 29 percent of the total. More than 15 percent of the overall waste stream was Recyclable Paper or Curbside Recyclables .

Figure 3-1. Overview of Overall Disposed Waste

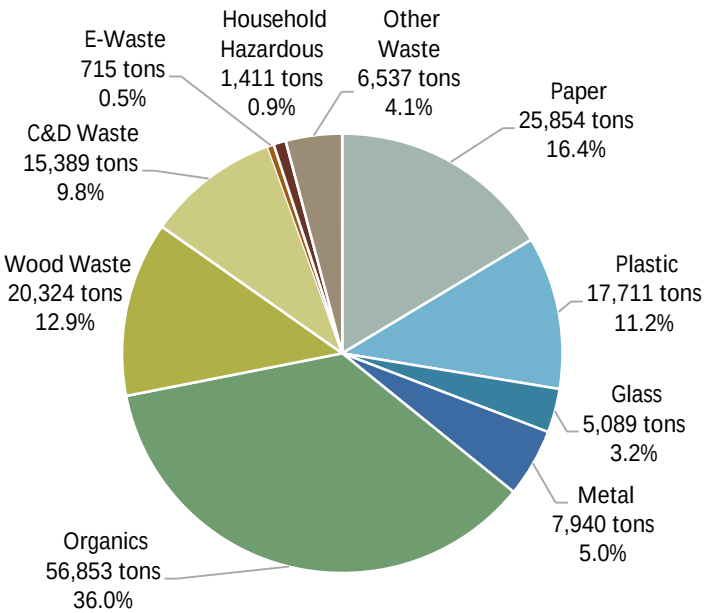
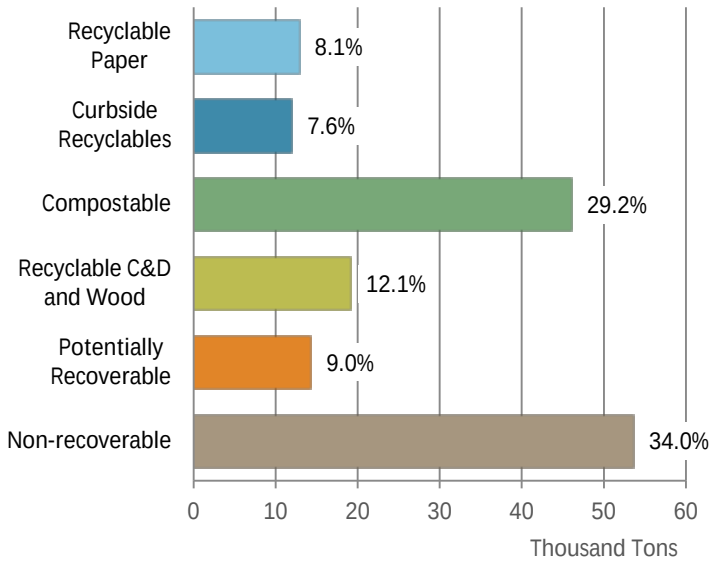


Figure 3-2. Summary of Recoverability of Overall Disposed Waste



As shown **Table 3-6**, the two most prevalent *material types—food waste, vegetative* and *other food waste*—accounted for almost 18% of the overall waste stream.

Table 3-6. Ten Most Prevalent *Materials Types* in Overall Disposed Waste

Material	Est. Percent	Cum. Percent	Est. Tons
Food Waste, Vegetative	12.6%	12.6%	19,815
Other Food Waste	5.3%	17.8%	8,338
Dimensional Lumber	4.5%	22.3%	7,051
Leaves and Grass	4.3%	26.6%	6,774
Compostable/Soiled Paper	4.2%	30.8%	6,571
Animal Excrement/Litter	3.9%	34.7%	6,203
Other Film	3.9%	38.5%	6,078
Disposable Diapers	3.6%	42.2%	5,735
Low-grade Paper	3.3%	45.5%	5,264
Textiles and Clothing	3.2%	48.7%	5,102
Total	**48.7%**		**76,930**

Table 3-7 presents detailed composition results by *material type*.

Table 3-7. Detailed Disposed Waste Composition Results: Overall

Material	Est. Percent	+ / -	Est. Tons
Paper	**16.4%**		**25,854**
Newspaper	1.1%	0.2%	1,704
Uncoated OCC/Kraft Paper	2.8%	0.6%	4,498
High-grade Paper	0.9%	0.2%	1,395
Low-grade Paper	3.3%	0.5%	5,264
Waxed OCC	0.2%	0.2%	285
Pizza Boxes	0.2%	0.0%	237
Compostable/Soiled Paper	4.2%	0.5%	6,571
Pot. Comp. Single-use Food Service Paper	0.7%	0.1%	1,067
Non-comp. Single-use Food Service Paper	0.3%	0.1%	540
Remainder/Composite Paper	2.7%	1.0%	4,294
Plastic	**11.2%**		**17,711**
#1 PET Bottles	0.9%	0.4%	1,404
#2 HDPE Bottles	0.4%	0.1%	610
#1-#7 Other Containers	0.7%	0.1%	1,099
Expanded Polystyrene Food grade	0.3%	0.1%	501
Expanded Polystyrene Non-food Grade	0.2%	0.1%	253
Pot. Comp. Single-use Food Service Plastic	0.2%	0.1%	243
Non-comp. Single-use Food Service Plastic	0.3%	0.1%	473
Clean Shopping/Dry Cleaning Bags	0.3%	0.0%	534
Other Clean PE Film	0.7%	0.4%	1,055
Other Film	3.9%	0.4%	6,078
Durable Plastic Products	1.6%	0.5%	2,451
Remainder/Composite Plastics	1.9%	0.9%	3,011
Glass	**3.2%**		**5,089**
Clear Glass Containers	0.9%	0.2%	1,444
Green Glass Containers	0.3%	0.1%	487
Brown Glass Containers	0.6%	0.2%	1,021
Plate Glass	0.3%	0.3%	483
Remainder/Composite Glass	1.0%	0.6%	1,653
Metal	**5.0%**		**7,940**
Aluminum Beverage Cans	0.3%	0.1%	449
Aluminum Foil/Containers	0.1%	0.0%	208
Other Non-ferrous	0.4%	0.2%	669
Tin Food Cans	0.4%	0.1%	613
Empty Aerosol Cans	0.2%	0.1%	239
Major Appliances	0.4%	0.4%	571
Oil Filters	0.0%	0.0%	36
Other Ferrous	2.0%	0.7%	3,092
Remainder/Composite Metal	1.3%	0.5%	2,064
Organics	**36.0%**		**56,853**
Food Waste, Vegetative	12.6%	1.2%	19,815
Other Food Waste	5.3%	0.7%	8,338
Leaves and Grass	4.3%	1.2%	6,774
Prunings and Trimmings	1.6%	0.8%	2,562
Branches and Stumps	0.1%	0.1%	145
Textiles and Clothing	3.2%	0.6%	5,102
Disposable Diapers	3.6%	0.4%	5,735
Animal Excrement/Litter	3.9%	0.6%	6,203
Remainder/Composite Organic	1.4%	0.7%	2,179

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**12.9%**		**20,324**
Dimensional Lumber	4.5%	1.3%	7,051
Pallets and Crates	1.9%	1.1%	3,048
Engineered Wood	1.8%	0.9%	2,899
Other Untreated Wood	0.5%	0.3%	730
Painted Wood	2.4%	0.7%	3,807
Treated Wood	1.0%	0.4%	1,526
Remainder/Composite Wood	0.8%	0.4%	1,264
C&D Waste	**9.8%**		**15,389**
Concrete	0.8%	0.4%	1,341
Clean Drywall	0.2%	0.2%	362
Other Drywall	1.3%	0.4%	1,982
Asphalt Paving	0.0%	0.0%	19
Asphalt Shingles	0.5%	0.4%	855
Other Asphalt Roofing	0.5%	0.4%	845
Insulation	0.1%	0.1%	213
Carpet	1.2%	0.5%	1,844
Carpet Padding	0.2%	0.1%	286
Soil, Rocks, and Sand	1.4%	0.7%	2,131
Ceramics and Brick	0.4%	0.3%	683
Remainder/Composite Construction	3.1%	1.5%	4,829
E-Waste	**0.5%**		**715**
Televisions and CRTs	0.3%	0.4%	520
Computers and Flat Monitors	0.0%	0.0%	60
Computer Peripherals	0.0%	0.0%	11
Other Consumer Electronics	0.1%	0.1%	123
Household Hazardous	**0.9%**		**1,411**
Pesticides and Herbicides	0.0%	0.0%	4
Fluorescent Lighting	0.0%	0.0%	4
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.1%	0.1%	119
Dry-cell Batteries	0.0%	0.0%	65
Wet-cell Batteries	0.0%	0.0%	15
Gasoline/Kerosene	0.0%	0.0%	5
Motor Oil	0.0%	0.0%	5
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.7%	0.8%	1,063
Pharmaceuticals	0.0%	0.0%	18
House Cleaners and Chemicals	0.1%	0.1%	104
Other Potentially Hazardous	0.0%	0.0%	9
Other Waste	**4.1%**		**6,537**
Furniture	2.3%	1.1%	3,566
Tires	0.0%	0.0%	10
Mattresses	1.4%	1.2%	2,188
Non-distinct Fines	0.5%	0.3%	773
Totals	**100.0%**		**157,824**
Sample Count			418

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

Residential Disposed Waste

Overall Residential

As shown in **Figure 3-3**, more than half (58.3%) of residential waste was composed of **Organics**. **Paper** and **Plastic** accounted for nearly an additional third (30.7%) of the waste. **Figure 3-4** summarizes the recoverability of materials found in the residential waste stream. Almost two thirds (65.1%) of this stream was recoverable or potentially recoverable, with the largest fraction made up of Compostable materials (37.7%). Almost one fifth of disposed residential waste was Curbside Recyclables and Recyclable Paper (19.0% combined).

Figure 3-3. Overview of Overall Residential Disposed **Waste**

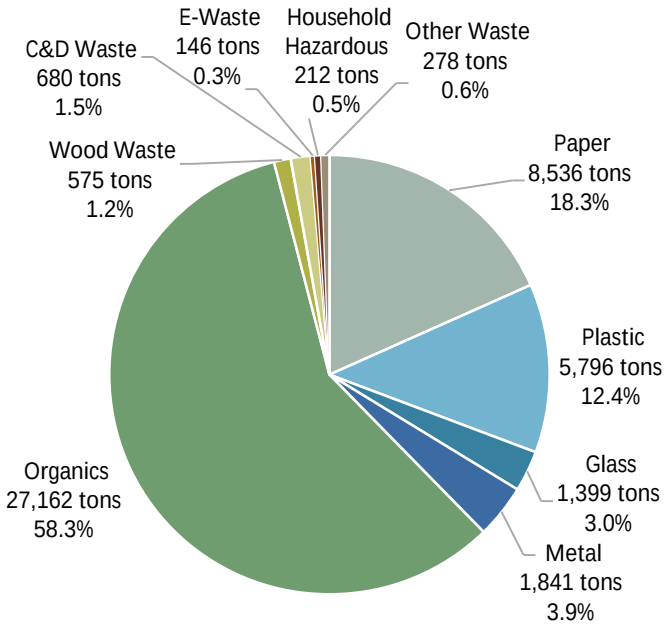
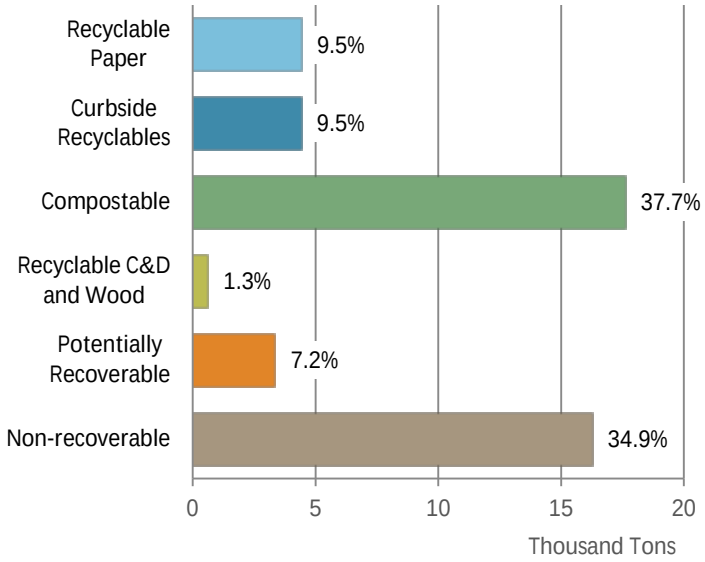


Figure 3-4. Summary of Recoverability of Overall Residential Disposed Waste



As presented in **Table 3-8**, the largest *material type*, *food waste, vegetative,* constituted nearly one-fifth (19.3%) of the residential waste by weight. *Animal excrement/litter* and *disposable diapers*, together, accounted for an additional fifth (21.8%) of the residential waste stream.

Table 3-8. Ten Most Prevalent *Materials Types* in the Overall Residential Disposed Waste Stream

Material	Est. Percent	Cum. Percent	Est. Tons
Food Waste, Vegetative	19.3%	19.3%	8,997
Animal Excrement/Litter	11.2%	30.5%	5,223
Disposable Diapers	10.6%	41.1%	4,929
Other Food Waste	8.8%	49.9%	4,121
Compostable/Soiled Paper	6.0%	55.9%	2,794
Other Film	5.3%	61.2%	2,467
Low-grade Paper	5.1%	66.3%	2,375
Textiles and Clothing	5.0%	71.3%	2,338
Leaves and Grass	2.1%	73.4%	979
Uncoated OCC/Kraft Paper	1.7%	75.1%	803
Total	**75.1%**		**35,025**

Table 3-9 presents detailed composition results for overall residential disposed waste by *material type*.

Table 3-9. Detailed Disposed Waste Composition Results: Overall Residential

Material	Est. Percent	+ / -	Est. Tons
Paper	**18.3%**		**8,536**
Newspaper	1.6%	0.3%	739
Uncoated OCC/Kraft Paper	1.7%	0.3%	803
High-grade Paper	1.1%	0.3%	496
Low-grade Paper	5.1%	0.4%	2,375
Waxed OCC	0.0%	0.0%	4
Pizza Boxes	0.3%	0.1%	150
Compostable/Soiled Paper	6.0%	0.5%	2,794
Pot. Comp. Single-use Food Service Paper	1.0%	0.2%	446
Non-comp. Single-use Food Service Paper	0.5%	0.1%	222
Remainder/Composite Paper	1.1%	0.2%	509
Plastic	**12.4%**		**5,796**
#1 PET Bottles	1.1%	0.1%	529
#2 HDPE Bottles	0.6%	0.1%	293
#1-#7 Other Containers	1.4%	0.2%	630
Expanded Polystyrene Food grade	0.6%	0.1%	261
Expanded Polystyrene Non-food Grade	0.1%	0.0%	50
Pot. Comp. Single-use Food Service Plastic	0.2%	0.0%	73
Non-comp. Single-use Food Service Plastic	0.3%	0.1%	146
Clean Shopping/Dry Cleaning Bags	0.8%	0.1%	394
Other Clean PE Film	0.1%	0.0%	24
Other Film	5.3%	0.4%	2,467
Durable Plastic Products	1.1%	0.2%	531
Remainder/Composite Plastics	0.9%	0.3%	399
Glass	**3.0%**		**1,399**
Clear Glass Containers	1.3%	0.2%	595
Green Glass Containers	0.5%	0.1%	229
Brown Glass Containers	0.8%	0.2%	381
Plate Glass	0.0%	0.0%	9
Remainder/Composite Glass	0.4%	0.1%	185
Metal	**3.9%**		**1,841**
Aluminum Beverage Cans	0.4%	0.1%	207
Aluminum Foil/Containers	0.3%	0.1%	147
Other Non-ferrous	0.2%	0.1%	93
Tin Food Cans	0.8%	0.1%	360
Empty Aerosol Cans	0.2%	0.1%	80
Major Appliances	0.3%	0.5%	133
Oil Filters	0.0%	0.0%	4
Other Ferrous	1.0%	0.3%	454
Remainder/Composite Metal	0.8%	0.2%	363
Organics	**58.3%**		**27,162**
Food Waste, Vegetative	19.3%	1.0%	8,997
Other Food Waste	8.8%	1.0%	4,121
Leaves and Grass	2.1%	0.9%	979
Prunings and Trimmings	0.0%	0.0%	11
Branches and Stumps	0.1%	0.1%	24
Textiles and Clothing	5.0%	0.8%	2,338
Disposable Diapers	10.6%	1.0%	4,929
Animal Excrement/Litter	11.2%	1.2%	5,223
Remainder/Composite Organic	1.2%	0.3%	541

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**1.2%**		**575**
Dimensional Lumber	0.3%	0.1%	117
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.1%	0.1%	50
Other Untreated Wood	0.2%	0.1%	87
Painted Wood	0.4%	0.2%	172
Treated Wood	0.1%	0.1%	62
Remainder/Composite Wood	0.2%	0.2%	87
C&D Waste	**1.5%**		**680**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.3%	0.4%	140
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.1%	0.2%	65
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.2%	0.1%	89
Carpet Padding	0.1%	0.1%	37
Soil, Rocks, and Sand	0.4%	0.4%	207
Ceramics and Brick	0.2%	0.1%	80
Remainder/Composite Construction	0.1%	0.1%	62
E-Waste	**0.3%**		**146**
Televisions and CRTs	0.1%	0.2%	60
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	11
Other Consumer Electronics	0.2%	0.1%	75
Household Hazardous	**0.5%**		**212**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	4
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.2%	0.2%	114
Dry-cell Batteries	0.0%	0.0%	19
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	5
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.1%	0.1%	28
Pharmaceuticals	0.0%	0.0%	9
House Cleaners and Chemicals	0.1%	0.0%	33
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.6%**		**278**
Furniture	0.1%	0.1%	41
Tires	0.0%	0.0%	5
Mattresses	0.1%	0.1%	31
Non-distinct Fines	0.4%	0.2%	201
Totals	**100.0%**		**46,625**
Sample Count			91

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

Single-family

As shown in **Figure 3-5**, more than half (59.3%) of single-family residential disposed waste was composed of **Organics**. **Paper** and **Plastic** accounted for almost an additional third (30.5%) of single-family residential waste. **Figure 3-6** summarizes the recoverability of materials measured in the waste. More than one third (36.6%) of the single-family substream was Non-recoverable material, and nearly one fifth (19.6%) of the stream was recyclable (Recyclable Paper, Curbside Recyclables, and Recyclable C&D and Wood). Compostable materials were the most prevalent recoverable material category (37.2%).

Figure 3-5. Overview of Single-family Residential Disposed Waste

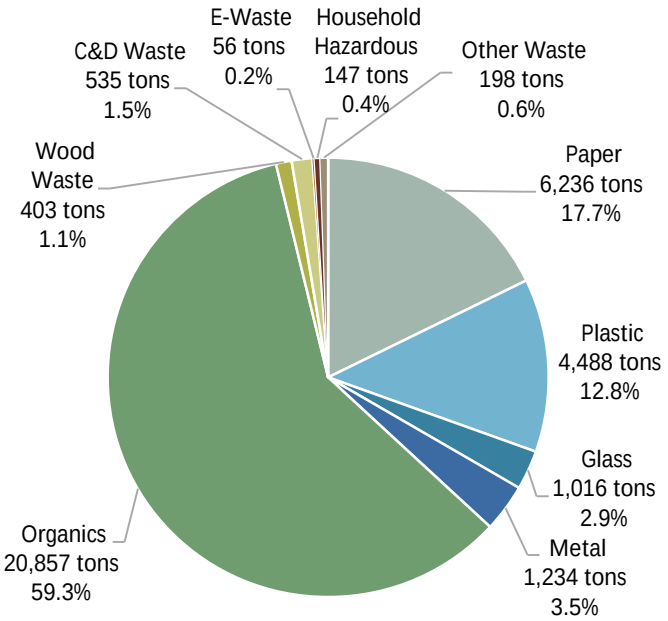
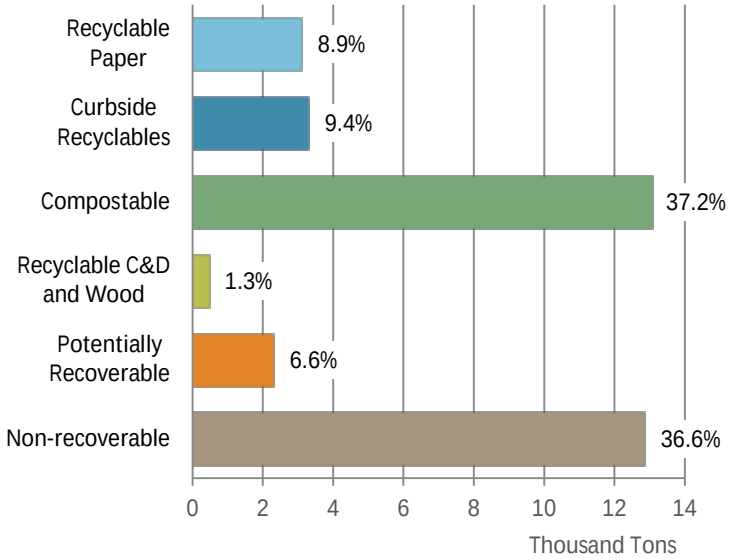


Figure 3-6. Summary of Recoverability of Single-family Residential Disposed Waste



As presented in **Table 3-10**, the most prevalent *material type* in this stream was *food waste, vegetative* (19.3% of single-family disposed residential waste). *Animal excrement/litter* and *disposable diapers*, together, accounted for almost an additional quarter (23.5%) of the single-family disposed waste stream.

Table 3-10. Ten Most Prevalent *Materials Types* in Single-family Residential Waste

Material	Est. Percent	Cum. Percent	Est. Tons
Food Waste, Vegetative	19.3%	19.3%	6,778
Animal Excrement/Litter	12.9%	32.2%	4,529
Disposable Diapers	10.6%	42.7%	3,717
Other Food Waste	8.9%	51.6%	3,138
Compostable/Soiled Paper	5.7%	57.4%	2,018
Other Film	5.6%	63.0%	1,976
Low-grade Paper	5.0%	68.0%	1,760
Textiles and Clothing	4.9%	72.9%	1,723
Leaves and Grass	1.7%	74.6%	591
Newspaper	1.5%	76.1%	536
Total	**76.1%**		**26,767**

Table 3-11 presents detailed composition results for single-family residential disposed waste by *material type*.

Table 3-11. Detailed Disposed Waste Composition Results: Single-family Residential

Material	Est. Percent	+ / -	Est. Tons
Paper	**17.7%**		**6,236**
Newspaper	1.5%	0.3%	536
Uncoated OCC/Kraft Paper	1.2%	0.2%	438
High-grade Paper	1.1%	0.3%	380
Low-grade Paper	5.0%	0.5%	1,760
Waxed OCC	0.0%	0.0%	3
Pizza Boxes	0.3%	0.1%	114
Compostable/Soiled Paper	5.7%	0.7%	2,018
Pot. Comp. Single-use Food Service Paper	1.1%	0.2%	374
Non-comp. Single-use Food Service Paper	0.6%	0.2%	193
Remainder/Composite Paper	1.2%	0.2%	420
Plastic	**12.8%**		**4,488**
#1 PET Bottles	1.1%	0.1%	380
#2 HDPE Bottles	0.6%	0.1%	213
#1-#7 Other Containers	1.4%	0.2%	507
Expanded Polystyrene Food grade	0.6%	0.1%	211
Expanded Polystyrene Non-food Grade	0.1%	0.0%	30
Pot. Comp. Single-use Food Service Plastic	0.1%	0.0%	51
Non-comp. Single-use Food Service Plastic	0.3%	0.1%	118
Clean Shopping/Dry Cleaning Bags	0.9%	0.1%	306
Other Clean PE Film	0.1%	0.1%	18
Other Film	5.6%	0.6%	1,976
Durable Plastic Products	1.1%	0.3%	383
Remainder/Composite Plastics	0.8%	0.4%	294
Glass	**2.9%**		**1,016**
Clear Glass Containers	1.2%	0.2%	409
Green Glass Containers	0.5%	0.2%	171
Brown Glass Containers	1.0%	0.2%	347
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.3%	0.1%	88
Metal	**3.5%**		**1,234**
Aluminum Beverage Cans	0.4%	0.1%	140
Aluminum Foil/Containers	0.3%	0.1%	110
Other Non-ferrous	0.2%	0.1%	86
Tin Food Cans	0.8%	0.1%	285
Empty Aerosol Cans	0.2%	0.1%	63
Major Appliances	0.0%	0.0%	0
Oil Filters	0.0%	0.0%	4
Other Ferrous	0.8%	0.3%	274
Remainder/Composite Metal	0.8%	0.3%	272
Organics	**59.3%**		**20,857**
Food Waste, Vegetative	19.3%	1.2%	6,778
Other Food Waste	8.9%	1.1%	3,138
Leaves and Grass	1.7%	0.7%	591
Prunings and Trimmings	0.0%	0.0%	7
Branches and Stumps	0.1%	0.1%	24
Textiles and Clothing	4.9%	0.9%	1,723
Disposable Diapers	10.6%	1.1%	3,717
Animal Excrement/Litter	12.9%	1.6%	4,529
Remainder/Composite Organic	1.0%	0.2%	349
Wood Waste	**1.1%**		**403**
Dimensional Lumber	0.3%	0.2%	96
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.1%	0.0%	22
Other Untreated Wood	0.2%	0.1%	69
Painted Wood	0.4%	0.2%	146
Treated Wood	0.1%	0.2%	40
Remainder/Composite Wood	0.1%	0.1%	31
C&D Waste	**1.5%**		**535**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.4%	0.5%	137
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.2%	0.2%	65
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.2%	0.2%	62
Carpet Padding	0.0%	0.1%	14
Soil, Rocks, and Sand	0.5%	0.5%	163
Ceramics and Brick	0.2%	0.2%	54
Remainder/Composite Construction	0.1%	0.1%	39
E-Waste	**0.2%**		**56**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	11
Other Consumer Electronics	0.1%	0.1%	46
Household Hazardous	**0.4%**		**147**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	1
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.3%	0.3%	93
Dry-cell Batteries	0.1%	0.0%	18
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	5
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	1
Pharmaceuticals	0.0%	0.0%	9
House Cleaners and Chemicals	0.1%	0.0%	20
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.6%**		**198**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.0%	5
Mattresses	0.1%	0.2%	31
Non-distinct Fines	0.5%	0.2%	162
Totals	**100.0%**		**35,169**
Sample Count			61

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

Multifamily

As shown in **Figure 3-7**, more than half (55.0%) of the multifamily residential disposed waste stream was composed of **Organics**. **Paper** and **Plastic** accounted for almost an additional third (31.5%) of multifamily waste. **Figure 3-8** demonstrates that recoverable and potentially recoverable materials, in total, accounted for about 70 percent of this waste. Compostables made up the largest fraction of recoverable material (39.3%), and recyclable materials (Recyclable Paper, Curbside Recyclables, and Recyclable C&D and Wood) were an additional 22 percent.

Figure 3-7. Overview of Multifamily Residential Disposed Waste

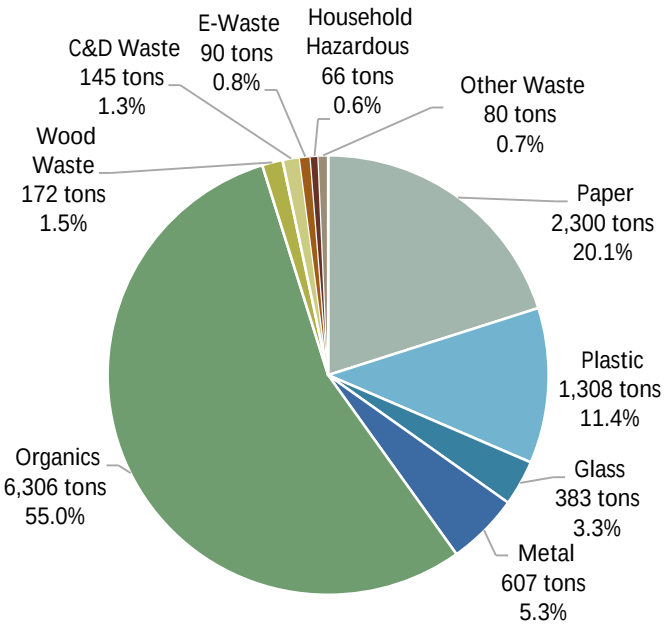


Figure 3-8. Summary of Recoverability of Multifamily Residential Disposed Waste

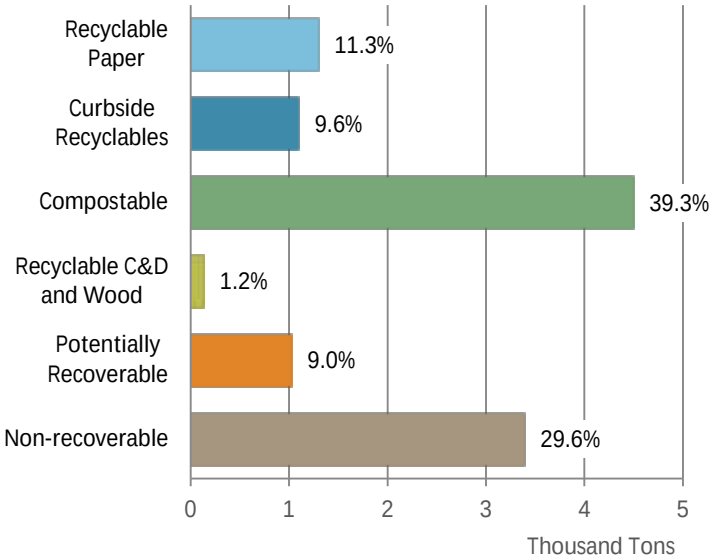


Table 3-12 shows that the largest *material type*, *food waste, vegetative,* constituted nearly one-fifth (19.4%) of the multifamily residential disposed waste by weight. The other two largest *material types* found in multifamily waste were *disposable diapers* (10.6%) and *other food waste* (8.6%).

Table 3-12. Ten Most Prevalent *Materials Types* in Multifamily Residential Waste

Material	Est. Percent	Cum. Percent	Est. Tons
Food Waste, Vegetative	19.4%	19.4%	2,219
Disposable Diapers	10.6%	29.9%	1,212
Other Food Waste	8.6%	38.5%	983
Compostable/Soiled Paper	6.8%	45.3%	775
Animal Excrement/Litter	6.1%	51.4%	694
Low-grade Paper	5.4%	56.7%	615
Textiles and Clothing	5.4%	62.1%	615
Other Film	4.3%	66.4%	491
Leaves and Grass	3.4%	69.8%	388
Uncoated OCC/Kraft Paper	3.2%	72.9%	365
Total	**72.9%**		**8,357**

Table 3-13 presents detailed composition results for the multifamily residential substream by *material type*.

Table 3-13. Detailed Disposed Waste Composition Results: Multifamily Residential

Material	Est. Percent	+ / -	Est. Tons
Paper	**20.1%**		**2,300**
Newspaper	1.8%	0.5%	203
Uncoated OCC/Kraft Paper	3.2%	0.9%	365
High-grade Paper	1.0%	0.4%	116
Low-grade Paper	5.4%	1.0%	615
Waxed OCC	0.0%	0.0%	2
Pizza Boxes	0.3%	0.1%	36
Compostable/Soiled Paper	6.8%	0.7%	775
Pot. Comp. Single-use Food Service Paper	0.6%	0.2%	71
Non-comp. Single-use Food Service Paper	0.2%	0.1%	28
Remainder/Composite Paper	0.8%	0.3%	89
Plastic	**11.4%**		**1,308**
#1 PET Bottles	1.3%	0.3%	149
#2 HDPE Bottles	0.7%	0.2%	80
#1-#7 Other Containers	1.1%	0.3%	122
Expanded Polystyrene Food grade	0.4%	0.1%	50
Expanded Polystyrene Non-food Grade	0.2%	0.1%	20
Pot. Comp. Single-use Food Service Plastic	0.2%	0.1%	22
Non-comp. Single-use Food Service Plastic	0.2%	0.1%	28
Clean Shopping/Dry Cleaning Bags	0.8%	0.2%	88
Other Clean PE Film	0.0%	0.0%	5
Other Film	4.3%	0.6%	491
Durable Plastic Products	1.3%	0.4%	148
Remainder/Composite Plastics	0.9%	0.5%	106
Glass	**3.3%**		**383**
Clear Glass Containers	1.6%	0.4%	186
Green Glass Containers	0.5%	0.4%	57
Brown Glass Containers	0.3%	0.1%	33
Plate Glass	0.1%	0.1%	9
Remainder/Composite Glass	0.8%	0.3%	97
Metal	**5.3%**		**607**
Aluminum Beverage Cans	0.6%	0.2%	67
Aluminum Foil/Containers	0.3%	0.1%	37
Other Non-ferrous	0.1%	0.0%	7
Tin Food Cans	0.7%	0.1%	75
Empty Aerosol Cans	0.2%	0.1%	18
Major Appliances	1.2%	1.9%	133
Oil Filters	0.0%	0.0%	0
Other Ferrous	1.6%	1.0%	181
Remainder/Composite Metal	0.8%	0.4%	90
Organics	**55.0%**		**6,306**
Food Waste, Vegetative	19.4%	2.1%	2,219
Other Food Waste	8.6%	2.0%	983
Leaves and Grass	3.4%	2.8%	388
Prunings and Trimmings	0.0%	0.0%	4
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	5.4%	1.3%	615
Disposable Diapers	10.6%	2.0%	1,212
Animal Excrement/Litter	6.1%	1.3%	694
Remainder/Composite Organic	1.7%	0.8%	191
Wood Waste	**1.5%**		**172**
Dimensional Lumber	0.2%	0.2%	21
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.2%	0.3%	28
Other Untreated Wood	0.2%	0.1%	18
Painted Wood	0.2%	0.1%	26
Treated Wood	0.2%	0.3%	23
Remainder/Composite Wood	0.5%	0.6%	57
C&D Waste	**1.3%**		**145**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.0%	0.0%	3
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.2%	0.4%	27
Carpet Padding	0.2%	0.3%	23
Soil, Rocks, and Sand	0.4%	0.4%	44
Ceramics and Brick	0.2%	0.3%	26
Remainder/Composite Construction	0.2%	0.3%	22
E-Waste	**0.8%**		**90**
Televisions and CRTs	0.5%	0.9%	60
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.3%	0.4%	30
Household Hazardous	**0.6%**		**66**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	3
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.2%	0.2%	21
Dry-cell Batteries	0.0%	0.0%	1
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.2%	0.3%	27
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.1%	0.1%	13
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.7%**		**80**
Furniture	0.4%	0.6%	41
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.3%	0.4%	39
Totals	**100.0%**		**11,456**
Sample Count			30

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

Commercial Waste

Overall Commercial

As shown in **Figure 3-9**, approximately three-quarters of the overall commercial disposed waste stream was composed of **Organics**, **Paper**, and **Plastic**. **Figure 3-10** demonstrates that recoverable and potentially recoverable materials, in total, accounted for approximately 70 percent of this waste. Compostable materials made up the largest recoverable fraction (35.6%), and Recyclable Paper and Curbside Recyclables, combined, contributed 19 percent.

Figure 3-9. Overview of Overall Commercial Disposed Waste

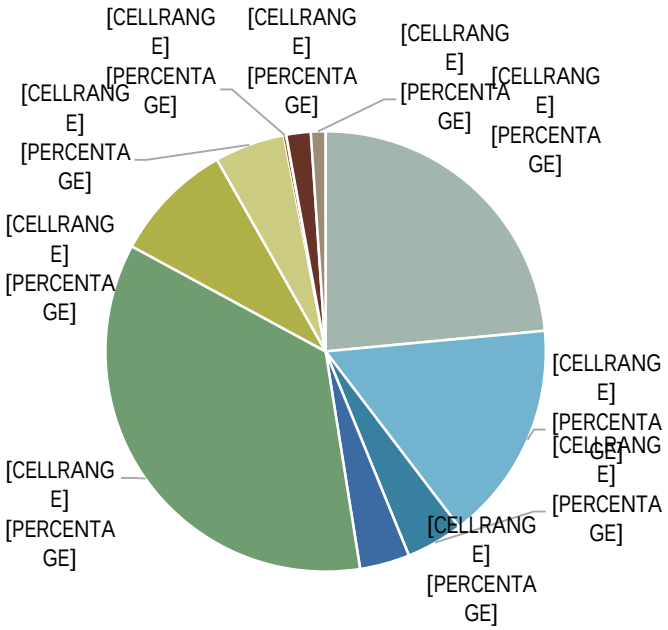


Figure 3-10. Summary of Recoverability of Overall Commercial Disposed Waste

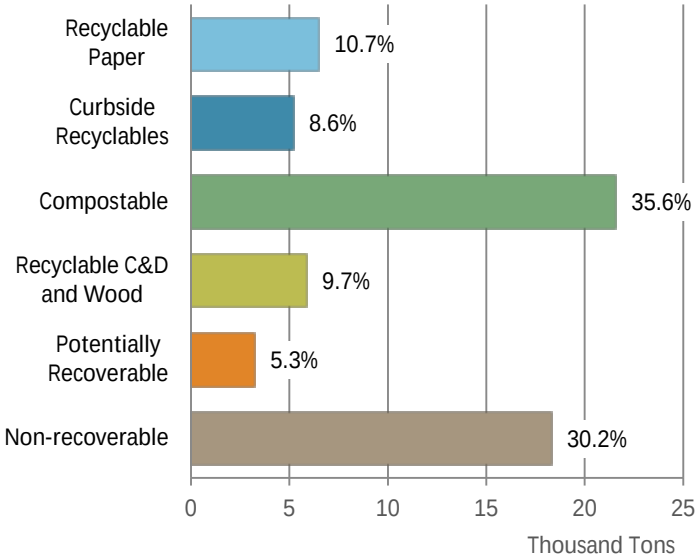


Table 3-14 demonstrates the the ten most prevalent *material types* in the overall commercial substream. *Food waste, vegetative* and *other food waste* accounted for almost a quarter (23.4%) of the commercial disposed waste by weight.

Table 3-14. Ten Most Prevalent *Materials Types* in Overall Commercial Disposed Waste

Material	Est. Percent	Cum. Percent	Est. Tons
Food Waste, Vegetative	16.7%	16.7%	10,146
Other Food Waste	6.7%	23.4%	4,036
Compostable/Soiled Paper	6.0%	29.4%	3,637
Other Film	5.4%	34.8%	3,272
Remainder/Composite Paper	4.8%	39.6%	2,902
Low-grade Paper	4.3%	43.8%	2,595
Leaves and Grass	4.3%	48.1%	2,585
Uncoated OCC/Kraft Paper	3.7%	51.8%	2,265
Remainder/Composite Plastics	3.1%	55.0%	1,894
Dimensional Lumber	2.8%	57.8%	1,718
Total	**57.8%**		**35,051**

Table 3-15 presents detailed composition results for the overall commercial substream *by material type*.

