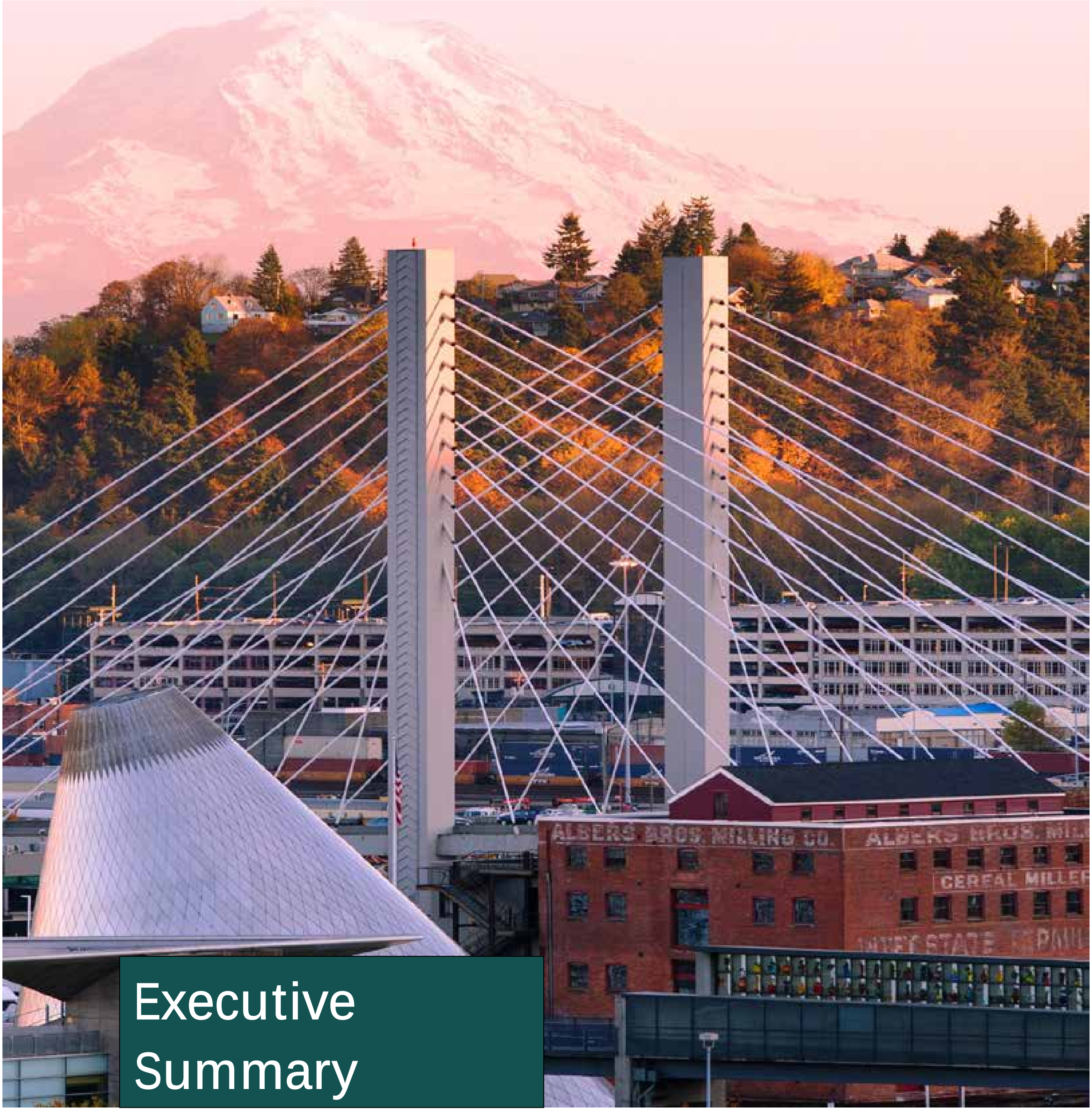
Sustainable Materials Management Plan

2015

City of Tacoma
WASHINGTON

CASCADIA
CONSULTING GROUP



Executive Summary

Sustainable Materials Management Plan

2015

City of Tacoma
WASHINGTON

CASCADIA
CONSULTING GROUP

Executive Summary

Background and Purpose

In May 2014, the Tacoma City Council passed Resolution No. 38907 reaffirming the City's commitment to divert 70 percent of Tacoma's solid waste from landfills by 2028. This goal was first articulated in the Tacoma-Pierce County Solid Waste Management Plan of 2008. The resolution called for the development of a sustainable materials management plan to "ensure that the diversion goal of 70 percent or more by 2028 is met and it defined sustainable materials management as "an approach that includes waste prevention and discard management, while seeking to reduce environmental impacts by managing materials through all stages of their life."

This executive summary provides an overview of this plan. The full plan is available as Volume 1 of the City of Tacoma Sustainable Materials Management Plan.

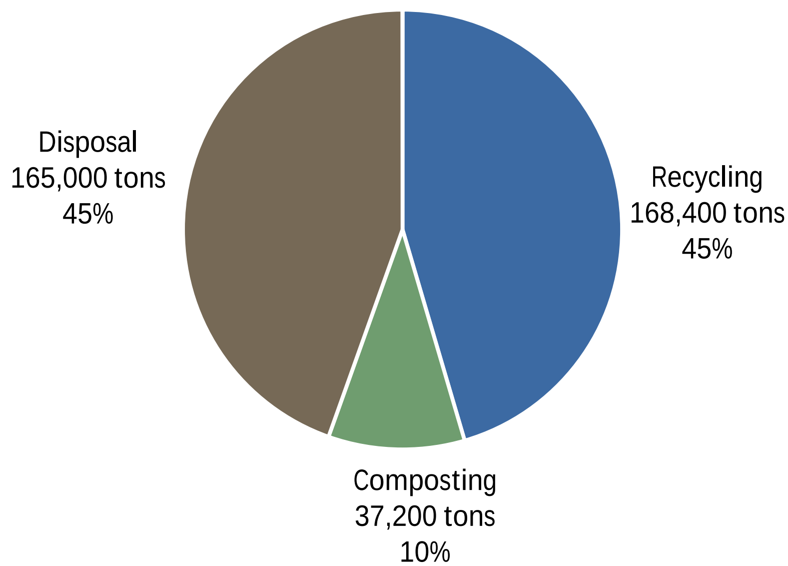
To develop the plan, the Office of Environmental Policy and Sustainability (OEPS) and Solid Waste Management, both within Environmental Services, commissioned a study of Tacoma's current waste stream and recycling levels, projections of future diversion levels under business-as-usual conditions, and an analysis of alternative options and strategies to achieve the 70 percent diversion goal. Development of the plan included significant stakeholder engagement through interviews, forums, and workshops.

Current Conditions

The planning effort began with an assessment of the composition of Tacoma's existing waste stream and the recovery potential in that stream. This information served as the foundation for building a targeted, effective plan to enable the City of Tacoma to achieve 70 percent diversion by 2028.

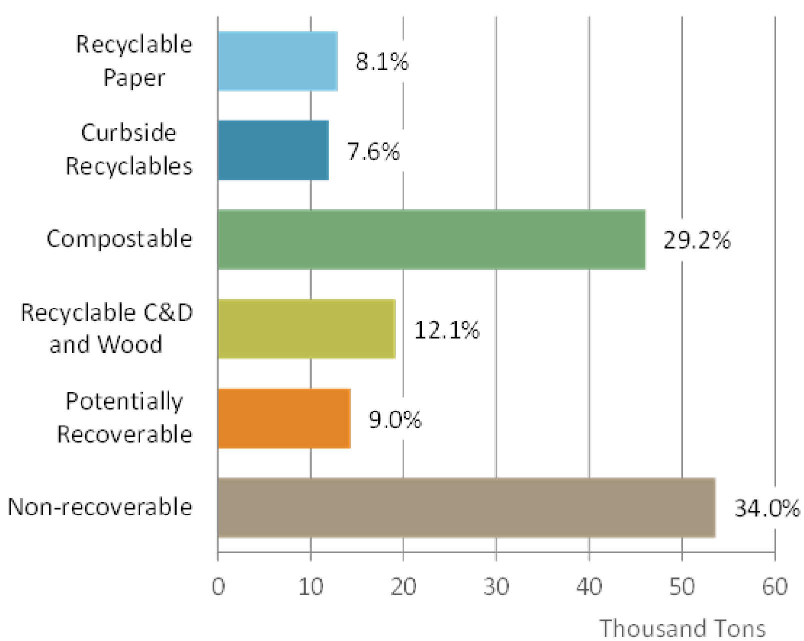
Figure 1 below depicts overall generation for the City of Tacoma in 2014. For the purposes of this study, generation was defined as the sum of materials from Tacoma that are disposed in the landfill, processed for recycling, or sent to composting facilities. Of the 370,500 tons of material generated in 2014, 55 percent of the material was recovered for recycling or composting.

Figure 1. City of Tacoma's 2014 Overall Generation and Recovery Profile



Of the disposed waste stream, approximately two-thirds (66%) or 108,900 tons are recoverable or potentially recoverable, as shown in **Figure 2** below.

Figure 2. Recoverability of Overall Disposed Waste (165,000 Tons)



Achieving 55 percent diversion as shown in Figure 1 above is significant, making the city a national leader in recycling. This high level of performance reflects the City's sustained efforts over time to implement state-of-the-art curbside and self-haul recycling programs and educate citizens and businesses to participate in those programs.

However, much more recovery is needed to achieve 70 percent diversion by 2028, especially considering the expected growth in waste over time due to population and economic growth. To achieve the 70 percent recycling rate by 2028, the City will need to recover an additional 62,000 tons, or about 50 percent of the recoverable tons in Tacoma's disposed waste stream. These tons will need to come from new and expanded programs, investments, incentives, regulations, and other initiatives.

Plan to Achieve 70 Percent Diversion

The Sustainable Materials Management Plan recommends that Tacoma implement these changes in four phases through 2028. The overriding purpose of this phased approach is to plan well for and cost-effectively attain the 70 percent diversion goal. In this process, stakeholders and the public will be regularly informed of progress, and the City Council can make informed decisions about when to implement needed policies, programs, and investments that take into account the potential impact on rates.

The proposed plan incorporates a "voluntary first" approach and suggests using existing infrastructure and systems, where possible, to increase diversion. In Phase I, the emphasis is on expanding education, outreach, and technical assistance with only limited mandates and investment in new or upgraded facilities. Decisions on whether to implement major new capital investments and considerations about additional mandates are deferred to the end of Phase I and the start of Phase II.

In this way, Environmental Services (ES) can move incrementally, with full Council and stakeholder support to adopt policies and make investment decisions as needed. With this approach, ES can also effectively manage the associated risks, including changes in technology, escalating costs, and the possibility of lagging participation and/or growth in waste generation that would require more extensive use of mandates and increased investments in new technology.

Phase I (2017–2020): Aggressive Education & Outreach; Limited Regulations

The purpose of Phase I is to increase recycling and waste prevention voluntarily with minimal new investment and regulations. These efforts build on Tacoma's existing successful outreach and education initiatives, such as the Knock & Talk campaigns, and take advantage of the excellent collection programs and infrastructure already in place in the city. These efforts also build the groundwork for designing and implementing Phase II and Phase III diversion programs.

The recommended plan calls for implementing 19 types of new programs and initiatives affecting all categories of waste generators (Table 1). These programs and initiatives are projected to divert an additional 22,800 tons of recoverable materials by 2028 and increase in the recycling rate by 7 percentage points, from 55 to 62 percent. The full plan provides more details on these proposals.

Phase I costs include approximately $950,000 (in 2015 dollars) of capital investment.[1] The estimated operating cost of these new programs will be approximately $950,000 per year beginning in 2017 and will increase to $1.3 million annually by 2020.

Table 1. Phase I (2017–2020) Programs

Category	Elements
Waste Reduction/ Extended Producer Responsibility	Provide education and outreach on waste reduction and waste prevention
	Promote reuse and supply chain management
	Promote extended producer responsibility (EPR)
	Implement campaign to reduce food waste
Education & Outreach	Provide technical assistance (including Master Recycler/Composter program)
	Deliver targeted education and outreach
	Promote reuse and recycling opportunities
	Promote construction and demolition (C&D) debris salvage and green building practices
	Promote organics diversion strategies
Operations & Programs	Ensure adequate infrastructure for commercial recycling
	Increase reuse and green purchasing
	Expand public space recycling
	Promote plastic bag take-back program
	Promote waste diversion strategies
	Expand food waste collection
Incentives & Rates	Provide incentives to increase diversion at Tacoma Recovery & Transfer Center (TRTC)
	Promote and provide incentives for food grinders
Regulations	Require adequate infrastructure for recycling
	Require use of certified C&D processing facilities and enforce “two-bin rule”

Phase II (2021–2022): Continue Aggressive Education; Additional Regulations; Limited Investment

Phase II consists of 10 types of initiatives, with the emphasis on new regulations as well as selected changes to operational practices and a significant investment in processing capacity to increase mixed organics recovery (Table 2). The investment in additional organics processing will provide the capacity to process 30,000 tons of organic materials (yard waste and limited amounts of food waste) collected through existing programs, plus an estimated additional 30,000 tons of yard waste, food waste, and compostable paper, which will be diverted through new Phase I and II programs.

[1] All costs in this section are expressed in 2015 dollars.

The new Phase II regulations, investments, operational changes, incentives, and programs are estimated to divert an additional 31,800 tons by 2028. This expanded diversion will increase the overall recycling rate by 6 percentage points, from 62 to 68 percent.

Phase II costs include $14.2 million (2015 $) in capital costs for mixed organics processing capable of handling yard and food waste as well as compostable paper. The estimated operating cost of all Phase II programs is approximately $1.1 million (2015 $) per year beginning in 2021 and increasing to $1.7 million by 2022. The annual operations and maintenance (O&M) costs include approximately $900,000 for the organics processing facility, which will increase over time. These costs would be offset by annual revenues from marketable commodities starting at about $60,000 and rising to $100,000 per year by 2022, depending on market conditions. In addition, since this planned investment in expanded organics processing is sized to replace existing processing of yard waste; substantial savings (approximately $2.1 million per year) will be realized.

Table 2. Phase II (2021–2022) Programs

Category	Elements
Waste Reduction/ EPR	Establish recurring reuse/drop-off events
Operations & Programs	Expand materials accepted curbside
	Enhance floor sorts at TRTC
Incentives & Rates	Increase Pay-As-You-Throw rate differentials
Capital Investment	Expand mixed organics processing capacity, and expand collection to accommodate compostable paper and food serviceware
Regulations	Require recycling of recoverable C&D materials
	Require job site recycling and enforce existing two-bin rule
	Require multifamily property owners to provide recycling collection service
	Ensure adequate collection infrastructure for multifamily recycling and organics
	Require separation of recyclables at TRTC

Phase III (2023–2028): Maximum Regulations & Programs or Acquire MRF Capacity

Though highly speculative at this point, Phase III without a new materials recovery facility (MRF) would consist primarily of new regulations mandating recycling services and practices. The list of potential options includes:

- Authorizing mandatory recycling laws for targeted materials.
- Requiring businesses with outdoor garbage bins for public use to provide adjacent recycling containers.
- Requiring commercial property owners and businesses to provide recycling collection service (subscription or self-haul).

- Mandating that food service establishments use recyclable and/or compostable food serviceware.
- Requiring large events on public property to recycle and compost.

Taken together, these regulations are projected to divert 12,000 tons annually when fully implemented over 3 to 5 years. Other elements of Phase III include creating an award/recognition program for businesses and holding neighborhood swap and repair events; together, these programs would divert an estimated 200 tons. If all other programs are performing as expected, these options would enable Tacoma to achieve a 71 percent recycling rate by 2028.

The heavy regulatory approach that comprises Phase III is a departure from the City's preference for voluntary behaviors and practices. Accordingly, the City will need to decide whether a regulatory or MRF-based approach is preferred in achieving the 70 percent goal as well as whether to continue to increase focus and investment in voluntary programs, if those appear to be performing better than expected.

Investing in an integrated MRF that processes commingled recycled materials plus dry commercial waste, along with dry waste routing and banning wood at the Tacoma Recovery & Transfer Center, would divert an additional 30,000 tons and achieve a 75 percent recycling rate by 2028.

Additional costs associated with the MRF would include $33 million in capital investments and annual operating costs starting at approximately $5.4 million (2015 $) and increasing with growing volumes of materials handled. These costs would be offset by revenues starting at an estimated $4.9 million per year based on 10-year average commodity prices, and with the potential to rise with increased volumes processed, depending on market conditions.

Phase IV (2028 and Beyond): Optional Strategies to Exceed 70 Percent

The strategy presented above—implementing education and outreach programs, new regulations and incentives, operational changes, and investments in Phase I, II, and III—is designed to achieve Tacoma's 70 percent diversion goal by 2028.

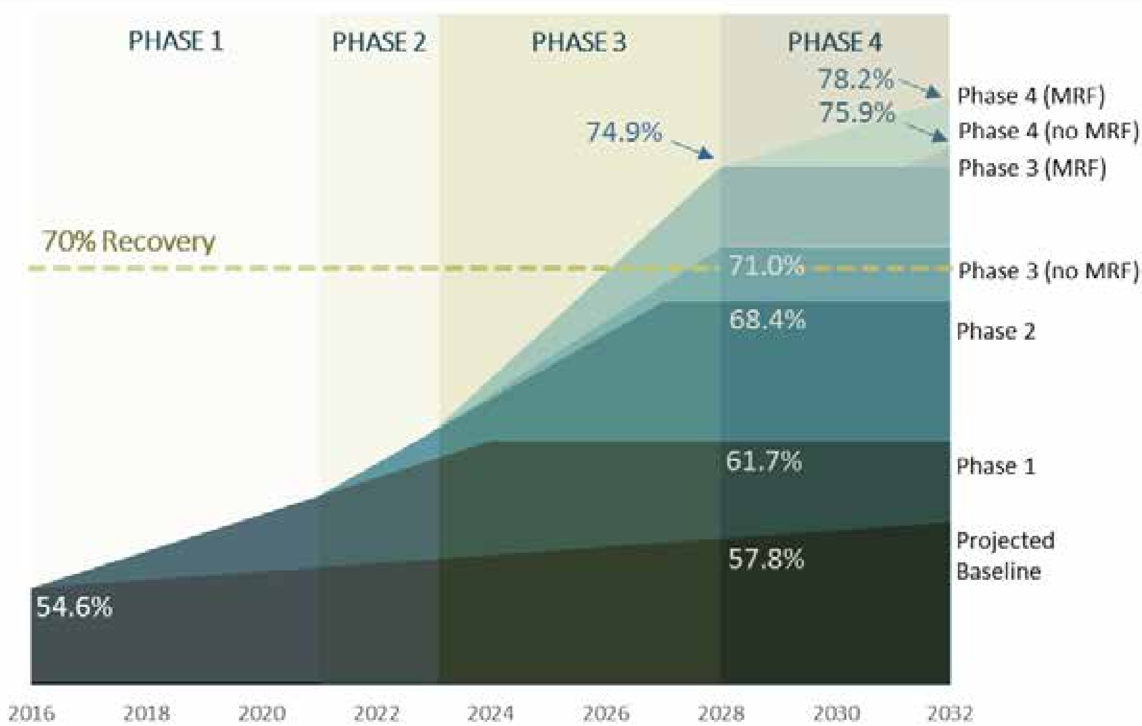
The City of Tacoma, however, considers the 70 percent goal to be a "waypoint" toward a truly sustainable materials management system that virtually eliminates waste, creates value for discards, and minimizes the negative environmental impact of materials throughout their entire life cycle. To go beyond 70 percent diversion with today's technologies and material economics, the City could consider additional regulations and programs. Regulations that would have the greatest potential impact include the following:

- Requiring composting for organic materials (including food waste, yard waste, compostable paper, clean wood, and other compostable products) for all generators, potentially diverting an additional 11,300 tons when fully implemented in 2032. Note that this option would require investment in robust new organics processing capacity.
- Mandating recycling of traditional materials for all generators, possibly diverting 10,800 additional tons when fully implemented in 2032.
- Providing retail building material and thrift/reuse stores at the TRTC.