Table 3-15. Detailed Disposed Waste Composition Results: Overall Commercial

Material	Est. Percent	+ / -	Est. Tons
Paper	**23.5%**		**14,246**
Newspaper	1.3%	0.5%	784
Uncoated OCC/Kraft Paper	3.7%	0.9%	2,265
High-grade Paper	1.4%	0.6%	840
Low-grade Paper	4.3%	1.1%	2,595
Waxed OCC	0.4%	0.4%	238
Pizza Boxes	0.1%	0.1%	69
Compostable/Soiled Paper	6.0%	1.2%	3,637
Pot. Comp. Single-use Food Service Paper	1.0%	0.4%	613
Non-comp. Single-use Food Service Paper	0.5%	0.3%	301
Remainder/Composite Paper	4.8%	2.3%	2,902
Plastic	**16.2%**		**9,797**
#1 PET Bottles	1.4%	1.0%	840
#2 HDPE Bottles	0.5%	0.2%	301
#1-#7 Other Containers	0.7%	0.2%	427
Expanded Polystyrene Food grade	0.4%	0.2%	234
Expanded Polystyrene Non-food Grade	0.2%	0.2%	140
Pot. Comp. Single-use Food Service Plastic	0.3%	0.3%	168
Non-comp. Single-use Food Service Plastic	0.5%	0.2%	324
Clean Shopping/Dry Cleaning Bags	0.2%	0.1%	136
Other Clean PE Film	1.7%	1.1%	1,014
Other Film	5.4%	0.8%	3,272
Durable Plastic Products	1.7%	0.8%	1,047
Remainder/Composite Plastics	3.1%	2.1%	1,894
Glass	**4.2%**		**2,538**
Clear Glass Containers	1.3%	0.6%	814
Green Glass Containers	0.4%	0.2%	253
Brown Glass Containers	1.0%	0.6%	603
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	1.4%	1.4%	868
Metal	**3.7%**		**2,229**
Aluminum Beverage Cans	0.4%	0.1%	230
Aluminum Foil/Containers	0.1%	0.0%	59
Other Non-ferrous	0.1%	0.1%	59
Tin Food Cans	0.3%	0.1%	207
Empty Aerosol Cans	0.2%	0.2%	114
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	18
Other Ferrous	1.9%	1.1%	1,144
Remainder/Composite Metal	0.7%	0.3%	399
Organics	**35.4%**		**21,476**
Food Waste, Vegetative	16.7%	3.1%	10,146
Other Food Waste	6.7%	1.7%	4,036
Leaves and Grass	4.3%	2.2%	2,585
Prunings and Trimmings	0.1%	0.1%	47
Branches and Stumps	0.1%	0.1%	33
Textiles and Clothing	2.5%	0.8%	1,495
Disposable Diapers	1.2%	0.6%	718
Animal Excrement/Litter	1.4%	1.3%	869
Remainder/Composite Organic	2.6%	1.7%	1,547
Wood Waste	**8.9%**		**5,383**
Dimensional Lumber	2.8%	2.6%	1,718
Pallets and Crates	2.2%	2.5%	1,322
Engineered Wood	1.4%	1.1%	852
Other Untreated Wood	0.4%	0.1%	234
Painted Wood	1.6%	1.1%	951
Treated Wood	0.3%	0.3%	177
Remainder/Composite Wood	0.2%	0.2%	130
C&D Waste	**5.1%**		**3,118**
Concrete	0.7%	0.6%	412
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.7%	0.4%	408
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.7%	1.0%	445
Other Asphalt Roofing	0.0%	0.0%	3
Insulation	0.1%	0.2%	75
Carpet	0.1%	0.1%	33
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	1.5%	1.3%	881
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	1.4%	1.8%	861
E-Waste	**0.2%**		**113**
Televisions and CRTs	0.0%	0.0%	16
Computers and Flat Monitors	0.1%	0.1%	60
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.1%	0.1%	37
Household Hazardous	**1.8%**		**1,099**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	6
Dry-cell Batteries	0.0%	0.0%	7
Wet-cell Batteries	0.0%	0.0%	15
Gasoline/Kerosene	0.0%	0.0%	5
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	1.7%	2.1%	1,035
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.1%	22
Other Potentially Hazardous	0.0%	0.0%	9
Other Waste	**1.1%**		**647**
Furniture	0.3%	0.1%	166
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.8%	0.7%	481
Totals	**100.0%**		**60,647**
Sample Count			72

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

Commercial Packer

Figure 3-11 shows commercial packer disposed waste composition by material class. The largest **material class**, **Organics**, made up approximately 44 percent of commercial packer disposed waste, followed by **Paper** (22.9%), and **Plastic** (13.4%). **Figure 3-12** summarizes the recoverability of materials in commercial packer waste. Almost three-quarters of the waste is recoverable or potentially recoverable materials (73.6%). Compostable materials accounted for most of the recoverable material (44.0%), and recyclable materials (Recyclable Paper, Curbside Recyclables, and Recyclable C&D and Wood) contributed almost one fifth of the waste (23.1%).

Figure 3-11. Overview of Commercial Packer Disposed Waste

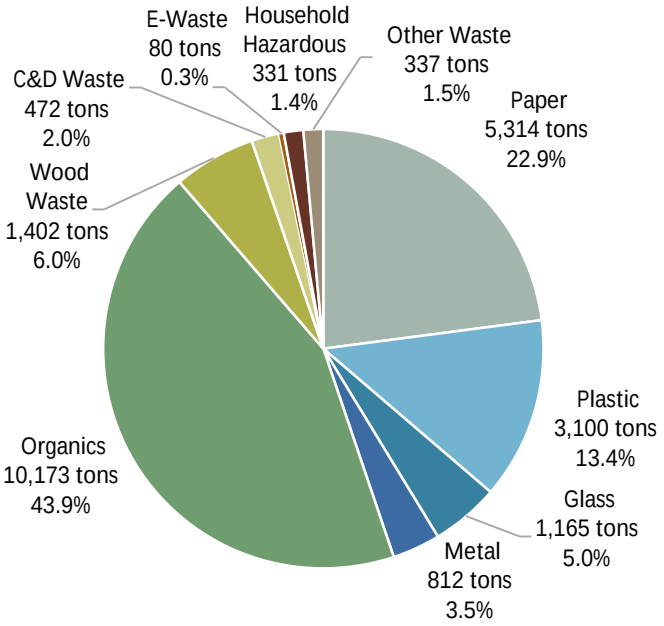
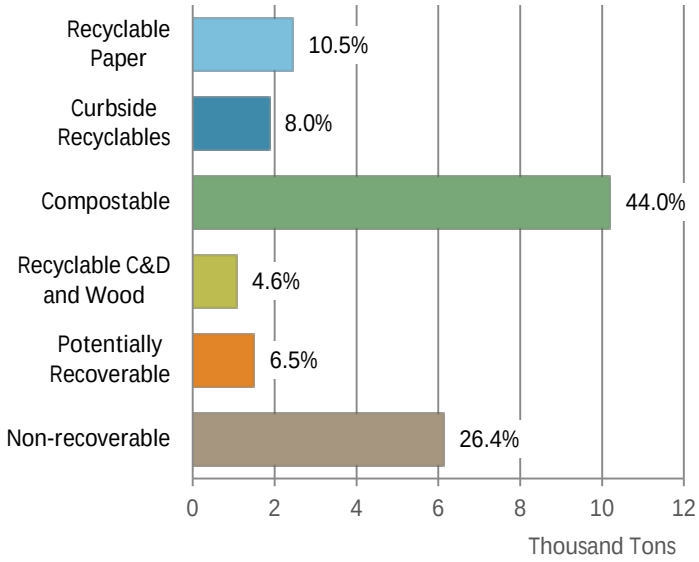


Figure 3-12. Summary of Recoverability of Commercial Packer Disposed Waste



The three most prevalent *material types – food waste, vegetative; other food waste; and leaves and grass* – accounted for more than one third (35.2%) of commercial packer disposed waste by weight (**Table 3-16**).

Table 3-16. Ten Most Prevalent *Materials Types* in Commercial Packer Disposed Waste

Material	Est. Percent	Cum. Percent	Est. Tons
Food Waste, Vegetative	20.3%	20.3%	4,698
Other Food Waste	8.2%	28.5%	1,911
Leaves and Grass	6.7%	35.2%	1,553
Compostable/Soiled Paper	6.4%	41.6%	1,488
Other Film	5.9%	47.5%	1,364
Low-grade Paper	4.4%	51.9%	1,027
Uncoated OCC/Kraft Paper	3.8%	55.8%	888
Remainder/Composite Paper	3.4%	59.2%	794
Textiles and Clothing	3.4%	62.6%	789
Remainder/Composite Glass	2.2%	64.8%	502
Total	**64.8%**		**15,014**

Table 3-17 presents detailed composition results for the commercial packer disposed waste stream by *material type*.

Table 3-17. Detailed Disposed Waste Composition Results: Commercial Packer

Material	Est. Percent	+ / -	Est. Tons
Paper	**22.9%**		**5,314**
Newspaper	1.1%	0.5%	261
Uncoated OCC/Kraft Paper	3.8%	1.1%	888
High-grade Paper	1.1%	0.6%	265
Low-grade Paper	4.4%	1.3%	1,027
Waxed OCC	0.7%	1.0%	151
Pizza Boxes	0.2%	0.1%	42
Compostable/Soiled Paper	6.4%	1.8%	1,488
Pot. Comp. Single-use Food Service Paper	1.0%	0.4%	232
Non-comp. Single-use Food Service Paper	0.7%	0.6%	165
Remainder/Composite Paper	3.4%	2.4%	794
Plastic	**13.4%**		**3,100**
#1 PET Bottles	0.7%	0.2%	174
#2 HDPE Bottles	0.6%	0.2%	140
#1-#7 Other Containers	0.8%	0.4%	185
Expanded Polystyrene Food grade	0.3%	0.2%	68
Expanded Polystyrene Non-food Grade	0.2%	0.1%	50
Pot. Comp. Single-use Food Service Plastic	0.2%	0.1%	41
Non-comp. Single-use Food Service Plastic	0.6%	0.2%	132
Clean Shopping/Dry Cleaning Bags	0.3%	0.1%	58
Other Clean PE Film	1.5%	1.1%	355
Other Film	5.9%	1.3%	1,364
Durable Plastic Products	0.9%	0.5%	214
Remainder/Composite Plastics	1.4%	0.6%	321
Glass	**5.0%**		**1,165**
Clear Glass Containers	1.4%	0.7%	318
Green Glass Containers	0.5%	0.3%	114
Brown Glass Containers	1.0%	0.8%	231
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	2.2%	2.9%	502
Metal	**3.5%**		**812**
Aluminum Beverage Cans	0.4%	0.1%	82
Aluminum Foil/Containers	0.1%	0.1%	31
Other Non-ferrous	0.0%	0.0%	4
Tin Food Cans	0.6%	0.3%	132
Empty Aerosol Cans	0.2%	0.1%	40
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.1%	9
Other Ferrous	1.5%	1.0%	352
Remainder/Composite Metal	0.7%	0.4%	162
Organics	**43.9%**		**10,173**
Food Waste, Vegetative	20.3%	3.8%	4,698
Other Food Waste	8.2%	2.4%	1,911
Leaves and Grass	6.7%	4.9%	1,553
Prunings and Trimmings	0.2%	0.3%	44
Branches and Stumps	0.1%	0.2%	33
Textiles and Clothing	3.4%	1.5%	789
Disposable Diapers	2.0%	1.4%	461
Animal Excrement/Litter	1.6%	0.9%	370
Remainder/Composite Organic	1.4%	0.5%	314

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**6.0%**		**1,402**
Dimensional Lumber	1.6%	1.9%	373
Pallets and Crates	0.5%	0.8%	115
Engineered Wood	1.3%	1.2%	297
Other Untreated Wood	0.0%	0.0%	6
Painted Wood	1.9%	2.3%	442
Treated Wood	0.4%	0.4%	98
Remainder/Composite Wood	0.3%	0.3%	71
C&D Waste	**2.0%**		**472**
Concrete	0.6%	0.7%	142
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.7%	1.0%	164
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.1%	0.2%	33
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	0.6%	0.7%	132
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	0.0%	0.0%	0
E-Waste	**0.3%**		**80**
Televisions and CRTs	0.1%	0.1%	16
Computers and Flat Monitors	0.3%	0.3%	60
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	4
Household Hazardous	**1.4%**		**331**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	6
Dry-cell Batteries	0.0%	0.0%	2
Wet-cell Batteries	0.1%	0.1%	15
Gasoline/Kerosene	0.0%	0.0%	5
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	1.2%	1.3%	272
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.1%	0.1%	22
Other Potentially Hazardous	0.0%	0.1%	9
Other Waste	**1.5%**		**337**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	1.5%	1.7%	337
Totals	**100.0%**		**23,186**
Sample Count			31

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

Commercial Roll-off (non-C&D)

Figure 3-13 demonstrated commercial roll-off composition by **material class**. Nearly three quarters of commercial roll-off (non-C&D) disposed waste was **Organics**, **Paper**, and **Plastic**. **Figure 3-14** shows that nearly one third of the waste was Compostable material (30.8%), and almost another third was Non-recoverable (32.5%). Recyclable Paper and Curbside Recyclables accounted for approximately another fifth (20.7%) of the commercial roll-off (MSW) waste.

Figure 3-13. Overview of Commercial Roll-Off Disposed Waste

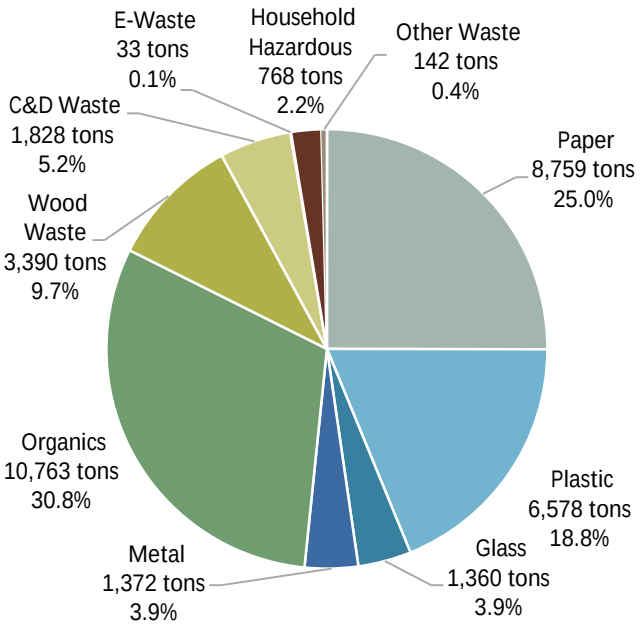
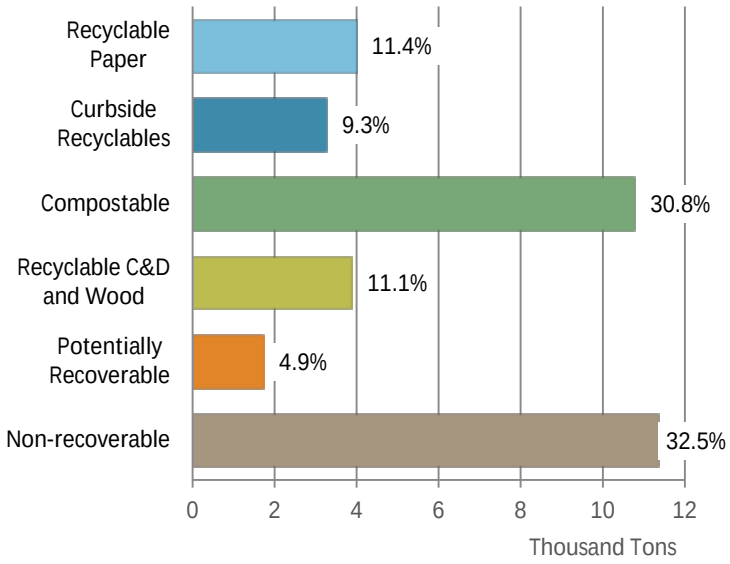


Figure 3-14. Summary of Recoverability of Commercial Roll-Off Disposed Waste



According to **Table 3-18**, the two most commonly observed *material types*, *food waste, vegetative* and *compostable/soiled paper* – both recoverable materials – accounted for approximately one fifth (21.2%) of commercial packer disposed waste by weight.

Table 3-18. Ten Most Prevalent *Materials Types* in Commercial Roll-Off Disposed Waste

Material	Est. Percent	Cum. Percent	Est. Tons
Food Waste, Vegetative	15.3%	15.3%	5,338
Compostable/Soiled Paper	6.0%	21.2%	2,096
Remainder/Composite Paper	5.9%	27.2%	2,076
Other Food Waste	5.5%	32.7%	1,937
Other Film	5.3%	38.1%	1,869
Remainder/Composite Plastics	4.5%	42.5%	1,565
Low-grade Paper	4.4%	46.9%	1,535
Uncoated OCC/Kraft Paper	3.9%	50.8%	1,360
Remainder/Composite Organic	3.5%	54.3%	1,231
Pallets and Crates	3.5%	57.8%	1,207
Total	**57.8%**		**20,215**

Detailed composition results by *material type* for the commercial roll-off waste stream are shown in **Table 3-19**.

Table 3-19. Detailed Disposed Waste Composition Results: Commercial Roll-Off

Material	Est. Percent	+ / -	Est. Tons
Paper	**25.0%**		**8,759**
Newspaper	1.5%	0.8%	523
Uncoated OCC/Kraft Paper	3.9%	1.4%	1,360
High-grade Paper	1.6%	1.0%	568
Low-grade Paper	4.4%	1.7%	1,535
Waxed OCC	0.2%	0.4%	87
Pizza Boxes	0.1%	0.1%	25
Compostable/Soiled Paper	6.0%	1.8%	2,096
Pot. Comp. Single-use Food Service Paper	1.0%	0.6%	367
Non-comp. Single-use Food Service Paper	0.4%	0.2%	124
Remainder/Composite Paper	5.9%	3.6%	2,076
Plastic	**18.8%**		**6,578**
#1 PET Bottles	1.9%	1.6%	662
#2 HDPE Bottles	0.5%	0.3%	158
#1-#7 Other Containers	0.7%	0.2%	236
Expanded Polystyrene Food grade	0.5%	0.2%	166
Expanded Polystyrene Non-food Grade	0.3%	0.3%	89
Pot. Comp. Single-use Food Service Plastic	0.4%	0.5%	124
Non-comp. Single-use Food Service Plastic	0.5%	0.3%	191
Clean Shopping/Dry Cleaning Bags	0.2%	0.1%	77
Other Clean PE Film	1.9%	1.8%	660
Other Film	5.3%	1.1%	1,869
Durable Plastic Products	2.2%	1.4%	781
Remainder/Composite Plastics	4.5%	3.7%	1,565
Glass	**3.9%**		**1,360**
Clear Glass Containers	1.4%	1.0%	491
Green Glass Containers	0.4%	0.3%	136
Brown Glass Containers	1.1%	0.9%	369
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	1.0%	1.6%	364
Metal	**3.9%**		**1,372**
Aluminum Beverage Cans	0.4%	0.2%	147
Aluminum Foil/Containers	0.1%	0.0%	27
Other Non-ferrous	0.0%	0.1%	16
Tin Food Cans	0.2%	0.1%	71
Empty Aerosol Cans	0.2%	0.3%	74
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	9
Other Ferrous	2.3%	1.8%	791
Remainder/Composite Metal	0.7%	0.5%	236
Organics	**30.8%**		**10,763**
Food Waste, Vegetative	15.3%	4.7%	5,338
Other Food Waste	5.5%	2.4%	1,937
Leaves and Grass	2.3%	1.8%	805
Prunings and Trimmings	0.0%	0.0%	2
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	2.0%	1.0%	701
Disposable Diapers	0.7%	0.6%	253
Animal Excrement/Litter	1.4%	2.1%	495
Remainder/Composite Organic	3.5%	2.9%	1,231

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**9.7%**		**3,390**
Dimensional Lumber	3.4%	4.3%	1,195
Pallets and Crates	3.5%	4.4%	1,207
Engineered Wood	1.6%	1.7%	555
Other Untreated Wood	0.1%	0.1%	27
Painted Wood	0.8%	1.0%	270
Treated Wood	0.2%	0.4%	79
Remainder/Composite Wood	0.2%	0.3%	58
C&D Waste	**5.2%**		**1,828**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.0%	0.0%	0
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	1.3%	1.8%	445
Other Asphalt Roofing	0.0%	0.0%	3
Insulation	0.2%	0.4%	75
Carpet	0.0%	0.0%	0
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	1.3%	1.8%	449
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	2.4%	3.1%	856
E-Waste	**0.1%**		**33**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.1%	0.2%	33
Household Hazardous	**2.2%**		**768**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	5
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	2.2%	3.5%	762
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.4%**		**142**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.4%	0.5%	142
Totals	**100.0%**		**34,992**
Sample Count			28

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

School Waste[3]

Figure 3-15 shows school disposed waste composition by **material class** for school waste. More than half (57.1%) of school waste was composed of **C&D Waste** and **Wood Waste**. **Organics** made up an additional one fifth of this waste (21.9%). As shown in **Figure 3-16**, Recyclable C&D and Wood is the largest category of recoverable material in this waste stream (37.3%). Compostable materials were almost another quarter of the waste stream (24.2%). By contrast, Recyclable Paper and Curbside Recyclables, combined, made up about five percent of composition. Recoverable and potentially recoverable materials, in total, accounted for about two thirds (67.1%) of the waste.

Figure 3-15. Overview of School Disposed Waste

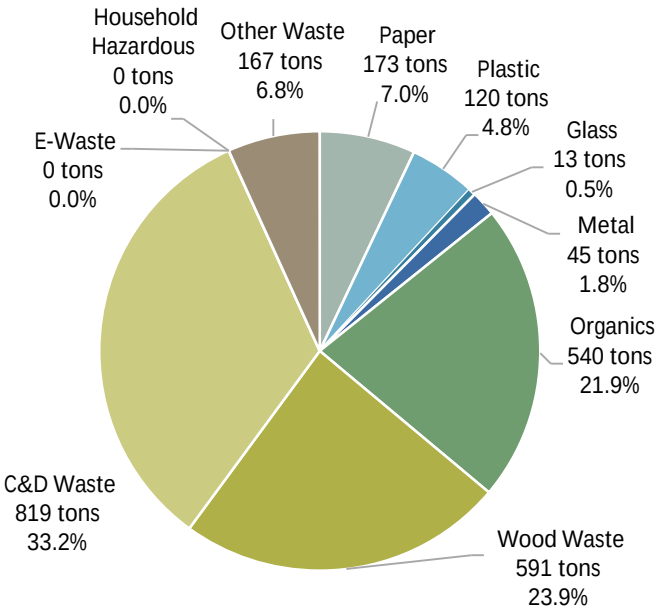
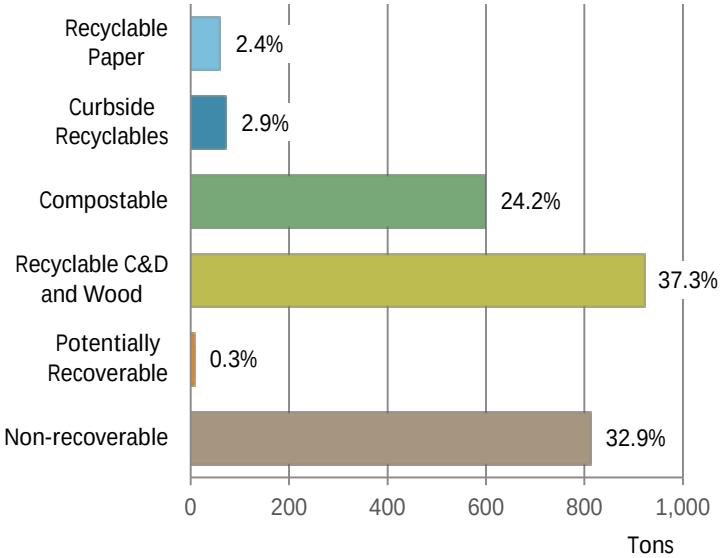


Figure 3-16. Summary of Recoverability of School Disposed Waste



As presented in **Table 3-20**, the three most prevalent *material types – soil, rocks and sand, concrete,* and *other drywall* – accounted for one third (33.0%) of school waste by weight when summed.

[3] Due to the sample size and prevalence of C&D and wood materials, this waste composition may not be representative of the typical waste stream for Tacoma Schools. Based on other waste characterization studies of school waste, it is unlikely that the quantities of C&D and wood waste would be present in this waste on an ongoing, continuing basis.

Table 3-20. Ten Most Prevalent *Materials Types* in School Disposed Waste

Material	Est. Percent	Cum. Percent	Est. Tons
Soil, Rocks, and Sand	12.1%	12.1%	300
Concrete	11.0%	23.1%	270
Other Drywall	9.9%	33.0%	243
Painted Wood	9.7%	42.6%	239
Leaves and Grass	9.2%	51.9%	227
Other Untreated Wood	8.2%	60.0%	201
Other Food Waste	7.6%	67.6%	187
Furniture	6.7%	74.3%	166
Dimensional Lumber	6.1%	80.4%	150
Food Waste, Vegetative	4.5%	84.8%	110
Total	**84.8%**		**2,094**

Table 3-21 presents detailed composition results for school disposed waste by *material type*.

Table 3-21. Detailed Disposed Waste Composition Results: School Waste

Material	Est. Percent	+ / -	Est. Tons
Paper	**7.0%**		**173**
Newspaper	0.0%	0.0%	0
Uncoated OCC/Kraft Paper	0.7%	0.5%	17
High-grade Paper	0.3%	0.3%	8
Low-grade Paper	1.4%	1.1%	34
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.1%	0.1%	3
Compostable/Soiled Paper	2.2%	1.6%	53
Pot. Comp. Single-use Food Service Paper	0.6%	0.7%	14
Non-comp. Single-use Food Service Paper	0.5%	0.7%	12
Remainder/Composite Paper	1.3%	1.1%	32
Plastic	**4.8%**		**120**
#1 PET Bottles	0.2%	0.2%	5
#2 HDPE Bottles	0.1%	0.2%	3
#1-#7 Other Containers	0.3%	0.3%	7
Expanded Polystyrene Food grade	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.0%	0.0%	1
Pot. Comp. Single-use Food Service Plastic	0.1%	0.2%	3
Non-comp. Single-use Food Service Plastic	0.0%	0.1%	1
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	1
Other Clean PE Film	0.0%	0.0%	0
Other Film	1.6%	1.2%	39
Durable Plastic Products	2.1%	1.9%	52
Remainder/Composite Plastics	0.3%	0.3%	7
Glass	**0.5%**		**13**
Clear Glass Containers	0.2%	0.2%	4
Green Glass Containers	0.1%	0.1%	2
Brown Glass Containers	0.2%	0.2%	4
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.1%	0.2%	2
Metal	**1.8%**		**45**
Aluminum Beverage Cans	0.0%	0.0%	1
Aluminum Foil/Containers	0.0%	0.0%	1
Other Non-ferrous	1.6%	2.1%	39
Tin Food Cans	0.1%	0.1%	3
Empty Aerosol Cans	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	0.0%	0.0%	1
Remainder/Composite Metal	0.0%	0.0%	0
Organics	**21.9%**		**540**
Food Waste, Vegetative	4.5%	3.5%	110
Other Food Waste	7.6%	5.8%	187
Leaves and Grass	9.2%	11.6%	227
Prunings and Trimmings	0.0%	0.0%	0
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	0.2%	0.3%	5
Disposable Diapers	0.2%	0.2%	4
Animal Excrement/Litter	0.2%	0.5%	5
Remainder/Composite Organic	0.1%	0.1%	2

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**23.9%**		**591**
Dimensional Lumber	6.1%	0.8%	150
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.0%	0.0%	0
Other Untreated Wood	8.2%	1.0%	201
Painted Wood	9.7%	1.3%	239
Treated Wood	0.0%	0.0%	0
Remainder/Composite Wood	0.0%	0.1%	1
C&D Waste	**33.2%**		**819**
Concrete	11.0%	14.2%	270
Clean Drywall	0.0%	0.0%	0
Other Drywall	9.9%	1.3%	243
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.0%	0.0%	0
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	12.1%	15.9%	300
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	0.2%	0.1%	5
E-Waste	**0.0%**		**0**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**0.0%**		**0**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	0
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**6.8%**		**167**
Furniture	6.7%	3.6%	166
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.0%	0.1%	1
Totals	**100.0%**		**2,468**
Sample Count			13

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

Self-Haul Waste

Overall Self-haul

As shown in **Figure 3-17**, **Organics, Wood Waste,** and **Other Waste** made up slightly more than 60 percent of overall self-haul waste. **Figure 3-18** summarizes the recoverability of the waste. Nearly two thirds (65.4%) of overall self-haul waste was composed of recoverable or potentially recoverable materials. Compostable material made up the largest recoverable fraction (21.2%) and was closely followed by Potentially Recoverable material (19.5%).

Figure 3-17. Overview of Overall Self-haul Disposed **Waste**

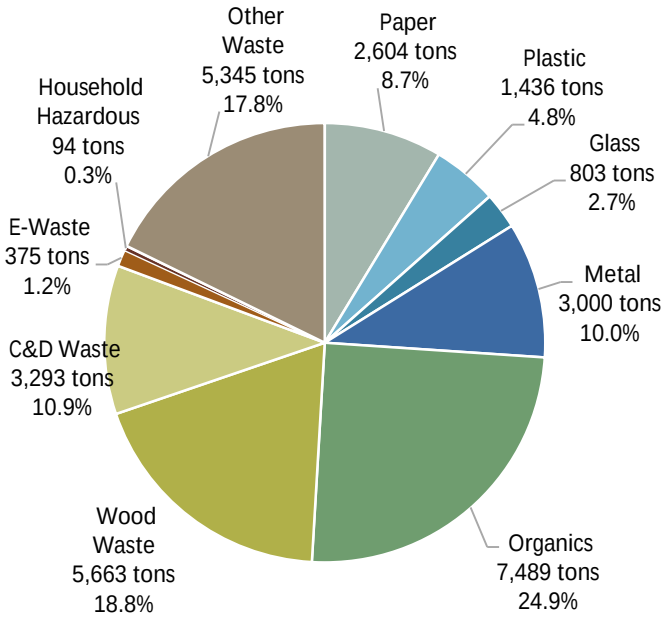
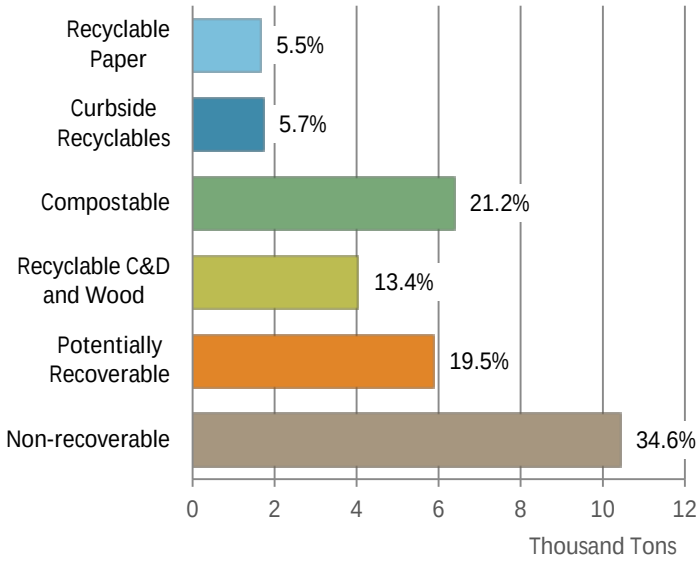


Figure 3-18. Summary of Recoverability of Overall Self-haul Disposed Waste



As presented in **Table 3-22**, the four most prevalent *material types – furniture, leaves and grass, prunings and trimmings*, and *dimensional lumber* – accounted for over one third (35.5%) of self-haul waste by weight.

Table 3-22. Ten Most Prevalent *Materials Types* in Overall Self-haul Disposed Waste

Material	Est. Percent	Cum. Percent	Est. Tons
Furniture	10.9%	10.9%	3,281
Leaves and Grass	9.5%	20.4%	2,867
Prunings and Trimmings	8.0%	28.4%	2,415
Dimensional Lumber	7.1%	35.5%	2,134
Mattresses	6.6%	42.1%	1,987
Remainder/Composite Construction	4.2%	46.4%	1,274
Uncoated OCC/Kraft Paper	3.9%	50.2%	1,166
Other Ferrous	3.5%	53.7%	1,041
Textiles and Clothing	3.4%	57.1%	1,026
Remainder/Composite Metal	3.4%	60.5%	1,025
Total	**60.5%**		**18,215**

Table 3-23 presents detailed overall composition results for this substream by *material type*.

Table 3-23. Detailed Disposed Waste Composition Results: Overall Self-haul

Material	Est. Percent	+ / -	Est. Tons
Paper	**8.7%**		**2,604**
Newspaper	0.6%	0.4%	179
Uncoated OCC/Kraft Paper	3.9%	2.8%	1,166
High-grade Paper	0.2%	0.1%	53
Low-grade Paper	0.9%	0.4%	262
Waxed OCC	0.1%	0.2%	42
Pizza Boxes	0.1%	0.0%	19
Compostable/Soiled Paper	0.4%	0.2%	111
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	7
Non-comp. Single-use Food Service Paper	0.1%	0.0%	18
Remainder/Composite Paper	2.5%	1.9%	748
Plastic	**4.8%**		**1,436**
#1 PET Bottles	0.1%	0.1%	32
#2 HDPE Bottles	0.0%	0.0%	14
#1-#7 Other Containers	0.1%	0.1%	26
Expanded Polystyrene Food grade	0.0%	0.0%	3
Expanded Polystyrene Non-food Grade	0.0%	0.0%	6
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	2
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	3
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	2
Other Clean PE Film	0.0%	0.0%	1
Other Film	0.6%	0.4%	186
Durable Plastic Products	2.2%	1.5%	670
Remainder/Composite Plastics	1.6%	1.1%	490
Glass	**2.7%**		**803**
Clear Glass Containers	0.1%	0.1%	34
Green Glass Containers	0.0%	0.0%	6
Brown Glass Containers	0.1%	0.1%	34
Plate Glass	1.4%	1.3%	431
Remainder/Composite Glass	1.0%	0.8%	298
Metal	**10.0%**		**3,000**
Aluminum Beverage Cans	0.0%	0.0%	10
Aluminum Foil/Containers	0.0%	0.0%	2
Other Non-ferrous	1.4%	1.2%	412
Tin Food Cans	0.1%	0.1%	30
Empty Aerosol Cans	0.1%	0.2%	44
Major Appliances	1.4%	1.7%	436
Oil filters	0.0%	0.0%	0
Other Ferrous	3.5%	2.2%	1,041
Remainder/Composite Metal	3.4%	2.4%	1,025
Organics	**24.9%**		**7,489**
Food Waste, Vegetative	2.2%	1.3%	665
Other Food Waste	0.6%	0.4%	172
Leaves and Grass	9.5%	4.4%	2,867
Prunings and Trimmings	8.0%	4.2%	2,415
Branches and Stumps	0.3%	0.4%	76
Textiles and Clothing	3.4%	2.5%	1,026
Disposable Diapers	0.3%	0.3%	88
Animal Excrement/Litter	0.4%	0.3%	108
Remainder/Composite Organic	0.2%	0.1%	72

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**18.8%**		**5,663**
Dimensional Lumber	7.1%	2.9%	2,134
Pallets and Crates	0.6%	0.7%	176
Engineered Wood	3.1%	2.5%	928
Other Untreated Wood	0.3%	0.3%	84
Painted Wood	3.4%	2.0%	1,020
Treated Wood	1.7%	1.6%	511
Remainder/Composite Wood	2.7%	1.9%	810
C&D Waste	**10.9%**		**3,293**
Concrete	1.2%	1.1%	368
Clean Drywall	0.3%	0.5%	89
Other Drywall	0.8%	0.8%	235
Asphalt Paving	0.0%	0.0%	2
Asphalt Shingles	0.1%	0.2%	40
Other Asphalt Roofing	0.0%	0.1%	13
Insulation	0.1%	0.2%	38
Carpet	3.2%	2.5%	954
Carpet Padding	0.2%	0.3%	64
Soil, Rocks, and Sand	0.7%	0.8%	216
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	4.2%	4.4%	1,274
E-Waste	**1.2%**		**375**
Televisions and CRTs	1.2%	1.9%	371
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	4
Household Hazardous	**0.3%**		**94**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.1%	0.2%	38
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	8
House Cleaners and Chemicals	0.2%	0.2%	48
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**17.8%**		**5,345**
Furniture	10.9%	5.8%	3,281
Tires	0.0%	0.0%	0
Mattresses	6.6%	6.0%	1,987
Non-distinct Fines	0.3%	0.3%	76
Totals	**100.0%**		**30,103**
Sample Count			131

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

Residential Self-haul (non-C&D)

Figure 3-19 illustrates the breakdown of **material classes** in residential self-haul disposed waste. Approximately one quarter (25.5%) of residential self-haul disposed waste was **Organics** and an additional third (33.8%) of the waste was **C&D Waste** and **Wood Waste**. As shown in **Figure 3-20**, approximately two fifths (40.5%) of residential self-haul waste was Non-recoverable. Compostable material was the second largest recoverability category present, accounting for almost a quarter (23.9%) of the waste.

Figure 3-19. Overview of Residential Self-haul Disposed Waste

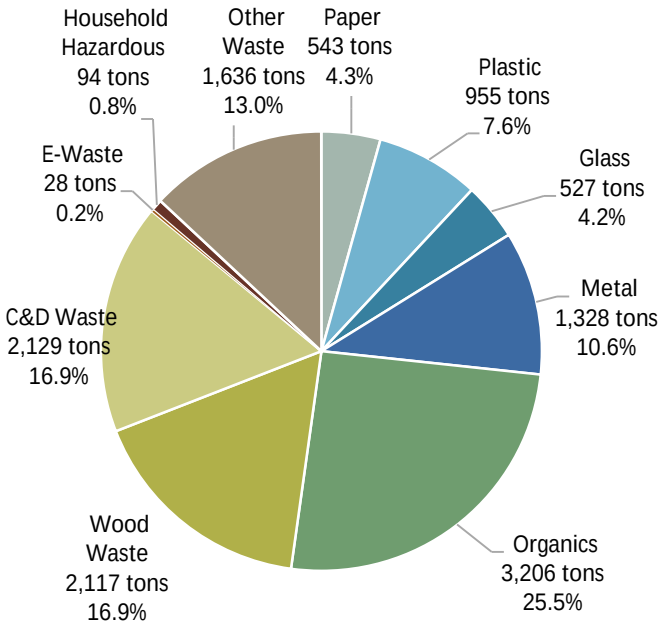
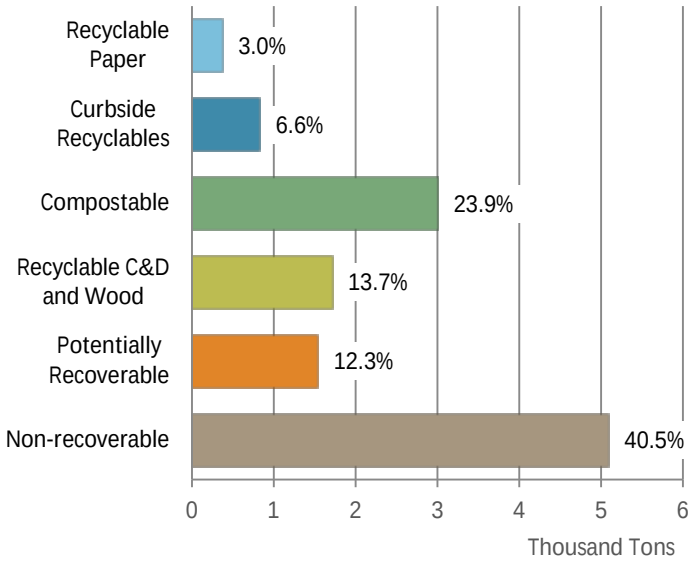


Figure 3-20. Summary of Recoverability of Residential Self-haul Disposed Waste



As shown in **Table 3-24**, the two most commonly observed *material types – leaves and grass* and *furniture* – each represented slightly over one tenth (10.7% *leaves and grass* and 10.3% *furniture*) of the residential self-haul disposed waste by weight.

Table 3-24. Ten Most Prevalent *Materials Types* in Residential Self-haul Disposed Waste

Material	Est. Percent	Cum. Percent	Est. Tons
Leaves and Grass	10.7%	10.7%	1,345
Furniture	10.3%	21.0%	1,295
Prunings and Trimmings	8.8%	29.8%	1,106
Dimensional Lumber	8.2%	38.1%	1,035
Remainder/Composite Construction	7.7%	45.8%	973
Other Ferrous	5.4%	51.2%	676
Durable Plastic Products	4.4%	55.6%	550
Major Appliances	3.5%	59.0%	436
Plate Glass	3.2%	62.3%	406
Treated Wood	3.2%	65.5%	402
Total	**65.5%**		**8,224**

Detailed overall composition results by *material type* for this substream are shown in **Table 3-25**.

Table 3-25. Detailed Disposed Waste Composition Results: Residential Self-haul

Material	Est. Percent	+ / -	Est. Tons
Paper	**4.3%**		**543**
Newspaper	0.7%	0.8%	93
Uncoated OCC/Kraft Paper	0.9%	0.6%	118
High-grade Paper	0.2%	0.1%	24
Low-grade Paper	1.1%	0.7%	141
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.0%	0.0%	5
Compostable/Soiled Paper	0.2%	0.1%	29
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	5
Non-comp. Single-use Food Service Paper	0.0%	0.0%	3
Remainder/Composite Paper	1.0%	0.6%	125
Plastic	**7.6%**		**955**
#1 PET Bottles	0.1%	0.1%	18
#2 HDPE Bottles	0.0%	0.0%	6
#1-#7 Other Containers	0.1%	0.1%	14
Expanded Polystyrene Food grade	0.0%	0.0%	1
Expanded Polystyrene Non-food Grade	0.0%	0.0%	1
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	1
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	1
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	0
Other Clean PE Film	0.0%	0.0%	0
Other Film	0.9%	0.8%	112
Durable Plastic Products	4.4%	3.5%	550
Remainder/Composite Plastics	2.0%	2.1%	251
Glass	**4.2%**		**527**
Clear Glass Containers	0.2%	0.2%	20
Green Glass Containers	0.0%	0.0%	0
Brown Glass Containers	0.2%	0.2%	21
Plate Glass	3.2%	3.1%	406
Remainder/Composite Glass	0.6%	0.9%	80
Metal	**10.6%**		**1,328**
Aluminum Beverage Cans	0.0%	0.0%	5
Aluminum Foil/Containers	0.0%	0.0%	1
Other Non-ferrous	0.2%	0.2%	26
Tin Food Cans	0.1%	0.1%	6
Empty Aerosol Cans	0.0%	0.0%	1
Major Appliances	3.5%	4.1%	436
Oil filters	0.0%	0.0%	0
Other Ferrous	5.4%	4.8%	676
Remainder/Composite Metal	1.4%	1.3%	176
Organics	**25.5%**		**3,206**
Food Waste, Vegetative	2.8%	2.2%	354
Other Food Waste	0.7%	0.7%	92
Leaves and Grass	10.7%	5.9%	1,345
Prunings and Trimmings	8.8%	5.9%	1,106
Branches and Stumps	0.6%	0.9%	70
Textiles and Clothing	1.4%	1.0%	179
Disposable Diapers	0.2%	0.2%	19
Animal Excrement/Litter	0.3%	0.4%	34
Remainder/Composite Organic	0.1%	0.1%	7

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**16.9%**		**2,117**
Dimensional Lumber	8.2%	5.5%	1,035
Pallets and Crates	0.8%	1.2%	101
Engineered Wood	0.7%	0.6%	84
Other Untreated Wood	0.1%	0.1%	7
Painted Wood	3.0%	3.2%	379
Treated Wood	3.2%	3.7%	402
Remainder/Composite Wood	0.9%	0.7%	111
C&D Waste	**16.9%**		**2,129**
Concrete	2.6%	2.6%	321
Clean Drywall	0.7%	1.2%	89
Other Drywall	1.4%	1.7%	175
Asphalt Paving	0.0%	0.0%	2
Asphalt Shingles	0.3%	0.4%	40
Other Asphalt Roofing	0.1%	0.2%	13
Insulation	0.3%	0.5%	37
Carpet	3.1%	3.0%	395
Carpet Padding	0.4%	0.6%	47
Soil, Rocks, and Sand	0.3%	0.3%	38
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	7.7%	10.4%	973
E-Waste	**0.2%**		**28**
Televisions and CRTs	0.2%	0.3%	24
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	4
Household Hazardous	**0.8%**		**94**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.3%	0.4%	38
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.1%	0.1%	8
House Cleaners and Chemicals	0.4%	0.6%	48
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**13.0%**		**1,636**
Furniture	10.3%	5.7%	1,295
Tires	0.0%	0.0%	0
Mattresses	2.2%	1.7%	277
Non-distinct Fines	0.5%	0.7%	64
Totals	**100.0%**		**12,564**
Sample Count			80

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

Commercial Self-haul (non-C&D)

Figure 3-21 illustrates the breakdown of **material classes** in commercial self-haul disposed waste. The three largest material classes observed in commercial self-haul disposed waste were **Organics**, **Other Waste**, and **Wood Waste**, which together accounted for nearly two thirds (65.7%) of commercial self-haul waste. As shown in **Figure 3-22**, approximately 70 percent of commercial self-haul waste was recoverable or potentially recoverable. Compostable material was the second largest recoverability category present, accounting for 19 percent of the waste. More than a quarter of the waste was recyclable (Recyclable Paper, Curbside Recyclables, and Recyclable C&D and Wood combined were 25.6% of the waste by weight).