These and other policies and programs could increase the recovery rate to over 76 percent without a MRF and to 78 percent with a new MRF. Either of these achievements would put Tacoma in a true leadership position in sustainable materials management and represent an upper bound in terms of cost-effective, feasible diversion.

Figure 3 depicts the increase in diversion related to each of the four phases summarized above and described in the full plan.

Figure 3. Recovery Estimates Resulting from SMM Plan Implementation, 2016–2032



The full implementation of Phase I, II, and III will result in a reduction in tonnage disposed at the landfill. Based on the current disposal costs of $47 per ton, the estimated average annual value between 2017 and 2032 of this avoided disposal is $2.1 million per year.

Costs of new diversion efforts would be met in part through reallocation of existing labor, cost savings from operational efficiencies, and reduced disposal costs. Any increases in funding needed would be addressed through the normal rate-setting process, which involves calculating impacts to rates through the City's rate model, review and recommendation from a citizens' Environmental Services Commission, and subsequent review, input, and approval by the City Council.

Conclusion and Recommendations

With a combination of new collection programs, processing infrastructure investments, incentives, regulations, and education—at an affordable net cost—a 70 percent diversion by 2028 is well within the City of Tacoma's reach. Achieving this diversion level will require timely decision-making, upfront investment, a sustained focus on implementing new and innovative strategies, and leadership to ensure the support of the public and key stakeholders.

The consultant team recommends the following process for achieving Tacoma's 70 percent goal by 2028 and then moving beyond that goal toward a zero waste future:

- Fully implement Phase I and II, including expanded organics processing capability.
- Assess progress in 2022 and decide whether to pursue a regulatory-based approach for achieving the 70 percent goal by 2028 or a technology-based approach that relies heavily on a new MRF. Based on cost, the consultant team recommends a regulatory approach that is designed to meet the 70 percent goal at a substantially lower cost than investing in a new MRF.
- Assess progress in 2028 and decide whether to implement the expanded Phase IV regulations or consider new investments in technology such as an integrated MRF or other alternative technologies that may become available over the next decade. The consultant team recommends implementing the Phase IV regulations first before making extensive infrastructure investments.

Regardless of the pathway selected above, attaining the 70 percent goal will demonstrate the City's commitment to sustainability and will provide long-term environmental, economic, and community benefits to residents, businesses, and institutions alike.

Table of Contents

List of Tables

List of Figures

1. Introduction

Purpose

In May of 2014, the Tacoma City Council passed Resolution #38907 reaffirming the City's commitment to divert 70 percent of the city's solid waste by 2028. This goal was first articulated in the Tacoma-Pierce County Solid Waste Management Plan of 2008. The resolution also called for the development of a sustainable materials management plan "to ensure that the diversion goal of 70 percent or more by 2028 is met" and defined sustainable materials management as "an approach that includes waste prevention and discard management, while seeking to reduce environmental impacts by managing materials through all stages of their life."

This resolution supports the City's 2008 Climate Action Plan, which called for maximizing recycling, reuse, and waste minimization as a key component of the City's effort to reduce greenhouse gases. The resolution is also consistent with the City's long-standing commitment to stewardship as a guiding principle in achieving the vision of Tacoma as "an attractive and progressive international city, regarded for the richness of its diverse population and its natural setting" and the strategic goal of a "diverse, productive, and sustainable economy."

To develop this plan, the Office of Environmental Policy and Sustainability (OEPS) and Solid Waste Management, within Environmental Services (ES), commissioned a study of the current waste stream and recycling levels,[1] projections of future diversion levels under business as usual conditions, and an analysis of alternative options and strategies to achieve the 70 percent diversion goal. The plan development process included significant stakeholder engagement through interviews, forums, and workshops.

The City of Tacoma Sustainable Materials Management Plan consists of three volumes. This document is Volume 1 which presents the plan to achieve a minimum of 70 percent diversion by 2028 and to advance sustainability in Tacoma through minimizing waste and its impacts on the environment. Volume 2 contains the City of Tacoma *Waste Stream Composition Study* and Volume 3 is the City of Tacoma *Material Recovery Facility (MRF) Feasibility Study*.

Methodology

Tacoma's Office of Environmental Policy and Sustainability (OEPS) and Solid Waste Management, within Environmental Services (ES) commissioned the development of this sustainable materials management plan (SMMP) in 2015-2016, contracting with a consulting team led by Cascadia Consulting Group under the direction of staff.[2] The work to create the plan consisted of 10 interrelated studies, tasks, and activities:

[1] Key terms, such as *waste stream* and *recycling* are defined in the Glossary in Appendix 1.

[2] Key staff members included Jeanne Walter, James Parvey, Gary Kato, Lewis Griffith, Jetta Antonakos, Kristi Lynett, Andrew Torres, and Jeff Geforos.

1) **Characterizing the disposed waste stream.** Tacoma last analyzed the composition of its waste stream in 2009. As a foundation for developing the SMMP, Cascadia sampled waste from the City's residential, commercial, self-haul, and construction and demolition (C&D) streams to determine the composition of these streams and, in particular, the tonnage of recoverable materials that are currently being disposed. Results of this work are summarized in Section 3: Baseline Conditions and presented in detail in a separate report, *Volume 2: Waste Stream Composition Study*.
2) **Documenting current recovery levels**. The City routinely reports a recycling rate based on the materials that the Solid Waste Management (SWM) collects curbside from residents and businesses and from items dropped off at the transfer station. However, there are also private hauling businesses that collect recoverable materials and private operations like metals recovery depots that accept recoverable materials from the commercial and Construction and demolition (C&D) substreams. The recycling rate the City historically reported did not include quantities from private operations. Cascadia surveyed these private entities to ascertain the 2014 tonnage of recyclable materials they handle annually and combined survey results with the City's 2014 recycling rate data to develop a more complete estimate of current recycling and diversion levels. These findings are presented in Section 3: Baseline Conditions. In this plan, the term *recycling rate* is equivalent to diversion as defined by Washington State Department of Ecology; the rate includes municipal solid waste (MSW), plus recovered C&D and other materials, such as agricultural and industrial organics and materials managed through energy recovery.

In this plan, the term *recycling rate* is equivalent to diversion as defined by Washington State Department of Ecology; the rate includes municipal solid waste (MSW), plus recovered C&D and other materials, such as agricultural and industrial organics and materials managed through energy recovery.

3) **Conducting a Materials Recovery Facility (MRF) feasibility study.** One potential option for achieving the 70 percent goal is for the City to enhance capacity for recovering and processing recyclable materials, either by investing in its own MRF or by contracting with a private entity to build and operate one for city-collected materials. To determine the viability of this solution, J.R. Miller (with support from HDR, Cascadia, and Herrera) conducted a technical and financial feasibility study of four different MRF options. Results of this study are presented in a separate report, titled *Volume 3: Material Recovery Facility (MRF) Feasibility Study*, as well as incorporated into the analysis of options and strategies for the SMMP presented in Section 4: Recommended Strategies.
4) **Projecting baseline waste generation, diversion, and disposal estimates to 2048**. Using population and employment projections applied to per capita and employee waste generation, diversion, and disposal factors, *Cascadia projected the growth in the waste stream and diversion assuming business as usual, meaning no new City or private initiatives to reduce or divert waste*. These projections, presented in Section 3: Baseline Conditions, form the basis for quantifying the additional materials that need to be recovered from the waste stream over the next 12 years to meet or exceed the 70 percent target. Please refer to Appendix 4 for more detail on the projection calculations.

5) **Establishing SMMP goals, metrics, and targets.** While the goal of achieving a 70 percent diversion rate was clearly stated in the Council's resolution and the 2008 Tacoma-Pierce County Solid Waste Management Plan, the 70 percent goal needed more definition around what materials and waste substreams to include in the recycling rate calculation as well as what other metrics (such as per capita generation measuring the success of waste prevention efforts) to incorporate into the planning process. The *Standardized Data Collection and Reduction Goal Calculations* technical memorandum discussing alternative goals and metrics can be found in Appendix 2. Key approaches and metrics from that memo have been incorporated into the plan and this report.
6) **Defining and characterizing options to increase diversion.** Working closely with OEPS and SWM staff, the consultant team identified a comprehensive list of possible new education and outreach programs, incentives, regulations, investments, and changes to the collection and operations systems to increase recovery of selected materials from selected segments of the waste stream. Over 100 options were identified. Using the team's in-house database and expertise, as well as data from Tacoma, we estimated recovery rates and costs for each option. The City staff and consultant team ranked these options and then combined them into alternative strategies and scenarios to define alternative pathways to achieving 70 percent diversion. This analysis and results are also presented in Section 4: Recommended Strategies. The methodology is further described in Appendix 3. For a list of options considered, see Appendix 5.
7) **Building a diversion potential assessment model to conduct the options and scenario analysis**. A core element of the work to craft this plan involved creating a model to quantify the impacts and costs of alternative strategies, policies, and programs on Tacoma's waste stream. This model, developed by Herrera, calculated diversion rates and life cycle costs of each option and combination of options from 2016 to 2048 (see Appendix 3 for a more detail).
8) **Analyzing scenarios.** The consultant team created and analyzed four scenarios combining different options and strategies, as an interim step in developing a recommended set of actions, initiatives, and investments to achieve the City's goals.
9) **Engaging stakeholders.** Stakeholder input and buy-in is essential to the success of any plan, especially one with the ambitious goal of achieving a 70 percent recycling rate. Accordingly, the City's SMMP staff and the Cascadia Team involved stakeholders in several ways as part of developing the plan. Stakeholder engagement activities included:
    a. Interviewing 14 individuals at the outset of the planning effort on the current performance of Solid Waste Management, options they would like to see analyzed, and other relevant inputs to the plan. These individuals represented a range of internal and external constituencies, including the private substream, the County, environmental interests, and City Council.
    b. Hosting four workshops and forums; two with ES staff and two with the Sustainable Tacoma Commission (STC) to discuss options and scenarios and obtain input.
    c. Briefing the City Council Infrastructure, Planning, and Sustainability committee twice and obtaining input from Council members.
10) **Developing the plan.** The final task involved selecting a preferred strategy from the scenarios presented and then drafting the plan to both achieve the 70 percent goal and attain the broader sustainability goals embedded in the Council's resolution and be consistent with the mission and

vision of the City, the leadership of ES, and SWM and OEPS. The plan was developed in draft form, circulated for comment and feedback, and then revised accordingly.

Assumptions

At the outset of the planning process, the SWM and OEPS staff provided guidance on key assumptions and parameters to inform the scope, goals, viable options, and strategies in the plan:

1) The 70 percent diversion goal includes the diversion of municipal solid waste (MSW), construction and demolition (C&D) waste, and quantifiable waste prevention.
2) Hazardous, special, or universal waste streams are not included in the calculation of diversion.
3) The diversion goal only applies to waste generated within the boundaries of the City of Tacoma, regardless of the hauler or location of disposal.
4) The path to the 70 percent diversion goal should be phased with milestones and front-loaded to ensure the City is on track to meet the goal by 2028. This approach allows for adaptive management if earlier strategies do not perform as intended.
5) City staff, who participated in the workshop, were most interested in strategies with the highest diversion potential that consider the following issues and sub-goals as applicable:
    a. A life cycle perspective – with a focus on measuring full financial costs and qualitatively considering other life cycle impacts.
    b. C&D debris management – with additional goals and management issues (such as addressing the concern about lost revenues) to be addressed in the plan.
    c. Potential for increasing commercial and multifamily recycling rates.
    d. Consumption of disposable bags, bottles, and other products, which have a significant life cycle impact relative to their utility.
    e. A focus on Tacoma for upstream practices and material impacts – the City is primarily interested in policies that can reduce the amount of material generated in Tacoma and only secondarily interested in the impact of programs on the environment elsewhere.
6) Plans and options should be evaluated using a triple bottom line lens, rather than least cost.

2. Vision & Goals

Vision & Goals

The City of Tacoma's goal to achieve a 70 percent diversion rate by 2028 is part of a broader and more fundamental commitment to sustainability and "triple bottom line" outcomes. Tacoma's Environmental Services Department vision states that "we are national leaders that operate fiscally sound utilities, reducing our environmental footprint for the benefit of our community and future generations." ES's mission is to "provide sustainable and cost-effective management services to protect the environment, recover value from Tacoma's waste stream, and enhance the quality of life for the citizens and ratepayers." Finally, sustainability is one of six core values – along with safety, integrity, service, excellence, and innovation – that guide the ES's work.

Several guiding principles and considerations relate to the 70 percent goal and inform the development of the sustainable materials management plan:

1) The 70 percent goal by 2028 should be considered a “waypoint” towards a future where “waste” is recognized as a resource and its value is harvested.
2) Reducing waste, increasing recycling, and minimizing unnecessary consumption will all contribute to reducing greenhouse gas emissions and other adverse impacts on the environment. Reducing emissions is a paramount goal.
3) The plan should be based on life cycle thinking, where upstream and downstream costs and impacts associated with waste are considered. For example, benefits of recycling include reducing the adverse impacts of mining, transportation, and energy consumption associated with sourcing raw materials and turning them into packaging and products. The plan will consider full life cycle impacts while primarily focusing on reducing the amount of waste generated in Tacoma.
4) Achieving service and social equity are critical aspects of sustainability. All communities should have equal access to services such as recycling collection and waste prevention education, and over time, all communities should equitably benefit from these services.
5) The plan should be cost-effective, in keeping with fiscally sound operations, but not necessarily least cost. When considering least cost options, full life cycle costs should be analyzed to the extent practical, taking into account environmental and social costs and benefits as well.

The stakeholder interviews demonstrated broad support for the 70 percent goal and the vision of Tacoma as a leader in sustainable materials management. Most considered the goal a stretch, but achievable, and many emphasized that this goal should not be considered an end in and of itself but a milestone on a journey towards minimizing discards and turning waste into resources. Additional input from stakeholders regarding issues, barriers, and opportunities is detailed below. This input informed development of the plan.

Summary of Major Issues, Barriers, & Opportunities to Increased Diversion

During interviews and workshops, stakeholders expressed appreciation for the Solid Waste Management’s services and strong performance. One stakeholder described the SWM as “efficient, well run, professional, and responsive to stakeholders.” Many stakeholders complimented management and staff on their innovative, open-minded, and risk-taking approaches. Specific praise included:

- Efficiency and ease of use of the transfer station
- High quality recycling services and performance at the recycling center
- Excellent roll-out and implementation of every-other-week garbage collection
- Performance of the food and yard waste programs – the roll-out as well as the value of “turning food waste into gas”
- Effectiveness of the Solid Waste Division’s community relations efforts, particularly the Knock & Talk campaigns

Stakeholders identified three areas where the City has room for improvement: 1) education and outreach; 2) diversion of food, fiber, and wood; and 3) increasing participation in diversion programs, especially within the commercial, multifamily, and C&D substreams. Stakeholders urged the city to "act faster with more urgency" and to include market development and product stewardship in the toolkit to achieve the 70 percent goal by 2028.

Related to education and outreach, stakeholders cited the following as opportunities for improvement on the city's current programs:

- Do better at getting the message out about the benefits of recycling and how the system works; tell the story of recycling in a way that is engaging and brings people on board.
- Consider redesigning outreach collateral – some of the same collateral has been in use for many years and doesn't reflect current programs.
- Provide customers with feedback about how they are doing in terms of program participation.
- Provide more opportunities for face-to-face interaction between customers and outreach personnel.
- Invest more in communication with private substream partners.

Related to diversion of food, fiber, and wood, stakeholders offered that the City of Tacoma should expand food waste collection to include other compostables like food-soiled paper and untreated wood.

Related to increasing participation in diversion programs, stakeholders reaffirmed that the commercial, multifamily, and C&D substreams are particular areas of opportunity. Specifically, the C&D substream is "kind of an unknown" in terms of the scope of opportunity, and banning C&D disposal may be the best way to enhance diversion in that substream, provided that there are facilities that can successfully process and divert C&D materials.

To get to 70 percent diversion from the landfill, stakeholders generally favored incentives and not mandates, though they recognized the value and efficacy of selected mandates in certain circumstances. They did not want to jeopardize customer goodwill and strong customer satisfaction, particularly among single-family residents. However, if mandates are needed to reach 70 percent, stakeholders recommended that there be a robust plan, long lead time, and extensive education prior to implementation. Many stakeholders expressed the opinion that they prefer mandatory recycling to bans, and all stakeholders urged that any mandates, if implemented, be uniformly enforced. Support for a plastic bag ban was mixed. Stakeholders said that they see rate incentives as a means of encouraging good customer choices through a price signal, with one stakeholder commenting: "Absolutely, increasing costs will drive diversion."

Other input received from stakeholders included:

- Be sure to involve the public – as soon and as much as possible – in both the planning and implementation processes.
- Expand education at events and continue Knock & Talk campaigns to fully engage the public in implementation.
- Consider partnering with private recyclers on education and outreach, processing, and market development.
- Make sure that the plan and its programs are data-driven and that the plan is innovative in developing new markets to enable the success of recycling new and different materials.

Key Metrics

Tacoma's definition of a recycling rate includes mixed solid waste (MSW) and other diverted materials, including construction & demolition (C&D) waste, and is equal to total recovery divided by total generation citywide and by substream of these materials. This rate is comparable to Washington State's annually reported diversion rate. Other key metrics used to measure Tacoma's performance include:

- **Per capita generation**: equal to citywide generation divided by population to measure trends that are normalized for population and employment growth over time.
- **Recoverability potential**: the percentage and tons of waste that could have been recycled or composted, in total and by substream.
- **Capture rates:** for key recyclable and compostable materials overall and for selected substreams. Capture rate is defined as the total tons of recyclables collected in recycling programs divided by the total tons of recyclables collected in recycling programs and disposed.

3. Baseline Conditions

This section provides an overview of the composition of the existing waste stream, the recovery potential in that stream, current recycling and capture rates, and existing diversion programs. The figures presented in this section are a combination of disposal, recycling, and composting tonnages from 2014, and composition study results from 2015. Cascadia collected the 2014 tonnages through a survey of Tacoma's records and of private haulers and processors collecting materials from the City of Tacoma. The 2015 composition study is one that Cascadia completed to fulfill Task 1 of its contract with the City of Tacoma. The study included an examination of the City's disposed waste and organics material streams.

All of the data presented in this section is intended to serve as the foundation for building a targeted, effective plan to support the City of Tacoma as they work towards reaching 70% diversion by 2028. Having up-to-date, accurate data to support this planning is essential for ensuring that the plan is well-informed and suggests realistic steps for achieving the city's goals.

Summary of Current Diversion Programs and Activities

The City of Tacoma has many successful current programs and activities to support diversion in the city. A sampling of these programs and activities include:

- **Curbside collection of commingled recyclables.** The City of Tacoma's Solid Waste Management (SWM) provides single-family generators with separate carts for garbage, commingled recyclable materials, recyclable glass (may be commingled in the future), and yard debris. Recycling collection services for single-family residents are voluntary, but in 2014, about 97% of residences participated in the recycling collection program.

  Tacoma offers the same voluntary curbside collection services to tri-plexes and four-plexes. Larger multifamily sites have also expressed interest in a curbside commingled recyclables collection program, and Tacoma designs and implements programs for these larger sites as requested.

Commercial customers also have voluntary access to collection services for glass and commingled recyclables. Commercial customers can subscribe to recycling collection services with private recycling companies for recyclables such as cardboard and mixed paper.