Figure 3-21. Overview of Commercial Self-haul Disposed Waste

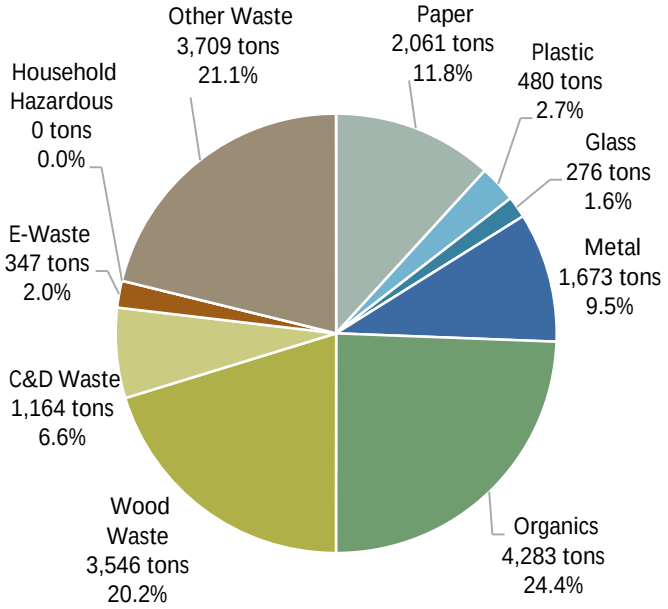
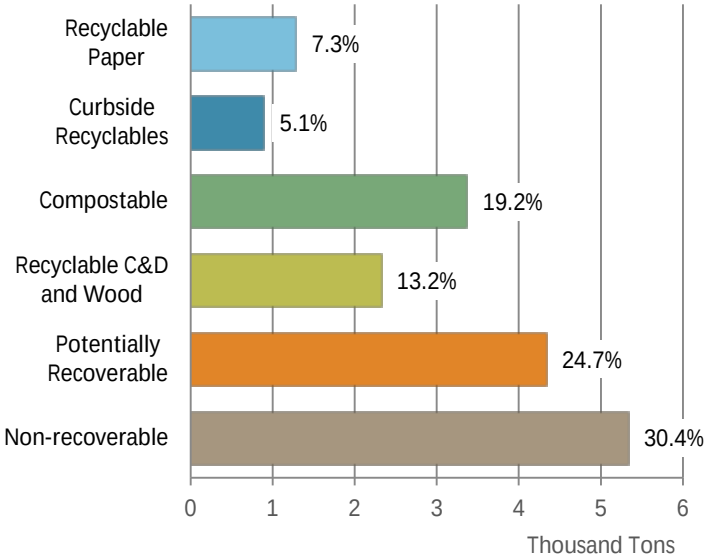


Figure 3-22. Summary of Recoverability of Commercial Self-haul Disposed Waste



As presented in **Table 3-26**, the two most commonly observed *material types – furniture* and *mattresses* – together accounted for over one fifth (21.1%) of the commercial self-haul disposed waste substream.

Table 3-26. Ten Most Prevalent *Materials Types* in Commercial Self-haul Disposed Waste

Material	Est. Percent	Cum. Percent	Est. Tons
Furniture	11.3%	11.3%	1,986
Mattresses	9.7%	21.1%	1,710
Leaves and Grass	8.7%	29.8%	1,522
Prunings and Trimmings	7.5%	37.2%	1,308
Dimensional Lumber	6.3%	43.5%	1,099
Uncoated OCC/Kraft Paper	6.0%	49.5%	1,049
Remainder/Composite Metal	4.8%	54.3%	848
Textiles and Clothing	4.8%	59.1%	847
Engineered Wood	4.8%	63.9%	844
Remainder/Composite Wood	4.0%	67.9%	700
Total	**67.9%**		**11,913**

Table 3-27 presents detailed overall composition results for this substream by *material type*.

Table 3-27. Detailed Disposed Waste Composition Results: Commercial Self-haul

Material	Est. Percent	+ / -	Est. Tons
Paper	**11.8%**		**2,061**
Newspaper	0.5%	0.3%	86
Uncoated OCC/Kraft Paper	6.0%	4.7%	1,049
High-grade Paper	0.2%	0.1%	28
Low-grade Paper	0.7%	0.5%	122
Waxed OCC	0.2%	0.3%	42
Pizza Boxes	0.1%	0.1%	13
Compostable/Soiled Paper	0.5%	0.3%	82
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	3
Non-comp. Single-use Food Service Paper	0.1%	0.1%	14
Remainder/Composite Paper	3.5%	3.2%	622
Plastic	**2.7%**		**480**
#1 PET Bottles	0.1%	0.1%	14
#2 HDPE Bottles	0.1%	0.0%	9
#1-#7 Other Containers	0.1%	0.1%	12
Expanded Polystyrene Food grade	0.0%	0.0%	2
Expanded Polystyrene Non-food Grade	0.0%	0.0%	5
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	1
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	1
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	2
Other Clean PE Film	0.0%	0.0%	1
Other Film	0.4%	0.3%	75
Durable Plastic Products	0.7%	0.4%	120
Remainder/Composite Plastics	1.4%	1.2%	238
Glass	**1.6%**		**276**
Clear Glass Containers	0.1%	0.1%	14
Green Glass Containers	0.0%	0.0%	6
Brown Glass Containers	0.1%	0.1%	14
Plate Glass	0.1%	0.2%	24
Remainder/Composite Glass	1.2%	1.3%	218
Metal	**9.5%**		**1,673**
Aluminum Beverage Cans	0.0%	0.0%	5
Aluminum Foil/Containers	0.0%	0.0%	1
Other Non-ferrous	2.2%	2.1%	386
Tin Food Cans	0.1%	0.1%	24
Empty Aerosol Cans	0.2%	0.3%	43
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	2.1%	1.5%	365
Remainder/Composite Metal	4.8%	4.0%	848
Organics	**24.4%**		**4,283**
Food Waste, Vegetative	1.8%	1.6%	311
Other Food Waste	0.5%	0.4%	80
Leaves and Grass	8.7%	6.3%	1,522
Prunings and Trimmings	7.5%	5.8%	1,308
Branches and Stumps	0.0%	0.1%	6
Textiles and Clothing	4.8%	4.2%	847
Disposable Diapers	0.4%	0.4%	69
Animal Excrement/Litter	0.4%	0.4%	73
Remainder/Composite Organic	0.4%	0.2%	65

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**20.2%**		**3,546**
Dimensional Lumber	6.3%	3.1%	1,099
Pallets and Crates	0.4%	0.7%	76
Engineered Wood	4.8%	4.3%	844
Other Untreated Wood	0.4%	0.5%	78
Painted Wood	3.7%	2.6%	641
Treated Wood	0.6%	0.7%	109
Remainder/Composite Wood	4.0%	3.2%	700
C&D Waste	**6.6%**		**1,164**
Concrete	0.3%	0.5%	47
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.3%	0.6%	60
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	2
Carpet	3.2%	3.8%	559
Carpet Padding	0.1%	0.2%	17
Soil, Rocks, and Sand	1.0%	1.4%	178
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	1.7%	1.6%	301
E-Waste	**2.0%**		**347**
Televisions and CRTs	2.0%	3.3%	347
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**0.0%**		**0**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	0
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**21.1%**		**3,709**
Furniture	11.3%	9.1%	1,986
Tires	0.0%	0.0%	0
Mattresses	9.7%	10.3%	1,710
Non-distinct Fines	0.1%	0.1%	13
Totals	**100.0%**		**17,540**
Sample Count			51

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

Construction and Demolition (C&D) Waste

Overall C&D

Figure 3-23 shows a breakdown of overall C&D waste by **material class**. More than 80 percent of overall C&D disposed waste was **Wood Waste** (42.6%) and **C&D Waste** (40.6%). **Figure 3-24** summarizes the recoverability of materials in the waste stream and demonstrates that most of C&D disposed waste was Recyclable C&D and Wood (42.1%) or Non-recoverable (42.2%).

Figure 3-23. Overview of Overall C&D Disposed Waste

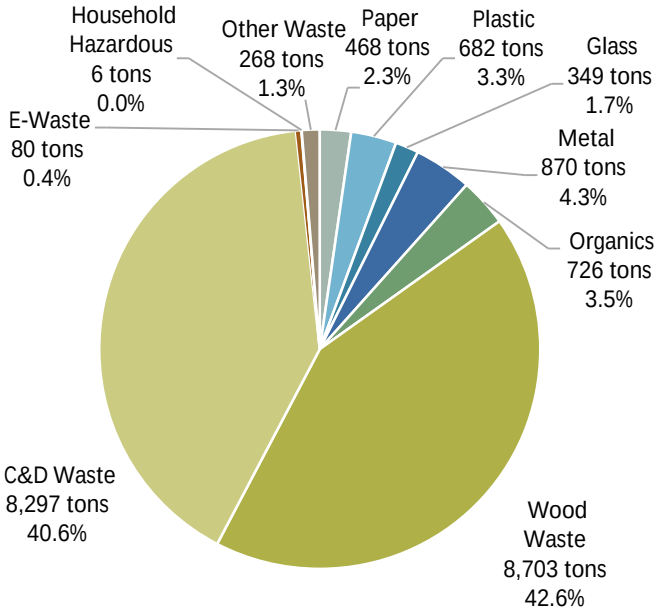


Figure 3-24. Summary of Recoverability of Overall C&D Disposed Waste

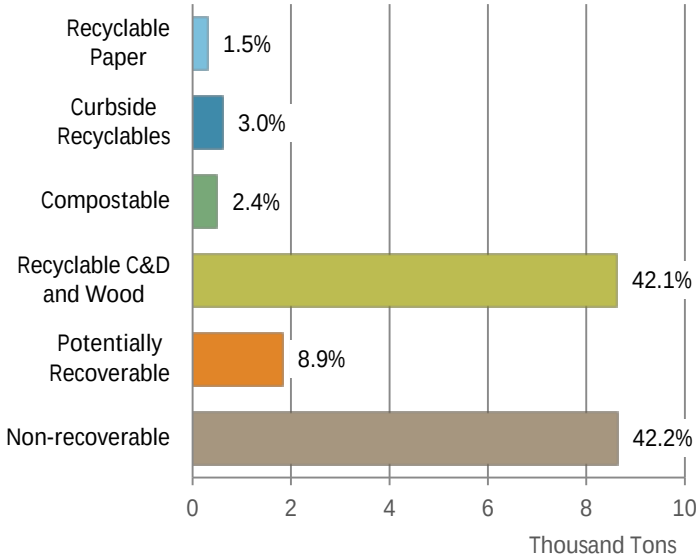


Table 3-28 shows that the three most commonly observed *material types – dimensional lumber, remainder/composite construction,* and *painted wood* – accounted for more than a third (36.1%) of overall C&D disposed waste by weight.

Table 3-28. Ten Most Prevalent *Materials Types* in Overall C&D Disposed Waste

Material	Est. Percent	Cum. Percent	Est. Tons
Dimensional Lumber	15.1%	15.1%	3,083
Remainder/Composite Construction	12.9%	27.9%	2,632
Painted Wood	8.1%	36.1%	1,665
Pallets and Crates	7.6%	43.7%	1,550
Other Drywall	5.9%	49.5%	1,200
Engineered Wood	5.2%	54.8%	1,069
Other Asphalt Roofing	4.1%	58.8%	829
Soil, Rocks, and Sand	4.0%	62.9%	827
Treated Wood	3.8%	66.7%	775
Carpet	3.8%	70.4%	767
Total	**70.4%**		**14,397**

Table 3-29 presents detailed overall composition results for this substream by *material type*.

Table 3-29. Detailed Disposed Waste Composition Results: Overall C&D

Material	Est. Percent	+ / -	Est. Tons
Paper	**2.3%**		**468**
Newspaper	0.0%	0.0%	1
Uncoated OCC/Kraft Paper	1.3%	0.6%	263
High-grade Paper	0.0%	0.0%	7
Low-grade Paper	0.2%	0.2%	31
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.0%	0.0%	0
Compostable/Soiled Paper	0.1%	0.2%	29
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	1
Non-comp. Single-use Food Service Paper	0.0%	0.0%	0
Remainder/Composite Paper	0.7%	0.3%	135
Plastic	**3.3%**		**682**
#1 PET Bottles	0.0%	0.0%	3
#2 HDPE Bottles	0.0%	0.0%	1
#1-#7 Other Containers	0.1%	0.1%	17
Expanded Polystyrene Food grade	0.0%	0.0%	3
Expanded Polystyrene Non-food Grade	0.3%	0.4%	57
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	2
Other Clean PE Film	0.1%	0.1%	16
Other Film	0.7%	0.6%	152
Durable Plastic Products	1.0%	1.2%	204
Remainder/Composite Plastics	1.1%	0.9%	228
Glass	**1.7%**		**349**
Clear Glass Containers	0.0%	0.0%	2
Green Glass Containers	0.0%	0.0%	0
Brown Glass Containers	0.0%	0.0%	3
Plate Glass	0.2%	0.4%	43
Remainder/Composite Glass	1.5%	0.8%	301
Metal	**4.3%**		**870**
Aluminum Beverage Cans	0.0%	0.0%	2
Aluminum Foil/Containers	0.0%	0.0%	0
Other Non-ferrous	0.5%	0.4%	105
Tin Food Cans	0.1%	0.1%	15
Empty Aerosol Cans	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	2
Oil filters	0.1%	0.1%	13
Other Ferrous	2.2%	2.0%	453
Remainder/Composite Metal	1.4%	0.6%	278
Organics	**3.5%**		**726**
Food Waste, Vegetative	0.0%	0.1%	7
Other Food Waste	0.0%	0.1%	9
Leaves and Grass	1.7%	1.9%	343
Prunings and Trimmings	0.4%	0.4%	90
Branches and Stumps	0.1%	0.1%	11
Textiles and Clothing	1.2%	1.7%	242
Disposable Diapers	0.0%	0.0%	0
Animal Excrement/Litter	0.0%	0.0%	3
Remainder/Composite Organic	0.1%	0.1%	20

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**42.6%**		**8,703**
Dimensional Lumber	15.1%	5.0%	3,083
Pallets and Crates	7.6%	4.3%	1,550
Engineered Wood	5.2%	5.4%	1,069
Other Untreated Wood	1.6%	2.1%	324
Painted Wood	8.1%	3.2%	1,665
Treated Wood	3.8%	1.7%	775
Remainder/Composite Wood	1.2%	0.5%	237
C&D Waste	**40.6%**		**8,297**
Concrete	2.7%	1.6%	561
Clean Drywall	1.3%	1.2%	273
Other Drywall	5.9%	2.1%	1,200
Asphalt Paving	0.1%	0.1%	18
Asphalt Shingles	1.5%	1.3%	304
Other Asphalt Roofing	4.1%	3.1%	829
Insulation	0.5%	0.7%	100
Carpet	3.8%	1.9%	767
Carpet Padding	0.9%	0.6%	185
Soil, Rocks, and Sand	4.0%	3.3%	827
Ceramics and Brick	2.9%	2.1%	602
Remainder/Composite Construction	12.9%	7.5%	2,632
E-Waste	**0.4%**		**80**
Televisions and CRTs	0.4%	0.4%	73
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.1%	7
Household Hazardous	**0.0%**		**6**
Pesticides and Herbicides	0.0%	0.0%	4
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	1
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**1.3%**		**268**
Furniture	0.4%	0.3%	78
Tires	0.0%	0.0%	5
Mattresses	0.8%	1.2%	169
Non-distinct Fines	0.1%	0.1%	15
Totals	**100.0%**		**20,449**
Sample Count			124

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

Commercial Roll-off C&D

As shown in **Figure 3-25**, more than 70 percent of the commercial roll-off C&D substream was **Wood Waste** (41.2%) and **C&D Waste** (30.4%). **Figure 3-26** shows what portion of the waste stream was recyclable, compostable, or non-recoverable. The two largest recoverability categories were Recyclable C&D and Wood (37.9%) and Non-Recoverable (36.4%); and the two smallest were Recyclable Paper (2.5%) and Compostable Material (2.2%).

Figure 3-25. Overview of Commercial Roll-off (C&D) Disposed Waste

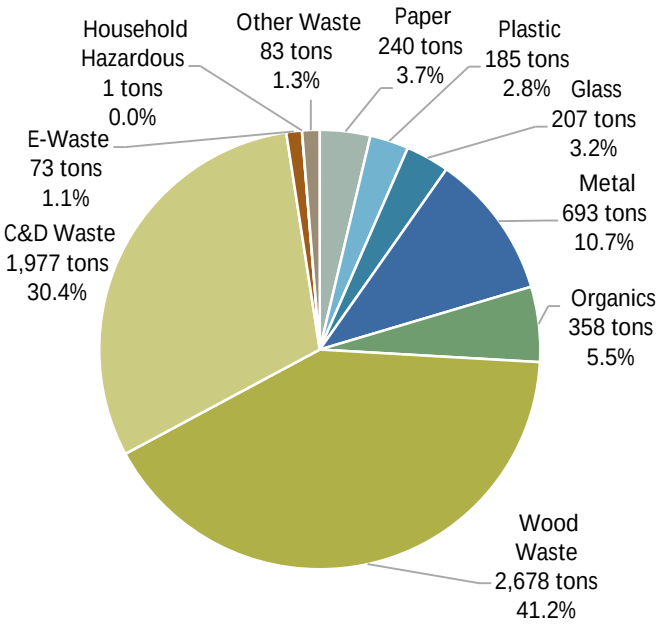
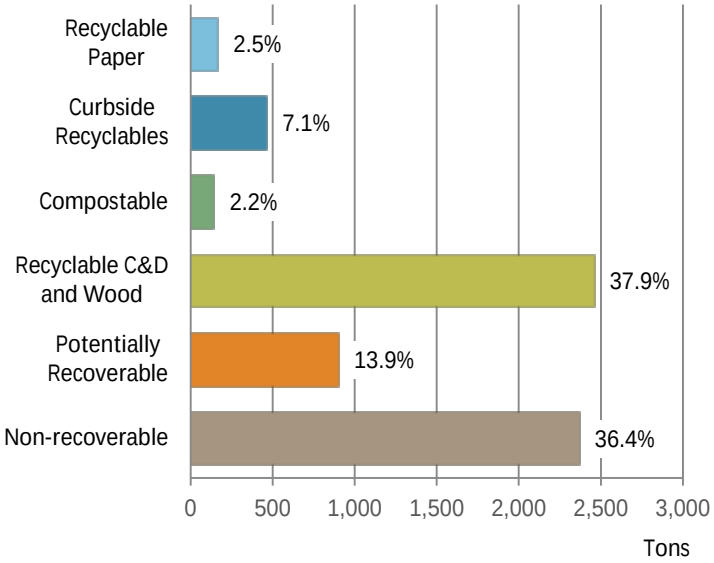


Figure 3-26. Summary of Recoverability of Commercial Roll-off (C&D) Disposed Waste



As presented in **Table 3-30**, the three most prevalent material types in this substream – *dimensional lumber, painted wood,* and *pallets and crates* – accounted for nearly one third (32.9%) of commercial roll-off C&D disposed waste by weight.

Table 3-30. Ten Most Prevalent *Materials Types* in Commercial Roll-off (C&D) Disposed Waste

Material	Est. Percent	Cum. Percent	Est. Tons
Dimensional Lumber	13.2%	13.2%	857
Painted Wood	11.2%	24.4%	730
Pallets and Crates	8.5%	32.9%	551
Remainder/Composite Construction	6.0%	39.0%	393
Other Ferrous	5.2%	44.1%	336
Soil, Rocks, and Sand	4.9%	49.0%	317
Other Drywall	3.8%	52.8%	248
Carpet	3.7%	56.5%	242
Concrete	3.5%	60.0%	227
Treated Wood	3.5%	63.5%	227
Total	**63.5%**		**4,126**

Table 3-31 presents detailed overall composition results for commercial roll-off C&D disposed waste *by material class*.

Table 3-31. Detailed Disposed Waste Composition Results: Commercial Roll-off (C&D)

Material	Est. Percent	+ / -	Est. Tons
Paper	**3.7%**		**240**
Newspaper	0.0%	0.0%	1
Uncoated OCC/Kraft Paper	2.1%	1.2%	133
High-grade Paper	0.1%	0.1%	5
Low-grade Paper	0.4%	0.5%	26
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.0%	0.0%	0
Compostable/Soiled Paper	0.4%	0.7%	27
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	0
Non-comp. Single-use Food Service Paper	0.0%	0.0%	0
Remainder/Composite Paper	0.7%	0.6%	47
Plastic	**2.8%**		**185**
#1 PET Bottles	0.0%	0.0%	2
#2 HDPE Bottles	0.0%	0.0%	1
#1-#7 Other Containers	0.0%	0.0%	2
Expanded Polystyrene Food grade	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.1%	0.1%	3
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	0
Other Clean PE Film	0.2%	0.2%	12
Other Film	0.8%	0.6%	49
Durable Plastic Products	0.8%	0.7%	49
Remainder/Composite Plastics	1.0%	1.0%	65
Glass	**3.2%**		**207**
Clear Glass Containers	0.0%	0.0%	2
Green Glass Containers	0.0%	0.0%	0
Brown Glass Containers	0.0%	0.0%	0
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	3.2%	2.1%	205
Metal	**10.7%**		**693**
Aluminum Beverage Cans	0.0%	0.0%	1
Aluminum Foil/Containers	0.0%	0.0%	0
Other Non-ferrous	1.6%	1.1%	102
Tin Food Cans	0.2%	0.4%	14
Empty Aerosol Cans	0.0%	0.0%	0
Major Appliances	0.0%	0.1%	2
Oil filters	0.2%	0.3%	13
Other Ferrous	5.2%	6.1%	336
Remainder/Composite Metal	3.5%	1.8%	224
Organics	**5.5%**		**358**
Food Waste, Vegetative	0.1%	0.2%	7
Other Food Waste	0.1%	0.1%	6
Leaves and Grass	0.9%	0.7%	58
Prunings and Trimmings	0.7%	0.9%	43
Branches and Stumps	0.0%	0.0%	1
Textiles and Clothing	3.5%	5.4%	224
Disposable Diapers	0.0%	0.0%	0
Animal Excrement/Litter	0.0%	0.1%	3
Remainder/Composite Organic	0.3%	0.3%	17

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**41.2%**		**2,678**
Dimensional Lumber	13.2%	7.6%	857
Pallets and Crates	8.5%	8.6%	551
Engineered Wood	2.7%	1.5%	175
Other Untreated Wood	0.1%	0.1%	8
Painted Wood	11.2%	6.7%	730
Treated Wood	3.5%	2.9%	227
Remainder/Composite Wood	2.0%	1.2%	130
C&D Waste	**30.4%**		**1,977**
Concrete	3.5%	2.4%	227
Clean Drywall	0.6%	0.7%	39
Other Drywall	3.8%	1.7%	248
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	2.3%	2.4%	151
Other Asphalt Roofing	1.9%	2.2%	125
Insulation	0.3%	0.4%	20
Carpet	3.7%	3.0%	242
Carpet Padding	1.3%	1.4%	82
Soil, Rocks, and Sand	4.9%	5.2%	317
Ceramics and Brick	2.1%	1.6%	134
Remainder/Composite Construction	6.0%	3.0%	393
E-Waste	**1.1%**		**73**
Televisions and CRTs	1.1%	1.2%	73
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**0.0%**		**1**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	1
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**1.3%**		**83**
Furniture	0.8%	0.7%	51
Tires	0.1%	0.1%	5
Mattresses	0.3%	0.3%	19
Non-distinct Fines	0.1%	0.1%	8
Totals	**100.0%**		**6,494**
Sample Count			38

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

Residential Self-haul C&D

As shown in **Figure 3-27**, approximately half of residential self-haul C&D disposed waste was **C&D Waste**. **Wood Waste** was the next largest **material class** observed, making up almost 44 percent of residential self-haul C&D waste, and the remaining **material classes** each accounted for 2 percent or less. **Figure 3-28** presents the composition results according to the recoverability of the sorted materials. Approximately half of the residential self-haul C&D waste was Non-recoverable. The remaining waste was primarily Recyclable C&D and Wood (36.9%), and only 2 percent of the waste was Recyclable Paper or Curbside Recyclable or Compostable material.

Figure 3-27. Overview of Residential Self-haul (C&D) Disposed **Waste**

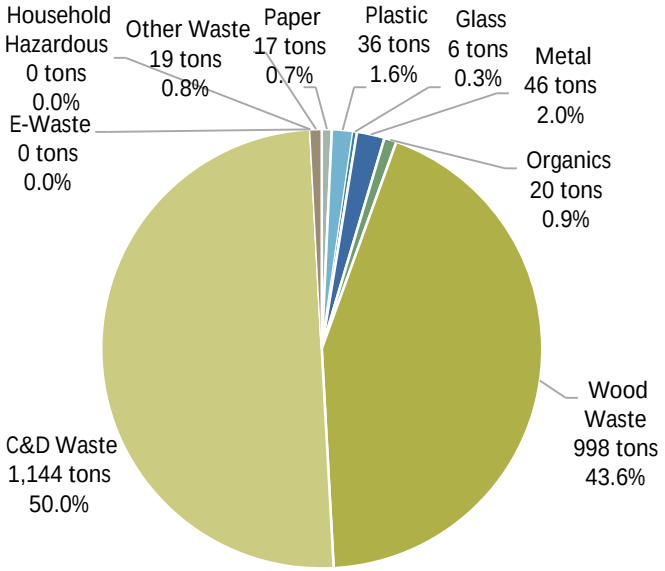


Figure 3-28. Summary of Recoverability of Residential Self-haul (C&D) Disposed **Waste**

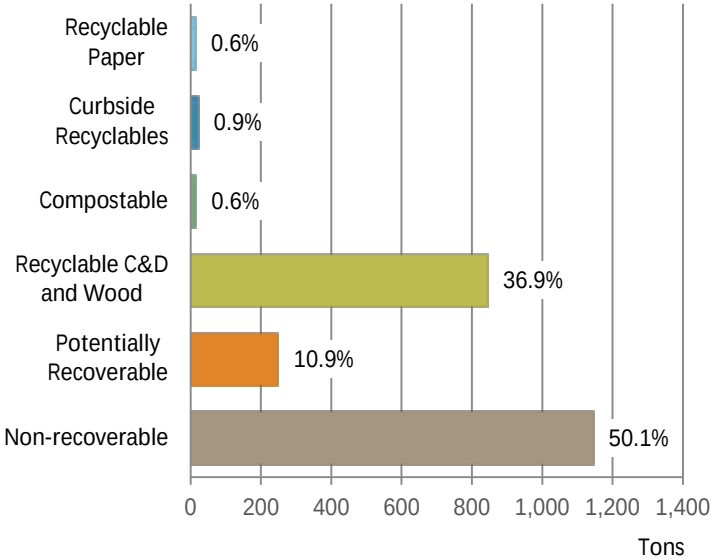


Table 3-32 demonstrates that the two most prevalent *material types– remainder/composite construction* and *dimensional lumber* – accounted for over half (52.0%) of residential self-haul C&D disposed waste by weight.

Table 3-32. Ten Most Prevalent *Materials Types* in Residential Self-haul (C&D) Disposed Waste

Material	Est. Percent	Cum. Percent	Est. Tons
Remainder/Composite Construction	29.4%	29.4%	672
Dimensional Lumber	22.7%	52.0%	518
Treated Wood	9.8%	61.9%	225
Carpet	8.3%	70.2%	190
Ceramics and Brick	6.0%	76.2%	138
Painted Wood	5.9%	82.0%	134
Clean Drywall	3.7%	85.7%	85
Engineered Wood	2.7%	88.4%	61
Other Drywall	1.5%	89.9%	35
Other Untreated Wood	1.5%	91.4%	34
Total	**91.4%**		**2,091**

Table 3-33 presents detailed overall composition results for residential self-haul C&D disposed waste by *material type*.

Table 3-33. Detailed Disposed Waste Composition Results: Residential Self-haul (C&D)

Material	Est. Percent	+ / -	Est. Tons
Paper	**0.7%**		**17**
Newspaper	0.0%	0.0%	0
Uncoated OCC/Kraft Paper	0.5%	0.2%	12
High-grade Paper	0.0%	0.0%	0
Low-grade Paper	0.1%	0.1%	1
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.0%	0.0%	0
Compostable/Soiled Paper	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	0
Non-comp. Single-use Food Service Paper	0.0%	0.0%	0
Remainder/Composite Paper	0.1%	0.1%	3
Plastic	**1.6%**		**36**
#1 PET Bottles	0.0%	0.0%	0
#2 HDPE Bottles	0.0%	0.0%	0
#1-#7 Other Containers	0.2%	0.3%	4
Expanded Polystyrene Food grade	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	0
Other Clean PE Film	0.0%	0.0%	0
Other Film	0.4%	0.7%	10
Durable Plastic Products	0.0%	0.0%	0
Remainder/Composite Plastics	0.9%	1.4%	20
Glass	**0.3%**		**6**
Clear Glass Containers	0.0%	0.0%	0
Green Glass Containers	0.0%	0.0%	0
Brown Glass Containers	0.0%	0.0%	0
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.3%	0.5%	6
Metal	**2.0%**		**46**
Aluminum Beverage Cans	0.0%	0.1%	1
Aluminum Foil/Containers	0.0%	0.0%	0
Other Non-ferrous	0.0%	0.0%	0
Tin Food Cans	0.1%	0.1%	1
Empty Aerosol Cans	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	0.6%	0.5%	14
Remainder/Composite Metal	1.3%	1.2%	29
Organics	**0.9%**		**20**
Food Waste, Vegetative	0.0%	0.0%	0
Other Food Waste	0.0%	0.0%	0
Leaves and Grass	0.4%	0.6%	9
Prunings and Trimmings	0.3%	0.3%	6
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	0.2%	0.2%	4
Disposable Diapers	0.0%	0.0%	0
Animal Excrement/Litter	0.0%	0.0%	0
Remainder/Composite Organic	0.1%	0.1%	1

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**43.6%**		**998**
Dimensional Lumber	22.7%	15.5%	518
Pallets and Crates	0.4%	0.7%	9
Engineered Wood	2.7%	2.8%	61
Other Untreated Wood	1.5%	1.6%	34
Painted Wood	5.9%	4.3%	134
Treated Wood	9.8%	8.1%	225
Remainder/Composite Wood	0.8%	0.8%	18
C&D Waste	**50.0%**		**1,144**
Concrete	0.0%	0.0%	0
Clean Drywall	3.7%	4.7%	85
Other Drywall	1.5%	1.7%	35
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	8.3%	7.3%	190
Carpet Padding	1.1%	1.3%	24
Soil, Rocks, and Sand	0.0%	0.0%	0
Ceramics and Brick	6.0%	10.4%	138
Remainder/Composite Construction	29.4%	25.4%	672
E-Waste	**0.0%**		**0**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**0.0%**		**0**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	0
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.8%**		**19**
Furniture	0.5%	0.8%	12
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.3%	0.5%	7
Totals	**100.0%**		**2,287**
Sample Count			36

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

Commercial Self-haul C&D

As shown in **Figure 3-29**, **C&D Waste** and **Wood Waste**, together, accounted for over 87 percent of commercial self-haul C&D disposed waste. The remaining **material classes** each were 3 percent or less of commercial self-haul C&D waste. As presented in **Figure 3-30**, recoverable and potentially recoverable materials, together, accounted for about 56 percent of the total by weight. Most of the recoverable material was Recyclable C&D and Wood, which accounted for almost half (45.5%) of the total waste stream.

Figure 3-29. Overview of Commercial Self-haul (C&D) Disposed Waste

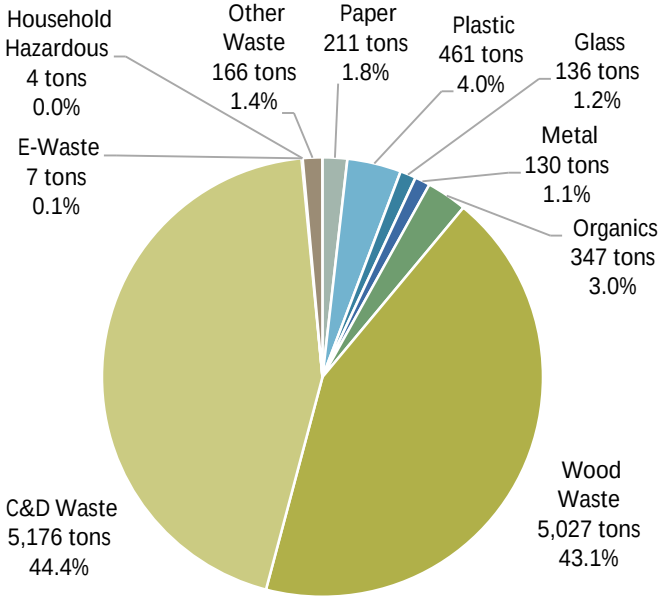


Figure 3-30. Summary of Recoverability of Commercial Self-haul (C&D) Disposed Waste

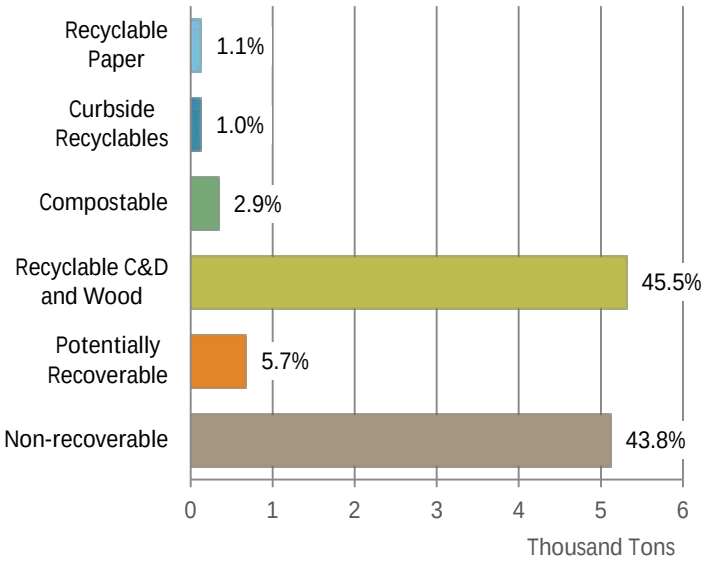


Table 3-34 shows that the top three *material types– dimensional lumber, remainder/composite construction,* and *pallets and crates* – made up more than one third (36.6%) of commercial self-haul C&D disposed waste.

Table 3-34. Ten Most Prevalent *Materials Types* in Commercial Self-haul (C&D) Disposed Waste

Material	Est. Percent	Cum. Percent	Est. Tons
Dimensional Lumber	14.6%	14.6%	1,709
Remainder/Composite Construction	13.4%	28.1%	1,568
Pallets and Crates	8.5%	36.6%	989
Other Drywall	7.9%	44.4%	917
Engineered Wood	7.1%	51.6%	833
Painted Wood	6.9%	58.4%	801
Other Asphalt Roofing	6.0%	64.5%	703
Soil, Rocks, and Sand	4.4%	68.8%	510
Carpet	2.9%	71.7%	336
Concrete	2.9%	74.6%	333
Total	**74.6%**		**8,699**

Detailed overall composition results by *material type* for this substream are shown in **Table 3-35**.

Table 3-35. Detailed Disposed Waste Composition Results: Commercial Self-haul (C&D)

Material	Est. Percent	+ / -	Est. Tons
Paper	**1.8%**		**211**
Newspaper	0.0%	0.0%	1
Uncoated OCC/Kraft Paper	1.0%	0.9%	118
High-grade Paper	0.0%	0.0%	1
Low-grade Paper	0.0%	0.0%	4
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.0%	0.0%	0
Compostable/Soiled Paper	0.0%	0.0%	2
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	1
Non-comp. Single-use Food Service Paper	0.0%	0.0%	0
Remainder/Composite Paper	0.7%	0.3%	85
Plastic	**4.0%**		**461**
#1 PET Bottles	0.0%	0.0%	0
#2 HDPE Bottles	0.0%	0.0%	0
#1-#7 Other Containers	0.1%	0.1%	11
Expanded Polystyrene Food grade	0.0%	0.0%	2
Expanded Polystyrene Non-food Grade	0.5%	0.7%	54
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	1
Other Clean PE Film	0.0%	0.0%	4
Other Film	0.8%	0.9%	93
Durable Plastic Products	1.3%	2.1%	155
Remainder/Composite Plastics	1.2%	1.4%	142
Glass	**1.2%**		**136**
Clear Glass Containers	0.0%	0.0%	0
Green Glass Containers	0.0%	0.0%	0
Brown Glass Containers	0.0%	0.0%	3
Plate Glass	0.4%	0.7%	43
Remainder/Composite Glass	0.8%	0.9%	90
Metal	**1.1%**		**130**
Aluminum Beverage Cans	0.0%	0.0%	0
Aluminum Foil/Containers	0.0%	0.0%	0
Other Non-ferrous	0.0%	0.0%	2
Tin Food Cans	0.0%	0.0%	0
Empty Aerosol Cans	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	1
Other Ferrous	0.9%	0.8%	103
Remainder/Composite Metal	0.2%	0.2%	24
Organics	**3.0%**		**347**
Food Waste, Vegetative	0.0%	0.0%	0
Other Food Waste	0.0%	0.0%	3
Leaves and Grass	2.4%	3.3%	277
Prunings and Trimmings	0.4%	0.3%	41
Branches and Stumps	0.1%	0.1%	10
Textiles and Clothing	0.1%	0.2%	14
Disposable Diapers	0.0%	0.0%	0
Animal Excrement/Litter	0.0%	0.0%	0
Remainder/Composite Organic	0.0%	0.0%	1

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**43.1%**		**5,027**
Dimensional Lumber	14.6%	7.1%	1,709
Pallets and Crates	8.5%	5.8%	989
Engineered Wood	7.1%	9.4%	833
Other Untreated Wood	2.4%	3.7%	283
Painted Wood	6.9%	4.2%	801
Treated Wood	2.8%	1.9%	324
Remainder/Composite Wood	0.8%	0.6%	89
C&D Waste	**44.4%**		**5,176**
Concrete	2.9%	2.5%	333
Clean Drywall	1.3%	1.8%	149
Other Drywall	7.9%	3.6%	917
Asphalt Paving	0.2%	0.3%	18
Asphalt Shingles	1.3%	1.8%	153
Other Asphalt Roofing	6.0%	5.3%	703
Insulation	0.7%	1.2%	79
Carpet	2.9%	2.4%	336
Carpet Padding	0.7%	0.6%	79
Soil, Rocks, and Sand	4.4%	5.0%	510
Ceramics and Brick	2.8%	3.0%	331
Remainder/Composite Construction	13.4%	12.1%	1,568
E-Waste	**0.1%**		**7**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.1%	0.1%	7
Household Hazardous	**0.0%**		**4**
Pesticides and Herbicides	0.0%	0.1%	4
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	0
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**1.4%**		**166**
Furniture	0.1%	0.2%	15
Tires	0.0%	0.0%	0
Mattresses	1.3%	2.1%	151
Non-distinct Fines	0.0%	0.0%	0
Totals	**100.0%**		**11,667**
Sample Count			50

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

Single-family Residential Curbside Organics Study

This section presents the tonnages associated with the single-family organics collected from curbside programs in the City of Tacoma along with detailed estimates about the composition and recoverability of materials.