- **Processing of commingled recyclables.** The City of Tacoma's recyclables go to Waste Management's JMK material recovery facility (MRF) for processing. WM retrofitted the existing MRF with updated technology and added a glass removal system and reopened the facility in 2013. Given these improvements, WM informed Tacoma's SWM that collecting glass separately was no longer necessary. However, SWM continued to collect glass separately: they have a well-established two-stream collection system with high participation rates and customers have grown accustomed to separating glass. Also, SWM had concerns that commingling the glass with the rest of the recycling stream could contaminate the commingled stream and impact commodity values. Tacoma's glass is hauled to JMK's facility and then transferred to Strategic Materials in Seattle for recycling.
- **Food and yard waste (Organics) collection programs.** The city recognizes that food and yard waste make up a significant portion of the waste stream. They offer curbside collection for these materials at no additional charge for residents, and at a subsidized rate for commercial customers. The curbside program roll-out was widely recognized as successful; the city received a 2013 SWANA Gold Excellence Award in Communication for its food waste program community outreach efforts. This roll-out included door-to-door Knock & Talk messaging that focused on what materials are acceptable in the program, how to make participating in the program simple, and tips to avoid odors and pests.
- **Tacoma Recovery and Transfer Center operations.** The Tacoma Recovery and Transfer Center (TRTC) offers a variety of diversion services all in one place. The Tacoma Recycling Center operates within the Tacoma Recovery and Transfer Center, and accepts self-hauled materials including metal items, glass bottles, plastics, cardboard and paper, batteries, electronics, among other difficult-to-handle materials like used motor oil and packing peanuts. The Recycling Center also accepts recyclables that the city's municipal collection system picks up curbside. Goodwill has a semi-permanent presence at the center, accepting unwanted clothing and household items. Center employees working at the garbage dumping floor survey incoming materials and hand remove materials that can be diverted, an effort that has resulted in significant diversion results. The center also features the EnviroHouse that teaches visitors about sustainable behaviors that they can adopt at home.
- **Every-other-week single-family garbage collection.** The City of Tacoma has offered every other week collection to their residents since March 2013. This collection service amendment, intended to reduce costs for the municipal collection service and increase waste diversion for the city, has demonstrated results. In the first quarter of the program, the city's municipal collection system reduced fuel costs by 44 percent, and carbon dioxide emissions by 20 percent.[3]

[3] http://www.cityoftacoma.org/cms/One.aspx?portalId=169&pageId=63053

- **Knock & talk outreach.** The city has used this approach for the launch of new programs such as the every-other-week collection. This approach, which has proved effective, involves going door-to-door to customers to explain the new program and answer any questions. This Knock & Talk outreach strategy played a large role in making every-other-week collection a success in the city by giving residents personalized assistance to make sure they had the right garbage collection infrastructure to make the program work for them.

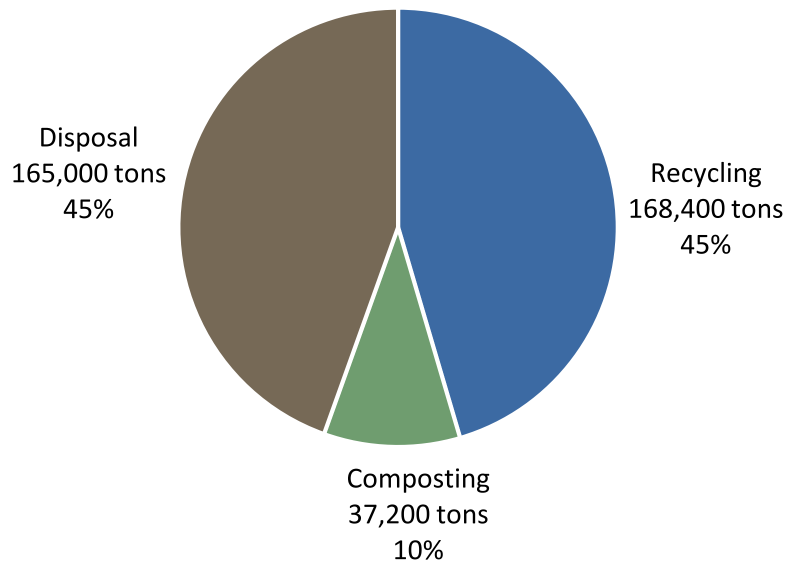
Overall Generation

Figure 1 below is a representation of overall generation for the City of Tacoma in 2014, divided by materials disposed, recycled, and composted. For the purposes of this study, generation is defined as the sum of materials from Tacoma that are disposed in the landfill, processed for recycling, and sent to composting facilities. Of the 370,500 tons of material generated in 2014, 55 percent of the material was recovered for recycling or composting.

Figure 1 also presents estimated capture rates for the recyclables and organics generated in Tacoma. A recycling capture rate compares the tons of recyclable materials being recycled to the sum of the tons of recyclable materials recycled and the tons of recyclables materials disposed. Capture rate is defined as the total tons of recyclables collected in recycling programs divided by the total tons of recyclables collected in recycling programs and disposed. For example, if 80 out of 100 tons of recyclables generated in Tacoma were recycled, the capture rate would be 80%.

In Tacoma in 2014, the estimated capture rate for recyclables was 73 percent, and the estimated capture rate for organics was 44 percent.

Figure 1. 2014 Overall Generation and Recovery Profile

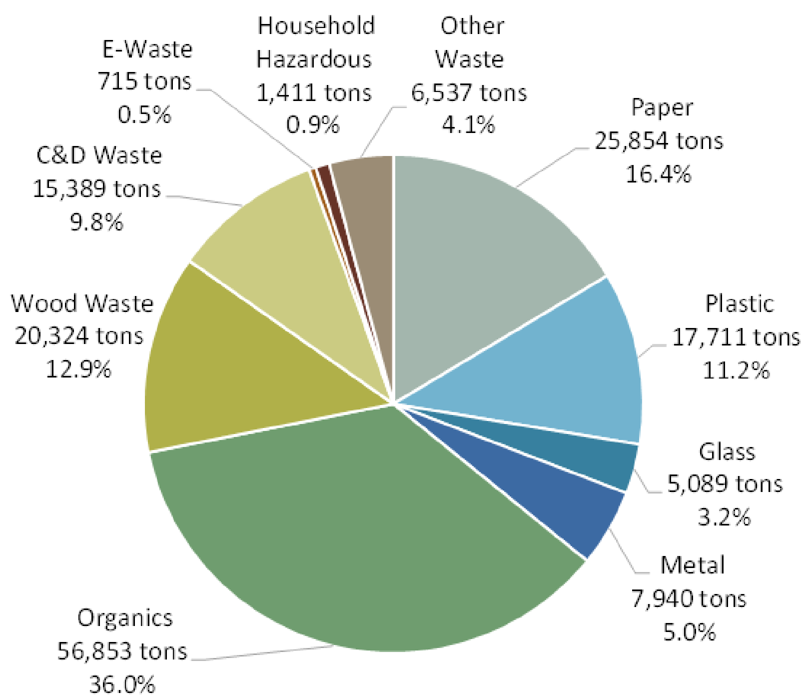


Waste Disposal by Material Class

Figure 2 below presents the composition of the waste that Tacoma disposed in 2014 by material class. These composition estimates are based on the waste characterization study that Cascadia completed in 2015. For sorting purposes, the study established 85 standard material types for the waste stream. These 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 example, the *newspaper* material type is categorized in the **Paper** material class.

The two most prevalent material classes in the disposed waste stream are **Organics** (36.0%) and **Paper** (16.4%), making up more than one-half of all disposed waste. Many of the materials in these two classes are recoverable (depending on the health of local and global markets) and represent significant opportunities for increased diversion through expanded recycling and composting programs.

Figure 2. 2014 Overall Waste Disposal by Material Class (165,000 tons)

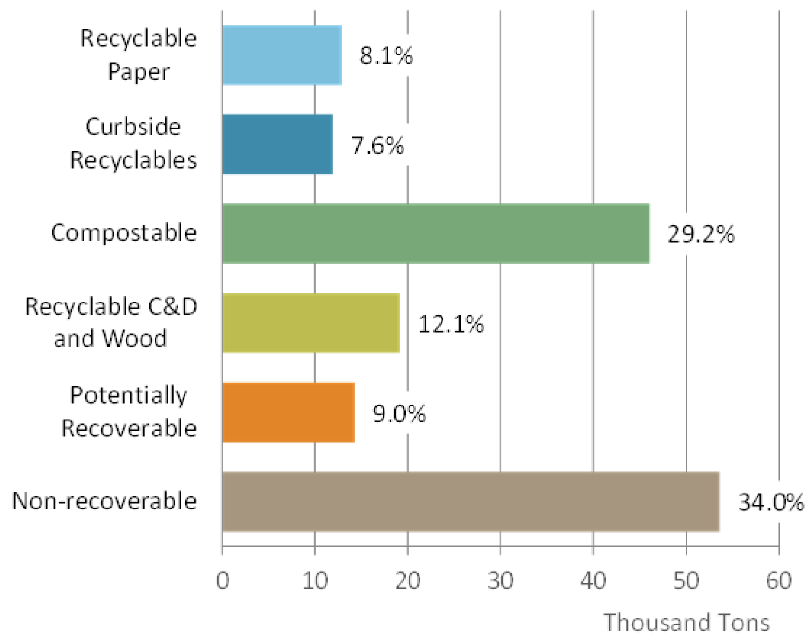


Waste Disposal by Recoverability Class

Figure 3 below presents the composition of the waste that Tacoma disposed in 2014 by recoverability class. The waste characterization study that Tacoma completed in 2015 defined 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.

Other than the Non-recoverable (34.0%) portion, the most prevalent recoverability classes were Compostable (29.2%) and Recyclable C&D and Wood (12.1%).

Figure 3. Recoverability of Overall Disposed Waste, 2014



Waste Disposal and Recoverability by Substream

Figure 4 below presents 2014 Tacoma waste disposal by substream. For the purposes of this report, “substreams” are essentially types of generators. This study divided Tacoma’s disposed waste stream into five substreams— single-family, multifamily, commercial, self-haul, and C&D.

Disposal is defined as the tons of material received at the Tacoma Recovery and Transfer Center and sent to the landfill. Generators in the commercial substream disposed the most waste in 2014; they were responsible for 37 percent of waste disposed in 2014. The single-family and self-haul substreams were each responsible for 20 percent of the waste disposed. The multifamily substream was responsible for the least amount of material disposed in 2014, at 8 percent of the total.

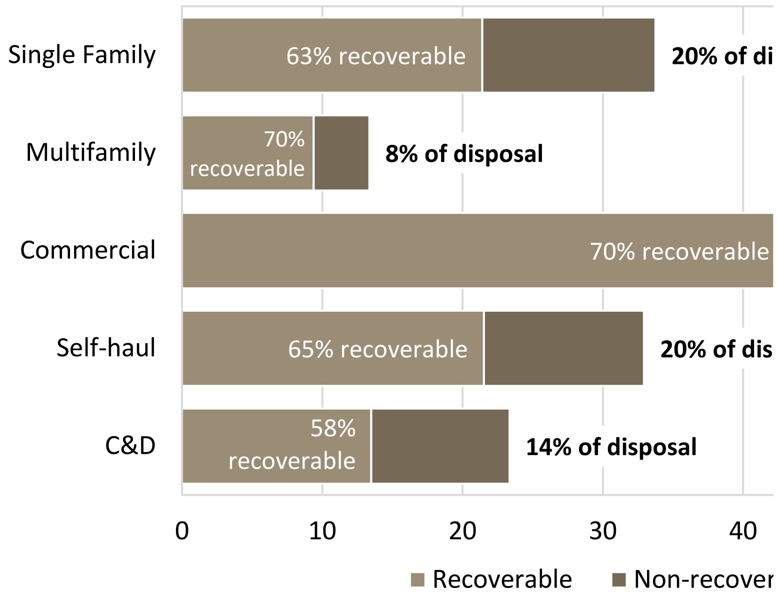
Figure 6 below also presents the portion of recoverable waste disposed by substream Recoverability is defined as materials that could be diverted through Tacoma’s current recycling and composting programs. As **Figure 6** demonstrates, the commercial and multifamily disposed waste stream were equally recoverable (70 percent of the disposed material in each substream was estimated to be recoverable). However, the commercial substream’s disposed waste represents the most significant opportunity for recoverable materials, with about 43,029 tons of recoverable material disposed in 2014. This is more than double the opportunity for material recovery in the disposed waste for any other substream.

Disposed waste for the single-family and self-haul substreams also represented significant opportunities for increasing diversion. The single-family substream’s disposed waste was 63 percent recoverable (an opportunity of about 21,397 tons), and the self-hauled substream’s disposed waste was 65 percent recoverable (an opportunity of about 21,525 tons).

For the purposes of this report, “substreams” are essentially types of generators. This study divided Tacoma’s disposed waste stream into five substreams— single-family, multifamily, commercial, self-haul, and C&D.

The commercial substream’s disposed waste represents the most significant opportunity for recoverable materials, with about 43,029 tons of recoverable material disposed in 2014. This is more than double the opportunity for material recovery in the disposed waste for any other substream.

Figure 4. Waste Disposal and Recoverability by Substream, 2014



Cascadia calculated the City of Tacoma's 2014 recycling rate by considering recycling from two sources: tons of recyclables managed by the city's municipal system and tons of recyclables managed by private haulers and processors.

For the purposes of this analysis, the term "recycling rate" includes all activities that the Washington State Department of Ecology (Ecology) defines as recycling, including materials that are composted, as well as all of the activities that the Ecology defines as diversion.

In 2014, Tacoma achieved a 41 percent recycling rate (excluding C&D) for residential and commercial waste and a 55 percent recycling rate overall when C&D debris is included.

Recycling and Capture Rates

Cascadia calculated the City of Tacoma's 2014 recycling rate by considering recycling from two sources: tons of recyclables managed by the city's municipal system and tons of recyclables managed by private haulers and processors. Previous recycling rate calculations had only considered tons managed by the municipal system, and therefore underestimated the city's recycling rate, both overall and for the commercial and C&D substreams in particular. For the purposes of this analysis, the term "recycling rate" includes all activities that the Washington State Department of Ecology (Ecology) defines as recycling, including materials that are composted, as well as all of the activities that the Ecology defines as diversion.

To calculate this recycling rate, we compared the amount of recoverable materials being recycled to the total amount of wastes that are generated (all materials that are recycled and disposed). We used the following equation to accomplish this:

$$recycling\ rate = \frac{total\ tons\ of\ recoverable\ material\ collected}{total\ tons\ of\ recoverable\ materials\ collected + total\ tons\ of\ garbage\ collected}$$

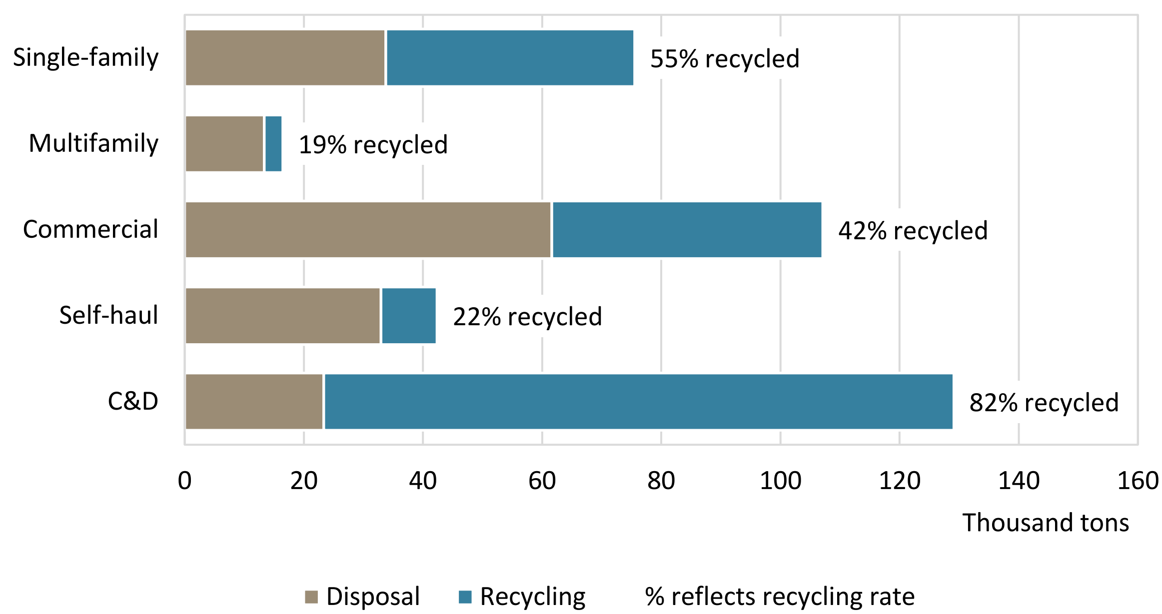
Cascadia collected information about the tonnage of recyclables managed by private haulers and processors by working with the City of Tacoma to survey these haulers and processors. The city and Cascadia identified 24 private haulers and processors that handle recyclables generated within the city of Tacoma and outside of Tacoma's municipal collection system. Cascadia obtained data from 12 of these companies on tons of commercial, self-haul, and C&D debris materials recycled.

These additional tons substantially increased the commercial and C&D debris recycling rates, and boosted overall recycling rates as well. In 2014, Tacoma achieved a 41 percent recycling rate (excluding C&D) for residential and commercial waste and a 55 percent recycling rate overall when C&D debris is included.

The C&D substream recycling rate is the highest among the substreams, at 82 percent, followed by the single-family substream at 55 percent.

Figure 5 below provides more detail about the City of Tacoma's recycling rate for each substream. The C&D substream recycling rate is the highest among the substreams, at 82 percent, followed by the single-family substream at 55 percent.

Figure 5. Waste Disposal and Recycling by Substream, 2014



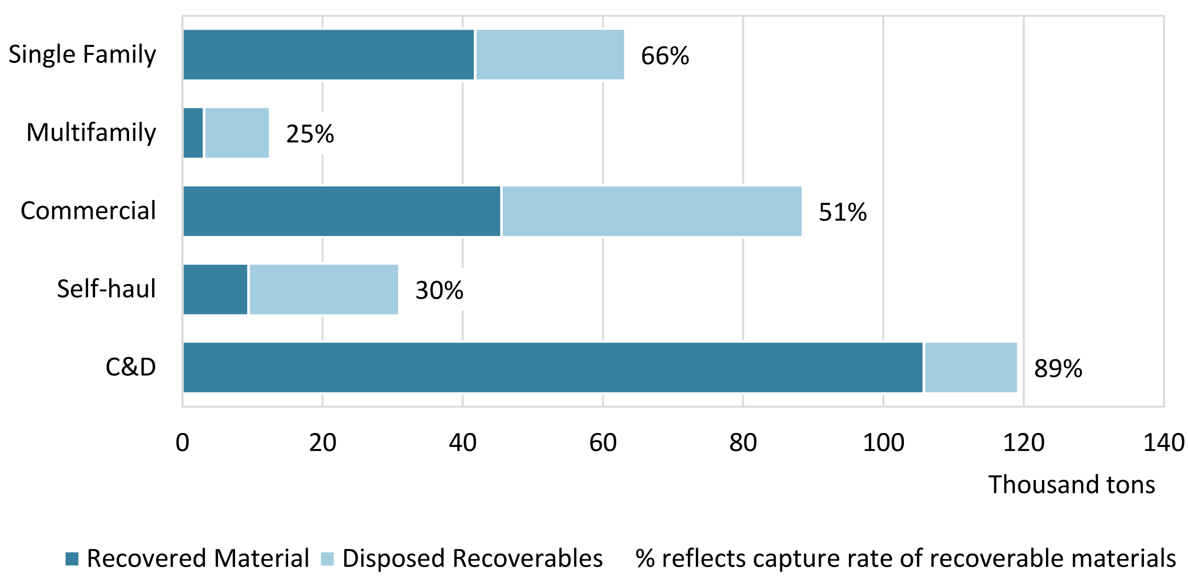
Capture Rates by Substream

Figure 6 demonstrates the capture rate of recoverable materials by substream. As discussed above, we calculated capture rates by comparing the tons of materials that are recovered to the sum of the tons of materials that are recovered and the tons of materials that are disposed in the garbage**.** The C&D substream has the highest capture rate of all of the substreams: 89 percent of recoverable materials that the substream generates are recovered. By contrast, the multifamily substream has the lowest capture rate: 25 percent of recoverable materials that the substream generates are recovered.

As discussed above, the most significant opportunities for recovering additional materials are in the commercial (43,029 tons of recoverable materials disposed in 2014), self-haul (21,525 tons of recoverable materials disposed in 2014), and single-family (21,397 tons of recoverable materials disposed in 2014) substreams.

The C&D substream has the highest capture rate of all of the substreams: 89 percent of recoverable materials that the substream generates are recovered.

Figure 6. Capture Rates of Recoverable Materials by Substream, 2014



Per Capita Normalized Generation Rates

The normalized generation rate for Tacoma in 2014 is a function of the number of tons of material generated, divided by the total population. In 2014, Tacoma generated 370,520 tons of material, and had a population of 200,900 people. Dividing population by generation yields a per capita annual generation rate of 1.84 tons of material per person.