Single-family Residential Organics Quantities

The City of Tacoma collected a total of 26,046 tons of organics through the single-family curbside collection program in 2015. The allocation of the organics collection over three seasons is shown in **Table 3-36** below. Detailed composition information by season is shown in **Appendix D: Additional Composition Results**.

Table 3-36. Estimated Tons of Organics by Season

Season	Tons	Percent of Total
Fall	8,317	32%
Spring	7,645	29%
Summer	10,084	39%
Total	**26,046**	**100%**

Organics Composition Results

As shown in **Figure 3-31**, slightly over 3 percent of the material in the single-family organics stream was Non-compostable and considered to be contaminants. **Figure 3-32** demonstrates that Food Waste was less than 5 percent of the organics stream; most of the organics collected was Yard Waste.

Figure 3-31. Overview of Overall Single-family Organics Stream

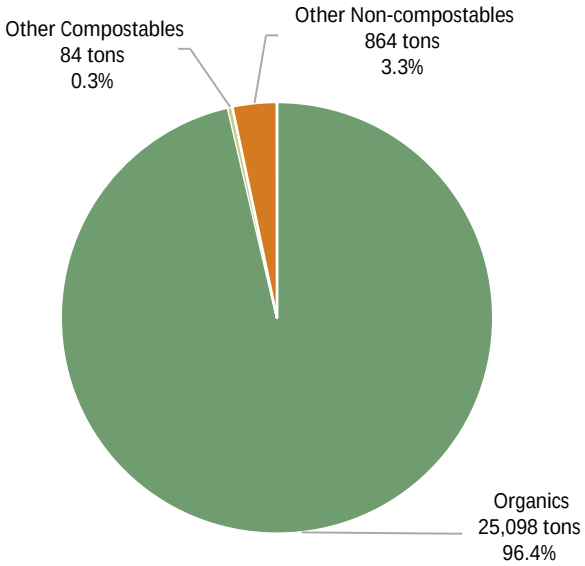
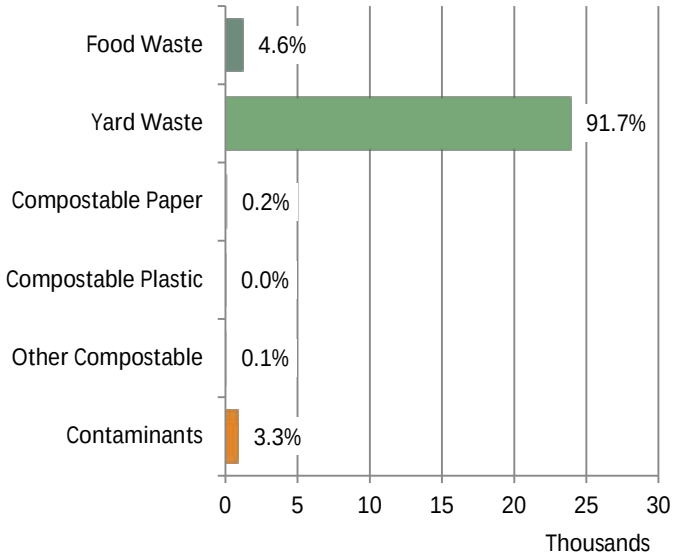


Figure 3-32. Summary of Recoverability of the Overall Single-family Organics Stream



As **Table 3-37** details, *leaves, grass, prunings, and trimmings* accounted for 91.2 percent of the organics stream by weight.

Table 3-37. Five Most Prevalent *Materials Types* in the Overall Single-family Organics Stream

Material	Est. Percent	Cum. Percent	Est. Tons
Leaves, Grass, Prunings and Trimmings	91.2%	91.2%	23,752
Food Waste, Vegetative	3.7%	94.9%	967
Other Materials	2.9%	97.8%	765
Other Food Waste	0.9%	98.8%	237
Branches and Stumps	0.5%	99.3%	142
Total	**99.3%**		**25,863**

Table 3-38 presents detailed composition results for the single-family curbside organics stream by *material type*.

Table 3-38. Detailed Single-family Curbside Organics Composition Results: Overall

Material	Est. Percent	+ / -	Est. Tons
Organics	**96.4%**		**25,098**
Food Waste, Vegetative	3.7%	1.8%	967
Other Food Waste	0.9%	0.4%	237
Leaves, Grass, Prunings and Trimmings	91.2%	4.1%	23,752
Branches and Stumps	0.5%	0.8%	142
Other Compostables	**0.3%**		**84**
Waxed Corrugated Cardboard	0.0%	0.0%	0
Pizza Boxes	0.0%	0.0%	12
Compostable Paper	0.1%	0.0%	15
Newspaper	0.1%	0.1%	29
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	4
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	6
Other Compostable Organics	0.1%	0.1%	17
Other Compostables	**3.3%**		**864**
Uncoated Corrugated Cardboard/Kraft Paper	0.0%	0.0%	2
Mixed Recyclable Paper	0.0%	0.0%	6
Recyclable Polycoated Paper	0.0%	0.0%	0
Non-comp. Single-use Food Service Paper	0.0%	0.0%	2
Recyclable Plastic	0.0%	0.0%	4
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	1
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	1
Other Non-compostable Film	0.0%	0.0%	8
Recyclable Glass	0.0%	0.0%	10
Recyclable Metal	0.0%	0.0%	3
Animal Excrement And Litter	0.2%	0.2%	62
Other Materials	2.9%	3.7%	765
Totals	**100.0%**		**26,046**
Sample Count			180

Confidence intervals calculated at the 90% confidence level.

Percentages for material types may not total 100% due to rounding.

Appendix A: Definitions of Material Types

Diposed Waste Material Definitions

Disposed waste samples were sorted into the following 85 *material types*. Each *material type* is also designated recyclable, compostable, or not recyclable.

Paper

1. **Newspaper—**printed and unprinted groundwood newsprint and other minimally bleached groundwood. This category also includes the glossy paper insert advertisements if included with the newspaper. ***(Recyclable)***
2. **Uncoated Corrugated Cardboard(OCC)/Kraft Paper—**Kraft linerboard, containerboard cartons, and shipping boxes with corrugated paper medium (unwaxed). This category also includes Kraft (brown) paper bags. Excludes waxed and plastic-coated cardboard, solid boxboard, and bags that are not pure unbleached Kraft. ***(Recyclable)***
3. **High-grade Paper—**high-grade white or light-colored bond and copy machine papers and envelopes, and continuous-feed computer printouts and forms of all types, except multiple copy carbonless paper. Also includes index cards. ***(Recyclable)***
4. **Low-grade Recyclable Paper—**magazines, phone books, junk mail, used envelopes, other material with sticky labels, construction paper, blueprint and thermal copy paper (NCR paper), fax paper, bright-dyed paper (fiesta or neon colors), paperback books, frozen food boxes, colored manila envelopes, gift wrapping paper, paperback books, polycoated containers (e.g., milk, ice cream), aseptic containers (e.g., soy milk, tofu), and groundwood catalogues. This category also includes other low-grade recyclable papers used in packaging, including chipboard and other solid boxboard such as for cases of beer and cereal, clothing forms, egg cartons (molded pulp), and other boxes. ***(Recyclable)***
5. **Waxed Corrugated Cardboard (OCC) —**containerboard cartons, and shipping boxes with corrugated paper medium that are waxed coated. ***(Compostable)***
6. **Pizza Boxes—**pizza boxes that are not plastic coated. ***(Compostable)***
7. **Compostable Paper—**includes tissues and paper soiled with food, and paper towels. ***(Compostable)***
8. **Potentially Compostable Single-use Food Service Paper—**paper plates, bowls, and cups, including wax-coated paper plates, bowls and cups and items labeled "compostable." Excludes items with visible plastic coating or lining. ***(Compostable)***
9. **Non-compostable Single-use Food Service Paper—**paper plates, bowls, and cups not labeled "compostable" and that appear to have a plastic lining or coating. ***(Not Recyclable)***
10. **Remainder/Composite Paper—**items that are primarily paper, but combined with other materials as well as paper not included above that is not easily recyclable. Includes frozen juice containers, cigarette packages, carbon paper, photographs, microwave containers, and hardcover books. ***(Not Recyclable)***

Plastics

11. **#1 PET Bottles—**all bottles made from polyethylene terephthalate (PET), both colored and clear, as commonly used in beverage bottles. Usually bears the #1 on the bottom of the bottle. ***(Recyclable)***
12. **#2 HDPE Bottles—**includes most milk jugs and water jugs, detergent bottles, orange juice jugs, some hair care product bottles, and any other plastic bottle bearing the #2. ***(Recyclable)***
13. **#1-#7 Other Containers—**all other rigid plastic bottles, jars, and containers with codes 3 through 7, as well as all #1 PETE and #2 HDPE containers other than bottles. Examples include plastic food trays, medicine bottles, yogurt, and margarine tubs. Does not include expanded polystyrene (Styrofoam) packaging. ***(Recyclable)***
14. **Expanded Polystyrene, Food Grade—**expanded polystyrene (EPS) packaging used for food. Includes food trays, cups, plates, clamshells, and other EPS food packaging. ***(Not Recyclable)***
15. **Expanded Polystyrene, Non-food Grade—**expanded polystyrene (EPS) used in non-food applications such as shipment packaging and peanuts and insulation used in construction projects. ***(Not Recyclable)***
16. **Potentially Compostable Single-use Food Service Plastics—**Includes clamshells, cups, cup lids, and salad trays labeled "compostable." Excludes clamshells, cups plates and bowls and other food service items made of Styrofoam. ***(Compostable)***
17. **Non-compostable single-use Food Service Plastics—**Includes forks and spoons, clamshells, cups, cup lids, and salad trays not labeled "compostable." Excludes clamshells, cups plates and bowls and other food service items made of Styrofoam. ***(Not Recyclable)***
18. **Clean Shopping/Dry Cleaner Bags—**labeled grocery and merchandise, dry cleaner, and newspaper polyethylene film bags that were not contaminated with food, liquid or grit during use. ***(Recyclable)***
19. **Other Clean Polyethylene Film—**polyethylene film and bags, other than those identified above, which were not contaminated with food, liquid or grit during use. Includes clean plastic sheeting, mattress packaging, shrink wrap. ***(Recyclable)***
20. **Other Film—**film packaging not defined above, or: was contaminated with food, liquid or grit during use; is woven together (e.g., grain bags); or that contains multiple layers of film or other materials that have been fused together (e.g., potato chip bags). This category also includes contaminated plastic sheeting, photographic negatives, shower curtains, any bags used to contain food or liquid (e.g., produce), garbage bags, and shopping bags used as garbage bags. ***(Not Recyclable)***
21. **Durable Plastic Products—**finished plastic products made entirely of plastic such as toys, toothbrushes, vinyl hoses and plastic lawn furniture. Includes fiberglass resin products and materials, and durable plastic pots. ***(Not Recyclable)***
22. **Remainder/Composite Plastic—** items that are primarily plastic, but combined with other materials as well as plastic items that do not fit into the above materials such as bottle caps and lids, disposable razors, pens, lighters, toys that include non-plastic parts, and 3-ring binders. ***(Not Recyclable)***

Glass

23. **Clear Glass Containers—**bottles and jars that are clear in color; used for food, soft drinks, beer, and wine. ***(Recyclable)***
24. **Green Glass Containers—**bottles and jars that are green in color; used for food, soft drinks, beer, and wine. ***(Recyclable)***
25. **Brown Glass Containers—**bottles and jars that are brown in color; used for food, soft drinks, beer, and wine. ***(Recyclable)***
26. **Plate Glass—**window glass and solid glass table tops. ***(Not Recyclable)***
27. **Remainder/Composite Glass—**other types of glass products and scrap that do not fit into the above materials, including light bulbs, glassware, Pyrex, kitchen ceramics and cooking ware. ***(Not Recyclable)***

Metals

28. **Aluminum Cans—**beverage cans composed of aluminum only. ***(Recyclable)***
29. **Aluminum Foil/Containers—**aluminum foil, food trays and similar items. ***(Recyclable)***
30. **Other Non-Ferrous—**metals that are not materials derived from iron, including copper, brass, bronze, aluminum bronze, lead, pewter, zinc, and other metals to which a magnet will not adhere. Metals that are significantly contaminated are not included. ***(Recyclable)***
31. **Tinned Food Cans—**tin-plated steel cans (food cans) whether lined or unlined. Does not include other bi-metals, paint cans, or other types of steel cans. ***(Recyclable)***
32. **Empty Aerosol Cans—e**mpty, mixed material/metal aerosol cans. (Aerosols that still contain product are sorted according to that material—for instance, paint.) ***(Recyclable)***
33. **Major Appliances—**includes washers, driers, refrigerators, stoves, freezers and similar large metal appliances. ***(Recyclable)***
34. **Oil Filters—**used metal oil filters, primarily those used in cars but possibly including similar filters from other types of vehicles and other applications. ***(Recyclable)***
35. **Other Ferrous—**ferrous and alloyed ferrous scrap materials derived from iron, including household, industrial, and commercial products including other cans and containers. Includes paint and aerosol cans. This category includes scrap iron and steel to which a magnet adheres. ***(Recyclable)***
36. **Remainder/Composite Metal—**items made of a mixture of ferrous and non-ferrous or a mixture of metal and non-metallic materials (as long as these are primarily metal). Includes some small appliances with power cords and insulated wire. ***(Not Recyclable)***

Organics

37. **Food Waste, Vegetative—**fruit and vegetable scraps including the food container when the container weight is not appreciable compared to the food inside. ***(Compostable)***
38. **Other Food Waste—**non-vegetative food waste including the food container when the container weight is not appreciable compared to the food inside. ***(Compostable)***

39. **Leaves and Grass—**plant material, except woody material, from any public or private landscapes. Examples include leaves, grass clippings, plants, and seaweed. This type does not include woody material or material from agricultural sources. ***(Compostable)***
40. **Prunings and Trimmings—**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. ***(Compostable)***
41. **Branches and Stumps—**woody plant material, branches, and stumps that exceed 4 inches in diameter, from any public or private landscape. ***(Compostable)***
42. **Textiles and Clothing—**fabric materials including natural and man-made textile materials such as cottons, wools, silks, woven nylon, rayon, polyesters and other materials. Also includes upholstery, leather, and shoes. ***(Not Recyclable)***
43. **Disposable Diapers—**diapers and similar products made from a combination of fibers, synthetic, and/or natural, and made for the purpose of a single use. Diapers that are all cloth and not originally intended for single use will be classified as a textile. This category includes fecal matter contained within, sanitary napkins and tampons, and adult disposable protective undergarments. ***(Not Recyclable)***
44. **Animal Excrement and Litter—**feces from animals including kitty litter and bedding. ***(Not Recyclable)***
45. **Remainder/Composite Organics—**examples include leather items, cork, hemp rope, garden hoses, rubber items, hair, wax, cigarette butts, lint, crayons, and any other organic material not categorized above or that is primarily organic but mixed with other materials. ***(Not Recyclable)***

Wood Waste

46. **Dimensional Lumber—**clean dimensional lumber commonly used in construction for framing and related uses, including 2 x 4's, 2 x 6', etc. ***(Recyclable)***
47. **Pallets and Crates—**clean, unpainted intact or broken pallets and crates ***(Recyclable)***
48. **Engineered Wood—**clean engineered wood commonly used in construction for framing and related uses, including sheets of plywood, strandboard, and particle board. ***(Recyclable)***
49. **Other Untreated Wood—**this type includes construction grade untreated/unpainted scrap from production of prefabricated wood products such as untreated cabinets and untreated or unpainted wood roofing and siding and that can't be included in the dimensional or engineered categories. ***(Recyclable)***
50. **Painted Wood—**wood that has been painted, varnished or clear sealed. ***(Not Recyclable)***
51. **Treated Wood—**wood treated with preservatives such as creosote, CCA and ACQ. This includes dimensional lumber and posts if treated, but does not include painted or varnished wood. This material may also include some plywood (especially "marine plywood"), strandboard, and other wood.in such a way that they cannot easily be separated, but consisting primarily (over 50 percent) of wood. Examples include wood with sheetrock attached. ***(Not Recyclable)***
52. **Remainder/Composite Wood—**items that consist primarily of wood but that do not fit into the above materials, including composite materials that consist primarily (over 50%) of wood. Examples

of composites include wood with sheetrock nailed to it or with tiles glued to it (such that the materials cannot be easily separated). ***(Not Recyclable)***

Construction Materials

53. **Concrete—**cement (mixed or unmixed), concrete blocks, and similar wastes. ***(Recyclable)***
54. **Clean Drywall—**used or new gypsum wallboard, sheetrock or drywall present in recoverable amounts or pieces (generally any piece larger than two inches square will be recovered from the sample). ***(Recyclable)***
55. **Other Drywall—**painted or otherwise contaminated gypsum wallboard, sheetrock or drywall. ***(Not Recyclable)***
56. **Asphalt Paving—**a black or brown, tar-like material mixed with aggregate used as a road paving material. ***(Recyclable)***
57. **Asphalt Shingles—**roofing material composed of fiberglass or organic felts saturated with asphalt and covered with inert aggregates as well as attached roofing tar and tar paper. Commonly known as three-tab roofing shingles but including older designs as well. ***(Recyclable)***
58. **Other Asphalt Roofing**—other roofing material made with layers of felt, asphalt, aggregates, and attached roofing tar and tar paper normally used on flat/low pitched roofs usually on commercial buildings. Includes torch-down and hot-tar roofs. **(Not Recyclable)**
59. **Insulation—**includes all pad, roll, or blown-in types of insulation. ***(Not Recyclable)***
60. **Carpet—**pieces of carpet and rugs made of similar material. ***(Not Recyclable)***
61. **Carpet Padding—**foam rubber and other materials used as padding under carpets. ***(Not Recyclable)***
62. **Soil, Rocks, Sand—**rock, gravel, soil, sand and similar naturally-occurring materials. ***(Recyclable)***
63. **Ceramics and Brick—**includes clay, porcelain bricks and tiles, such as used toilets, sinks and bricks of various types and sizes. Does not include kitchen ceramics. ***(Recyclable)***
64. **Remainder/Composite Construction Materials—**other construction and demolition materials that do not fit easily into the above materials or that are composites made up of two or more different materials. ***(Not Recyclable)***

E-Waste

65. **Televisions and Other CRTs—**televisions and computer monitors containing a CRT (cathode ray tube). ***(Recyclable)***
66. **Computers and Flat-screen Monitors—**towers, laptops, flat computer screens and portable computers. ***(Recyclable)***
67. **Computer Peripherals—**keyboards, mice and mouse pads, printers, disk drives, etc. ***(Not Recyclable)***
68. **Other Consumer Electronics—**other electronic goods that have some circuitry. Examples include non-portable products such as microwaves, stereos, VCRs, DVD players, large radios, and audio/visual equipment and portable electronics such as PDAs, cell phones, computer games, camcorders, and digital cameras. ***(Not Recyclable)***

Household Hazardous/Special Waste

69. **Pesticides and Herbicides—**variety of chemicals whose purpose is to discourage or kill pests, weeds, or microorganisms. Fungicides and wood preservatives, such as pentachlorophenol, are also included. ***(Not Recyclable)***
70. **Fluorescent Lighting**—includes both compact and tube-style fluorescent lighting. ***(Recyclable)***
71. **Asbestos—**pure asbestos, and asbestos-containing products where the asbestos present is the most distinguishing characteristic of the material. ***(Not Recyclable)***
72. **Paints, Solvents, and Adhesives—**water-based and solvent-based paints and varnishes, solvents, and thinners. Also includes glues and other adhesives such as rubber cement, wood putty, glazing and spackling compounds, caulking compounds, grout, and joint and auto body fillers. ***(Not Recyclable)***
73. **Dry-cell Batteries—**dry-cell batteries of various sizes and types as commonly used in households. Includes cell phone and button cell batteries. Distinguish between single use batteries and rechargeable batteries. ***(Recyclable)***
74. **Wet-cell Batteries—**wet-cell batteries of various sizes and types as commonly used in automobiles. ***(Recyclable)***
75. **Gasoline and Kerosene—**gasoline, kerosene, diesel fuel, and fuel oils. ***(Recyclable)***
76. **Motor Oil—**lubricating oils such as crankcase and transmission oil, gear oil, and hydraulic oil. ***(Recyclable)***
77. **Vehicle and Equipment Fluids—**automobile and other equipment fluids such as break, power steering, antifreeze mixtures based on ethylene or propylene glycol. Does not include motor oil. ***(Not Recyclable)***
78. **Medical Waste—**wastes related to medical activities, including syringes, intravenous (I.V.) tubing, bandages, medications, and other wastes. ***(Not Recyclable)***
79. **Pharmaceuticals—**both prescription and over-the-counter medications and supplements in all forms, including pills, liquid medications, creams, and ointments. Does not include containers for these items, except for tubes for creams and ointments and other containers that cannot be easily separated from the product they contain. ***(Not Recyclable)***
80. **Household Cleaners and Chemicals**—soaps, caustic and non-caustic cleaners, cosmetics, and other household chemicals. ***(Not Recyclable)***
81. **Other Potentially Hazardous Waste—**other chemicals or potentially harmful wastes that do not fit into the above categories, including unidentifiable materials. ***(Not Recyclable)***

Other Wastes

82. **Furniture—**furniture made of all materials and in any condition. ***(Not Recyclable)***
83. **Tires—**tires manufactured for use on any type of vehicle such as trucks, automobiles, motorcycles, bicycles and heavy equipment. ***(Recyclable)***
84. **Mattresses—**includes mattresses and box springs. ***(Not Recyclable)***

85. **Non-distinct Fines—**this material will consist primarily of small pieces of multiple materials homogeneously mixed to such an extent that further sorting is difficult. ***(Not Recyclable)***

Single-family Residential Curbside Organics Material Definitions

Single-family curbside organics samples were sorted into the following 23 *material types*. As with the waste *material types*, each *material type* is also labeled with its recoverability status: compostable, recyclable, or not recyclable.

Organics

1. **Food Waste, Vegetative—**fruit and vegetable scraps, peelings, and pits including the food container when the container weight is not appreciable compared to the food inside. ***(Compostable)***
2. **Other Food Waste—**non-vegetative food waste such as meat, fish, dairy, shells, bones, grains, pasta, cereal, bread, coffee grounds, and tea bags including the food container when the container weight is not appreciable compared to the food inside. ***(Compostable)***
3. **Leaves, Grass, Prunings and Trimmings—**plant material, including woody material, up to 4 inches in diameter from any public or private landscapes. Examples include leaves, grass clippings, plants, seaweed, prunings, shrubs, and small branches with diameters that do not exceed 4 inches. This type does not include woody material or material from agricultural sources. ***(Compostable)***
4. **Branches and Stumps—**woody plant material, branches, and stumps that exceed 4 inches in diameter, from any public or private landscape. ***(Compostable)***

Other Compostables

5. **Waxed Corrugated Cardboard—**containerboard cartons, and shipping boxes with corrugated paper medium that are waxed coated. ***(Compostable)***
6. **Pizza Boxes—**pizza boxes that are not plastic coated. ***(Compostable)***
7. **Compostable Paper—**includes tissues and paper soiled with food, and paper towels. ***(Compostable)***
8. **Potentially Compostable Single-use Food Service Paper—**paper plates, bowls, and cups, including wax-coated paper plates, bowls and cups and items labeled "compostable." Excludes items with visible plastic coating or lining. ***(Compostable)***
9. **Potentially Compostable Single-use Food Service Plastics—**Includes clamshells, cups, cup lids, and salad trays labeled "compostable." Excludes clamshells, cups plates and bowls and other food service items made of Styrofoam. ***(Compostable)***
10. **Other Compostable Organics—**examples chopsticks, toothpicks, clean dimensional lumber, pallets, wood crates, burlap sacks, hemp rope, hair, wax, lint. ***(Compostable)***

Other Non-compostables

11. **Newspaper—**printed and unprinted groundwood newsprint and other minimally bleached groundwood. This category also includes the glossy paper insert advertisements if included with the newspaper. ***(Recyclable)***

12. **Uncoated Corrugated Cardboard/Kraft Paper—**Kraft linerboard, containerboard cartons, and shipping boxes with corrugated paper medium (unwaxed). This category also includes Kraft (brown) paper bags. Excludes waxed and plastic-coated cardboard, solid boxboard, and bags that are not pure unbleached Kraft. ***(Recyclable)***
13. **Mixed Recyclable Paper—**includes high- and low-grade paper including white or light-colored bond and copy machine papers and envelopes, and continuous-feed computer printouts and forms of all types, except multiple copy carbonless paper. Also includes index cards. magazines, phone books, junk mail, used envelopes, other material with sticky labels, construction paper, blueprint and thermal copy paper (NCR paper), fax paper, bright-dyed paper (fiesta or neon colors), paperback books, frozen food boxes, colored manila envelopes, gift wrapping paper, paperback books, and groundwood catalogues. This category also includes other low-grade recyclable papers used in packaging, including chipboard and other solid boxboard such as for cases of beer and cereal, clothing forms, egg cartons (molded pulp), and other boxes. ***(Recyclable)***
14. **Recyclable Polycoated Paper—**includes polycoated containers that would typically be recycled such as milk and juice cartons, ice cream containers, and aseptic containers (e.g., soy milk, tofu). ***(Recyclable)***
15. **Non-compostable Single-use Food Service Paper—**paper plates, bowls, and cups not labeled "compostable" and that appear to have a plastic lining or coating. ***(Not Recyclable)***
16. **Recyclable Plastic—**includes recyclable containers such as bottles, jugs, jars, and tubs of all plastic resin types (#1-#7). Items include soda and water bottles, milk jugs and water jugs, detergent bottles, orange juice jugs, some hair care product bottles, plastic food trays, medicine bottles, yogurt and margarine tubs. Does not include expanded polystyrene (Styrofoam) packaging. ***(Recyclable)***
17. **Non-compostable Single-use Food Service Plastics—**Includes forks and spoons, clamshells, cups, cup lids, and salad trays not labeled "compostable." Includes food service items made of Styrofoam. ***(Not Recyclable)***
18. **Clean Shopping/Dry Cleaner Bags—**labeled grocery and merchandise, dry cleaner, and newspaper polyethylene film bags that were not contaminated with food, liquid or grit during use. Also includes polyethylene film and bags, other than those identified above, which were not contaminated with food, liquid or grit during use. Includes clean plastic sheeting, mattress packaging, shrink wrap. ***(Recyclable)***
19. **Other Non-compostable Film—**includes film packaging not defined above, or: was contaminated with food, liquid or grit during use; is woven together (e.g., grain bags); or that contains multiple layers of film or other materials that have been fused together (e.g., potato chip bags). This category also includes contaminated plastic sheeting, photographic negatives, shower curtains, any bags used to contain food or liquid (e.g., produce), garbage bags, and shopping bags used as garbage bags. ***(Not Recyclable)***
20. **Recyclable Glass—**glass bottles and jars of any color; used for food, soft drinks, beer, and wine. ***(Recyclable)***
21. **Recyclable Metal—**includes beverage cans composed of aluminum or tin aluminum foil, food trays and similar items, tin-plated steel cans (food cans) whether lined or unlined. Includes both ferrous and non-ferrous metals including copper, brass, bronze, aluminum bronze, lead, pewter, zinc, and other metals to which a magnet will not adhere ***(Recyclable)***

22. **Animal Excrement and Litter—**feces from animals including kitty litter and bedding. ***(Not Recyclable)***
23. **Other Materials—**All other material that do not fit into any of the above categories including furniture, tires, mattresses, and construction waste. ***(Not Recyclable)***

Appendix B: Sampling Methodology

This appendix provides a detailed description of the methodology used to plan and execute Tacoma's 2015 waste composition study.

Overview

Study Objectives

In 2015, the City of Tacoma commissioned a detailed waste composition study that analyzed the waste stream from the residential, commercial, self-haul, and construction substreams over three seasons. The objective of the current study is to assess how the waste stream has changed since the 2015 study and provide baseline data to inform Tacoma's sustainable materials management plan and the assessment of MRF options. Additionally, this study provides baseline residential organics set-out and composition data to assist the City in planning for increased organics diversion.

Waste Substream Definitions

A "substream" is determined by the particular generation, collection, or composition characteristics that make it a unique portion of the total waste stream. This study targeted three main waste substreams in Tacoma: the residential, commercial, and self-haul substreams. These three substreams were further divided as shown in detail below.

Substream	
Residential—waste generated from single-family homes and multifamily buildings that is collected and transported by the City of Tacoma.	**Single-family**—waste generated from single-family dwellings and duplexes.
	Multifamily—waste generated from residential buildings with three or more dwelling units, including large apartment or condo buildings.
Commercial—waste generated by businesses, industries (e.g., factories, farms), institutions, and government (e.g., highways, parks) that is collected and transported by City of Tacoma garbage collection trucks.	**Commercial Packer (MSW)**—waste generated by a business or industry that is generated from a non-construction activity and hauled by the City of Tacoma in a front load, side load, or rear load packer truck.
	Commercial Roll-off (MSW)—waste generated by a business or industry that is generated from a non-construction activity and hauled by the City of Tacoma in an open-top or compacted roll-off box.
	Commercial Roll-off (C&D)—Waste generated by a business or industry that is generated from a construction activity at a business or residence and hauled by the City of Tacoma in open top roll-off boxes.

Substream	
Self-haul—waste that is a) generated at residences as well as businesses and institutions, and b) hauled by the household or business that generated the waste.	**Residential Self-haul (MSW)**—waste that is generated from a non-construction activity and hauled to the Tacoma Recovery and Transfer Center by a resident.
	Residential Self-haul (C&D)—waste that is generated from a construction activity and hauled to the Tacoma Recovery and Transfer Center by a resident.
	Commercial Self-haul (MSW)—waste that is generated from a non-construction activity and hauled to the Tacoma Recovery and Transfer Center by a commercial enterprise (such as a landscaper), including waste from residential dwellings.
	Commercial Self-haul (C&D)—waste that is generated from a construction activity and hauled to the Tacoma Recovery and Transfer Center by a commercial enterprise (such as a contractor), including waste from residential dwellings.
	School Waste—waste generated and hauled by the Tacoma Public Schools.

Single-family Residentail Curbside Organics Substream Definitions

This study also targeted the single-family residential organics substream. This substream was defined as organics set-out by single-family residents in yard waste containers for curbside collection by the City of Tacoma.

Detailed Sampling Calendar and Substream Allocations

Substream Allocations

The sampling crew collected and sorted samples during three week-long periods occurring in the spring, summer, and autumn of 2015, resulting in a total of 418 waste samples and 180 organics samples. The planned allocation of samples (402 waste and 180 organic samples) to the various substreams is shown below in **Table B-1**.

Table B-1: Overall Sample Allocations by Substream and Season

Waste Substream		Spring	Summer	Autumn	Total
RESIDENTIAL	Single Family	20	20	20	60
	Multifamily	10	10	10	30
COMMERICAL	Commercial Packer MSW	10	10	10	30
	Commercial Roll-off MSW	10	10	10	30
	Commercial Roll-off C&D	13	14	13	40
SELF-HAUL	Residential MSW Self-haul	27	26	27	80
	Residential C&D Self-haul	7	6	7	20
	Commercial MSW Self-haul	17	17	16	50
	Commercial C&D Self-haul	16	17	17	50
	School Waste	4	4	4	12
RESIDENTIAL	Total Residential	30	30	30	90
COMMERICAL	Total Commercial	33	34	33	100
SELF-HAUL	Total Self-haul	71	70	71	212
	Overall Total	134	134	134	402

Organics Substream		Spring	Summer	Autumn	Total
RESIDENTIAL	Single Family Organics	60	60	60	180

Sampling Calendar

The sampling calendar was designed to equally represent each season and to avoid sampling on or near major holidays. In addition, the schedule included an even distribution of samples across days of the week. As an example, **Table B-2** shows the sampling calendar for the summer sampling season by substream and day of the week. It reflects a total of 134 waste samples and 60 organics samples for the season.

Table B-2: Summer Season Calendar by Substream and Day of Week

Waste Substream		Sun 8/16	Mon 8/17	Tue 8/18	Wed 8/19	Thu 8/20	Fri 8/21	Total
RESIDENTIAL	Single Family	0	4	4	4	4	4	20
	Multifamily	0	2	2	2	2	2	10
COMMERICAL	Commercial Packer MSW	0	2	2	2	2	2	10
	Commercial Roll-off MSW	0	2	2	2	2	2	10
	Commercial Roll-off C&D	0	3	3	2	3	3	14
SELF-HAUL	Residential MSW Self-haul	20	1	1	2	1	1	26
	Residential C&D Self-haul	5	1	0	0	0	0	6
	Commercial MSW Self-haul	0	3	4	3	3	4	17
	Commercial C&D Self-haul	0	3	3	4	4	3	17
	School Waste	0	1	0	1	1	1	4
	Daily Total	25	22	21	22	22	22	134
Waste Substream		Sun 8/16	Mon 8/17	Tue 8/18	Wed 8/19	Thu 8/20	Fri 8/21	Total
RESIDENTIAL	Single Family Organics				60			60

Sampling Event Coordination

During each seasonal event, the sampling crew sampled waste and organics using two different methods. The crew collected and characterized waste samples at the transfer station as described below in *Waste Load Selection* and *Waste Sampling Procedures*. Organics samples were collected at the curb and sorted at the transfer station as described in *Organics Sampling Procedures*.

Waste Load Selection

Each seasonal event spanned five weekdays and one weekend day, alternating between Saturday and Sunday to capture any variation in incoming loads. The sampling crew sampled waste from all substreams Monday through Friday. Only self-haul vehicles were sampled on the weekend as the city does not collect residential and commercial waste on weekends. The strategies for selecting both weekday and weekend loads is described below by substream.

Residential (Single-family and Multifamily) and Commercial Packer MSW Loads

For scheduled residential and commercial routes, loads were selected the week prior to each sampling event. Typically, city trucks transport more than one load per shift. Since there are more vehicles per shift than the quota to be sampled, specific loads were designated for sampling by assigning an identifier to every expected load on a given sampling day. A random number generator sorted the identifiers by vehicle type; loads were selected in that sequence until the quota was reached for each vehicle type. *Vehicle Selection Forms* listed selected loads for each sampling day and a *Sample Placards* will be created for all selected loads (see **Appendix F: Field Forms**).

Prior to each sampling event, a sampling coordinator sent vehicle selection sheets and sample placards to route supervisors for each day of sampling. The sample coordinator also provided instruction sheets to the route supervisors; these sheets described the roles of route supervisors and drivers on sampling days. The route supervisors distributed *Sample Placards* to the drivers of the loads selected for sampling. The route supervisors also modified sample placards to reflect any changes to the anticipated drivers or truck numbers prior to distribution to ensure that vehicle identification and sample selection were carried out accurately.

This study was designed to sample pure loads from each of the substreams. On sampling days, drivers of selected routes that are normally mixed commercial and multifamily were required to modify their routes to collect pure commercial and multifamily loads.

Commercial Roll-offs (MSW and C&D)

Scheduled roll-off loads were selected for sampling as described above.

In the morning of each sampling day, unscheduled or on-call commercial roll-off loads were randomly selected using a list of roll-off accounts planned for that day provided by the route supervisor. The drivers of these loads did not receive pre-printed sample placards.

In addition, the sampling crew asked drivers of selected roll-off loads to provide additional information about their loads. Roll-off drivers were asked whether their load was generated from a C&D activity.

Additionally, the Sampling Crew Supervisor gave roll-off drivers a net weight card as they tipped their load and asked them to weigh out through the attended, rather than the automated, scale so that they could return the net weight card to the scalehouse attendant. (See Appendix F: Field Forms for a sample net weight card.) The Sampling Crew Supervisor collected the net weight cards from the scalehouse attendant at the end of each sampling day.

Self-haul (Residential and Commercial MSW, Residential and Commercial C&D, and School Waste)

For both weekday and weekend sampling events, scalehouse attendants systematically selected self-haul loads for sampling and directed selected vehicles to the sampling crew. Systematic selection consists of taking every "nth" vehicle that enters the facility at a randomly selected start time. The sampling intervals (*n*) were determined by dividing the day's expected number of arriving vehicles by the number of samples needed on that day. The expected traffic count was based on either the average weekday or weekend vehicle count from the same month from the previous year. The sampling intervals for each self-haul substream were listed on the *Self-haul Vehicle Selection Form* (**Appendix F: Field Forms**). When a self-haul vehicle was selected for sampling, the attendant placed a sample placard on that vehicle's windshield or dashboard and directed the vehicle to the field crew for sampling.

Prior to sampling, Cascadia sent scalehouse staff *Self-haul Vehicle Selection Forms*, *Sample Placards*, and instructions regarding their roles in both selecting self-haul and school waste vehicles and surveying self-haul vehicles.

We trained scalehouse staff to conduct a survey of self-haul vehicles that collects information on substreams (e.g., residential MSW self-haul, residential C&D self-haul). Scalehouse staff recorded this information and the net weights on the *Self-haul Vehicle Survey Forms* (see **Appendix F: Field Forms**). We used the survey data in the analysis to allocate tonnages to each self-haul substream.

Waste Sampling Procedures

The sampling crew used either a hand-sorting procedure or a visual characterization procedure to sort samples. Hand-sorting is the preferred method for loads that tend toward homogeneity (residential and commercial MSW), whereas visual characterization is more effective when heavy, bulky, and highly variable materials are expected (self-haul and C&D loads). Utilizing these two methods in parallel leads to a more representative characterization of each load and, therefore, the waste stream as a whole.

Table B-3 below shows which sampling procedure—hand-sorting or visual estimating—we applied to the various substreams.

Table B-3: Sampling Procedure by Substream

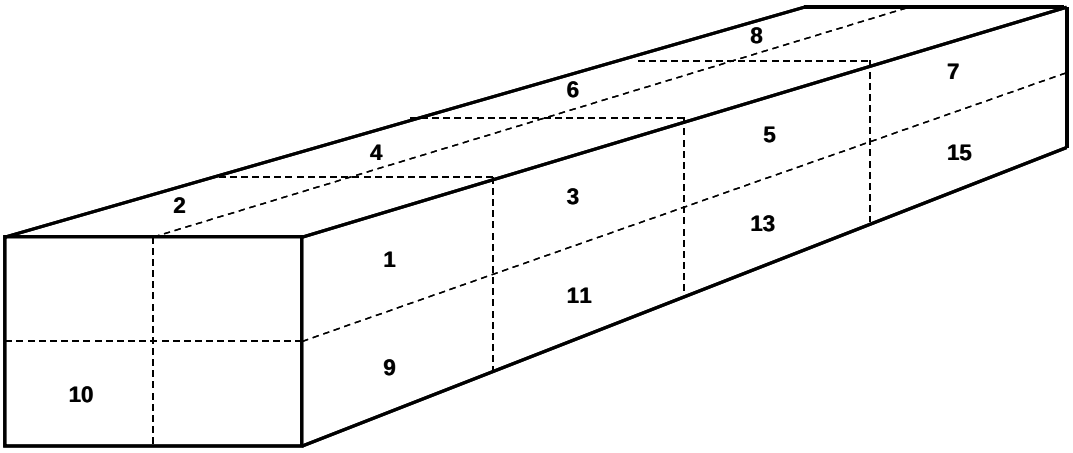
Waste Substream		Hand	Visual
RESIDENTIAL	Single Family	x	
	Multifamily	x	
COMMERICAL	Commercial Packer MSW	x	
	Commercial Roll-off MSW	x	
	Commercial Roll-off C&D		x
SELF-HAUL	Residential MSW Self-haul		x
	Residential C&D Self-haul		x
	Commercial MSW Self-haul		x
	Commercial C&D Self-haul		x
	School Waste	x	

Waste Substream		Hand	Visual
RESIDENTIAL	Single Family Organics	x	

Hand-sorting Procedure

Selected loads of residential and non-C&D commercial waste were dumped in an elongated pile five to seven feet high. From each load, the Sampling Crew Supervisor selected a sample using an imaginary 16-cell grid superimposed over the dumped material.

Figure B-1: 16-Cell Grid for Sampling



The Sampling Crew Supervisor identified the randomly selected cell to be extracted and ensured that the facility's loader operator obtained a sample of waste weighing approximately 200 pounds or larger from the selected cell and transported the sample to the characterization area.

Each sample was placed on a clean tarp and labeled for sorting. The sampling crew sorted each sample by hand into the component categories that were defined for the study (**Appendix A: Definitions of Material Types**). The crew placed sorted components in plastic laundry baskets to be weighed and recorded. The Sampling Crew Supervisor monitored the homogeneity of the component baskets as material accumulates, rejecting items which may have been improperly classified. Open laundry baskets allowed the Sampling Crew Supervisor to see the material at all times. The Sampling Crew Supervisor

also verified the purity of each component as it was weighed before recording the weight on the sampling form. The weights of all materials were recorded on tally sheets.