In 2014, Tacoma generated 370,520 tons of material, and had a population of 200,900 people, which is equivalent to a per capita annual generation rate of 1.84 tons of material per person.

Baseline Projections

As part of the planning process, Cascadia projected the growth in generation, diversion, and disposal through 2028 assuming business as usual, meaning no new City or private initiatives to reduce or divert waste. Business as usual is described in Section 3, above. This assumption included the supposition that diversion results from these current diversion programs and activities would also stay the same over time.

Generation, Disposal, Diversion to 2028

Cascadia estimated growth in the waste stream through 2048 by multiplying per capita, per household, and per employee waste generation by the relevant projections for each generator group. These projections, presented at the summary level in this section, define the additional tons that need to be recovered from the waste stream over the next 12 years to meet or exceed 70 percent diversion by 2028.

The specific data types and sources that Cascadia used to calculate these projections are shown in **Table 1** below.

Table 1. Data Sources for Generation Projections, by Generator Group

Generator Group	Data Type	Source
Residential Self-Haul	Total Population	Office of Financial Management
Single-Family	Single-family households	Puget Sound Regional Council
Multifamily	Multifamily households	Puget Sound Regional Council
Commercial/Commercial Self-Haul	Total employment	Employment Security Department
Construction and Demolition	Construction employment	Employment Security Department

Cascadia allocated total waste generation for future years to disposal, recycling, and organics streams based on 2014 recycling and composting rates for each substream. The 2014 data sources included: the recycling survey described in the Recycling and Capture Rate section (in which Cascadia surveyed 12 private haulers and processors that handle recyclables generated within the city of Tacoma and outside of Tacoma’s municipal collection system about the tons of material they recycle); and the recycling and composition data that the City of Tacoma consistently tracks and reports on. Cascadia split the City of Tacoma data into substreams—such as single-family and multifamily—based on Tacoma recycling data, Seattle recycling data, and 2015 Tacoma waste composition data.

Total Recovery and Disposed Tons MSW and C&D

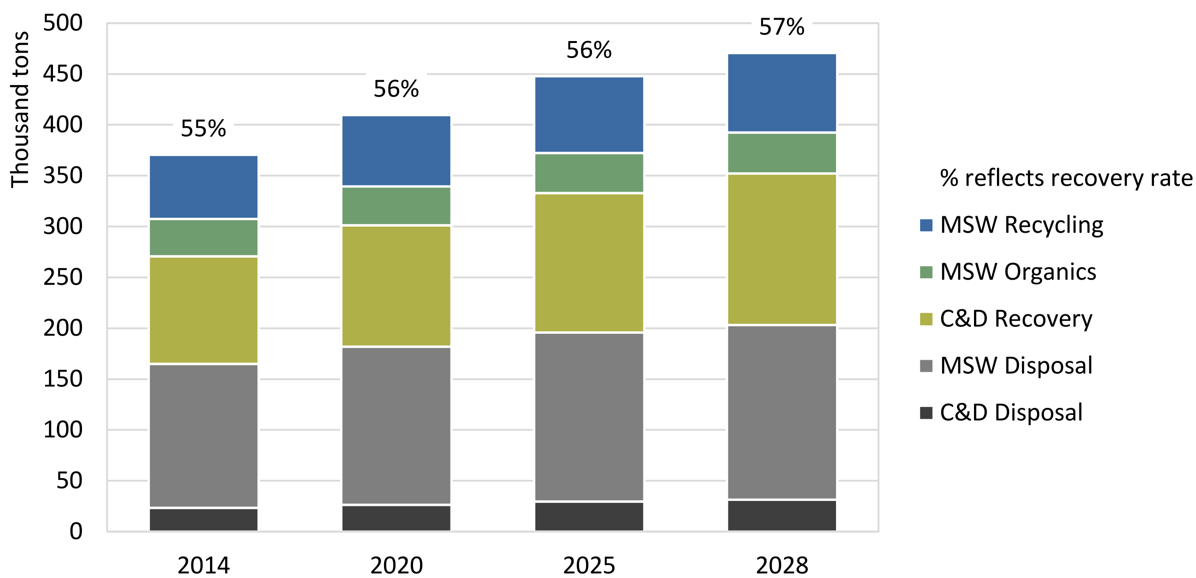
Figure 7 below provides projected total recovery and disposal tons. The column representing 2014 is based on actual data collected for this plan, and the 2020, 2025, and 2028 columns are projections. Between 2014 and 2028, overall recovery is projected to increase by about 61,900 tons; and overall disposal is projected to increase by about 38,100 tons in the same time period.

C&D Recovery is expected to increase substantially (by 43,406 tons), as is MSW Disposal (projected to increase by 30,176 tons). MSW Recycling is also projected to increase, by an estimated 15,000 tons. The smallest changes are expected for MSW Organics (projected increase of 3,484 tons) and C&D Disposal (projected increase of 7,932 tons).

C&D Recovery is expected to increase substantially (by 43,406 tons), as is MSW Disposal (projected to increase by 30,176 tons).

The smallest changes are expected for MSW Organics (projected increase of 3,484 tons) and C&D Disposal (projected increase of 7,932 tons).

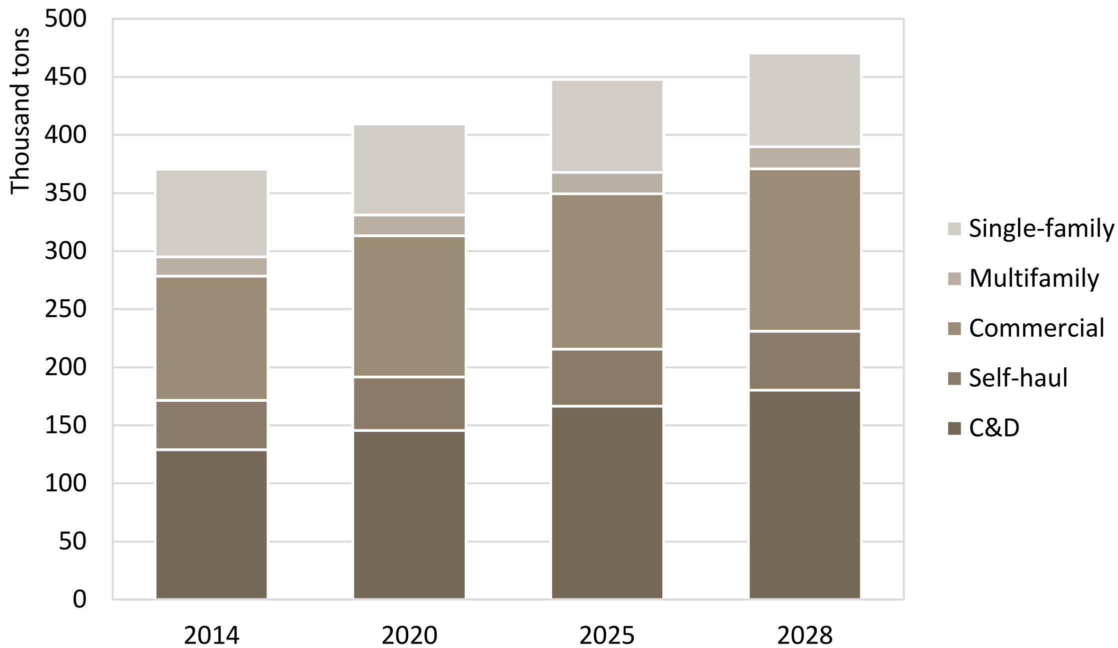
Figure 7. Projected Disposal and Recovery of MSW and C&D, 2014-2028



Generation by Substream

Figure 8 below provides information about generation projections by substream between 2014 and 2028. Projections indicate that C&D and commercial generation will both increase substantially in this time frame: C&D generation by 51,338 tons, and commercial by 32,790 tons.

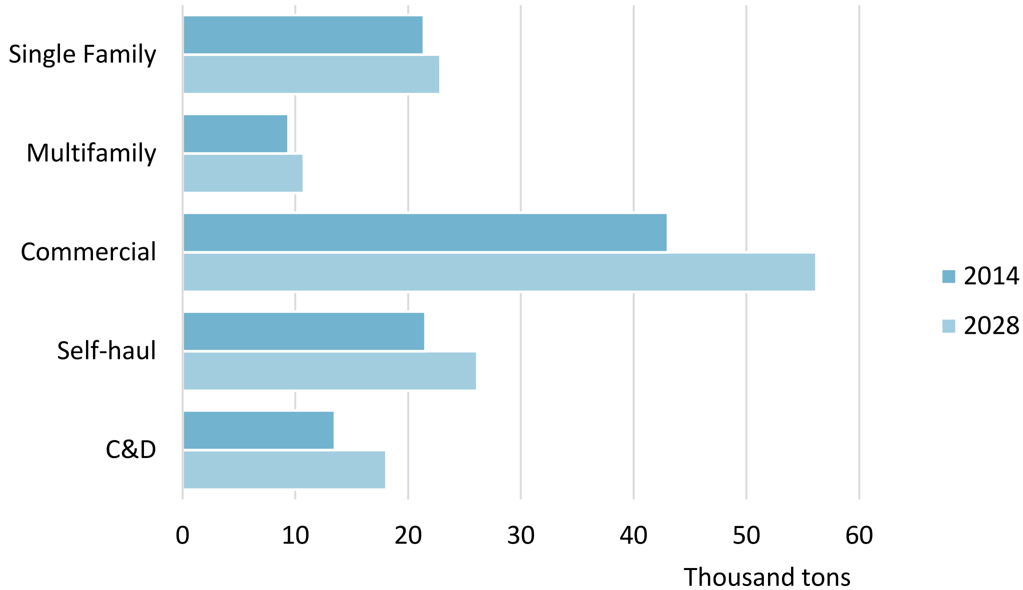
Figure 8. Projected Generation by Substream, 2014-2028



Projected Recoverable Waste in the Disposal Stream

Figure 9 presents projections for the tons of recoverable waste bound for disposal. By 2028, the commercial substream is projected to present the largest opportunity for recoverable materials in the garbage stream (at 56,201 tons), followed by the self-haul (26,130 tons) and single-family (22,875 tons) substreams.