Visual Characterization Procedure

The sampling crew characterized all samples from the substreams marked as "Visual" in **Table B-3** using volumetric-based visual estimations. A trained crewmember used the following seven steps to characterize these loads:

Step 1. Obtain information about the load. The visual estimator recorded relevant information about the sample, such as the sample number, date, and driver/hauler info on the *Visual Characterization Tally Sheet* (see Appendix F: Field Forms)

Step 1. Photograph the sample. The crewmember took a photograph of the sample using a digital camera. The *Sample Placard* was positioned to be visible in each photograph (see Appendix F: Field Forms).

Step 2. Measure load volume. The crewmember used a tape measure to record the length, width, and height of the load on the *Visual Characterization Tally Sheet*.

Step 3. Note which material classes are present. After the driver dumped the load onto the ground, the crewmember walked entirely around the load and noted on the *Visual Characterization Tally Sheet* which **material classes** were present in the load. **Material classes** are identified with green headings in **Appendix A: Definitions of Material Types**.

Step 4. Estimate composition by volume for each material class. Beginning with the largest **material class** present (e.g., **Paper**), the crewmember estimated the volumetric percentage of this **material class** and recorded it on the form. The crewmember then repeated this process for the next most prevalent **material class**, until the volumetric percentage of every **material class** was estimated. The crewmember then calculated the sum of all **material class** volumetric percentages, ensuring that they totaled 100 percent.

Step 5. Estimate composition by volume for each *material type*. The crewmember considered *material types* within each material class separately and estimated the percentage of each *material type*. For example, *newspaper* is a *material type* within the **Paper material class**. While considering only the **Paper material class**, the crewmember estimated the volume percentage of *newspaper*. The crewmember did the same for every other *material type* within the **Paper material class** (e.g., *corrugated cardboard*, *compostable paper*). The crewmember then ensured that the summed estimated volumetric composition percentages of the *material types* equaled 100 percent.

Step 6. Check and reconcile percentage data. The crewmember ensured the percentage estimates for the **material classes** and for the *material types* within each material class totaled 100 percent.

Step 7. Convert volume estimates to weight estimates. At the Cascadia office, a crewmember entered data from the *Visual Characterization Tally Sheets* into a customized database and used accepted density conversion factors to develop estimates of the weight of each *material type* in each load.

The sampling crew thoroughly swept and cleaned the site after each day of work to ensure the site was left in good condition.

Organics Sampling Procedures

Each organics sampling event coincided with a waste sampling event. The organics sampling event spanned two days within the five weekdays of the waste event. The first of the organics days were a sample capture day. On the second day, the sampling crew hand sorted the samples at the transfer station. The procedure for capturing and sorting samples is discussed below.

Route Selection

Five organics collection areas were sampled on the selected sampling days. The city provided the route surveyors with a count of subscribers along each route as well as a route map with the route start location indicated. The route surveyors traversed each of the five collection areas, one surveyor per area, counting set-outs. An example of the set-out count form is included in **Appendix F: Field Forms**.

The route surveyor began traversing the route 30 minutes before the organics route driver began collection and covered the route in the same order as the route driver. This ensured that the surveyor remained sufficiently ahead of the driver to prevent any disruptions to regular collection operations while still allowing residents the maximum amount of time to set out their organics containers for counting and collection.

Sample Collection

The route surveyor was also responsible for selecting set-outs for sampling. Using a predetermined sampling interval, each route surveyor collected all material from 12 set-outs each day. We determined the sampling interval using the following procedure:

1. For each sampling day and collection area, the city provided the number of subscribers in the collection area. The number of subscribers (L) was reduced by one-fifth (producing 0.8 x L). This method ensured that samples were collected from the targeted number of set-outs on each sampling day, even if there were fewer set-outs than expected.
2. Next, the interval *n* was calculated to ensure systematic sampling of set-outs. The route surveyors selected every *n*th set-out for sampling. If *r* represents the number of samples needed, and 0.8 x L represents the number of expected set-outs, then $n = \frac{(0.8 \times L)}{r}$.

All the material from each set-out constituted a sample. Each sample was stored and labeled separately. An example sample label is included in **Appendix F: Field Forms**. After the route surveyor completed their route, they transported the samples to the transfer station for sorting.

Organics Hand-sorting Procedure

The sampling crew placed each sample on a clean tarp and labeled it for sorting. The crew sorted each sample by hand into the specific organics *material types* that had been defined for the study (**Appendix A: Definitions of Material Types**). The crew placed sorted components in plastic laundry baskets to be weighed and recorded. The Sampling Crew Supervisor monitored the homogeneity of the component baskets as material accumulated, rejecting items which may have been improperly classified. Open

laundry baskets allowed the Sampling Crew Supervisor to see the material at all times. The Sampling Crew Supervisor also verified the purity of each component as it was weighed before recording the weight on the sampling form. The weights of all materials were recorded on the hand sort tally sheets (see **Appendix F: Field Forms**).

Appendix C: Waste Composition Calculations

Converting Volumes to Weights

The composition calculations rely on the availability of individual material weights for each sample. For bulky and self-haul samples, Cascadia converted volume estimates to weights using accepted waste density conversion factors. These factors are listed in **Table C-3** at the end of this appendix, and data sources accompany the table.

Using the volume-to-weight conversion factors and the volume estimates obtained during the characterization of visual samples, individual material weights were calculated using the following formula: [5]

$$c = m \times s \times v \times d$$

where:

- *m* = percentage estimate of the material, as a portion of **material class** (e.g., the extent to which *newspaper* constitutes all of the **Paper** in the sample)
- *s* = percentage estimate of the **material class**, as a portion of all of the material in the sample (e.g., the extent to which **Paper** constitutes all of the material in the sample)
- *v* = total volume of the sample (in cubic yards)
- *d* = density conversion of the material (in pounds/cubic yard)
- *c* = the total weight of the specific material in the sample

Each material weight was than scaled so that the sum of all material weights equaled the actual total sample weight (or net weight of the load).

Composition Calculations

The composition estimates represent the ratio of the *material type*'s weight to the total waste for each noted substream. They are derived by summing each material's weight across all of the selected records and dividing by the sum of the total weight of waste, as shown in the following equation:

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

where:

[5] For more detail, please refer to Chapter 6 "Ratio, Regression and Difference Estimation" of Elementary Survey Sampling by R.L. Scheaffer, W. Mendenhall and L. Ott (PWS Publishers, 1986).

- c = weight of a particular material
- w = sum of all material weights
- for i = 1 to n
- where n = number of selected samples
- for j = 1 to m
- where m = number of *material types*

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

$$\hat{v}_{r_j} = \left(\frac{1}{n}\right) \times \left(\frac{1}{\overline{w}^2}\right) \times \left(\frac{\sum_i \left(c_{ij} - r_j w_i\right)^2}{n-1}\right)$$

where:

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

Second, precision levels at the 90% confidence interval are calculated for a material's mean as follows:

$$r_j \pm \left(t \times \sqrt{\hat{v}_{r_j}}\right)$$

where:

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

Weighted Averages

The overall city disposed waste and single-family residential curbside organics composition estimates were calculated by performing a weighted average across the substreams, seasons, and, in the case of single-family waste, collection districts. **Table C-1** lists the weighting percentages that were used to perform the overall waste composition calculations, and **Table C-2** lists the weighting percentages that were used to perform the organics composition calculations.

Table C-1. Weighting Percentages, Overall Disposed Waste

Substream	MSW or C&D	District	Season	Tons	Percent of Total

Substream		MSW or C&D	District	Season	Tons	Percent of Total
C&D	Commercial roll-off	C&D	N/A	Fall	3,952	5%
C&D	Commercial roll-off	C&D	All	Fall	983	3%
C&D	Commercial roll-off	C&D	All	Spring	1,560	1%
C&D	Commercial Self-haul	C&D	All	Summer	2,198	1%
C&D	Commercial Self-haul	C&D	All	Fall	5,626	1%
C&D	Commercial Self-haul	C&D	All	Spring	3,844	4%
C&D	Residential Self-haul	C&D	All	Summer	264	2%
C&D	Residential Self-haul	C&D	All	Fall	1,356	0%
C&D	Residential Self-haul	C&D	All	Spring	667	1%
Commercial	Commercial packer	MSW	All	Summer	8,008	0%
Commercial	Commercial packer	MSW	All	Fall	7,541	5%
Commercial	Commercial packer	MSW	All	Spring	7,637	5%
Commercial	Commercial roll-off	MSW	All	Summer	10,173	5%
Commercial	Commercial roll-off	MSW	All	Fall	11,839	6%
Commercial	Commercial roll-off	MSW	All	Spring	12,981	8%
Commercial	School	MSW	All	Summer	981	8%
Commercial	School	MSW	All	Fall	786	1%
Commercial	School	MSW	All	Spring	701	0%
Residential	Multifamily	MSW	All	Summer	3,964	0%
Residential	Multifamily	MSW	All	Fall	3,751	3%
Residential	Multifamily	MSW	All	Spring	3,741	2%
Residential	Single-family	MSW	All	Summer	2,180	2%

Substream		MSW or C&D	District	Season	Tons	Percent of Total
Residential	Single-family	MSW	District 5 (Friday)	Fall	2,213	1%
Residential	Single-family	MSW	District 5 (Friday)	Spring	2,374	1%
Residential	Single-family	MSW	District 5 (Friday)	Summer	2,265	2%
Residential	Single-family	MSW	District 1 (Monday)	Fall	2,107	1%
Residential	Single-family	MSW	District 1 (Monday)	Spring	2,266	1%
Residential	Single-family	MSW	District 1 (Monday)	Summer	2,501	1%
Residential	Single-family	MSW	District 4 (Thursday)	Fall	2,325	2%
Residential	Single-family	MSW	District 4 (Thursday)	Spring	2,384	1%
Residential	Single-family	MSW	District 4 (Thursday)	Summer	2,427	2%
Residential	Single-family	MSW	District 2 (Tuesday)	Fall	2,151	2%
Residential	Single-family	MSW	District 2 (Tuesday)	Spring	2,204	1%
Residential	Single-family	MSW	District 2 (Tuesday)	Summer	2,760	1%
Residential	Single-family	MSW	District 3 (Wednesday)	Fall	2,457	2%
Residential	Single-family	MSW	District 3 (Wednesday)	Spring	2,554	2%

Substream		MSW or C&D	District	Season	Tons	Percent of Total
Self-haul	Commercial Self-haul	MSW	District 3 (Wednesday)	Summer	7,456	2%
Self-haul	Commercial Self-haul	MSW	All	Fall	3,921	5%
Self-haul	Commercial Self-haul	MSW	All	Spring	6,163	2%
Self-haul	Residential Self-haul	MSW	All	Summer	4,178	4%
Self-haul	Residential Self-haul	MSW	All	Fall	3,173	3%
Self-haul	Residential Self-haul	MSW	All	Spring	5,213	2%
Total					**157,824**	**100%**

Table C-2. Weighting Percentages, Overall Single-family Residential Curbside Organics

Substream	Season	Tons	Percent of Total
Single-family	Fall	8,317	32%
Single-family	Spring	7,645	29%
Single-family	Summer	10,084	39%
Total		**26,046**	26,046

The weighted average for an overall composition estimate is performed as follows:

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

where:

- p = the proportion of tonnage contributed by the noted sample group
- r = ratio of material weight to total waste weight in the noted sample group
- for j = 1 to m
- where m = number of *material types*

The variance of the weighted average is calculated as:

$$VarO_j = (p_1^2 * \hat{V}_{r_{j1}}) + (p_2^2 * \hat{V}_{r_{j2}}) + (p_3^2 * \hat{V}_{r_{j3}}) + \ldots$$

Table C-3. Volume-to-weight Conversion Factors

Material Type	Conversion Factor	Source
Newspaper	360	U.S. EPA
Uncoated OCC/Kraft Paper	100	CIWMB2004
High-grade Paper	158	U.S. EPA
Low-grade Paper	158	U.S. EPA
Compostable/Soiled Paper	138	Starbucks
Remainder/Composite Paper	364	U.S. EPA
#1 PET Bottles	35	U.S. EPA
#2 HDPE Bottles	24	U.S. EPA
#1-#7 Other Containers	35	U.S. EPA
Expanded Polystyrene, Food Grade	32	CIWMB2004
Expanded Polystyrene, Non-food Grade	32	CIWMB2004
Clean Shopping/Dry Cleaning Bags	36	Tellus
Other Clean PE Film	36	CIWMB2005
Other Film	23	Tellus
Durable Plastic Products	50	U.S. EPA
Remainder/Composite Plastics	50	U.S. EPA
Clear Glass Containers	600	U.S. EPA
Green Glass Containers	600	U.S. EPA
Brown Glass Containers	600	U.S. EPA
Plate Glass	1,400	U.S. EPA
Remainder/Composite Glass	1,400	U.S. EPA
Aluminum Beverage Cans	65	U.S. EPA
Aluminum Foil/Containers	48	Tellus
Other Nonferrous	225	U.S. EPA
Tin Food Cans	150	U.S. EPA
Empty Aerosol Cans	150	U.S. EPA
Major Appliances	167	U.S. EPA
Oil filters	834	Tellus
Other Ferrous	225	CIWMB2004

Material Type	Conversion Factor	Source
Remainder/Composite Metal	143	Average of metals, without Used Oil Filters
Food Waste, Vegetative	1,443	Tellus
Other Food Waste	486	FEECO, Tellus
Leaves & Grass	313	U.S. EPA
Prunings and Trimmings	127	CIWMB2004
Branches and Stumps	127	CIWMB2004
Textiles/Clothing	225	Tellus
Disposable Diapers	540	Tellus
Animal Excrement/Litter	675	FEECO
Remainder/Composite Organic	225	Average of all organics materials, except Manure
Dimensional Lumber	169	CIWMB2004
Pallets and Crates	169	CIWMB2004
Engineered Wood	268	CIWMB2004
Other Untreated Wood	169	CIWMB2004
Painted Wood	169	CIWMB2004
Treated Wood	169	CIWMB2004
Remainder/Composite Wood	169	CIWMB2004
Concrete	860	CIWMB2004
Clean Drywall	467	CIWMB2004
Other Drywall	467	CIWMB2004
Asphalt Paving	773	Tellus scaled down by factor from Florida C&D study
Asphalt Shingles	731	CIWMB2004
Other Asphalt Roofing	731	CIWMB2004
Insulation	17	Tellus
Carpet	147	CIWMB2004
Carpet Padding	62	CIWMB2004
Soil, Rocks, Sand	964	CIWMB2004
Ceramics and Brick	860	CIWMB2004
Remainder/Composite Construction	417	CIWMB2004
Televisions and CRTs	405	CIWMB2004
Computers/Flat Monitors	763	Tellus

Material Type	Conversion Factor	Source
Computer Peripherals	354	CIWMB2004
Other Consumer Electronics	438	CIWMB2004
Pesticides/Herbicides	1,505	U.S. EPA
Fluorescent Lighting	300	Cascadia Measurement
Asbestos	17	Tellus
Paints/Solvents/Adhesives	1,836	Tellus
Dry-cell Batteries	2,400	MN State
Wet-cell Batteries	2,400	MN State
Gasoline/Kerosene	1,653	Tellus
Motor Oil	1,525	Tellus
Vehicle/Equipment Fluids	1,653	Tellus
Medical Wastes	64	Cascadia and CIWMB
Pharmaceuticals	486	FEECO, Tellus
House Cleaners/Chemicals	1,505	U.S. EPA
Other Potentially Hazardous	1,671	Average of HHW liquids
Furniture	80	Tellus
Tires	200	CIWMB Staff Estimate
Mattresses & Box Springs	80	Tellus
Non-distinct Fines	999	FEECO

Sources:

- **Cascadia** refers to direct measurements of representative samples taken by Cascadia staff members for this and other studies.
- **CIWMB** refers to measurements, estimates, or correspondence from California Integrated Waste Management Board staff during 2006.
- **CIWMB 2004** refers to *Targeted Statewide Waste Characterization Study: Detailed Characterization of Construction and Demolition Waste*, performed by Cascadia Consulting Group for California Integrated Waste Management Board, 2006.
- **FEECO** refers to FEECO International, Complete Systems and Equipment Handbook, 9th printing.
- **Florida C&D Study** refers to Converting C&D Debris from Volume to Weight: A Fact Sheet for C&D Debris Facility Operators, University of Florida, 2000.
- **San Diego** refers to conversion factors that were used in the San Diego Waste Comp. Study, conducted by Cascadia Consulting Group in 2000.
- **Tellus** refers to the Tellus Institute, Boston, Massachusetts.
- **U.S. EPA** refers to the U.S. Environmental Protection Agency's "Measuring Recycling: A Guide for State and Local Governments," document no. EPA530-R-97-011, published September 1997.

Appendix D: Additional Composition Results

Detailed Residential Disposed Waste Tables

Table D-1. Detailed Disposed Waste Composition Results: Single-family, Spring

Material	Est. Percent	+ / -	Est. Tons
Paper	**18.3%**		**2,061**
Newspaper	1.8%	0.8%	198
Uncoated OCC/Kraft Paper	0.9%	0.5%	96
High-grade Paper	1.5%	0.6%	165
Low-grade Paper	5.1%	1.1%	575
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.3%	0.2%	37
Compostable/Soiled Paper	5.7%	1.0%	640
Pot. Comp. Single-use Food Service Paper	0.9%	0.4%	106
Non-comp. Single-use Food Service Paper	0.8%	0.3%	85
Remainder/Composite Paper	1.4%	0.6%	158
Plastic	**16.0%**		**1,806**
#1 PET Bottles	1.6%	0.4%	179
#2 HDPE Bottles	0.8%	0.2%	89
#1-#7 Other Containers	1.8%	0.4%	201
Expanded Polystyrene Food grade	1.0%	0.2%	108
Expanded Polystyrene Non-food Grade	0.1%	0.0%	6
Pot. Comp. Single-use Food Service Plastic	0.4%	0.1%	47
Non-comp. Single-use Food Service Plastic	0.3%	0.2%	34
Clean Shopping/Dry Cleaning Bags	1.5%	0.4%	167
Other Clean PE Film	0.1%	0.2%	12
Other Film	6.2%	1.1%	701
Durable Plastic Products	1.2%	0.7%	141
Remainder/Composite Plastics	1.1%	1.1%	122
Glass	**3.3%**		**376**
Clear Glass Containers	1.2%	0.4%	139
Green Glass Containers	0.5%	0.2%	61
Brown Glass Containers	1.2%	0.4%	138
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.3%	0.2%	38
Metal	**3.6%**		**400**
Aluminum Beverage Cans	0.4%	0.1%	50
Aluminum Foil/Containers	0.3%	0.1%	34
Other Non-ferrous	0.2%	0.2%	26
Tin Food Cans	1.0%	0.3%	117
Empty Aerosol Cans	0.1%	0.1%	16
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	0.9%	0.6%	103
Remainder/Composite Metal	0.5%	0.3%	53
Organics	**56.0%**		**6,302**
Food Waste, Vegetative	16.1%	2.2%	1,811
Other Food Waste	13.5%	2.7%	1,521
Leaves and Grass	2.9%	1.9%	328
Prunings and Trimmings	0.0%	0.0%	0
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	4.4%	1.4%	494
Disposable Diapers	8.7%	2.6%	975
Animal Excrement/Litter	9.8%	3.6%	1,104
Remainder/Composite Organic	0.6%	0.5%	69
Wood Waste	**0.9%**		**107**
Dimensional Lumber	0.1%	0.1%	13
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.1%	0.1%	8
Other Untreated Wood	0.2%	0.3%	28
Painted Wood	0.1%	0.2%	16
Treated Wood	0.3%	0.5%	33
Remainder/Composite Wood	0.1%	0.1%	9
C&D Waste	**0.6%**		**69**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.0%	0.0%	0
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.0%	0.0%	0
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	0.3%	0.5%	32
Ceramics and Brick	0.3%	0.4%	33
Remainder/Composite Construction	0.0%	0.1%	4
E-Waste	**0.3%**		**38**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.3%	0.4%	38
Household Hazardous	**0.6%**		**71**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.6%	0.9%	63
Dry-cell Batteries	0.0%	0.0%	2
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	1
Pharmaceuticals	0.0%	0.1%	4
House Cleaners and Chemicals	0.0%	0.0%	1
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.2%**		**24**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.2%	0.3%	24
Totals	**100.0%**		**11,253**
Sample Count			21

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

Table D-2. Detailed Disposed Waste Composition Results: Single-family, Summer

Material	Est. Percent	+ / -	Est. Tons
Paper	**16.4%**		**1,930**
Newspaper	1.3%	0.3%	154
Uncoated OCC/Kraft Paper	1.5%	0.3%	175
High-grade Paper	0.6%	0.3%	67
Low-grade Paper	4.7%	0.7%	555
Waxed OCC	0.0%	0.0%	3
Pizza Boxes	0.3%	0.1%	38
Compostable/Soiled Paper	5.7%	0.6%	677
Pot. Comp. Single-use Food Service Paper	1.2%	0.2%	146
Non-comp. Single-use Food Service Paper	0.2%	0.1%	20
Remainder/Composite Paper	0.8%	0.2%	95
Plastic	**9.6%**		**1,134**
#1 PET Bottles	0.8%	0.1%	95
#2 HDPE Bottles	0.5%	0.1%	61
#1-#7 Other Containers	0.9%	0.1%	108
Expanded Polystyrene Food grade	0.3%	0.1%	40
Expanded Polystyrene Non-food Grade	0.1%	0.0%	9
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	1
Non-comp. Single-use Food Service Plastic	0.4%	0.1%	43
Clean Shopping/Dry Cleaning Bags	0.8%	0.1%	99
Other Clean PE Film	0.0%	0.0%	4
Other Film	3.7%	0.5%	438
Durable Plastic Products	1.2%	0.4%	139
Remainder/Composite Plastics	0.8%	0.3%	97
Glass	**2.6%**		**301**
Clear Glass Containers	1.2%	0.2%	139
Green Glass Containers	0.4%	0.2%	51
Brown Glass Containers	0.8%	0.3%	91
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.2%	0.1%	21
Metal	**3.9%**		**457**
Aluminum Beverage Cans	0.3%	0.1%	34
Aluminum Foil/Containers	0.2%	0.1%	27
Other Non-ferrous	0.5%	0.2%	60
Tin Food Cans	0.4%	0.1%	51
Empty Aerosol Cans	0.2%	0.1%	18
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.1%	4
Other Ferrous	1.0%	0.6%	123
Remainder/Composite Metal	1.2%	0.6%	140
Organics	**62.4%**		**7,356**
Food Waste, Vegetative	21.4%	1.7%	2,520
Other Food Waste	6.0%	1.0%	704
Leaves and Grass	0.8%	0.6%	93
Prunings and Trimmings	0.0%	0.0%	1
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	5.3%	1.5%	629
Disposable Diapers	12.2%	1.5%	1,434
Animal Excrement/Litter	15.2%	2.1%	1,786
Remainder/Composite Organic	1.6%	0.5%	189

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**1.8%**		**208**
Dimensional Lumber	0.5%	0.4%	59
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.0%	0.0%	2
Other Untreated Wood	0.3%	0.2%	34
Painted Wood	0.8%	0.6%	96
Treated Wood	0.0%	0.1%	5
Remainder/Composite Wood	0.1%	0.2%	12
C&D Waste	**1.8%**		**212**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.2%	0.2%	21
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.4%	0.6%	46
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.5%	0.5%	58
Carpet Padding	0.1%	0.2%	14
Soil, Rocks, and Sand	0.2%	0.4%	27
Ceramics and Brick	0.1%	0.2%	16
Remainder/Composite Construction	0.3%	0.4%	30
E-Waste	**0.1%**		**11**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.1%	0.1%	11
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**0.3%**		**38**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.1%	0.1%	9
Dry-cell Batteries	0.1%	0.1%	11
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	3
House Cleaners and Chemicals	0.1%	0.1%	15
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**1.1%**		**134**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.1%	5
Mattresses	0.0%	0.0%	0
Non-distinct Fines	1.1%	0.3%	130
Totals	**100.0%**		**11,782**
Sample Count			20

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

Table D-3. Detailed Disposed Waste Composition Results: Single-family, Fall

Material	Est. Percent	+ / -	Est. Tons
Paper	**18.5%**		**2,245**
Newspaper	1.5%	0.6%	184
Uncoated OCC/Kraft Paper	1.4%	0.3%	167
High-grade Paper	1.2%	0.7%	148
Low-grade Paper	5.2%	0.7%	630
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.3%	0.2%	39
Compostable/Soiled Paper	5.8%	1.6%	701
Pot. Comp. Single-use Food Service Paper	1.0%	0.4%	121
Non-comp. Single-use Food Service Paper	0.7%	0.4%	88
Remainder/Composite Paper	1.4%	0.5%	167
Plastic	**12.8%**		**1,548**
#1 PET Bottles	0.9%	0.2%	106
#2 HDPE Bottles	0.5%	0.1%	63
#1-#7 Other Containers	1.6%	0.4%	199
Expanded Polystyrene Food grade	0.5%	0.2%	63
Expanded Polystyrene Non-food Grade	0.1%	0.0%	14
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	3
Non-comp. Single-use Food Service Plastic	0.3%	0.1%	41
Clean Shopping/Dry Cleaning Bags	0.3%	0.1%	40
Other Clean PE Film	0.0%	0.0%	3
Other Film	6.9%	1.2%	838
Durable Plastic Products	0.9%	0.4%	103
Remainder/Composite Plastics	0.6%	0.2%	75
Glass	**2.8%**		**339**
Clear Glass Containers	1.1%	0.3%	132
Green Glass Containers	0.5%	0.3%	60
Brown Glass Containers	1.0%	0.4%	118
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.2%	0.1%	29
Metal	**3.1%**		**377**
Aluminum Beverage Cans	0.5%	0.2%	56
Aluminum Foil/Containers	0.4%	0.2%	48
Other Non-ferrous	0.0%	0.0%	0
Tin Food Cans	1.0%	0.2%	117
Empty Aerosol Cans	0.2%	0.2%	29
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	0.4%	0.4%	47
Remainder/Composite Metal	0.7%	0.4%	79
Organics	**59.3%**		**7,199**
Food Waste, Vegetative	20.2%	2.2%	2,447
Other Food Waste	7.5%	1.6%	913
Leaves and Grass	1.4%	0.9%	170
Prunings and Trimmings	0.1%	0.1%	6
Branches and Stumps	0.2%	0.3%	24
Textiles and Clothing	4.9%	1.9%	599
Disposable Diapers	10.8%	1.7%	1,308
Animal Excrement/Litter	13.5%	2.4%	1,639
Remainder/Composite Organic	0.8%	0.3%	92
Wood Waste	**0.7%**		**87**
Dimensional Lumber	0.2%	0.2%	23
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.1%	0.1%	11
Other Untreated Wood	0.1%	0.1%	7
Painted Wood	0.3%	0.2%	33
Treated Wood	0.0%	0.0%	2
Remainder/Composite Wood	0.1%	0.1%	10
C&D Waste	**2.1%**		**254**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	1.0%	1.4%	116
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.2%	0.3%	20
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.0%	0.1%	4
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	0.9%	1.4%	104
Ceramics and Brick	0.0%	0.1%	5
Remainder/Composite Construction	0.0%	0.1%	6
E-Waste	**0.1%**		**7**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.1%	0.1%	7
Household Hazardous	**0.3%**		**38**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.2%	0.3%	20
Dry-cell Batteries	0.0%	0.0%	4
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.1%	5
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	3
House Cleaners and Chemicals	0.0%	0.1%	5
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.3%**		**39**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.0%	0
Mattresses	0.3%	0.4%	31
Non-distinct Fines	0.1%	0.1%	8
Totals	**100.0%**		**12,134**
Sample Count			20

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

Table D-4. Detailed Disposed Waste Composition Results: Single-family, District 1 (Monday)

Material	Est. Percent	+ / -	Est. Tons
Paper	**17.8%**		**1,180**
Newspaper	1.8%	1.0%	117
Uncoated OCC/Kraft Paper	1.1%	0.4%	72
High-grade Paper	0.9%	0.8%	61
Low-grade Paper	4.4%	0.8%	290
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.4%	0.3%	25
Compostable/Soiled Paper	6.1%	0.8%	406
Pot. Comp. Single-use Food Service Paper	1.7%	0.7%	116
Non-comp. Single-use Food Service Paper	0.1%	0.1%	6
Remainder/Composite Paper	1.3%	0.8%	88
Plastic	**10.0%**		**661**
#1 PET Bottles	0.8%	0.3%	55
#2 HDPE Bottles	0.5%	0.1%	36
#1-#7 Other Containers	1.1%	0.5%	75
Expanded Polystyrene Food grade	0.2%	0.1%	14
Expanded Polystyrene Non-food Grade	0.1%	0.1%	5
Pot. Comp. Single-use Food Service Plastic	0.1%	0.1%	7
Non-comp. Single-use Food Service Plastic	0.2%	0.1%	15
Clean Shopping/Dry Cleaning Bags	0.5%	0.2%	34
Other Clean PE Film	0.0%	0.0%	0
Other Film	3.9%	1.1%	257
Durable Plastic Products	0.8%	0.4%	51
Remainder/Composite Plastics	1.7%	1.8%	111
Glass	**4.2%**		**280**
Clear Glass Containers	1.3%	0.6%	86
Green Glass Containers	0.9%	0.4%	63
Brown Glass Containers	1.8%	0.5%	117
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.2%	0.1%	14
Metal	**3.3%**		**221**
Aluminum Beverage Cans	0.3%	0.1%	22
Aluminum Foil/Containers	0.2%	0.1%	13
Other Non-ferrous	0.1%	0.2%	10
Tin Food Cans	0.6%	0.1%	39
Empty Aerosol Cans	0.1%	0.0%	5
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	1.4%	0.9%	93
Remainder/Composite Metal	0.6%	0.4%	41
Organics	**62.4%**		**4,140**
Food Waste, Vegetative	15.2%	2.9%	1,006
Other Food Waste	10.4%	2.2%	692
Leaves and Grass	2.3%	1.4%	151
Prunings and Trimmings	0.1%	0.2%	6
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	4.4%	1.2%	290
Disposable Diapers	12.1%	2.3%	801
Animal Excrement/Litter	16.9%	2.3%	1,122
Remainder/Composite Organic	1.1%	0.8%	73

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**1.6%**		**104**
Dimensional Lumber	0.3%	0.3%	19
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.0%	0.0%	1
Other Untreated Wood	0.1%	0.1%	4
Painted Wood	1.2%	0.9%	77
Treated Wood	0.0%	0.0%	0
Remainder/Composite Wood	0.0%	0.1%	3
C&D Waste	**0.7%**		**45**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.1%	0.2%	8
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.1%	0.1%	4
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	0.5%	0.7%	30
Ceramics and Brick	0.0%	0.0%	1
Remainder/Composite Construction	0.0%	0.0%	1
E-Waste	**0.0%**		**0**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**0.1%**		**7**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	2
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.1%	0.1%	4
House Cleaners and Chemicals	0.0%	0.0%	1
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.0%**		**0**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.0%	0.0%	0
Totals	**100.0%**		**6,638**
Sample Count			12

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

Table D-5. Detailed Disposed Waste Composition Results: Single-family, District 2 (Tuesday)

Material	Est. Percent	+ / -	Est. Tons
Paper	**17.6%**		**1,193**
Newspaper	2.0%	1.2%	136
Uncoated OCC/Kraft Paper	1.4%	0.7%	96
High-grade Paper	1.4%	0.7%	94
Low-grade Paper	5.0%	1.3%	339
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.3%	0.1%	18
Compostable/Soiled Paper	5.1%	1.3%	348
Pot. Comp. Single-use Food Service Paper	1.1%	0.5%	72
Non-comp. Single-use Food Service Paper	0.2%	0.2%	13
Remainder/Composite Paper	1.1%	0.6%	77
Plastic	**11.4%**		**774**
#1 PET Bottles	0.8%	0.5%	56
#2 HDPE Bottles	0.5%	0.2%	33
#1-#7 Other Containers	1.1%	0.2%	72
Expanded Polystyrene Food grade	0.6%	0.2%	41
Expanded Polystyrene Non-food Grade	0.1%	0.0%	6
Pot. Comp. Single-use Food Service Plastic	0.1%	0.0%	6
Non-comp. Single-use Food Service Plastic	0.3%	0.1%	17
Clean Shopping/Dry Cleaning Bags	0.7%	0.3%	47
Other Clean PE Film	0.2%	0.3%	12
Other Film	5.3%	1.4%	359
Durable Plastic Products	1.2%	0.6%	80
Remainder/Composite Plastics	0.7%	0.2%	45
Glass	**2.1%**		**145**
Clear Glass Containers	1.0%	0.3%	69
Green Glass Containers	0.3%	0.2%	23
Brown Glass Containers	0.6%	0.5%	38
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.2%	0.2%	16
Metal	**4.5%**		**304**
Aluminum Beverage Cans	0.4%	0.1%	25
Aluminum Foil/Containers	0.3%	0.1%	18
Other Non-ferrous	0.1%	0.2%	10
Tin Food Cans	0.8%	0.4%	53
Empty Aerosol Cans	0.1%	0.1%	7
Major Appliances	0.0%	0.0%	0
Oil filters	0.1%	0.1%	4
Other Ferrous	1.2%	1.0%	85
Remainder/Composite Metal	1.5%	1.1%	102
Organics	**58.8%**		**3,987**
Food Waste, Vegetative	18.3%	2.2%	1,244
Other Food Waste	5.7%	1.7%	387
Leaves and Grass	2.6%	2.1%	175
Prunings and Trimmings	0.0%	0.0%	0
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	5.8%	3.3%	396
Disposable Diapers	10.4%	2.6%	706
Animal Excrement/Litter	14.7%	4.5%	999
Remainder/Composite Organic	1.2%	0.8%	80

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**1.1%**		**75**
Dimensional Lumber	0.2%	0.2%	15
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.1%	0.1%	4
Other Untreated Wood	0.1%	0.1%	6
Painted Wood	0.2%	0.3%	17
Treated Wood	0.5%	0.8%	34
Remainder/Composite Wood	0.0%	0.0%	0
C&D Waste	**3.7%**		**253**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	1.6%	2.4%	108
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.3%	0.5%	20
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.0%	0.0%	1
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	1.5%	2.4%	101
Ceramics and Brick	0.3%	0.4%	20
Remainder/Composite Construction	0.1%	0.1%	4
E-Waste	**0.0%**		**0**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**0.3%**		**22**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.1%	0.2%	9
Dry-cell Batteries	0.1%	0.1%	7
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.1%	0.1%	5
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	1
Pharmaceuticals	0.0%	0.0%	1
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.4%**		**28**
Furniture	0.0%	0.0%	0
Tires	0.1%	0.1%	5
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.3%	0.6%	24
Totals	**100.0%**		**6,782**
Sample Count			12

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

Table D-6. Detailed Disposed Waste Composition Results: Single-family, District 3 (Wednesday)

Material	Est. Percent	+ / -	Est. Tons
Paper	**15.7%**		**1,223**
Newspaper	1.0%	0.4%	81
Uncoated OCC/Kraft Paper	1.5%	0.6%	118
High-grade Paper	0.5%	0.5%	39
Low-grade Paper	4.3%	0.8%	337
Waxed OCC	0.0%	0.1%	3
Pizza Boxes	0.3%	0.1%	24
Compostable/Soiled Paper	4.7%	0.9%	363
Pot. Comp. Single-use Food Service Paper	1.5%	0.6%	115
Non-comp. Single-use Food Service Paper	0.5%	0.5%	41
Remainder/Composite Paper	1.3%	0.4%	103
Plastic	**14.1%**		**1,097**
#1 PET Bottles	1.3%	0.3%	98
#2 HDPE Bottles	0.6%	0.1%	46
#1-#7 Other Containers	1.5%	0.4%	117
Expanded Polystyrene Food grade	0.7%	0.2%	56
Expanded Polystyrene Non-food Grade	0.1%	0.0%	7
Pot. Comp. Single-use Food Service Plastic	0.3%	0.1%	20
Non-comp. Single-use Food Service Plastic	0.3%	0.1%	23
Clean Shopping/Dry Cleaning Bags	1.2%	0.3%	94
Other Clean PE Film	0.0%	0.0%	3
Other Film	6.4%	1.3%	495
Durable Plastic Products	1.1%	0.6%	85
Remainder/Composite Plastics	0.7%	0.3%	51
Glass	**2.4%**		**187**
Clear Glass Containers	1.0%	0.4%	77
Green Glass Containers	0.4%	0.4%	31
Brown Glass Containers	0.8%	0.4%	58
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.3%	0.2%	20
Metal	**3.8%**		**299**
Aluminum Beverage Cans	0.6%	0.3%	43
Aluminum Foil/Containers	0.6%	0.2%	47
Other Non-ferrous	0.0%	0.0%	0
Tin Food Cans	1.1%	0.3%	87
Empty Aerosol Cans	0.4%	0.4%	30
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	0.5%	0.4%	39
Remainder/Composite Metal	0.7%	0.4%	53
Organics	**61.6%**		**4,786**
Food Waste, Vegetative	23.4%	2.2%	1,820
Other Food Waste	10.4%	2.8%	804
Leaves and Grass	1.8%	2.1%	139
Prunings and Trimmings	0.0%	0.0%	1
Branches and Stumps	0.3%	0.5%	24
Textiles and Clothing	4.0%	1.9%	313
Disposable Diapers	11.3%	2.8%	875
Animal Excrement/Litter	10.0%	2.9%	774
Remainder/Composite Organic	0.5%	0.3%	35

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**0.8%**		**62**
Dimensional Lumber	0.1%	0.2%	8
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.1%	0.1%	4
Other Untreated Wood	0.1%	0.2%	11
Painted Wood	0.2%	0.2%	16
Treated Wood	0.0%	0.0%	0
Remainder/Composite Wood	0.3%	0.3%	22
C&D Waste	**0.9%**		**72**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.1%	0.1%	6
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	1
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.1%	0.1%	6
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	0.4%	0.7%	32
Ceramics and Brick	0.3%	0.6%	27
Remainder/Composite Construction	0.0%	0.0%	0
E-Waste	**0.1%**		**5**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.1%	0.1%	5
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**0.4%**		**31**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.3%	0.4%	20
Dry-cell Batteries	0.0%	0.0%	2
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.1%	0.1%	5
House Cleaners and Chemicals	0.1%	0.1%	4
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.1%**		**8**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.1%	0.2%	8
Totals	**100.0%**		**7,771**
Sample Count			12

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

Table D-7. Detailed Disposed Waste Composition Results: Single-family, District 4 (Thursday)

Material	Est. Percent	+ / -	Est. Tons
Paper	**18.3%**		**1,323**
Newspaper	1.1%	0.7%	77
Uncoated OCC/Kraft Paper	1.0%	0.3%	70
High-grade Paper	1.3%	0.6%	97
Low-grade Paper	6.8%	1.5%	490
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.5%	0.3%	33
Compostable/Soiled Paper	5.4%	2.4%	389
Pot. Comp. Single-use Food Service Paper	0.9%	0.3%	67
Non-comp. Single-use Food Service Paper	0.6%	0.5%	43
Remainder/Composite Paper	0.8%	0.3%	58
Plastic	**15.1%**		**1,086**
#1 PET Bottles	1.5%	0.2%	109
#2 HDPE Bottles	0.7%	0.2%	52
#1-#7 Other Containers	1.7%	0.3%	122
Expanded Polystyrene Food grade	0.9%	0.3%	66
Expanded Polystyrene Non-food Grade	0.1%	0.0%	5
Pot. Comp. Single-use Food Service Plastic	0.2%	0.2%	16
Non-comp. Single-use Food Service Plastic	0.4%	0.3%	31
Clean Shopping/Dry Cleaning Bags	1.0%	0.5%	72
Other Clean PE Film	0.0%	0.0%	1
Other Film	7.2%	1.2%	518
Durable Plastic Products	0.7%	0.3%	52
Remainder/Composite Plastics	0.6%	0.3%	40
Glass	**3.5%**		**255**
Clear Glass Containers	1.8%	0.3%	127
Green Glass Containers	0.3%	0.2%	23
Brown Glass Containers	1.3%	0.6%	91
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.2%	0.2%	14
Metal	**2.4%**		**176**
Aluminum Beverage Cans	0.5%	0.1%	37
Aluminum Foil/Containers	0.2%	0.1%	16
Other Non-ferrous	0.1%	0.2%	9
Tin Food Cans	0.9%	0.3%	68
Empty Aerosol Cans	0.2%	0.1%	11
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	0.2%	0.1%	17
Remainder/Composite Metal	0.3%	0.3%	18
Organics	**57.1%**		**4,121**
Food Waste, Vegetative	20.6%	3.0%	1,482
Other Food Waste	6.8%	1.3%	493
Leaves and Grass	0.5%	0.5%	36
Prunings and Trimmings	0.0%	0.0%	0
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	6.3%	2.3%	458
Disposable Diapers	11.0%	2.4%	790
Animal Excrement/Litter	10.6%	2.9%	768
Remainder/Composite Organic	1.3%	0.4%	93

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**0.9%**		**68**
Dimensional Lumber	0.2%	0.1%	12
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.2%	0.2%	13
Other Untreated Wood	0.4%	0.5%	32
Painted Wood	0.0%	0.1%	3
Treated Wood	0.1%	0.1%	5
Remainder/Composite Wood	0.0%	0.0%	3
C&D Waste	**0.5%**		**36**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.0%	0.0%	0
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.0%	0.0%	0
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	0.0%	0.0%	0
Ceramics and Brick	0.1%	0.1%	6
Remainder/Composite Construction	0.4%	0.7%	30
E-Waste	**0.6%**		**44**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.1%	0.1%	5
Other Consumer Electronics	0.5%	0.6%	39
Household Hazardous	**1.0%**		**70**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.9%	1.4%	63
Dry-cell Batteries	0.1%	0.1%	5
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	1
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.4%**		**32**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.0%	0
Mattresses	0.4%	0.7%	31
Non-distinct Fines	0.0%	0.0%	1
Totals	**100.0%**		**7,211**
Sample Count			13

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

Table D-8. Detailed Disposed Waste Composition Results: Single-family, District 5 (Friday)

Material	Est. Percent	+ / -	Est. Tons
Paper	**19.5%**		**1,317**
Newspaper	1.9%	0.5%	125
Uncoated OCC/Kraft Paper	1.2%	0.3%	82
High-grade Paper	1.3%	1.0%	90
Low-grade Paper	4.5%	0.9%	304
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.2%	0.1%	14
Compostable/Soiled Paper	7.6%	1.6%	512
Pot. Comp. Single-use Food Service Paper	0.1%	0.1%	5
Non-comp. Single-use Food Service Paper	1.3%	0.5%	90
Remainder/Composite Paper	1.4%	0.5%	94
Plastic	**12.9%**		**871**
#1 PET Bottles	0.9%	0.2%	62
#2 HDPE Bottles	0.7%	0.2%	44
#1-#7 Other Containers	1.8%	0.6%	121
Expanded Polystyrene Food grade	0.5%	0.2%	34
Expanded Polystyrene Non-food Grade	0.1%	0.1%	8
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	2
Non-comp. Single-use Food Service Plastic	0.5%	0.1%	32
Clean Shopping/Dry Cleaning Bags	0.9%	0.3%	59
Other Clean PE Film	0.0%	0.0%	2
Other Film	5.1%	1.2%	348
Durable Plastic Products	1.7%	1.1%	114
Remainder/Composite Plastics	0.7%	0.2%	47
Glass	**2.2%**		**149**
Clear Glass Containers	0.7%	0.2%	51
Green Glass Containers	0.5%	0.4%	31
Brown Glass Containers	0.6%	0.2%	43
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.4%	0.2%	24
Metal	**3.5%**		**234**
Aluminum Beverage Cans	0.2%	0.1%	13
Aluminum Foil/Containers	0.2%	0.1%	16
Other Non-ferrous	0.8%	0.3%	57
Tin Food Cans	0.6%	0.2%	40
Empty Aerosol Cans	0.1%	0.0%	9
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	0.6%	0.6%	40
Remainder/Composite Metal	0.9%	0.6%	59
Organics	**56.5%**		**3,823**
Food Waste, Vegetative	18.1%	3.0%	1,225
Other Food Waste	11.2%	3.4%	761
Leaves and Grass	1.3%	1.1%	90
Prunings and Trimmings	0.0%	0.0%	0
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	3.9%	1.0%	266
Disposable Diapers	8.1%	2.4%	546
Animal Excrement/Litter	12.8%	4.8%	867
Remainder/Composite Organic	1.0%	0.4%	67
Wood Waste	**1.4%**		**94**
Dimensional Lumber	0.6%	0.7%	41
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.0%	0.0%	0
Other Untreated Wood	0.2%	0.2%	16
Painted Wood	0.5%	0.4%	33
Treated Wood	0.0%	0.0%	0
Remainder/Composite Wood	0.1%	0.1%	3
C&D Waste	**1.9%**		**128**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.2%	0.4%	15
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.7%	1.0%	45
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.7%	0.8%	50
Carpet Padding	0.2%	0.4%	14
Soil, Rocks, and Sand	0.0%	0.0%	0
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	0.1%	0.1%	4
E-Waste	**0.1%**		**6**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.1%	0.2%	6
Household Hazardous	**0.2%**		**16**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	2
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.2%	0.2%	14
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**1.9%**		**130**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	1.9%	0.6%	130
Totals	**100.0%**		**6,768**
Sample Count			12

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

Table D-9. Detailed Disposed Waste Composition Results: Multifamily, Fall

Material	Est. Percent	+ / -	Est. Tons
Paper	**18.8%**		**744**
Newspaper	1.7%	0.8%	67
Uncoated OCC/Kraft Paper	3.2%	0.8%	125
High-grade Paper	1.1%	0.9%	43
Low-grade Paper	5.7%	2.1%	224
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.4%	0.3%	18
Compostable/Soiled Paper	5.5%	1.2%	219
Pot. Comp. Single-use Food Service Paper	0.4%	0.3%	16
Non-comp. Single-use Food Service Paper	0.3%	0.2%	12
Remainder/Composite Paper	0.5%	0.2%	21
Plastic	**9.5%**		**378**
#1 PET Bottles	1.2%	0.3%	47
#2 HDPE Bottles	0.6%	0.2%	24
#1-#7 Other Containers	0.8%	0.3%	33
Expanded Polystyrene Food grade	0.4%	0.1%	15
Expanded Polystyrene Non-food Grade	0.2%	0.2%	9
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	1
Non-comp. Single-use Food Service Plastic	0.2%	0.1%	9
Clean Shopping/Dry Cleaning Bags	0.4%	0.2%	16
Other Clean PE Film	0.0%	0.0%	1
Other Film	4.0%	1.4%	158
Durable Plastic Products	1.1%	0.7%	45
Remainder/Composite Plastics	0.5%	0.3%	21
Glass	**3.2%**		**126**
Clear Glass Containers	2.0%	0.8%	81
Green Glass Containers	0.1%	0.1%	5
Brown Glass Containers	0.6%	0.3%	22
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.5%	0.3%	19
Metal	**3.5%**		**138**
Aluminum Beverage Cans	0.7%	0.3%	27
Aluminum Foil/Containers	0.3%	0.1%	11
Other Non-ferrous	0.0%	0.0%	0
Tin Food Cans	0.7%	0.2%	27
Empty Aerosol Cans	0.1%	0.0%	3
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	0.8%	0.7%	31
Remainder/Composite Metal	1.0%	0.7%	40
Organics	**58.8%**		**2,332**
Food Waste, Vegetative	18.9%	3.6%	749
Other Food Waste	8.1%	3.0%	321
Leaves and Grass	6.2%	7.7%	246
Prunings and Trimmings	0.1%	0.1%	4
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	4.8%	1.7%	191
Disposable Diapers	10.6%	3.6%	420
Animal Excrement/Litter	8.0%	2.9%	315
Remainder/Composite Organic	2.2%	2.0%	86

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**2.4%**		**97**
Dimensional Lumber	0.1%	0.1%	4
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.7%	0.8%	28
Other Untreated Wood	0.4%	0.4%	15
Painted Wood	0.2%	0.2%	7
Treated Wood	0.0%	0.0%	0
Remainder/Composite Wood	1.1%	1.6%	44
C&D Waste	**0.7%**		**30**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.1%	0.1%	3
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.7%	1.1%	27
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	0.0%	0.0%	0
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	0.0%	0.0%	0
E-Waste	**0.7%**		**30**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.7%	1.2%	30
Household Hazardous	**0.9%**		**34**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	1
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.1%	0.1%	3
Dry-cell Batteries	0.0%	0.0%	0
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.6%	0.9%	23
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.2%	0.3%	8
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**1.4%**		**54**
Furniture	1.0%	1.7%	41
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.3%	0.6%	14
Totals	**100.0%**		**3,964**
Sample Count			10

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

Table D-10. Detailed Disposed Waste Composition Results: Multifamily, Spring

Material	Est. Percent	+ / -	Est. Tons
Paper	**24.0%**		**901**
Newspaper	2.0%	1.0%	75
Uncoated OCC/Kraft Paper	3.3%	2.1%	123
High-grade Paper	1.4%	0.8%	53
Low-grade Paper	5.1%	1.8%	192
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.3%	0.1%	12
Compostable/Soiled Paper	9.8%	1.5%	366
Pot. Comp. Single-use Food Service Paper	0.7%	0.4%	26
Non-comp. Single-use Food Service Paper	0.3%	0.3%	10
Remainder/Composite Paper	1.1%	0.8%	43
Plastic	**15.2%**		**571**
#1 PET Bottles	1.6%	0.6%	62
#2 HDPE Bottles	0.9%	0.4%	35
#1-#7 Other Containers	1.6%	0.7%	61
Expanded Polystyrene Food grade	0.5%	0.3%	21
Expanded Polystyrene Non-food Grade	0.1%	0.1%	2
Pot. Comp. Single-use Food Service Plastic	0.5%	0.4%	20
Non-comp. Single-use Food Service Plastic	0.1%	0.1%	3
Clean Shopping/Dry Cleaning Bags	1.1%	0.5%	43
Other Clean PE Film	0.1%	0.1%	2
Other Film	5.8%	1.2%	216
Durable Plastic Products	1.1%	0.6%	43
Remainder/Composite Plastics	1.7%	1.6%	62
Glass	**3.0%**		**112**
Clear Glass Containers	1.3%	0.6%	48
Green Glass Containers	1.0%	1.1%	37
Brown Glass Containers	0.2%	0.2%	7
Plate Glass	0.1%	0.1%	3
Remainder/Composite Glass	0.4%	0.3%	17
Metal	**7.7%**		**288**
Aluminum Beverage Cans	0.7%	0.4%	24
Aluminum Foil/Containers	0.4%	0.3%	15
Other Non-ferrous	0.1%	0.1%	2
Tin Food Cans	0.7%	0.2%	26
Empty Aerosol Cans	0.3%	0.2%	11
Major Appliances	3.5%	5.8%	133
Oil filters	0.0%	0.0%	0
Other Ferrous	1.1%	0.9%	41
Remainder/Composite Metal	1.0%	0.9%	36
Organics	**44.7%**		**1,677**
Food Waste, Vegetative	13.6%	2.6%	511
Other Food Waste	11.1%	4.2%	417
Leaves and Grass	2.5%	2.7%	94
Prunings and Trimmings	0.0%	0.0%	0
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	4.2%	1.0%	159
Disposable Diapers	9.1%	3.6%	341
Animal Excrement/Litter	2.5%	2.0%	94
Remainder/Composite Organic	1.6%	1.2%	61
Wood Waste	**1.3%**		**50**
Dimensional Lumber	0.4%	0.6%	16
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.0%	0.0%	0
Other Untreated Wood	0.0%	0.0%	0
Painted Wood	0.0%	0.0%	0
Treated Wood	0.6%	1.0%	23
Remainder/Composite Wood	0.3%	0.5%	11
C&D Waste	**2.3%**		**87**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.0%	0.0%	0
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.0%	0.0%	0
Carpet Padding	0.6%	1.0%	23
Soil, Rocks, and Sand	0.9%	1.2%	35
Ceramics and Brick	0.2%	0.3%	7
Remainder/Composite Construction	0.6%	1.0%	22
E-Waste	**1.6%**		**60**
Televisions and CRTs	1.6%	2.7%	60
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**0.1%**		**4**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	0
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.1%	0.1%	3
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.0%**		**0**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.0%	0.0%	0
Totals	**100.0%**		**3,751**
Sample Count			9

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

Table D-11. Detailed Disposed Waste Composition Results: Multifamily, Summer

Material	Est. Percent	+ / -	Est. Tons
Paper	**17.5%**		**655**
Newspaper	1.6%	0.5%	61
Uncoated OCC/Kraft Paper	3.1%	1.4%	116
High-grade Paper	0.5%	0.5%	20
Low-grade Paper	5.3%	1.0%	199
Waxed OCC	0.0%	0.1%	2
Pizza Boxes	0.2%	0.1%	6
Compostable/Soiled Paper	5.1%	0.7%	190
Pot. Comp. Single-use Food Service Paper	0.8%	0.3%	29
Non-comp. Single-use Food Service Paper	0.2%	0.1%	6
Remainder/Composite Paper	0.7%	0.3%	25
Plastic	**9.6%**		**359**
#1 PET Bottles	1.1%	0.4%	40
#2 HDPE Bottles	0.6%	0.1%	21
#1-#7 Other Containers	0.8%	0.2%	29
Expanded Polystyrene Food grade	0.4%	0.1%	14
Expanded Polystyrene Non-food Grade	0.2%	0.2%	9
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.4%	0.2%	15
Clean Shopping/Dry Cleaning Bags	0.8%	0.2%	29
Other Clean PE Film	0.1%	0.1%	2
Other Film	3.1%	0.2%	117
Durable Plastic Products	1.6%	0.6%	60
Remainder/Composite Plastics	0.6%	0.3%	23
Glass	**3.9%**		**144**
Clear Glass Containers	1.5%	0.6%	58
Green Glass Containers	0.4%	0.3%	15
Brown Glass Containers	0.1%	0.1%	4
Plate Glass	0.2%	0.3%	6
Remainder/Composite Glass	1.6%	0.9%	61
Metal	**4.8%**		**180**
Aluminum Beverage Cans	0.4%	0.1%	16
Aluminum Foil/Containers	0.3%	0.1%	11
Other Non-ferrous	0.1%	0.1%	4
Tin Food Cans	0.6%	0.2%	22
Empty Aerosol Cans	0.1%	0.1%	4
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	2.9%	2.9%	108
Remainder/Composite Metal	0.4%	0.3%	15
Organics	**61.4%**		**2,297**
Food Waste, Vegetative	25.6%	4.5%	959
Other Food Waste	6.5%	3.3%	245
Leaves and Grass	1.3%	1.0%	48
Prunings and Trimmings	0.0%	0.0%	0
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	7.1%	3.5%	266
Disposable Diapers	12.1%	3.2%	451
Animal Excrement/Litter	7.6%	1.8%	284
Remainder/Composite Organic	1.2%	0.3%	44

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**0.7%**		**25**
Dimensional Lumber	0.0%	0.0%	1
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.0%	0.0%	0
Other Untreated Wood	0.1%	0.1%	3
Painted Wood	0.5%	0.4%	19
Treated Wood	0.0%	0.0%	0
Remainder/Composite Wood	0.0%	0.1%	2
C&D Waste	**0.7%**		**28**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.0%	0.0%	0
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.0%	0.0%	0
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	0.2%	0.3%	9
Ceramics and Brick	0.5%	0.8%	19
Remainder/Composite Construction	0.0%	0.0%	0
E-Waste	**0.0%**		**0**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**0.7%**		**27**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.1%	2
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.5%	0.7%	18
Dry-cell Batteries	0.0%	0.0%	1
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	1
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.1%	0.2%	6
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.7%**		**26**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.7%	1.1%	26
Totals	**100.0%**		**3,741**
Sample Count			11

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

Detailed Commercial (non-C&D) Disposed Waste Tables

Table D-12. Detailed Disposed Waste Composition Results: Commercial Packer, Fall

Material	Est. Percent	+ / -	Est. Tons
Paper	**17.7%**		**1,414**
Newspaper	0.9%	0.5%	74
Uncoated OCC/Kraft Paper	3.6%	1.3%	292
High-grade Paper	0.7%	0.4%	59
Low-grade Paper	3.6%	1.8%	288
Waxed OCC	0.1%	0.1%	11
Pizza Boxes	0.1%	0.1%	10
Compostable/Soiled Paper	5.0%	1.7%	404
Pot. Comp. Single-use Food Service Paper	0.5%	0.5%	39
Non-comp. Single-use Food Service Paper	1.7%	1.6%	135
Remainder/Composite Paper	1.3%	0.7%	104
Plastic	**13.6%**		**1,091**
#1 PET Bottles	0.6%	0.3%	47
#2 HDPE Bottles	0.4%	0.2%	32
#1-#7 Other Containers	1.2%	1.0%	94
Expanded Polystyrene Food grade	0.3%	0.1%	21
Expanded Polystyrene Non-food Grade	0.2%	0.1%	15
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.6%	0.3%	46
Clean Shopping/Dry Cleaning Bags	0.2%	0.1%	16
Other Clean PE Film	1.6%	2.0%	127
Other Film	5.9%	2.5%	472
Durable Plastic Products	1.2%	1.1%	94
Remainder/Composite Plastics	1.6%	1.3%	127
Glass	**8.7%**		**697**
Clear Glass Containers	2.0%	1.9%	162
Green Glass Containers	0.5%	0.3%	37
Brown Glass Containers	1.0%	1.2%	77
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	5.2%	8.3%	420
Metal	**4.7%**		**374**
Aluminum Beverage Cans	0.4%	0.2%	32
Aluminum Foil/Containers	0.1%	0.1%	7
Other Non-ferrous	0.0%	0.0%	0
Tin Food Cans	0.1%	0.1%	10
Empty Aerosol Cans	0.1%	0.1%	6
Major Appliances	0.0%	0.0%	0
Oil filters	0.1%	0.2%	9
Other Ferrous	2.7%	2.4%	219
Remainder/Composite Metal	1.1%	1.0%	92
Organics	**46.1%**		**3,694**
Food Waste, Vegetative	18.5%	6.4%	1,479
Other Food Waste	7.5%	4.0%	602
Leaves and Grass	12.2%	12.3%	976
Prunings and Trimmings	0.0%	0.0%	0
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	3.3%	1.8%	264
Disposable Diapers	1.4%	1.6%	110
Animal Excrement/Litter	2.1%	1.7%	168
Remainder/Composite Organic	1.2%	0.6%	96
Wood Waste	**2.8%**		**227**
Dimensional Lumber	0.2%	0.3%	20
Pallets and Crates	1.4%	2.4%	115
Engineered Wood	0.6%	0.9%	46
Other Untreated Wood	0.1%	0.1%	6
Painted Wood	0.0%	0.0%	2
Treated Wood	0.3%	0.4%	25
Remainder/Composite Wood	0.2%	0.3%	13
C&D Waste	**2.0%**		**158**
Concrete	0.6%	1.0%	48
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.2%	0.4%	18
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.0%	0.0%	0
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	1.1%	1.9%	91
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	0.0%	0.0%	0
E-Waste	**0.0%**		**2**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	2
Household Hazardous	**0.4%**		**29**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.1%	4
Dry-cell Batteries	0.0%	0.0%	1
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.1%	0.1%	5
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.2%	0.4%	20
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**4.0%**		**323**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	4.0%	5.1%	323
Totals	**100.0%**		**8,008**
Sample Count			11

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

Table D-13. Detailed Disposed Waste Composition Results: Commercial Packer, Spring

Material	Est. Percent	+ / -	Est. Tons
Paper	**28.0%**		**2,111**
Newspaper	1.1%	0.7%	79
Uncoated OCC/Kraft Paper	3.8%	2.6%	287
High-grade Paper	1.5%	1.3%	110
Low-grade Paper	4.1%	1.7%	307
Waxed OCC	1.9%	3.0%	141
Pizza Boxes	0.3%	0.2%	22
Compostable/Soiled Paper	7.3%	4.8%	550
Pot. Comp. Single-use Food Service Paper	1.1%	0.9%	82
Non-comp. Single-use Food Service Paper	0.3%	0.5%	25
Remainder/Composite Paper	6.7%	7.4%	508
Plastic	**12.5%**		**940**
#1 PET Bottles	0.7%	0.4%	55
#2 HDPE Bottles	0.9%	0.6%	70
#1-#7 Other Containers	0.6%	0.3%	43
Expanded Polystyrene Food grade	0.5%	0.6%	36
Expanded Polystyrene Non-food Grade	0.1%	0.1%	11
Pot. Comp. Single-use Food Service Plastic	0.5%	0.4%	40
Non-comp. Single-use Food Service Plastic	0.2%	0.2%	12
Clean Shopping/Dry Cleaning Bags	0.1%	0.1%	9
Other Clean PE Film	0.4%	0.7%	30
Other Film	6.9%	2.8%	521
Durable Plastic Products	0.4%	0.5%	32
Remainder/Composite Plastics	1.1%	1.3%	80
Glass	**3.3%**		**247**
Clear Glass Containers	1.1%	0.5%	85
Green Glass Containers	0.4%	0.3%	29
Brown Glass Containers	1.6%	2.1%	119
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.2%	0.2%	14
Metal	**1.4%**		**104**
Aluminum Beverage Cans	0.3%	0.2%	23
Aluminum Foil/Containers	0.2%	0.1%	13
Other Non-ferrous	0.0%	0.0%	2
Tin Food Cans	0.6%	0.3%	47
Empty Aerosol Cans	0.1%	0.1%	9
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	0.1%	0.1%	6
Remainder/Composite Metal	0.0%	0.1%	3
Organics	**45.0%**		**3,395**
Food Waste, Vegetative	23.9%	7.8%	1,801
Other Food Waste	12.1%	5.7%	911
Leaves and Grass	6.2%	7.6%	470
Prunings and Trimmings	0.6%	1.0%	44
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	0.8%	0.5%	61
Disposable Diapers	0.0%	0.1%	3
Animal Excrement/Litter	0.8%	1.0%	58
Remainder/Composite Organic	0.6%	0.5%	46

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**8.5%**		**642**
Dimensional Lumber	0.5%	0.8%	36
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	2.3%	3.5%	172
Other Untreated Wood	0.0%	0.0%	0
Painted Wood	5.0%	7.0%	374
Treated Wood	0.7%	1.1%	51
Remainder/Composite Wood	0.1%	0.2%	8
C&D Waste	**0.4%**		**33**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.0%	0.0%	0
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.4%	0.7%	33
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	0.0%	0.0%	0
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	0.0%	0.0%	0
E-Waste	**0.2%**		**18**
Televisions and CRTs	0.2%	0.4%	16
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	2
Household Hazardous	**0.6%**		**45**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	2
Dry-cell Batteries	0.0%	0.0%	0
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.5%	0.7%	40
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.1%	2
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.1%**		**5**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.1%	0.1%	5
Totals	**100.0%**		**7,541**
Sample Count			10

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

Table D-14. Detailed Disposed Waste Composition Results: Commercial Packer, Summer

Material	Est. Percent	+ / -	Est. Tons
Paper	**23.4%**		**1,789**
Newspaper	1.4%	1.1%	108
Uncoated OCC/Kraft Paper	4.1%	1.7%	310
High-grade Paper	1.3%	1.0%	96
Low-grade Paper	5.7%	3.0%	432
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.1%	0.1%	10
Compostable/Soiled Paper	7.0%	1.6%	534
Pot. Comp. Single-use Food Service Paper	1.5%	0.7%	111
Non-comp. Single-use Food Service Paper	0.1%	0.1%	6
Remainder/Composite Paper	2.4%	1.2%	183
Plastic	**14.0%**		**1,069**
#1 PET Bottles	0.9%	0.3%	71
#2 HDPE Bottles	0.5%	0.2%	38
#1-#7 Other Containers	0.6%	0.3%	47
Expanded Polystyrene Food grade	0.1%	0.1%	11
Expanded Polystyrene Non-food Grade	0.3%	0.3%	24
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	1
Non-comp. Single-use Food Service Plastic	1.0%	0.6%	74
Clean Shopping/Dry Cleaning Bags	0.4%	0.2%	33
Other Clean PE Film	2.6%	2.5%	197
Other Film	4.9%	0.9%	371
Durable Plastic Products	1.1%	0.6%	87
Remainder/Composite Plastics	1.5%	0.6%	114
Glass	**2.9%**		**221**
Clear Glass Containers	0.9%	0.9%	71
Green Glass Containers	0.6%	0.9%	48
Brown Glass Containers	0.5%	0.3%	35
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.9%	0.5%	68
Metal	**4.4%**		**334**
Aluminum Beverage Cans	0.3%	0.1%	27
Aluminum Foil/Containers	0.1%	0.1%	10
Other Non-ferrous	0.0%	0.0%	2
Tin Food Cans	1.0%	0.8%	75
Empty Aerosol Cans	0.3%	0.2%	25
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	1.7%	1.5%	127
Remainder/Composite Metal	0.9%	0.6%	68
Organics	**40.4%**		**3,083**
Food Waste, Vegetative	18.6%	5.4%	1,418
Other Food Waste	5.2%	1.8%	398
Leaves and Grass	1.4%	1.4%	107
Prunings and Trimmings	0.0%	0.0%	0
Branches and Stumps	0.4%	0.7%	33
Textiles and Clothing	6.1%	4.1%	464
Disposable Diapers	4.6%	4.0%	348
Animal Excrement/Litter	1.9%	2.0%	143
Remainder/Composite Organic	2.3%	1.1%	172
Wood Waste	**7.0%**		**533**
Dimensional Lumber	4.1%	5.8%	317
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	1.0%	0.9%	78
Other Untreated Wood	0.0%	0.0%	1
Painted Wood	0.9%	1.0%	66
Treated Wood	0.3%	0.5%	22
Remainder/Composite Wood	0.7%	0.9%	50
C&D Waste	**3.7%**		**281**
Concrete	1.2%	2.0%	93
Clean Drywall	0.0%	0.0%	0
Other Drywall	1.9%	3.2%	147
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.0%	0.0%	0
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	0.5%	0.9%	41
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	0.0%	0.0%	0
E-Waste	**0.8%**		**60**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.8%	0.9%	60
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**3.4%**		**257**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	1
Wet-cell Batteries	0.2%	0.3%	15
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	2.8%	3.7%	213
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.3%	0.4%	20
Other Potentially Hazardous	0.1%	0.2%	9
Other Waste	**0.1%**		**9**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.1%	0.2%	9
Totals	**100.0%**		**7,637**
Sample Count			10

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

Table D-15. Detailed Disposed Waste Composition Results: Commercial Roll-off, Fall

Material	Est. Percent	+ / -	Est. Tons
Paper	**34.7%**		**3,533**
Newspaper	2.1%	2.1%	211
Uncoated OCC/Kraft Paper	6.7%	3.3%	683
High-grade Paper	2.0%	2.2%	203
Low-grade Paper	8.4%	5.4%	853
Waxed OCC	0.1%	0.2%	13
Pizza Boxes	0.0%	0.0%	0
Compostable/Soiled Paper	8.6%	4.8%	872
Pot. Comp. Single-use Food Service Paper	0.6%	0.8%	57
Non-comp. Single-use Food Service Paper	0.7%	0.6%	67
Remainder/Composite Paper	5.6%	6.1%	574
Plastic	**24.4%**		**2,484**
#1 PET Bottles	0.6%	0.4%	58
#2 HDPE Bottles	0.3%	0.2%	27
#1-#7 Other Containers	0.8%	0.6%	84
Expanded Polystyrene Food grade	0.6%	0.5%	61
Expanded Polystyrene Non-food Grade	0.6%	1.0%	64
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	1
Non-comp. Single-use Food Service Plastic	0.7%	0.7%	72
Clean Shopping/Dry Cleaning Bags	0.1%	0.1%	13
Other Clean PE Film	3.5%	5.9%	361
Other Film	9.2%	3.0%	932
Durable Plastic Products	1.0%	0.7%	99
Remainder/Composite Plastics	7.0%	10.2%	712
Glass	**0.6%**		**61**
Clear Glass Containers	0.5%	0.5%	50
Green Glass Containers	0.0%	0.0%	2
Brown Glass Containers	0.1%	0.1%	9
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.0%	0.0%	0
Metal	**3.4%**		**342**
Aluminum Beverage Cans	0.2%	0.2%	25
Aluminum Foil/Containers	0.1%	0.1%	11
Other Non-ferrous	0.1%	0.2%	10
Tin Food Cans	0.2%	0.1%	16
Empty Aerosol Cans	0.1%	0.1%	5
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	1.5%	2.4%	154
Remainder/Composite Metal	1.2%	1.3%	122
Organics	**26.4%**		**2,683**
Food Waste, Vegetative	15.7%	10.1%	1,599
Other Food Waste	4.0%	3.5%	412
Leaves and Grass	0.0%	0.0%	0
Prunings and Trimmings	0.0%	0.0%	0
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	2.2%	2.0%	223
Disposable Diapers	0.3%	0.4%	33
Animal Excrement/Litter	0.0%	0.1%	4
Remainder/Composite Organic	4.1%	4.6%	412

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**0.6%**		**65**
Dimensional Lumber	0.0%	0.1%	4
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.6%	0.7%	56
Other Untreated Wood	0.1%	0.1%	5
Painted Wood	0.0%	0.0%	0
Treated Wood	0.0%	0.0%	0
Remainder/Composite Wood	0.0%	0.0%	0
C&D Waste	**9.9%**		**1,004**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.0%	0.0%	0
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	3.7%	6.1%	381
Other Asphalt Roofing	0.0%	0.1%	3
Insulation	0.0%	0.0%	0
Carpet	0.0%	0.0%	0
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	0.0%	0.0%	0
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	6.1%	10.1%	620
E-Waste	**0.0%**		**0**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**0.0%**		**0**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	0
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.0%**		**0**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.0%	0.0%	0
Totals	**100.0%**		**10,173**
Sample Count			9

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

Table D-16. Detailed Disposed Waste Composition Results: Commercial Roll-off, Spring

Material	Est. Percent	+ / -	Est. Tons
Paper	**26.0%**		**3,077**
Newspaper	0.9%	0.6%	101
Uncoated OCC/Kraft Paper	3.4%	2.7%	399
High-grade Paper	2.4%	2.1%	288
Low-grade Paper	3.3%	1.8%	388
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.1%	0.1%	11
Compostable/Soiled Paper	3.8%	2.3%	452
Pot. Comp. Single-use Food Service Paper	0.4%	0.3%	42
Non-comp. Single-use Food Service Paper	0.4%	0.5%	52
Remainder/Composite Paper	11.4%	9.3%	1,345
Plastic	**13.2%**		**1,567**
#1 PET Bottles	0.5%	0.3%	62
#2 HDPE Bottles	0.5%	0.2%	56
#1-#7 Other Containers	0.8%	0.4%	89
Expanded Polystyrene Food grade	0.3%	0.3%	40
Expanded Polystyrene Non-food Grade	0.1%	0.1%	10
Pot. Comp. Single-use Food Service Plastic	1.0%	1.4%	122
Non-comp. Single-use Food Service Plastic	0.1%	0.1%	15
Clean Shopping/Dry Cleaning Bags	0.2%	0.1%	21
Other Clean PE Film	2.2%	1.8%	264
Other Film	3.4%	1.3%	397
Durable Plastic Products	1.6%	1.9%	186
Remainder/Composite Plastics	2.6%	1.6%	306
Glass	**3.6%**		**427**
Clear Glass Containers	2.1%	2.5%	244
Green Glass Containers	0.4%	0.5%	49
Brown Glass Containers	0.9%	0.9%	110
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.2%	0.2%	23
Metal	**2.7%**		**321**
Aluminum Beverage Cans	0.4%	0.2%	46
Aluminum Foil/Containers	0.0%	0.0%	0
Other Non-ferrous	0.0%	0.0%	0
Tin Food Cans	0.2%	0.2%	29
Empty Aerosol Cans	0.1%	0.1%	9
Major Appliances	0.0%	0.0%	0
Oil filters	0.1%	0.1%	9
Other Ferrous	1.5%	2.1%	180
Remainder/Composite Metal	0.4%	0.4%	48
Organics	**24.5%**		**2,901**
Food Waste, Vegetative	8.0%	4.3%	943
Other Food Waste	6.4%	5.6%	761
Leaves and Grass	4.5%	4.8%	536
Prunings and Trimmings	0.0%	0.0%	0
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	2.7%	2.1%	321
Disposable Diapers	1.2%	1.6%	141
Animal Excrement/Litter	0.0%	0.0%	0
Remainder/Composite Organic	1.7%	1.8%	199

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**16.9%**		**2,002**
Dimensional Lumber	1.8%	2.7%	219
Pallets and Crates	10.2%	13.0%	1,207
Engineered Wood	4.0%	5.0%	475
Other Untreated Wood	0.1%	0.2%	14
Painted Wood	0.2%	0.3%	29
Treated Wood	0.0%	0.0%	0
Remainder/Composite Wood	0.5%	0.8%	58
C&D Waste	**5.8%**		**685**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.0%	0.0%	0
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.0%	0.0%	0
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	3.8%	5.4%	449
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	2.0%	2.7%	236
E-Waste	**0.3%**		**33**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.3%	0.5%	33
Household Hazardous	**6.4%**		**763**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	0
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	6.4%	10.4%	762
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.5%**		**63**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.5%	0.9%	63
Totals	**100.0%**		**11,839**
Sample Count			11

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

Table D-17. Detailed Disposed Waste Composition Results: Commercial Roll-off, Summer

Material	Est. Percent	+ / -	Est. Tons
Paper	**16.6%**		**2,149**
Newspaper	1.6%	1.2%	211
Uncoated OCC/Kraft Paper	2.1%	0.7%	278
High-grade Paper	0.6%	0.4%	77
Low-grade Paper	2.3%	1.2%	294
Waxed OCC	0.6%	0.9%	73
Pizza Boxes	0.1%	0.2%	14
Compostable/Soiled Paper	5.9%	2.3%	771
Pot. Comp. Single-use Food Service Paper	2.1%	1.3%	268
Non-comp. Single-use Food Service Paper	0.0%	0.1%	5
Remainder/Composite Paper	1.2%	0.7%	157
Plastic	**19.5%**		**2,526**
#1 PET Bottles	4.2%	4.4%	542
#2 HDPE Bottles	0.6%	0.7%	75
#1-#7 Other Containers	0.5%	0.3%	62
Expanded Polystyrene Food grade	0.5%	0.4%	65
Expanded Polystyrene Non-food Grade	0.1%	0.1%	15
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	1
Non-comp. Single-use Food Service Plastic	0.8%	0.7%	104
Clean Shopping/Dry Cleaning Bags	0.3%	0.2%	44
Other Clean PE Film	0.3%	0.4%	35
Other Film	4.2%	1.4%	540
Durable Plastic Products	3.8%	3.4%	496
Remainder/Composite Plastics	4.2%	5.8%	548
Glass	**6.7%**		**873**
Clear Glass Containers	1.5%	1.3%	197
Green Glass Containers	0.7%	0.8%	85
Brown Glass Containers	1.9%	2.3%	250
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	2.6%	4.2%	341
Metal	**5.5%**		**709**
Aluminum Beverage Cans	0.6%	0.6%	77
Aluminum Foil/Containers	0.1%	0.1%	15
Other Non-ferrous	0.0%	0.1%	6
Tin Food Cans	0.2%	0.2%	26
Empty Aerosol Cans	0.5%	0.8%	60
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	3.5%	4.0%	458
Remainder/Composite Metal	0.5%	0.5%	66
Organics	**39.9%**		**5,179**
Food Waste, Vegetative	21.5%	9.0%	2,796
Other Food Waste	5.9%	3.2%	765
Leaves and Grass	2.1%	2.3%	269
Prunings and Trimmings	0.0%	0.0%	2
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	1.2%	0.7%	157
Disposable Diapers	0.6%	0.6%	79
Animal Excrement/Litter	3.8%	5.7%	491
Remainder/Composite Organic	4.8%	6.8%	620

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**10.2%**		**1,323**
Dimensional Lumber	7.5%	11.3%	972
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.2%	0.3%	23
Other Untreated Wood	0.1%	0.1%	8
Painted Wood	1.9%	2.7%	240
Treated Wood	0.6%	1.0%	79
Remainder/Composite Wood	0.0%	0.0%	0
C&D Waste	**1.1%**		**139**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.0%	0.0%	0
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.5%	0.8%	64
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.6%	0.9%	75
Carpet	0.0%	0.0%	0
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	0.0%	0.0%	0
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	0.0%	0.0%	0
E-Waste	**0.0%**		**0**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**0.0%**		**5**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.1%	5
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.6%**		**79**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.6%	1.0%	79
Totals	**100.0%**		**12,981**
Sample Count			8

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

Table D-18. Detailed Disposed Waste Composition Results: School Waste, Fall

Material	Est. Percent	+ / -	Est. Tons
Paper	**1.2%**		**12**
Newspaper	0.0%	0.0%	0
Uncoated OCC/Kraft Paper	0.2%	0.4%	2
High-grade Paper	0.0%	0.0%	0
Low-grade Paper	0.2%	0.3%	2
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.1%	0.1%	1
Compostable/Soiled Paper	0.4%	0.9%	4
Pot. Comp. Single-use Food Service Paper	0.1%	0.2%	1
Non-comp. Single-use Food Service Paper	0.3%	0.7%	3
Remainder/Composite Paper	0.0%	0.0%	0
Plastic	**2.3%**		**23**
#1 PET Bottles	0.0%	0.1%	0
#2 HDPE Bottles	0.0%	0.1%	0
#1-#7 Other Containers	0.1%	0.1%	1
Expanded Polystyrene Food grade	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.0%	0.1%	0
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	0
Other Clean PE Film	0.0%	0.0%	0
Other Film	0.6%	1.1%	6
Durable Plastic Products	1.5%	0.2%	14
Remainder/Composite Plastics	0.1%	0.1%	1
Glass	**0.0%**		**0**
Clear Glass Containers	0.0%	0.0%	0
Green Glass Containers	0.0%	0.0%	0
Brown Glass Containers	0.0%	0.0%	0
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.0%	0.0%	0
Metal	**0.1%**		**1**
Aluminum Beverage Cans	0.0%	0.0%	0
Aluminum Foil/Containers	0.0%	0.0%	0
Other Non-ferrous	0.0%	0.0%	0
Tin Food Cans	0.1%	0.2%	1
Empty Aerosol Cans	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	0.0%	0.0%	0
Remainder/Composite Metal	0.0%	0.0%	0
Organics	**3.6%**		**36**
Food Waste, Vegetative	1.8%	3.8%	18
Other Food Waste	0.5%	1.0%	5
Leaves and Grass	0.8%	2.0%	7
Prunings and Trimmings	0.0%	0.0%	0
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	0.0%	0.1%	0
Disposable Diapers	0.0%	0.1%	0
Animal Excrement/Litter	0.5%	1.2%	5
Remainder/Composite Organic	0.0%	0.0%	0
Wood Waste	**58.7%**		**575**
Dimensional Lumber	14.7%	1.9%	144
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.0%	0.0%	0
Other Untreated Wood	20.5%	2.6%	201
Painted Wood	23.5%	3.0%	230
Treated Wood	0.0%	0.0%	0
Remainder/Composite Wood	0.0%	0.0%	0
C&D Waste	**25.4%**		**249**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	24.8%	3.2%	243
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.0%	0.0%	0
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	0.0%	0.0%	0
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	0.5%	0.2%	5
E-Waste	**0.0%**		**0**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**0.0%**		**0**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	0
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**8.7%**		**85**
Furniture	8.7%	1.1%	85
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.0%	0.0%	0
Totals	**100.0%**		**981**
Sample Count			4

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

Table D-19. Detailed Disposed Waste Composition Results: School Waste, Spring

Material	Est. Percent	+ / -	Est. Tons
Paper	**17.6%**		**138**
Newspaper	0.1%	0.1%	0
Uncoated OCC/Kraft Paper	0.8%	0.7%	6
High-grade Paper	0.6%	0.6%	5
Low-grade Paper	3.6%	3.1%	28
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.2%	0.4%	2
Compostable/Soiled Paper	6.0%	4.8%	47
Pot. Comp. Single-use Food Service Paper	1.7%	2.1%	13
Non-comp. Single-use Food Service Paper	1.2%	1.9%	9
Remainder/Composite Paper	3.4%	3.2%	27
Plastic	**7.4%**		**58**
#1 PET Bottles	0.6%	0.7%	5
#2 HDPE Bottles	0.3%	0.4%	2
#1-#7 Other Containers	0.8%	1.0%	6
Expanded Polystyrene Food grade	0.0%	0.1%	0
Expanded Polystyrene Non-food Grade	0.1%	0.2%	1
Pot. Comp. Single-use Food Service Plastic	0.4%	0.7%	3
Non-comp. Single-use Food Service Plastic	0.1%	0.1%	1
Clean Shopping/Dry Cleaning Bags	0.0%	0.1%	0
Other Clean PE Film	0.0%	0.0%	0
Other Film	4.2%	3.4%	33
Durable Plastic Products	0.4%	0.5%	3
Remainder/Composite Plastics	0.6%	0.6%	4
Glass	**1.6%**		**12**
Clear Glass Containers	0.5%	0.6%	4
Green Glass Containers	0.3%	0.4%	2
Brown Glass Containers	0.5%	0.7%	4
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.3%	0.5%	2
Metal	**0.5%**		**4**
Aluminum Beverage Cans	0.1%	0.1%	1
Aluminum Foil/Containers	0.1%	0.1%	1
Other Non-ferrous	0.0%	0.0%	0
Tin Food Cans	0.2%	0.3%	2
Empty Aerosol Cans	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	0.0%	0.1%	0
Remainder/Composite Metal	0.1%	0.1%	0
Organics	**36.3%**		**285**
Food Waste, Vegetative	11.6%	9.8%	91
Other Food Waste	23.2%	18.3%	182
Leaves and Grass	0.4%	0.5%	3
Prunings and Trimmings	0.1%	0.1%	0
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	0.6%	0.8%	4
Disposable Diapers	0.3%	0.5%	2
Animal Excrement/Litter	0.0%	0.0%	0
Remainder/Composite Organic	0.2%	0.2%	1

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**0.0%**		**0**
Dimensional Lumber	0.0%	0.0%	0
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.0%	0.0%	0
Other Untreated Wood	0.0%	0.0%	0
Painted Wood	0.0%	0.0%	0
Treated Wood	0.0%	0.0%	0
Remainder/Composite Wood	0.0%	0.0%	0
C&D Waste	**36.7%**		**288**
Concrete	34.4%	44.6%	270
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.0%	0.0%	0
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.0%	0.0%	0
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	2.3%	2.9%	18
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	0.0%	0.0%	0
E-Waste	**0.0%**		**0**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**0.0%**		**0**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	0
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.0%**		**0**
Furniture	0.0%	0.0%	0
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.0%	0.0%	0
Totals	**100.0%**		**786**
Sample Count			5

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

Table D-20. Detailed Disposed Waste Composition Results: School Waste, Summer

Material	Est. Percent	+ / -	Est. Tons
Paper	**3.3%**		**23**
Newspaper	0.0%	0.0%	0
Uncoated OCC/Kraft Paper	1.3%	1.6%	9
High-grade Paper	0.4%	0.9%	3
Low-grade Paper	0.6%	1.3%	4
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.0%	0.0%	0
Compostable/Soiled Paper	0.3%	0.6%	2
Pot. Comp. Single-use Food Service Paper	0.0%	0.1%	0
Non-comp. Single-use Food Service Paper	0.0%	0.0%	0
Remainder/Composite Paper	0.7%	1.5%	5
Plastic	**5.5%**		**39**
#1 PET Bottles	0.0%	0.0%	0
#2 HDPE Bottles	0.1%	0.2%	1
#1-#7 Other Containers	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.0%	0.1%	0
Other Clean PE Film	0.0%	0.0%	0
Other Film	0.1%	0.2%	1
Durable Plastic Products	5.0%	6.7%	35
Remainder/Composite Plastics	0.3%	0.7%	2
Glass	**0.0%**		**0**
Clear Glass Containers	0.0%	0.1%	0
Green Glass Containers	0.0%	0.0%	0
Brown Glass Containers	0.0%	0.0%	0
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.0%	0.0%	0
Metal	**5.7%**		**40**
Aluminum Beverage Cans	0.0%	0.0%	0
Aluminum Foil/Containers	0.0%	0.0%	0
Other Non-ferrous	5.6%	7.3%	39
Tin Food Cans	0.0%	0.1%	0
Empty Aerosol Cans	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	0.1%	0.1%	0
Remainder/Composite Metal	0.0%	0.0%	0
Organics	**31.4%**		**220**
Food Waste, Vegetative	0.1%	0.2%	1
Other Food Waste	0.0%	0.0%	0
Leaves and Grass	31.0%	40.7%	217
Prunings and Trimmings	0.0%	0.0%	0
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	0.1%	0.2%	0
Disposable Diapers	0.2%	0.4%	1
Animal Excrement/Litter	0.0%	0.0%	0
Remainder/Composite Organic	0.1%	0.1%	0

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**2.2%**		**15**
Dimensional Lumber	0.9%	1.1%	6
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	0.0%	0.0%	0
Other Untreated Wood	0.0%	0.0%	0
Painted Wood	1.3%	1.7%	9
Treated Wood	0.0%	0.0%	0
Remainder/Composite Wood	0.1%	0.2%	1
C&D Waste	**40.2%**		**282**
Concrete	0.0%	0.0%	0
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.0%	0.0%	0
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	0.0%	0.0%	0
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	40.2%	55.7%	282
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	0.0%	0.0%	0
E-Waste	**0.0%**		**0**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**0.0%**		**0**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	0
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**11.7%**		**82**
Furniture	11.6%	12.5%	81
Tires	0.0%	0.0%	0
Mattresses	0.0%	0.0%	0
Non-distinct Fines	0.2%	0.3%	1
Totals	**100.0%**		**701**
Sample Count			4

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

Detailed Self-haul (non-C&D) Disposed Waste Tables

Table D-21. Detailed Disposed Waste Composition Results: Overall Self-haul, Fall

Material	Est. Percent	+ / -	Est. Tons
Paper	**13.0%**		**1,507**
Newspaper	0.6%	0.5%	75
Uncoated OCC/Kraft Paper	4.8%	3.7%	562
High-grade Paper	0.3%	0.2%	33
Low-grade Paper	1.2%	0.8%	143
Waxed OCC	0.3%	0.5%	40
Pizza Boxes	0.1%	0.1%	6
Compostable/Soiled Paper	0.4%	0.3%	50
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	0
Non-comp. Single-use Food Service Paper	0.1%	0.1%	9
Remainder/Composite Paper	5.1%	4.8%	591
Plastic	**8.2%**		**954**
#1 PET Bottles	0.1%	0.1%	9
#2 HDPE Bottles	0.1%	0.1%	8
#1-#7 Other Containers	0.2%	0.2%	18
Expanded Polystyrene Food grade	0.0%	0.0%	1
Expanded Polystyrene Non-food Grade	0.0%	0.0%	3
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	2
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	1
Other Clean PE Film	0.0%	0.0%	1
Other Film	1.3%	0.9%	146
Durable Plastic Products	3.9%	3.7%	458
Remainder/Composite Plastics	2.6%	2.5%	307
Glass	**4.0%**		**461**
Clear Glass Containers	0.1%	0.1%	12
Green Glass Containers	0.0%	0.1%	4
Brown Glass Containers	0.1%	0.1%	12
Plate Glass	2.7%	3.2%	309
Remainder/Composite Glass	1.1%	1.1%	123
Metal	**4.3%**		**497**
Aluminum Beverage Cans	0.0%	0.0%	1
Aluminum Foil/Containers	0.0%	0.0%	0
Other Non-ferrous	0.0%	0.0%	2
Tin Food Cans	0.0%	0.0%	1
Empty Aerosol Cans	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	3.7%	3.4%	434
Remainder/Composite Metal	0.5%	0.4%	59
Organics	**20.8%**		**2,414**
Food Waste, Vegetative	2.7%	2.5%	318
Other Food Waste	0.6%	0.6%	70
Leaves and Grass	9.8%	7.9%	1,146
Prunings and Trimmings	2.0%	3.2%	231
Branches and Stumps	0.6%	1.0%	70
Textiles and Clothing	4.4%	5.2%	508
Disposable Diapers	0.0%	0.0%	2
Animal Excrement/Litter	0.5%	0.5%	55
Remainder/Composite Organic	0.1%	0.1%	16
Wood Waste	**10.9%**		**1,267**
Dimensional Lumber	3.0%	2.1%	349
Pallets and Crates	0.0%	0.1%	5
Engineered Wood	2.6%	3.5%	304
Other Untreated Wood	0.7%	0.7%	78
Painted Wood	2.7%	3.3%	310
Treated Wood	0.6%	0.6%	66
Remainder/Composite Wood	1.3%	1.7%	154
C&D Waste	**9.0%**		**1,048**
Concrete	1.3%	1.7%	157
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.0%	0.0%	0
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.1%	0.1%	10
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.3%	0.5%	36
Carpet	3.7%	5.5%	429
Carpet Padding	0.1%	0.3%	17
Soil, Rocks, and Sand	1.2%	2.1%	141
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	2.2%	2.2%	257
E-Waste	**0.2%**		**28**
Televisions and CRTs	0.2%	0.3%	24
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	4
Household Hazardous	**0.0%**		**0**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	0
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**29.7%**		**3,457**
Furniture	17.9%	14.2%	2,082
Tires	0.0%	0.0%	0
Mattresses	11.8%	15.3%	1,374
Non-distinct Fines	0.0%	0.0%	0
Totals	**100.0%**		**11,634**
Sample Count			43

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

Table D-22. Detailed Disposed Waste Composition Results: Overall Self-haul, Spring

Material	Est. Percent	+ / -	Est. Tons
Paper	**6.3%**		**444**
Newspaper	0.3%	0.2%	21
Uncoated OCC/Kraft Paper	1.8%	1.6%	127
High-grade Paper	0.3%	0.2%	20
Low-grade Paper	1.0%	0.6%	71
Waxed OCC	0.0%	0.0%	2
Pizza Boxes	0.2%	0.1%	12
Compostable/Soiled Paper	0.8%	0.5%	58
Pot. Comp. Single-use Food Service Paper	0.1%	0.1%	6
Non-comp. Single-use Food Service Paper	0.1%	0.1%	8
Remainder/Composite Paper	1.7%	1.0%	118
Plastic	**1.6%**		**114**
#1 PET Bottles	0.1%	0.1%	6
#2 HDPE Bottles	0.0%	0.0%	3
#1-#7 Other Containers	0.1%	0.0%	6
Expanded Polystyrene Food grade	0.0%	0.0%	2
Expanded Polystyrene Non-food Grade	0.0%	0.1%	3
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	2
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	1
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	1
Other Clean PE Film	0.0%	0.0%	1
Other Film	0.4%	0.2%	26
Durable Plastic Products	0.7%	0.4%	50
Remainder/Composite Plastics	0.2%	0.2%	14
Glass	**2.1%**		**147**
Clear Glass Containers	0.3%	0.4%	19
Green Glass Containers	0.0%	0.0%	0
Brown Glass Containers	0.3%	0.4%	19
Plate Glass	0.9%	1.5%	62
Remainder/Composite Glass	0.7%	1.1%	47
Metal	**8.0%**		**569**
Aluminum Beverage Cans	0.1%	0.0%	5
Aluminum Foil/Containers	0.0%	0.0%	2
Other Non-ferrous	0.5%	0.4%	38
Tin Food Cans	0.3%	0.3%	22
Empty Aerosol Cans	0.1%	0.1%	10
Major Appliances	2.4%	3.9%	168
Oil filters	0.0%	0.0%	0
Other Ferrous	2.8%	3.0%	196
Remainder/Composite Metal	1.8%	1.3%	128
Organics	**23.8%**		**1,687**
Food Waste, Vegetative	2.9%	2.7%	202
Other Food Waste	1.4%	1.2%	103
Leaves and Grass	13.2%	8.5%	939
Prunings and Trimmings	4.2%	3.0%	299
Branches and Stumps	0.1%	0.2%	6
Textiles and Clothing	1.0%	0.9%	71
Disposable Diapers	0.4%	0.5%	29
Animal Excrement/Litter	0.2%	0.3%	16
Remainder/Composite Organic	0.3%	0.3%	21

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**38.0%**		**2,698**
Dimensional Lumber	12.4%	7.0%	879
Pallets and Crates	0.0%	0.0%	0
Engineered Wood	8.5%	9.1%	604
Other Untreated Wood	0.1%	0.1%	6
Painted Wood	9.4%	6.6%	664
Treated Wood	5.2%	6.6%	367
Remainder/Composite Wood	2.5%	2.8%	178
C&D Waste	**8.8%**		**625**
Concrete	0.0%	0.0%	0
Clean Drywall	1.3%	2.1%	89
Other Drywall	2.5%	3.0%	175
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	0.4%	0.7%	30
Other Asphalt Roofing	0.2%	0.3%	13
Insulation	0.0%	0.0%	2
Carpet	2.1%	3.4%	150
Carpet Padding	0.0%	0.0%	0
Soil, Rocks, and Sand	1.1%	0.9%	76
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	1.3%	1.6%	92
E-Waste	**0.0%**		**0**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**1.3%**		**94**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.5%	0.8%	38
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.1%	0.2%	8
House Cleaners and Chemicals	0.7%	1.0%	48
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**10.1%**		**716**
Furniture	5.4%	3.9%	385
Tires	0.0%	0.0%	0
Mattresses	3.6%	2.9%	255
Non-distinct Fines	1.1%	1.3%	76
Totals	**100.0%**		**7,093**
Sample Count			45

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

Table D-23. Detailed Disposed Waste Composition Results: Overall Self-haul, Summer

Material	Est. Percent	+ / -	Est. Tons
Paper	**5.7%**		**653**
Newspaper	0.7%	0.9%	83
Uncoated OCC/Kraft Paper	4.2%	6.2%	477
High-grade Paper	0.0%	0.0%	0
Low-grade Paper	0.4%	0.6%	48
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.0%	0.0%	1
Compostable/Soiled Paper	0.0%	0.0%	3
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	1
Non-comp. Single-use Food Service Paper	0.0%	0.0%	1
Remainder/Composite Paper	0.3%	0.4%	39
Plastic	**3.2%**		**367**
#1 PET Bottles	0.2%	0.2%	17
#2 HDPE Bottles	0.0%	0.0%	3
#1-#7 Other Containers	0.0%	0.0%	2
Expanded Polystyrene Food grade	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	0
Other Clean PE Film	0.0%	0.0%	0
Other Film	0.1%	0.1%	15
Durable Plastic Products	1.4%	1.1%	162
Remainder/Composite Plastics	1.5%	1.7%	168
Glass	**1.7%**		**195**
Clear Glass Containers	0.0%	0.0%	3
Green Glass Containers	0.0%	0.0%	2
Brown Glass Containers	0.0%	0.0%	3
Plate Glass	0.5%	0.6%	60
Remainder/Composite Glass	1.1%	1.8%	128
Metal	**17.0%**		**1,935**
Aluminum Beverage Cans	0.0%	0.0%	4
Aluminum Foil/Containers	0.0%	0.0%	0
Other Non-ferrous	3.3%	3.2%	372
Tin Food Cans	0.1%	0.1%	8
Empty Aerosol Cans	0.3%	0.5%	34
Major Appliances	2.4%	3.9%	269
Oil filters	0.0%	0.0%	0
Other Ferrous	3.6%	4.3%	411
Remainder/Composite Metal	7.4%	6.3%	837
Organics	**29.8%**		**3,388**
Food Waste, Vegetative	1.3%	1.6%	145
Other Food Waste	0.0%	0.0%	0
Leaves and Grass	6.9%	6.5%	783
Prunings and Trimmings	16.6%	10.5%	1,884
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	3.9%	3.7%	446
Disposable Diapers	0.5%	0.6%	57
Animal Excrement/Litter	0.3%	0.5%	37
Remainder/Composite Organic	0.3%	0.3%	35

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**14.9%**		**1,699**
Dimensional Lumber	8.0%	5.9%	906
Pallets and Crates	1.5%	1.7%	172
Engineered Wood	0.2%	0.3%	20
Other Untreated Wood	0.0%	0.0%	0
Painted Wood	0.4%	0.6%	46
Treated Wood	0.7%	0.9%	78
Remainder/Composite Wood	4.2%	4.4%	478
C&D Waste	**14.2%**		**1,620**
Concrete	1.9%	2.4%	212
Clean Drywall	0.0%	0.0%	0
Other Drywall	0.5%	0.9%	60
Asphalt Paving	0.0%	0.0%	2
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	0.0%	0.0%	0
Insulation	0.0%	0.0%	0
Carpet	3.3%	2.9%	375
Carpet Padding	0.4%	0.7%	47
Soil, Rocks, and Sand	0.0%	0.0%	0
Ceramics and Brick	0.0%	0.0%	0
Remainder/Composite Construction	8.1%	11.4%	925
E-Waste	**3.1%**		**347**
Televisions and CRTs	3.1%	5.0%	347
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**0.0%**		**0**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	0
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**10.3%**		**1,172**
Furniture	7.2%	4.7%	814
Tires	0.0%	0.0%	0
Mattresses	3.1%	2.7%	358
Non-distinct Fines	0.0%	0.0%	0
Totals	**100.0%**		**11,376**
Sample Count			43

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

Detailed C&D Disposed Waste Tables

Table D-24. Detailed Disposed Waste Composition Results: Overall C&D, Fall

Material	Est. Percent	+ / -	Est. Tons
Paper	**4.3%**		**274**
Newspaper	0.0%	0.0%	1
Uncoated OCC/Kraft Paper	2.6%	1.3%	165
High-grade Paper	0.1%	0.1%	6
Low-grade Paper	0.4%	0.5%	26
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.0%	0.0%	0
Compostable/Soiled Paper	0.4%	0.7%	27
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	0
Non-comp. Single-use Food Service Paper	0.0%	0.0%	0
Remainder/Composite Paper	0.8%	0.6%	50
Plastic	**5.0%**		**323**
#1 PET Bottles	0.0%	0.0%	2
#2 HDPE Bottles	0.0%	0.0%	0
#1-#7 Other Containers	0.1%	0.1%	4
Expanded Polystyrene Food grade	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.1%	0.1%	3
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	1
Other Clean PE Film	0.2%	0.3%	12
Other Film	1.1%	0.8%	72
Durable Plastic Products	1.0%	0.8%	63
Remainder/Composite Plastics	2.6%	2.7%	165
Glass	**3.5%**		**222**
Clear Glass Containers	0.0%	0.0%	0
Green Glass Containers	0.0%	0.0%	0
Brown Glass Containers	0.0%	0.1%	3
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	3.4%	2.2%	219
Metal	**9.7%**		**623**
Aluminum Beverage Cans	0.0%	0.0%	2
Aluminum Foil/Containers	0.0%	0.0%	0
Other Non-ferrous	0.6%	0.8%	39
Tin Food Cans	0.2%	0.4%	15
Empty Aerosol Cans	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0
Oil filters	0.2%	0.3%	13
Other Ferrous	5.4%	6.3%	344
Remainder/Composite Metal	3.3%	1.8%	209
Organics	**5.0%**		**324**
Food Waste, Vegetative	0.1%	0.2%	7
Other Food Waste	0.1%	0.2%	9
Leaves and Grass	0.8%	0.8%	49
Prunings and Trimmings	0.3%	0.4%	17
Branches and Stumps	0.0%	0.0%	0
Textiles and Clothing	3.5%	5.4%	224
Disposable Diapers	0.0%	0.0%	0
Animal Excrement/Litter	0.0%	0.1%	3
Remainder/Composite Organic	0.2%	0.3%	15
Wood Waste	**43.0%**		**2,760**
Dimensional Lumber	15.2%	8.2%	977
Pallets and Crates	8.6%	8.7%	550
Engineered Wood	3.0%	2.0%	191
Other Untreated Wood	0.1%	0.2%	7
Painted Wood	11.8%	6.8%	758
Treated Wood	3.0%	2.9%	189
Remainder/Composite Wood	1.4%	1.0%	88
C&D Waste	**27.6%**		**1,773**
Concrete	3.6%	3.4%	233
Clean Drywall	2.3%	3.4%	149
Other Drywall	3.8%	2.9%	245
Asphalt Paving	0.3%	0.5%	18
Asphalt Shingles	0.0%	0.0%	0
Other Asphalt Roofing	1.3%	2.1%	84
Insulation	0.1%	0.1%	5
Carpet	6.0%	4.5%	386
Carpet Padding	2.1%	1.7%	135
Soil, Rocks, and Sand	3.2%	4.9%	205
Ceramics and Brick	1.2%	1.4%	76
Remainder/Composite Construction	3.7%	2.6%	237
E-Waste	**1.2%**		**75**
Televisions and CRTs	1.1%	1.2%	68
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.1%	0.2%	7
Household Hazardous	**0.1%**		**4**
Pesticides and Herbicides	0.1%	0.1%	4
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	0
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**0.6%**		**36**
Furniture	0.4%	0.5%	26
Tires	0.1%	0.1%	5
Mattresses	0.1%	0.1%	6
Non-distinct Fines	0.0%	0.0%	0
Totals	**100.0%**		**6,413**
Sample Count			36

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

Table D-25. Detailed Disposed Waste Composition Results: Overall C&D, Spring

Material	Est. Percent	+ / -	Est. Tons
Paper	**1.6%**		**127**
Newspaper	0.0%	0.0%	0
Uncoated OCC/Kraft Paper	0.8%	1.1%	68
High-grade Paper	0.0%	0.0%	1
Low-grade Paper	0.0%	0.0%	3
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.0%	0.0%	0
Compostable/Soiled Paper	0.0%	0.0%	2
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	1
Non-comp. Single-use Food Service Paper	0.0%	0.0%	0
Remainder/Composite Paper	0.7%	0.3%	54
Plastic	**3.5%**		**275**
#1 PET Bottles	0.0%	0.0%	0
#2 HDPE Bottles	0.0%	0.0%	0
#1-#7 Other Containers	0.2%	0.2%	12
Expanded Polystyrene Food grade	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.0%	0.0%	3
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	0
Other Clean PE Film	0.1%	0.1%	4
Other Film	0.8%	1.3%	66
Durable Plastic Products	1.7%	3.1%	137
Remainder/Composite Plastics	0.7%	0.6%	53
Glass	**1.1%**		**84**
Clear Glass Containers	0.0%	0.0%	0
Green Glass Containers	0.0%	0.0%	0
Brown Glass Containers	0.0%	0.0%	0
Plate Glass	0.5%	1.0%	43
Remainder/Composite Glass	0.5%	1.0%	41
Metal	**1.3%**		**104**
Aluminum Beverage Cans	0.0%	0.0%	0
Aluminum Foil/Containers	0.0%	0.0%	0
Other Non-ferrous	0.4%	0.4%	33
Tin Food Cans	0.0%	0.0%	0
Empty Aerosol Cans	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0
Other Ferrous	0.6%	0.5%	51
Remainder/Composite Metal	0.2%	0.2%	19
Organics	**3.6%**		**290**
Food Waste, Vegetative	0.0%	0.0%	1
Other Food Waste	0.0%	0.0%	0
Leaves and Grass	2.8%	4.7%	223
Prunings and Trimmings	0.6%	0.8%	49
Branches and Stumps	0.0%	0.0%	1
Textiles and Clothing	0.2%	0.3%	14
Disposable Diapers	0.0%	0.0%	0
Animal Excrement/Litter	0.0%	0.0%	0
Remainder/Composite Organic	0.0%	0.0%	3

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**40.8%**		**3,253**
Dimensional Lumber	9.7%	8.2%	774
Pallets and Crates	12.2%	8.6%	974
Engineered Wood	9.6%	13.7%	762
Other Untreated Wood	0.2%	0.2%	19
Painted Wood	5.8%	3.6%	459
Treated Wood	3.1%	2.6%	244
Remainder/Composite Wood	0.2%	0.2%	20
C&D Waste	**46.1%**		**3,670**
Concrete	0.3%	0.4%	20
Clean Drywall	0.1%	0.1%	6
Other Drywall	4.3%	2.8%	339
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	1.5%	1.8%	117
Other Asphalt Roofing	3.5%	5.3%	276
Insulation	1.0%	1.8%	79
Carpet	3.6%	2.9%	287
Carpet Padding	0.5%	0.6%	41
Soil, Rocks, and Sand	2.9%	3.9%	230
Ceramics and Brick	2.5%	3.1%	199
Remainder/Composite Construction	26.1%	19.0%	2,075
E-Waste	**0.0%**		**0**
Televisions and CRTs	0.0%	0.0%	0
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**0.0%**		**1**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	1
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**2.0%**		**159**
Furniture	0.2%	0.3%	15
Tires	0.0%	0.0%	1
Mattresses	1.7%	3.0%	138
Non-distinct Fines	0.1%	0.1%	5
Totals	**100.0%**		**7,964**
Sample Count			35

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

Table D-26. Detailed Disposed Waste Composition Results: Overall C&D, Summer

Material	Est. Percent	+ / -	Est. Tons
Paper	**1.1%**		**67**
Newspaper	0.0%	0.0%	0
Uncoated OCC/Kraft Paper	0.5%	0.3%	31
High-grade Paper	0.0%	0.0%	0
Low-grade Paper	0.0%	0.0%	3
Waxed OCC	0.0%	0.0%	0
Pizza Boxes	0.0%	0.0%	0
Compostable/Soiled Paper	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	0
Non-comp. Single-use Food Service Paper	0.0%	0.0%	0
Remainder/Composite Paper	0.5%	0.5%	32
Plastic	**1.4%**		**84**
#1 PET Bottles	0.0%	0.0%	1
#2 HDPE Bottles	0.0%	0.0%	1
#1-#7 Other Containers	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.0%	0.1%	2
Expanded Polystyrene Non-food Grade	0.8%	1.3%	51
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	0
Other Clean PE Film	0.0%	0.0%	0
Other Film	0.2%	0.2%	15
Durable Plastic Products	0.1%	0.0%	4
Remainder/Composite Plastics	0.2%	0.1%	9
Glass	**0.7%**		**43**
Clear Glass Containers	0.0%	0.0%	2
Green Glass Containers	0.0%	0.0%	0
Brown Glass Containers	0.0%	0.0%	0
Plate Glass	0.0%	0.0%	0
Remainder/Composite Glass	0.7%	0.9%	41
Metal	**2.4%**		**143**
Aluminum Beverage Cans	0.0%	0.0%	0
Aluminum Foil/Containers	0.0%	0.0%	0
Other Non-ferrous	0.5%	0.6%	33
Tin Food Cans	0.0%	0.0%	0
Empty Aerosol Cans	0.0%	0.0%	0
Major Appliances	0.0%	0.1%	2
Oil filters	0.0%	0.0%	0
Other Ferrous	1.0%	0.9%	58
Remainder/Composite Metal	0.8%	0.6%	50
Organics	**1.8%**		**112**
Food Waste, Vegetative	0.0%	0.0%	0
Other Food Waste	0.0%	0.0%	0
Leaves and Grass	1.2%	1.2%	71
Prunings and Trimmings	0.4%	0.4%	24
Branches and Stumps	0.2%	0.3%	11
Textiles and Clothing	0.1%	0.1%	5
Disposable Diapers	0.0%	0.0%	0
Animal Excrement/Litter	0.0%	0.0%	0
Remainder/Composite Organic	0.0%	0.0%	2

Material	Est. Percent	+ / -	Est. Tons
Wood Waste	**44.3%**		**2,690**
Dimensional Lumber	21.9%	9.7%	1,332
Pallets and Crates	0.4%	0.4%	25
Engineered Wood	1.9%	1.4%	116
Other Untreated Wood	4.9%	7.1%	298
Painted Wood	7.4%	6.7%	448
Treated Wood	5.6%	3.4%	342
Remainder/Composite Wood	2.1%	1.3%	129
C&D Waste	**47.0%**		**2,855**
Concrete	5.1%	4.1%	307
Clean Drywall	1.9%	1.9%	118
Other Drywall	10.1%	5.4%	615
Asphalt Paving	0.0%	0.0%	0
Asphalt Shingles	3.1%	3.6%	187
Other Asphalt Roofing	7.7%	7.6%	469
Insulation	0.3%	0.4%	16
Carpet	1.6%	1.4%	94
Carpet Padding	0.2%	0.2%	9
Soil, Rocks, and Sand	6.5%	8.2%	392
Ceramics and Brick	5.4%	5.6%	328
Remainder/Composite Construction	5.3%	4.1%	320
E-Waste	**0.1%**		**5**
Televisions and CRTs	0.1%	0.1%	5
Computers and Flat Monitors	0.0%	0.0%	0
Computer Peripherals	0.0%	0.0%	0
Other Consumer Electronics	0.0%	0.0%	0
Household Hazardous	**0.0%**		**0**
Pesticides and Herbicides	0.0%	0.0%	0
Fluorescent Lighting	0.0%	0.0%	0
Asbestos	0.0%	0.0%	0
Paints, Solvents, and Adhesives	0.0%	0.0%	0
Dry-cell Batteries	0.0%	0.0%	0
Wet-cell Batteries	0.0%	0.0%	0
Gasoline/Kerosene	0.0%	0.0%	0
Motor Oil	0.0%	0.0%	0
Vehicle and Equipment Fluids	0.0%	0.0%	0
Medical Wastes	0.0%	0.0%	0
Pharmaceuticals	0.0%	0.0%	0
House Cleaners and Chemicals	0.0%	0.0%	0
Other Potentially Hazardous	0.0%	0.0%	0
Other Waste	**1.2%**		**73**
Furniture	0.6%	0.6%	37
Tires	0.0%	0.0%	0
Mattresses	0.4%	0.4%	25
Non-distinct Fines	0.2%	0.2%	10
Totals	**100.0%**		**6,071**
Sample Count			53

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

Detailed Single-family Residential Curbside Organics Tables

Table D-27. Detailed Organics Composition Results: Single-family, Fall

Material	Est. Percent	+ / -	Est. Tons
Organics	**98.9%**		**8,221**
Food Waste, Vegetative	1.5%	0.9%	122
Other Food Waste	0.9%	0.9%	76
Leaves, Grass, Prunings and Trimmings	96.4%	1.9%	8,020
Branches and Stumps	0.1%	0.1%	4
Other Compostables	**0.2%**		**14**
Waxed Corrugated Cardboard	0.0%	0.0%	0
Pizza Boxes	0.0%	0.0%	0
Compostable Paper	0.1%	0.1%	6
Newspaper	0.0%	0.1%	4
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	3
Other Compostable Organics	0.0%	0.0%	1
Other Compostables	**1.0%**		**81**
Uncoated Corrugated Cardboard/Kraft Paper	0.0%	0.0%	0
Mixed Recyclable Paper	0.0%	0.0%	3
Recyclable Polycoated Paper	0.0%	0.0%	0
Non-comp. Single-use Food Service Paper	0.0%	0.0%	0
Recyclable Plastic	0.0%	0.0%	2
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	0
Other Non-compostable Film	0.0%	0.0%	3
Recyclable Glass	0.1%	0.1%	10
Recyclable Metal	0.0%	0.0%	1
Animal Excrement And Litter	0.2%	0.4%	20
Other Materials	0.5%	0.7%	41
Totals	**100.0%**		**8,317**
Sample Count			60

Confidence intervals calculated at the 90% confidence level.

Percentages for material types may not total 100% due to rounding.

Table D-28. Detailed Residential Organics Composition Results: Single-family, Spring

Material	Est. Percent	+ / -	Est. Tons
Organics	**98.5%**		**7,529**
Food Waste, Vegetative	2.0%	1.0%	154
Other Food Waste	0.8%	0.5%	64
Leaves, Grass, Prunings and Trimmings	94.0%	3.0%	7,184
Branches and Stumps	1.7%	2.6%	127
Other Compostables	**0.3%**		**26**
Waxed Corrugated Cardboard	0.0%	0.0%	0
Pizza Boxes	0.1%	0.2%	10
Compostable Paper	0.0%	0.0%	3
Newspaper	0.1%	0.1%	7
Pot. Comp. Single-use Food Service Paper	0.1%	0.1%	4
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0
Other Compostable Organics	0.0%	0.0%	2
Other Compostables	**1.2%**		**90**
Uncoated Corrugated Cardboard/Kraft Paper	0.0%	0.0%	2
Mixed Recyclable Paper	0.0%	0.0%	1
Recyclable Polycoated Paper	0.0%	0.0%	0
Non-comp. Single-use Food Service Paper	0.0%	0.0%	2
Recyclable Plastic	0.0%	0.0%	2
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	0
Other Non-compostable Film	0.0%	0.0%	1
Recyclable Glass	0.0%	0.0%	0
Recyclable Metal	0.0%	0.0%	1
Animal Excrement And Litter	0.5%	0.6%	41
Other Materials	0.5%	0.6%	41
Totals	**100.0%**		**7,645**
Sample Count			60

Confidence intervals calculated at the 90% confidence level.

Percentages for material types may not total 100% due to rounding.

Table D-29. Detailed Residential Organics Composition Results: Single-family, Summer

Material	Est. Percent	+ / -	Est. Tons
Organics	**92.7%**		**9,348**
Food Waste, Vegetative	6.9%	4.5%	692
Other Food Waste	1.0%	0.7%	98
Leaves, Grass, Prunings and Trimmings	84.8%	10.1%	8,548
Branches and Stumps	0.1%	0.2%	10
Other Compostables	**0.4%**		**43**
Waxed Corrugated Cardboard	0.0%	0.0%	0
Pizza Boxes	0.0%	0.0%	2
Compostable Paper	0.1%	0.1%	5
Newspaper	0.2%	0.2%	18
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	0.0%	0.1%	4
Other Compostable Organics	0.1%	0.1%	14
Other Compostables	**6.9%**		**693**
Uncoated Corrugated Cardboard/Kraft Paper	0.0%	0.0%	0
Mixed Recyclable Paper	0.0%	0.0%	2
Recyclable Polycoated Paper	0.0%	0.0%	0
Non-comp. Single-use Food Service Paper	0.0%	0.0%	0
Recyclable Plastic	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	0
Other Non-compostable Film	0.0%	0.0%	4
Recyclable Glass	0.0%	0.0%	0
Recyclable Metal	0.0%	0.0%	1
Animal Excrement And Litter	0.0%	0.0%	2
Other Materials	6.8%	9.6%	683
Totals	**100.0%**		**10,084**
Sample Count			60

Confidence intervals calculated at the 90% confidence level.

Percentages for material types may not total 100% due to rounding.

Appendix E: Analysis of Results among Single-family Collection Districts

The City of Tacoma is interested in knowing if single-family composition of recyclable materials in disposed waste varies across the city's five waste and recycling service areas. To determine if differences exist, Cascadia conducted an analysis of the proportion of recyclable materials in the disposed waste streams in each of the city's five single-family service areas. This appendix describes the **methods** Cascadia used to conduct this analysis, and **results** of the analysis.

Methods

This section describes the methods Cascadia used to prepare and analyze the single-family sample data.

Sample Data Preparation

In preparation for the analysis, Cascadia categorized the 59 single-family samples sorted for this study according to the day of the week they were collected. A sample collected on Monday was considered from Service Area 1, and a sample collected on Tuesday was categorized as Service Area 2.

For each sample, weights for the material types that are recyclable in Tacoma's current curbside program were grouped according to the recyclable categories **paper**, **plastic**, **glass**, and **metal**. The recyclable categories and associated material types are presented in **Table E-1**. All material types not listed in the table were included in the category "other."

Table E-1. Material Types by Recyclable Category

Recyclable Category/Material Type	Recyclable Category/Material Type
Recyclable Paper	**Recyclable Glass**
Newspaper	Clear Glass Containers
OCC/Kraft Paper	Green Glass Containers
High Grade Paper	Brown Glass Containers
Low-grade Paper	**Recyclable Metal**
Recyclable Plastic	Aluminum Beverage Cans
#1 PET Bottles	Aluminum Foil/Containers
#2 HDPE Bottles	Tin Food Cans
#1-#7 Other Containers	Empty Aerosol Cans
Clean Shopping/Dry Cleaning Bags	

Calculations

The analysis consisted of three steps:

1. Descriptive statistics of sampling data.
2. Composition estimates were calculated for each recyclable category for each service area.
3. Pair-wise t-tests were conducted for each recyclable category across all five service areas.

Descriptive Statistics of Sampling Data

1. Analyze the sampling data across the five service areas using common descriptive statistics. This analysis included count of samples (n), the range (minimum and maximum), central tendencies (mean and median), and measure of dispersion of data (variance).

Composition Estimates

The individual **composition estimates** for each material category within each service area were obtained using the ratio estimator method applied to the grouped data. The ratio estimate (r_j) was calculated by summing the weight of the particular material category across all samples in the service area and dividing by the total weight of all samples in the service area, according to the formula:

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

where:

- **c** = weight of a particular material
- **w** = sum of all material weights
- for **i** =1 to n where n = number of selected samples
- for **j** = 1 to m where m = number of material categories

The **variance** of the ratio estimator was approximated according to the formula:

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

where:

- $\bar{w} = \frac{\sum_i w_i}{n}$.
- **n** = number of selected samples

- **i** and **j** are as previously defined.

Lower and upper limits for **90% confidence intervals** were found according to the formula:

$$r_j \pm \left(t^* \sqrt{\mathrm{Var}\left(r_j\right)} \right)$$

where:

- $t^* = t_{0.10(2),n-1}$ is a two-tailed critical value from the Student's *t* distribution.

The sample sizes are fairly small relative to the total population of collection days. Therefore, the *t* distribution was used instead of the standard normal, or z distribution, because the sample sizes are fairly small. The degrees of freedom used for each service area varied slightly due to minor differences in the total number of samples for each service area. The finite population correction (FPC) factor was excluded from the variance formula because the FPC factor has virtually no effect on the variance estimate given small sample size.

Pair-wise t-tests

For a given material category, pair-wise t-tests were conducted for the composition estimates across service areas. This resulted in 10 pair-wise tests per material category. Each pair-wise test examined the following null hypothesis (H_0) that:

- the true composition estimates of a particular material category are the same for each of two service areas ($p_{jd_a} - p_{jd_b} = 0$).

against the alternative hypothesis (H_A) that,

- the true composition estimates of a particular material category are different for each of two service areas ($p_{jd_a} - p_{jd_b} \neq 0$).

In the statistical hypotheses, p_j represents the *true* composition estimates; composition estimates are *estimated* from sample data as r_j. The *t*-statistic was constructed using the formula:

$$t = \frac{\left(r_{j,d_a} - r_{j,d_b}\right) - 0}{\sqrt{\frac{\mathrm{Var}\left(r_{j,d_a}\right)}{n_{d_a}} + \frac{\mathrm{Var}\left(r_{j,d_b}\right)}{n_{d_b}}}}$$

where:

- r_{j,d_a} = the composition estimate for material category *j* and service area d_a
- $\mathrm{Var}(r_{j,d_a})$ = variance of the composition estimate for material category *j* and service area d_a
- n_{d_a} = total sample weight for service area d_a

Since multiple tests were conducted using the same data, the significance level (α) of 0.01 was adjusted to α = 0.001 using a Bonferroni correction to maintain an α ≈ 10% within each set of 10 comparisons (α/10). Then the null hypothesis of the two-tailed test can be rejected if $t \leq -t_{\alpha/2}$ or $t \geq t_{\alpha/2}$, where $t_{\alpha/2}$

is the 100(1 − α) percentile of the standard normal distribution. For α=0.001, $\pm t\alpha/2$ equals $\pm$ 3.29. Hence, the null hypothesis can be rejected if $t \geq 3.29$ or if $t \leq -3.29$ and the pair-wise comparison can be considered to be "statistically significant."

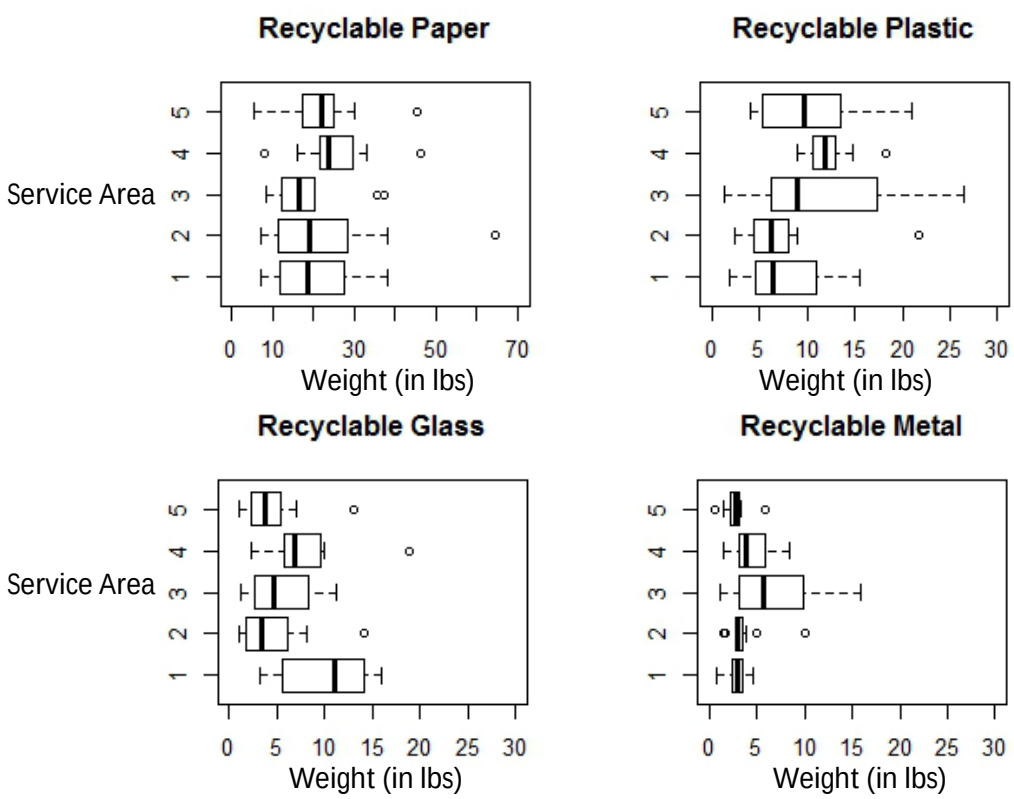
For example, if the t-statistic was calculated to be -25.96, it does not lie between the critical values -3.29 and 3.29. Hence, at 0.001 significance level, we can *reject* the null hypothesis that the true composition estimates of a particular material category are the same for each of two service areas. On the other hand, if the t-statistic was calculated to be 0.89, it lies between the critical values -3.29 and 3.29. Hence, at 0.001 significance level, we do *not* reject the null hypothesis.

Results and Conclusions

Descriptive Statistics

Figure E-1 shows the boxplots developed based on the sample composition data for the four recyclable material categories across the five service areas, expressed as actual weights (in pounds). The boxplots show the median, the minimum, the maximum, the first and the third quartiles, and potential outliers in the data.

Figure E-1. Boxplots of the Sample Composition Data across Service Areas by Material Category (in pounds)



A visual inspection of the boxplots suggests that the median values across the five service areas are noticeably dispersed, except for the recyclable paper material category, where the median values are

more visually similar. The quartile ranges, as indicated by the length of the boxes either to the right and the left of the median value, suggest that there is noticeable variation across the five service areas for all material categories, and that the quartile ranges often overlap among service areas. There are outlier values in all service areas except for Service Area 1; these outliers are typically singular values extended beyond the upper quartiles of the boxplots.

Table E-2 below summarizes the sampling data across the five service areas using common descriptive statistics – count of samples (n), the range (minimum and maximum), central tendencies (mean and median), and measure of dispersion of data (variance) – for all four of the recyclable material categories as well as for the "Other" category, which represents the non-recyclable fraction of the sample.

Table E-2. Descriptive Statistics on the Sampling Data (in pounds)

Service Area 1 (n=12)		Total	Paper	Plastic	Glass	Metal	Other
	mean	249.87	20.35	7.55	10.12	2.92	208.93
	SD	23.83	10.24	4.31	4.58	1.04	19.95
	median	245.85	18.35	6.45	11.10	2.95	202.10
	min	221.10	7.00	1.90	3.20	0.70	182.90
	max	306.00	38.00	15.50	16.00	4.50	249.10

Service Area 2 (n=12)		Total	Paper	Plastic	Glass	Metal	Other
	mean	231.43	22.94	7.20	4.48	3.56	193.24
	SD	13.27	15.95	5.00	3.86	2.21	18.58
	median	230.55	18.95	6.20	3.35	3.00	192.50
	min	209.80	7.20	2.40	1.00	1.50	164.80
	max	259.10	64.60	21.80	14.20	10.00	221.90

Service Area 3 (n=12)		Total	Paper	Plastic	Glass	Metal	Other
	mean	249.36	18.46	11.78	5.44	6.71	206.98
	SD	19.51	9.14	7.92	3.53	4.68	9.58
	median	253.26	16.5	8.95	4.65	5.65	205.95
	min	220.90	8.40	1.30	1.20	1.10	193.40
	max	291.20	37.20	26.40	11.30	15.90	229.40

Service Area 4 (n=12)		Total	Paper	Plastic	Glass	Metal	Other
	mean	243.64	25.28	12.15	8.02	4.55	193.63
	SD	29.93	9.13	2.54	4.02	2.13	31.25
	median	232.10	23.50	11.90	6.80	3.80	183.80
	min	211.40	8.10	9.00	2.30	1.40	159.30
	max	328.10	46.20	18.30	18.90	8.40	279.10

Service Area 5 (n=12)		Total	Paper	Plastic	Glass	Metal	Other
	mean	240.81	21.59	10.03	4.41	2.73	202.06
	SD	27.70	10.43	5.08	3.27	1.26	30.75
	median	236.01	21.75	9.75	3.75	2.80	195.01
	min	209.70	5.30	4.00	1.00	0.50	171.30
	max	310.90	45.50	21.00	13.00	5.80	279.40

The descriptive statistics show that:

1. The number of samples for each service area is 12, except in Service Area 3 where n=13.
2. The total sample weight ranges from 200 to 300 pounds, with some samples exceeding 300 pounds but no sample weighing less than 210 pounds.
3. The "Other" material category, which represents non-recyclable materials, represents a major share of the total sample weight in all service areas. "Other" materials weighed about 200 pounds per sample.
4. The recyclable paper is the heaviest of the recyclable material category in all five service areas. The means and the medians for recyclable paper are more or less comparable in all service areas, with broad overlap in the standard deviations. However, some fraction weights far exceed the typical weight range, as indicated by the recyclable paper maxima for Service Area 2 (64.60 pounds), Service Area 4 (46.20 pounds), and Service Area 5 (45.50 pounds).
5. The recyclable plastic material category is the second-heaviest recyclable material category across the five service areas.
6. The recyclable glass and the recyclable metal material categories interchangeably represent the smallest fraction among the recyclable material categories. The mean and the median fraction weights typically range from around 3 to 8 lbs, with the singular exception of recyclable glass in Service Area 1 (mean=10.12 lbs, median=11.10 lbs).

Composition Estimates

The composition estimates (Est.), lower limit of the 90% confidence interval (LL), and upper limit of the 90% confidence interval (UL) for each material category considered in this analysis are presented in **Table E-3** by service area.

Table E-3. Composition Estimates with Confidence Intervals, by Service Area (in percent)

		Service Area 1	Service Area 2	Service Area 3	Service Area 4	Service Area 5
Recyclable Paper	LL	6.4	6.7	5.8	8.5	7.0
	Est.	**8.1**	**9.9**	**7.4**	**10.4**	**9.0**
	UL	9.9	13.1	9.0	12.3	10.9
Recyclable Plastic	LL	2.1	2.1	3.3	4.5	3.0
	Est.	**3.0**	**3.1**	**4.7**	**5.0**	**4.2**
	UL	3.9	4.1	6.2	5.5	5.3

		Service Area 1	Service Area 2	Service Area 3	Service Area 4	Service Area 5
Recyclable Glass	LL	3.2	1.2	1.5	2.5	1.1
	Est.	**4.0**	**1.9**	**2.2**	**3.3**	**1.8**
	UL	4.9	2.7	2.8	4.1	2.5
Recyclable Metal	LL	1.0	1.1	1.9	1.5	1.00
	Est.	**1.2**	**1.5**	**2.7**	**1.9**	**1.1**
	UL	1.4	2.0	3.5	2.2	1.4
Other	LL	82.1	80.0	80.6	77.3	81.5
	Est.	**83.6**	**83.5**	**83.0**	**79.5**	**83.9**
	UL	85.1	87.1	05.3	81.7	86.3

Figure E-2 presents the estimated proportions for each material category, by service area. For clarity purposes, this figure does not include confidence interval ranges.

Figure E-2. Recyclable Category Composition Estimates by Service Area (As Percentages)

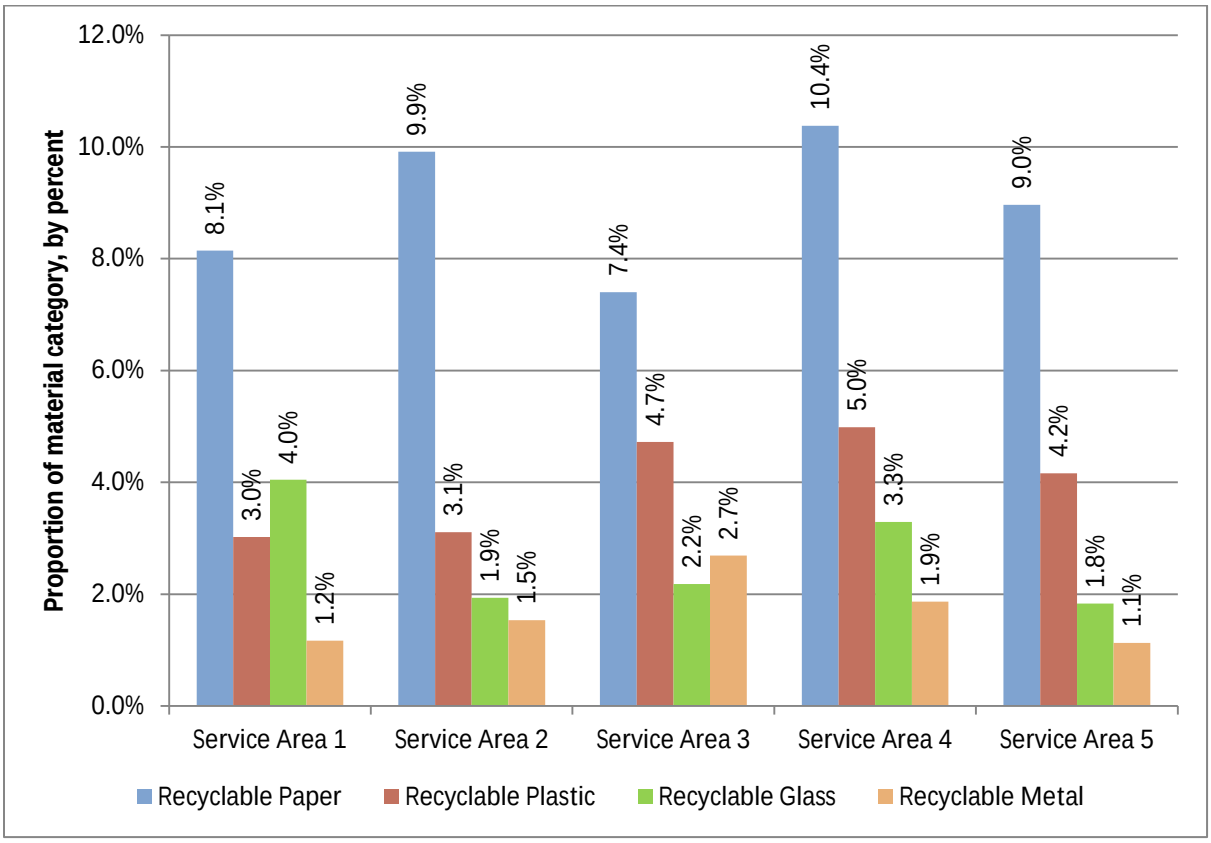


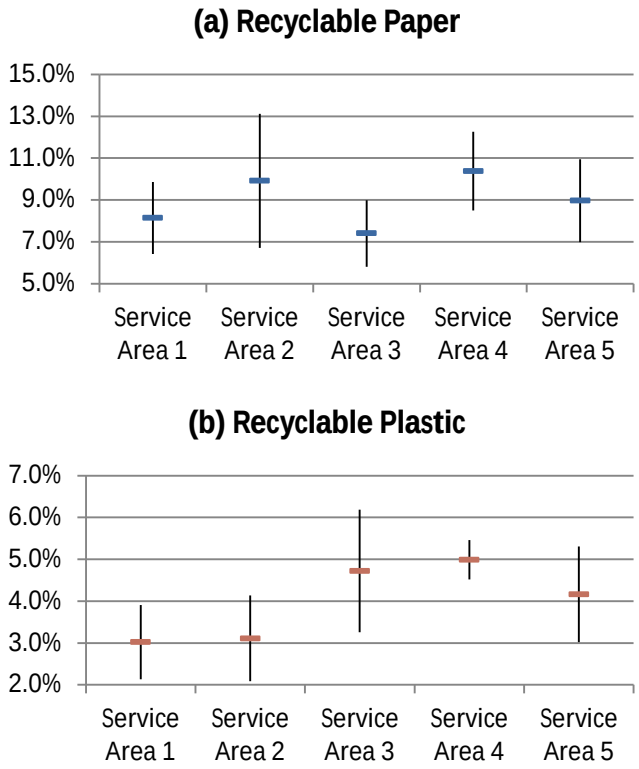
Table E-3 and **Figure E-2** show that:

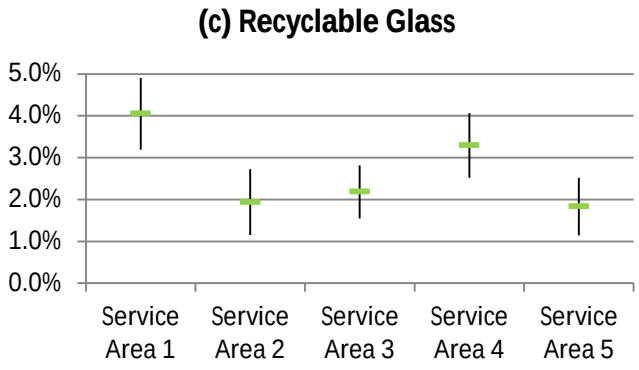
1. The "Other" material category, which represents all non-recyclable materials in the samples, makes up between 80% and 84% of the total sample weight in all service areas.

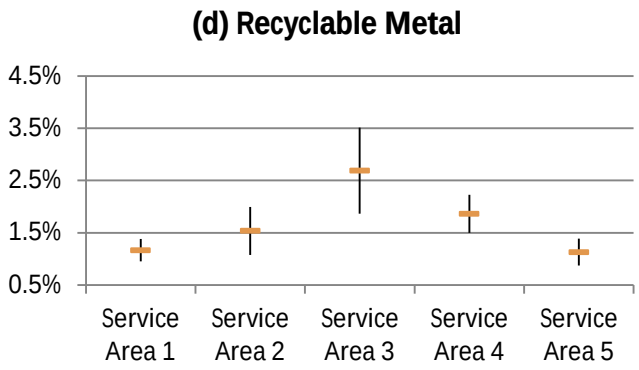
2. In other words, the recyclable portion of the disposed waste samples was around 16% to 20% in the samples analyzed across the five service area.
3. The composition percentages for the recyclable categories appear similar across the five service areas.
4. Recyclable paper is the largest recyclable material category in all five service areas, followed by recyclable plastic (except in service area 1), then by recyclable glass, and finally by recyclable metals.

Figure E-3a-d presents the percent composition estimates and their corresponding confidence intervals for each individual recyclable material category, by service area. A visual comparison of the position of the percent composition estimates and the confidence interval bar overlaps indicates the likelihood of statistically significant differences between service area results. Typically, the greater the overlap between the confidence interval bars, the less likely there is to be a significant difference, even though the composition estimates may be placed at different heights on the plot.

Figure E-3. Composition Estimates (As Percentages) with Confidence Intervals, by Service Area







The visual inspection suggests:

- For recyclable paper: there are no instances of confidence intervals that do not overlap.
- For recyclable plastic: Service Area 4 can be distinguished from Service Areas 1 and 2.
- For recyclable glass: Service Area 1 can be distinguished from Service Areas 2, 3 and 4.
- For recyclable metal: Service Area 3 can be distinguished from Service Areas 1, 5 and possibly from Service Area 2 as well.

Detecting Significant Differences

As mentioned above, Cascadia also used pair-wise t-tests for two population proportions for each recyclable material category to detect significant differences in the composition estimates and their corresponding confidence intervals among the five service areas. The pair-wise t-test was performed for a total of forty service area pairs, ten per recyclable material category (**Table E-4**).

Table E-4. t-statistic for Service Area Pairs, by Recyclable Materials Category

	(1,2)	(1,3)	(1,4)	(1,5)	(2,3)	(2,4)	(2,5)	(3,4)	(3,5)	(4,5)
Paper	-0.68	0.31	-0.86	-0.33	0.98	-0.17	0.35	-1.16	-0.63	0.53
Plastic	-0.06	-0.98	-1.12	-0.68	-0.91	-1.03	-0.61	-0.14	0.30	0.43

Glass	1.35	1.20	0.45	1.45	-0.19	-0.92	0.09	-0.76	0.28	1.02
Metal	-0.35	-1.24	-0.64	0.04	-0.87	-0.28	0.38	0.61	1.26	0.66

As mentioned earlier, the value of t-statistic should be between the critical values -3.29 and 3.29 for the test to be called statistically significant. The value of t-statistic was between the critical values -3.29 and 3.29 ($\pm t\alpha/2$ at $\alpha = 0.001$), for all service area pairs. Hence, the null hypothesis – the true composition estimates of a particular material category are the same for each of two service areas – could not be rejected for any sample pairs for any recyclable material category.

A possible reason for failing to reject the null hypothesis could be to have a very stringent cutoff criterion or the critical value. The pair-wise t-test was repeated for $\alpha = 0.01$ ($\pm t\alpha/2 = \pm 2.57$), 0.05 ($\pm t\alpha/2 = \pm 1.96$), and 0.1 ($\pm t\alpha/2 = \pm 1.645$). Thus, increasing the critical value by two order of magnitudes does not change the results obtained from the original t-test.

The t-tests used assume independent samples and normality of the ratio estimator. Therefore, non-independent samples may affect the result of the t-test. The composition vector for a given service area sum to one because of the cumulative addition of the material fractions. This built-in dependence in the proportions means that a change in one material category automatically means a change in another material category within a given service area. However, this dependence is more likely to affect a multi-variate analysis where the composite differences among several material categories across the service areas are compared. In this case, the assumption of independent samples is met because the samples collected do not affect each other and also because the pair-wise t-test compares service areas with respect to proportions derived from these independent samples.

A couple of qualifications should be considered when reviewing the estimated proportions, the calculated confidence interval limits, and the pair-wise comparisons:

1. The t-tests used assume normality of the composition estimates. The assumption of normality, though, may not be reasonable. The Shapiro-Wilk test for univariate normality was used to test the null hypothesis that the composition estimates for a given material category follow normal distribution. Table E-5 shows the results of the normality test, with the test statistic W and the corresponding P-value.

Table E-5. Test for Univariate Normality (Shapiro-Wilk normality test)

	W	P
Paper	0.92	0.00
Plastic	0.94	0.00
Glass	0.92	0.00
Metal	0.77	0.00

Since $p<0.05$, then we can reject the null hypothesis for all component categories normal.

2. The t-test used assume homogeneity of variance of the composition estimates. The boxplots and the confidence intervals mentioned above indicate that there is noticeable overlap between the quartile ranges or the confidence intervals of many service areas, although the central value, either the median or the ratio estimate, may be located distinctly. The Flinger-Killeen test for homogeneity of univariate variance was used to test the null hypothesis that the variances of the composition estimates for a given material category across the five service areas are equal. This test is robust against departures from normality. Table E-6 shows the results of the variance test, with the test statistic "Chi-sq" and the corresponding P-value.

Table E-6. Test for Univariate Homogeneity of Variance (Flinger-Killen test)

	Chi-sq	P
Paper	0.87	0.93
Plastic	9.47	0.05
Glass	4.82	0.31
Metal	14.46	0.01

The test for homogeneity of variance indicate that the null hypothesis can be rejected only for the recyclable metal category, and possibly for the recyclable plastic category. Since p-value > .05 for the recyclable paper and glass material categories, we cannot reject the null hypothesis that the variances for the service areas are equal.

Given the failure to meet the normality assumption, an alternative approach was adopted for assessing statistically significant differences in the composition estimates among the five service areas. This alternative approach was a non-parametric, 2-sample chi-squared test for testing the null hypothesis that the composition estimates from two service areas for a given recyclable material category are equal. The null hypothesis was rejected if the P-value associated with the test statistic, X-squared, is less than a significance level of 0.05.

Table E-7 shows the X-squared statistic, while **Table E-8** shows the corresponding P-values for the non-parametric (chi-squared) method for service area pairs, by recyclable materials category.

Table E-7. X-squared Statistic for the Non-Parametric (chi-squared) Method for Service Area Pairs, by Recyclable Materials Category

	(1,2)	(1,3)	(1,4)	(1,5)	(2,3)	(2,4)	(2,5)	(3,4)	(3,5)	(4,5)
Paper	0.27	0.02	0.49	0.03	0.67	0.00	0.04	1.00	0.22	0.14
Plastic	0.00	0.57	0.78	0.19	0.45	0.64	0.13	0.00	0.01	0.05
Glass	1.17	0.89	0.04	1.40	0.00	0.40	0.00	0.23	0.00	0.53
Metal	0.00	0.83	0.07	0.00	0.31	0.00	0.00	0.10	0.86	0.08

Table E-8. P-values corresponding the Non-Parametric (chi-squared) Method for Service Area Pairs, by Recyclable Materials Category

	(1,2)	(1,3)	(1,4)	(1,5)	(2,3)	(2,4)	(2,5)	(3,4)	(3,5)	(4,5)
Paper	0.60	0.89	0.48	0.87	0.41	0.99	0.85	0.32	0.64	0.71
Plastic	1.00	0.45	0.38	0.66	0.50	0.42	0.72	1.00	0.94	0.83
Glass	0.28	0.35	0.84	0.24	1.00	0.52	1.00	0.63	1.00	0.47
Metal	1.00	0.36	0.79	1.00	0.58	1.00	1.00	0.76	0.35	0.77

The non-parametric X-squared test for population proportions was performed for a total of forty service area pairs, ten per recyclable material category. As mentioned earlier, the P-value should be less than 0.05 (P-value at $\alpha = 0.05$) for the test to be called statistically significant.

The P-value of t-statistic was greater than 0.05 for all service area pairs. Hence, the null hypothesis that the proportions (composition estimates) from two service areas for a given recyclable material category are equal could not be rejected for any sample pairs for any recyclable material category.

Summary

Appendix E describes the **methods** and **results** of the analysis that was conducted to decide if single-family composition varies across the City of Tacoma's five waste and recycling service areas. The various analyses used to determine if differences existed were divided into three broad categories.

1. The descriptive statistics summarized the sampling data using commonly used descriptive statistics such as the count of samples (n), the range (minimum and maximum), central tendencies (mean and median), and the measure of dispersion of data (variance).
2. These descriptive statistics were used to derive the composition estimates for each individual recyclable material category across the five service areas using the ratio estimator approach. Additionally, the upper and lower bounds on the composition estimate were calculated.
3. The ratio estimates were then used for pair-wise t-tests that compared different pairs of service areas with respect to the recyclable materials category, one category at a time.

The resulting data were visualized to facilitate qualitative, visual interpretation of the sampled data or of the results of the analysis.

The results of the analyses can be summarized as follows:

1. About a one-fifth of the total material in the samples were made up of materials from the four recyclable material categories – paper, plastic, glass, and metal – across the five service areas. Recyclable paper was largest recyclable material category by proportion in the samples, followed by plastic, glass, and/or metal. This pattern was consistent across the five service areas.
2. Qualitative and visual inspection of the data suggest a noticeable variation in the proportion of the material categories among the different samples within a given service area as well as among the five service areas. The dispersed sample proportions overlapped more or less with

other dispersed sample proportions making the distinction among different service areas less apparent in any given material category.

3. The composition estimates were derived from the actual sample weights of different material categories using the ratio estimator approach; the corresponding variance and the upper and the lower bounds were also calculated. These composition estimates follow a similar narrative to that established by the actual sample weights. Visual inspection of these composition estimates show slight variation in the composition estimates among the five service areas, but no service areas are particularly distinguishable. The confidence intervals often have overlapping extents making the distinction, if any, even less clear.
4. A battery of statistical analyses were employed to detect differences among the five service areas.
5. The conventional t-test indicated that the null hypothesis – the true composition estimates of a particular material category are the same for each of two service areas – could not be rejected for any sample pairs for any recyclable material category. The result held true even after relaxing the rigorous cut-off criterion.
6. Diagnostic statistical tests suggested that although the data subjected to the pair-wise t-test was independent, they did not meet the assumption of normality and homogeneity of variance. Hence, the pair-wise test was repeated using a non-parametric, chi-squared test for testing the null hypothesis that the composition estimates from two service areas for a given recyclable material category are equal. **The test suggested that the null hypothesis could not be rejected for any pair of service areas.**
7. Overall, it can be concluded that the five service areas could not be distinguished from one another, statistically or otherwise, based on the composition estimates derived from the sampling data. This can be broadly translated as "the single-family composition did not vary across the five waste and recycling service areas for recyclable materials."

There are other statistical methods to compare results among service areas that this analysis did not consider. Multi-variate statistical analyses can provide a way to compare percent composition for each of the four recyclable material categories in each of the five service areas. Here, given the large variation both within and among the sample proportions, pair-wise analyses were preferred over multi-variate, composite statistical techniques. An alternative approach would be to consider confidence intervals generated via bootstrapping or conducting the analysis using a randomized distribution of the data. Also, the data could be transformed such that that they conform to the requirements and assumptions of the ensuing statistical analyses. Careful consideration of the implications on the interpretation of the analyses is required before undertaking an alternate route of analysis.

Appendix F: Field Forms

The field forms are included in the following order:

- Vehicle Selection Form
- Self-haul Vehicle Survey Form
- Hand Sort Tally Sheets - Waste
- Visual Characterization Tally Sheets - Waste
- Set Out Count Sheet
- Hand Sort Tally Sheets - Organics
- Sample Placards
- Net Weight Cards (used for self-haul samples)

Figure F-1. Vehicle Selection Form

City of Tacoma Waste Characterization
Vehicle Selection Form

Site: Tacoma Landfill
Date: Saturday, November 07 **Goal: 25 Samples Total**

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

Cross off each number as a vehicle representing each category passes through the scalehouse. When a circled number comes up, cross it off and hand the corresponding vehicle a pink placard. Record placard ID on vehicle survey form.

Place a number placard in the window of each vehicle chosen for a sample and instruct them to drive to the sampling area where they will be met by the sorting supervisor.

Residential Self Haul

Non-C&D: **SH-RN** (13 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
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80

C&D: **SH-RCD** (4 total)

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20

Commercial Self Haul

Non-C&D: **SH-CN (4 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
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60

C&D: **SH_CCD (4 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

Figure F-2. Hand Sort Tally Sheet (front) - Waste

2015 Tacoma Waste Composition Study

Tally Sheet - Page 1

PAPER	Newspaper				
	OCC/Kraft				
	High Grade Paper				
	Low Grade Paper				
	Waxed OCC				
	Pizza Boxes				
	Compostable/Soiled Paper				
	. Comp. Single-use Food Service				
	n-comp. Single-use Food Service				
	R/C Paper				
PLASTIC	#1 PET Bottles				
	#2 HDPE Bottles				
	#1-#7 Other Containers				
	Expanded Poly. Food grade				
	Expanded Poly. Nonfood				
	. Comp. Single-use Food Service				
	n-comp. Single-use Food Service				
	ean Shopping/Dry Cleaning Bags				
	Other Clean PE Film				
	Other Film				
	Durable Plastic Products				
	R/C Plastics				
GLASS	Clear Glass Containers				
	Green Glass Containers				
	Brown Glass Containers				
	Plate Glass				
	R/C Glass				
METAL	Aluminum Beverage Cans				
	Aluminum Foil/Containers				
	Other Nonferrous				
	Tin Food Cans				
	Empty Aerosol Cans				
	Major Appliances				
	Oil filters			Filter Count:	
	Other Ferrous				
	R/C Metal				

ORGANICS	Food Waste, Vegetative				
	Other Food Waste				
	Leaves & Grass				
	Prunings and Trimmings				
	Branches and Stumps				
	Textiles/Clothing				
	Disposable Diapers				
	Animal Excrement/Litter				
	R/C Organic				
Wood Waste	Dimensional Lumber				
	Pallets and Crates				
	Engineered Wood				
	Other Untreated Wood				
	Painted Wood				
	Treated Wood				
	R/C Wood				
Construction Materials	Concrete				
	Clean Drywall				
	Other Drywall				
	Asphalt Paving				
	Asphalt Shingles				
	Other Asphalt Roofing				
	Insulation				
	Carpet				
	Carpet Padding				
	Soil, Rocks, Sand				
	Ceramics and Brick				
	R/C Construction				

Figure F-3. Hand Sort Tally Sheet (back) - Waste

E-Waste	Televisions and CRTs				
	Computers/Flat Monitors				
	Computer Peripherals				
	Other Consumer Electronics				
HOUSEHOLD HAZ. / SPECIAL WASTE	Pesticides/Herbicides				
	Flourescent Lighting				
	Asbestos				
	Paints/Solvents/Adhesives				
	Dry-cell Batteries				
	Wet-cell Batteries				
	Gasoline/Kerosene				
	Motor Oil				
	Vehicle/Equipment Fluids				
	Medical Wastes				
	Pharmaceuticals				
	House Cleaners/Chemicals				
	Other Potentially Hazardous				
Other	Furniture				
	Tires				
	Mattresses				
	Non-distinct Fines				

SAMPLE NUMBER_____

DATE_____

ROUTE # / DRIVER_____

VEHICLE TYPE: (circle)

A - Auto (Car or SUV)
P - Pickup Trucks
V - Van
T - Other Truck
RL - Rear Loader
FL - Front Loader
SL - Side Loader
ROC - Compactor Roll-Off
ROD - Loose Roll-Off

For RO Loads:

Biz Name:

_____

Industry Group: (circle)

A - Manufacturing
B - Wholesale
C - Retail
D - Restaurant
E - Hotel/Motel
F - Office
G - Health Care
H - Education
I - Transportation
J - Other Services
K - Mixed Businesses
L - CDL
M - Other Non-residential
N - Homeowner Box

Notes:

Tally Sheet - Page 2

Figure F-4. Visual Characterization Tally Sheet - Waste

Step 1:

Sample ID: _____

Date: _____

Route/Driver:_____

Step2 : Record Construction and Vehicle Data Below

Step 3: Measure & record load volume.
(Include trailer dimensions if applicable.)

Dimensions:

_____in x _____in x _____in

_____in x _____in x _____in (trailer)

Step 4 : Photograph Sample

Step 5: Identify and record all broad material categories (in bold) that appear in the load.

Step 6: Estimate composition of load by volume for each broad material category (in bold).

Step 7: For each broad material category, estimate composition by volume of each specific material component.

Step 8: Make sure broad material category estimates AND material component estimates EACH total 100%.

Construction Type (circle):

N=new construction
R=remodel
D=demolition
RF=roofing
O=other c&d/mixed
DK=don't know

Vehicle Type (circle):

A - Auto/SUV
P - Pickups
V - Van
T - Other

RL - Rear Loader
FL - Front Loader
SL - Side Loader
ROC - Compactor Roll-Off
ROD - Loose Roll-Off

Notes:

☐ **Paper: _____%**

	Newspaper
	OCC/Kraft
	High Grade Paper
	Low Grade Recyclable Paper
	Waxed OCC
	Pizza Boxes
	Compostable Paper
	Pot. Comp. Single-use Food Service
	Non-comp. Single-use Food Service
	R/C Paper

☐ **Plastic: _____%**

	#1 PETE Bottles
	#2 HDPE Bottles
	#1-#7 Other Containers
	Expanded Polystyrene, Food Grade
	Expanded Polystyrene, Non-food Grade
	Pot. Comp. Single-use Food Service
	Non-comp. Single-use Food Service
	Clean Shopping/Dry Cleaner Bags
	Other Clean PE Film
	Other Film
	Durable Plastic Products
	R/C Plastic
%	***Subtotal (must equal 100%)***

☐ **Glass: _____%**

	Clear Glass Containers
	Green Glass Containers
	Brown Glass Containers
	Plate Glass
	R/C Glass
%	***Subtotal (must equal 100%)***

☐ **Metals: _____%**

	Aluminum Cans
	Aluminum Foil/Containers
	Other Non-Ferrous
	Tinned Food Cans
	Empty Aerosol Cans
	Major Appliances
	Oil Filters
	Other Ferrous
	R/C Metal
%	***Subtotal (must equal 100%)***

☐ **Organics: _____%**

	Food Waste, Vegetative
	Food Waste, Other
	Leaves and Grass
	Prunings and Trimmings
	Branches and Stumps
	Textiles and Clothing
	Disposable Diapers
	Animal Excrement/Litter
	R/C Organics
%	***Subtotal (must equal 100%)***

☐ **Wood Waste: _____%**

	Dimensional Lumber
	Pallets and Crates
	Engineered Wood
	Other Untreated Wood
	Painted Wood
	Treated Wood
	R/C Wood
%	***Subtotal (must equal 100%)***

☐ **Construction Materials: _____%**

	Concrete
	Clean Drywall
	Other Drywall
	Asphalt Paving
	Asphalt Shingles
	Other Asphalt Roofing
	Insulation
	Carpet
	Carpet Padding
	Soil, Rocks, Sand
	Ceramics and Brick
	R/C Construction Materials
%	***Subtotal (must equal 100%)***

☐ **E-Waste: _____%**

	Televisions/Other Items with CRT's
	Computers and Flat Screen Monitors
	Computer Peripherals
	Other Consumer Electronics
%	***Subtotal (must equal 100%)***

☐ **HHW/Special: _____%**

	Pesticides and Herbicides
	Fluorescent Lighting
	Asbestos
	Paints, Solvents, and Adhesives
	Dry-cell Batteries
	Wet-cell Batteries
	Gasoline and Kerosene
	Motor Oil
	Vehicle and Equipment Fluids
	Medical Waste
	Pharmaceuticals
	Household Cleaners and Chemicals
	Other Potentially Hazardous Waste
%	***Subtotal (must equal 100%)***

☐ **Mixed Residue/MSW: _____%**

	Furniture
	Tires
	Matresses
	Non-distinct Fines
%	***Subtotal (must equal 100%)***

Grand Total:_____%
(Must equal 100%)

Figure F-5. Set Out Count Sheet
City of Tacoma Organics Compostion Study
Set Out and Participant Count Form

Day: _____ **Route:** _____

Surveyor: _____ **Subscribers:** _____

n= _____

1. Cross off one number from the set out column for each set out
2. Cross off one number from the participant column if the set out contains food waste
3. Circle the corresponding number from the set out column for each sampled set out

Set Outs

1	2	3	4	5	6	7	8	9	10	451	452	453	454	455	456	457	458	459	460
11	12	13	14	15	16	17	18	19	20	461	462	463	464	465	466	467	468	469	470
21	22	23	24	25	26	27	28	29	30	471	472	473	474	475	476	477	478	479	480
31	32	33	34	35	36	37	38	39	40	481	482	483	484	485	486	487	488	489	490
41	42	43	44	45	46	47	48	49	50	491	492	493	494	495	496	497	498	499	500
51	52	53	54	55	56	57	58	59	60	501	502	503	504	505	506	507	508	509	510
61	62	63	64	65	66	67	68	69	70	511	512	513	514	515	516	517	518	519	520
71	72	73	74	75	76	77	78	79	80	521	522	523	524	525	526	527	528	529	530
81	82	83	84	85	86	87	88	89	90	531	532	533	534	535	536	537	538	539	540
91	92	93	94	95	96	97	98	99	100	541	542	543	544	545	546	547	548	549	550
101	102	103	104	105	106	107	108	109	110	551	552	553	554	555	556	557	558	559	560
111	112	113	114	115	116	117	118	119	120	561	562	563	564	565	566	567	568	569	570
121	122	123	124	125	126	127	128	129	130	571	572	573	574	575	576	577	578	579	580
131	132	133	134	135	136	137	138	139	140	581	582	583	584	585	586	587	588	589	590
141	142	143	144	145	146	147	148	149	150	591	592	593	594	595	596	597	598	599	600
151	152	153	154	155	156	157	158	159	160	601	602	603	604	605	606	607	608	609	610
161	162	163	164	165	166	167	168	169	170	611	612	613	614	615	616	617	618	619	620
171	172	173	174	175	176	177	178	179	180	621	622	623	624	625	626	627	628	629	630
181	182	183	184	185	186	187	188	189	190	631	632	633	634	635	636	637	638	639	640
191	192	193	194	195	196	197	198	199	200	641	642	643	644	645	646	647	648	649	650
201	202	203	204	205	206	207	208	209	210	651	652	653	654	655	656	657	658	659	660
211	212	213	214	215	216	217	218	219	220	661	662	663	664	665	666	667	668	669	670
221	222	223	224	225	226	227	228	229	230	671	672	673	674	675	676	677	678	679	680
231	232	233	234	235	236	237	238	239	240	681	682	683	684	685	686	687	688	689	690
241	242	243	244	245	246	247	248	249	250	691	692	693	694	695	696	697	698	699	700
251	252	253	254	255	256	257	258	259	260	701	702	703	704	705	706	707	708	709	710
261	262	263	264	265	266	267	268	269	270	711	712	713	714	715	716	717	718	719	720
271	272	273	274	275	276	277	278	279	280	721	722	723	724	725	726	727	728	729	730
281	282	283	284	285	286	287	288	289	290	731	732	733	734	735	736	737	738	739	740
291	292	293	294	295	296	297	298	299	300	741	742	743	744	745	746	747	748	749	750
301	302	303	304	305	306	307	308	309	310	751	752	753	754	755	756	757	758	759	760
311	312	313	314	315	316	317	318	319	320	761	762	763	764	765	766	767	768	769	770
321	322	323	324	325	326	327	328	329	330	771	772	773	774	775	776	777	778	779	780
331	332	333	334	335	336	337	338	339	340	781	782	783	784	785	786	787	788	789	790
341	342	343	344	345	346	347	348	349	350	791	792	793	794	795	796	797	798	799	800
351	352	353	354	355	356	357	358	359	360	801	802	803	804	805	806	807	808	809	810
361	362	363	364	365	366	367	368	369	370	811	812	813	814	815	816	817	818	819	820
371	372	373	374	375	376	377	378	379	380	821	822	823	824	825	826	827	828	829	830
381	382	383	384	385	386	387	388	389	390	831	832	833	834	835	836	837	838	839	840
391	392	393	394	395	396	397	398	399	400	841	842	843	844	845	846	847	848	849	850
401	402	403	404	405	406	407	408	409	410	851	852	853	854	855	856	857	858	859	860
411	412	413	414	415	416	417	418	419	420	861	862	863	864	865	866	867	868	869	870
421	422	423	424	425	426	427	428	429	430	871	872	873	874	875	876	877	878	879	880
431	432	433	434	435	436	437	438	439	440	881	882	883	884	885	886	887	888	889	890
441	442	443	444	445	446	447	448	449	450	891	892	893	894	895	896	897	898	899	900

Samples _____

SO _____

Totals:

Route _____

Day _____

Sampler _____

Draft

Figure F-6. Hand Sort Tally Sheet - Organics

Sample ID: _____

Date: _____

Route: _____

Sampler: _____

Volume:_____X_____X_____

Notes:

Organics	Wt.1	Wt.2	Wt.3	Wt.4
Food Waste, Vegetative				
Other Food Waste				
Leaves, Grass, Prunings, Trimmings				
Branches				

Other Compostable	Wt.1	Wt.2	Wt.3	Wt.4
Waxed Cardboard				
Pizza Boxes				
Compostable paper				
Potentially Compostable Single-use Food Service Paper				
Potentially Compostable Single-use Food Service Plastic				
Other Compostable Organics				

Other Non-ompostable	Wt.1	Wt.2	Wt.3	Wt.4
Newspaper				
OCC/Kraft				
Mixed recyclable paper				
Recyclable polycoats				
Non-compostable Single-use Food Service Paper				
Recyclable plastic				
Non-compostable Single-use Food Service Plastic				
Clean shopping/dry cleaning bags				
Other non-compostable film				
Recyclable glass				
Recyclable Metal				
Animal poo				
Other Materials				

Figure F-7. Sample Placard

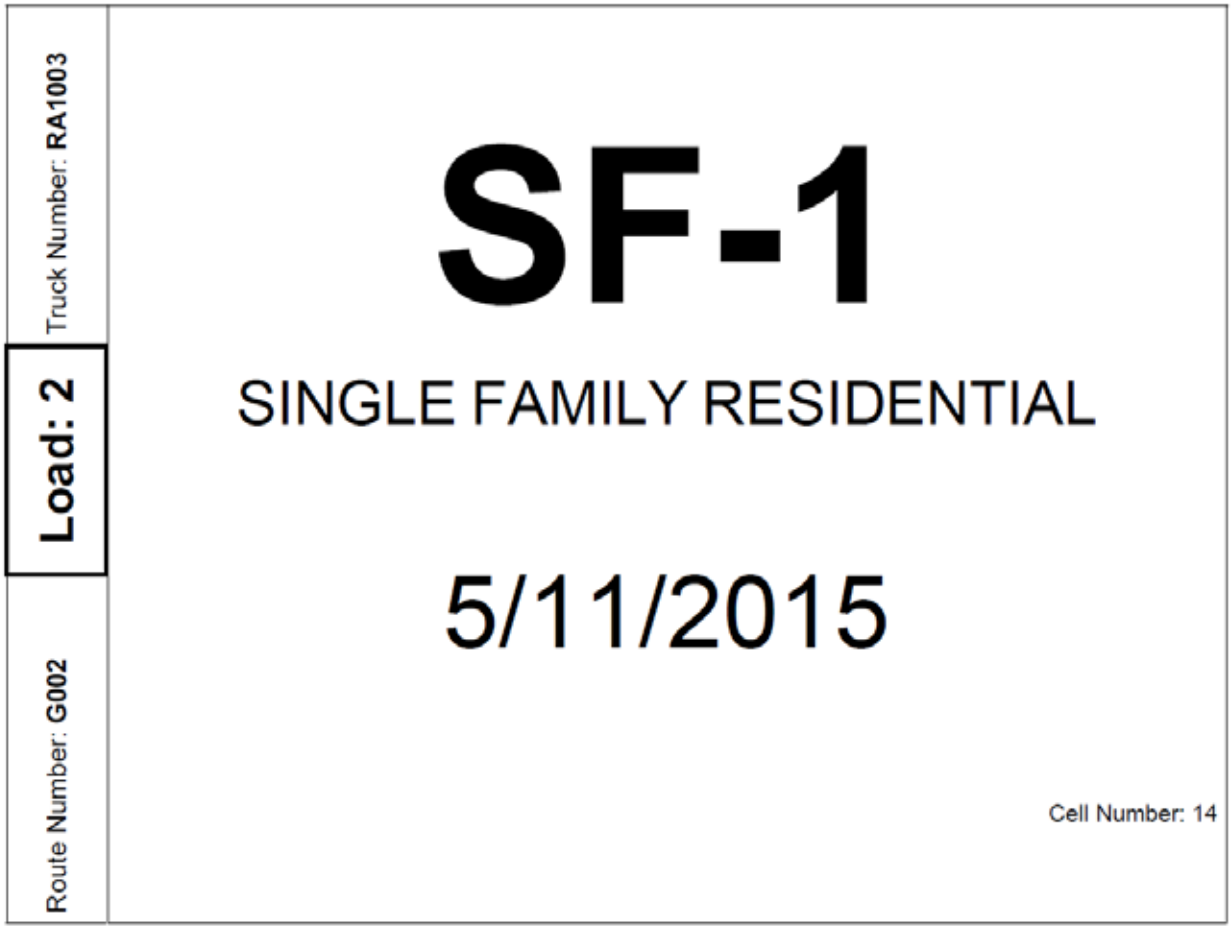


Figure F-8. Net Weight Cards

1 **Net Weight:**_____	**2** **Net Weight:**_____
3 **Net Weight:**_____	**4** **Net Weight:**_____
5 **Net Weight:**_____	**6** **Net Weight:**_____