Figure 9. Projections of Recoverable Waste for Disposal, 2014 and 2028



4. Recommended Strategies

This section summarizes recommended strategies to attain 70 percent diversion by 2028. Recommended staffing and capital improvements included in the plan also serve to build a foundation for moving well beyond the 70 percent goal.

70 Percent by 2028

Overview of plan to achieve 70 percent

Achieving 55 percent diversion as shown in **Figure 1** is significant, making the city a national leader in recycling. This high level of performance reflects the City's sustained efforts over time to implement state-of-the-art curbside and self-haul recycling programs and educate citizens and businesses to participate in those programs.

However, much more recovery is needed to achieve 70 percent diversion by 2028, especially considering the expected growth in waste over time due to population and economic growth. To achieve the 70 percent recycling rate by 2028, the City will need to recover an additional 62,000 tons, or about 50 percent of the recoverable tons in Tacoma's disposed waste stream. These tons will need to come from new and expanded programs, investments, incentives, regulations, and other initiatives.

The plan recommends that Tacoma implement these changes in four phases over the next 12 years. The overriding purpose of this phased approach is to plan well for and cost effectively attain the 70 percent diversion goal, with stakeholders and the public regularly informed of progress and the City Council making informed decisions about when to implement needed policies, programs, and investments that take into account the potential impact on rates.

The proposed plan incorporates a "voluntary first" approach and suggests utilizing existing infrastructure and systems, where possible, to increase diversion. In Phase I, the emphasis is on expanding education, outreach, and technical assistance with only limited mandates and investment in new or upgraded facilities. Decisions on whether to implement major new capital investments and considerations about additional mandates are deferred to the end of Phase I and to the start of Phase II.

In this way, Environmental Services (ES) can move incrementally, with full Council and stakeholder buy-in to adopt policies and make investment decisions as needed. With this approach, ES can also effectively manage the associated risks, including changes in technology, escalating costs, and the possibility of lagging participation and/or growth in waste generation that would require more intensive use of mandates and increased investments in new technology. Each of the four phases is described below:

Phase I runs from 2017-2020 and features vigorous implementation of new education and outreach initiatives, coupled with selected, highly targeted regulations, incentives, and investments. These initiatives are expected to increase diversion by 22,800 tons by 2028, increasing the recycling rate from 55 percent to 62 percent. Phase I costs include approximately $950,000 (2015 $)[4]of capital investment, with estimated operating cost of the programs at about $950,000 per year beginning in 2017 and increasing to $1.3 million by 2020. These costs would be offset by annual revenues from marketable commodities starting at about $15,000 and rising to $25,000 per year by 2020, depending on market conditions.

Phase II runs from 2021-2022 and adds new regulations and education initiatives, increased organics collection and processing capacity, and related operational changes. These efforts are expected to increase diversion by an additional 31,800 tons, or 6 percentage points to 68 percent by 2028. Phase II costs include $14.2 million (2015 $) in capital costs for mixed organics processing capable of handling yard and food waste as well as compostable paper. The estimated operating cost of all Phase II programs is approximately $1.1 million (2015 $) per year beginning in 2021 and increasing to $1.6 million by 2022. These costs would be offset by annual revenues from marketable commodities starting at about $60,000 and rising to $100,000 per year by 2022, depending on market conditions. In this period, the City will need to decide whether and how to add material recovery facility (MRF) capacity to the system by 2028, an alternative means of increasing diversion to customer-facing education programs and mandates.

Phase III begins in 2023. While it is premature at this point to say exactly what programs and investments will be implemented, Phase III will likely include continuing with mandates to increase diversion by an additional 12,200 tons by 2028, resulting in a 71 percent recycling rate. These Phase III costs would include an estimated $85,000 in operating cost for the programs starting in 2023 and rising to $435,000 by 2028. Alternatively, bringing on MRF capacity could result in a 7 point increase in diversion by 2028, from 68 percent to 75 percent, and would require approximately $33 million (2015 $) in capital costs, and annual operating costs starting at $250,000 in 2023 and rising to $5.9

[4] All costs in this section are expressed in 2015 dollars.

million when the MRF comes on line. Both Phase III with and without a MRF would produce revenues to offset costs. Phase III programs without a MRF would produce about $5,000 in revenues, while Phase III programs with a MRF would produce $260,000 in revenues beginning in 2023 and rising to $4.9 million when the MRF begins operations in 2028. All of these revenue figures would depend on market conditions.

Phase IV starts in 2029 with new targets established at that time. This phase includes programs and initiatives to get the City to 76 percent diversion by 2032. With MRF capacity, the City could achieve 78 percent diversion by 2032. Phase IV capital costs would be approximately $8.9 million (2015 $), with annual operating costs of approximately $570,000 in 2029 and rising to $800,000 in 2032. Phase IV produces some revenues to offset these costs, estimated at this time to be nominal. If necessary to meet the 70 percent recycling goal, these programs and initiatives, in particular the regulations, could be implemented prior to 2028.

Figure 10 depicts the increase in diversion related to each phase. **Table 2** shows net new average annual costs between 2017 and 2032 to achieve that additional diversion.[5] The full implementation of Phase I, II, and III will result in a reduction in tonnage disposed at the landfill. Based on the current disposal costs of $47 per ton, the estimated average annual value between 2017 and 2032 of this avoided disposal is $2.1 million per year.

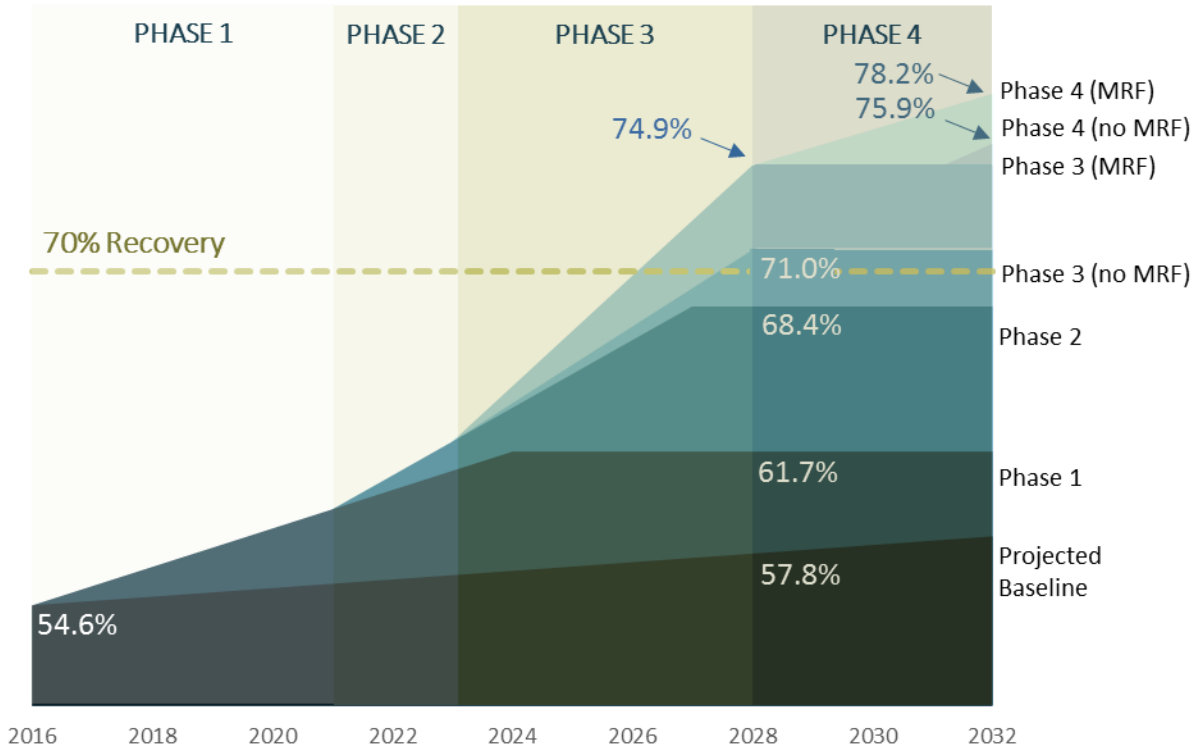
Costs of new diversion efforts would be met in part through reallocation of existing labor, cost savings from operational efficiencies, and reduced disposal costs. Any increases in funding needed would be addressed through the normal ratemaking process, which involves calculating impacts to rates through the City's rate model, review and recommendation from a citizen's Environmental Services Commission, and subsequent review, input, and approval by the City Council.

Table 2. Net Average Annual Costs by Phase

Phase	Average Annual Through 2032
Phase I	$727,843
Phase I, II	$2,165,402
Phase I, II, III No MRF	$2,379,484
Phase I, II, III w/ MRF	$3,314,353
Phase I, II, III No MRF, IV	$2,675,492
Phase I, II, III w/ MRF, IV	$3,604,051

[5] Net annual average costs between 2017 and 2032 are expressed in 2015 dollars and assume a 20-year asset life for major investments and net cash flows for each phase and combination of phases (including direct and staffing costs for program and education activities, fixed operation and maintenance costs, amortized capital expenditures, and revenues).

Figure 10. Recovery Estimates Resulting from SMMP Implementation, 2016-2032



Diversion Options

In developing the SMMP, the Cascadia Team and the ES considered a comprehensive set of options. In total, the team considered over 100 specific policy, programmatic, investment, or operational options and incorporated 73 into the recommended plan (refer to Appendix 4 for a detailed list of the 73 options). These options fall into six different categories as described below.

Waste Reduction/Extended Producer Responsibility (EPR)

This category primarily consists of: 1) engaging producers to take responsibility for the end-of-life management of certain products and packaging (extended producer responsibility) and 2) educating customers about their waste reduction options. Options evaluated as part of the planning process include providing outreach specific to waste reduction and prevention (mostly focused on single and multifamily customers, though potentially expanding to reach other customers); launching a food waste prevention education campaign for single-family customers; promoting reuse and supply chain management to self-haul and commercial customers; and promoting EPR. This category does include one option that is not explicitly education related: establishing ongoing reuse drop-off events for self-haul customers.

Education & Outreach

This category includes general and targeted education, outreach, and technical assistance. Options include targeted outreach to different customer segments, general education, application of community-based social marketing principles, technical assistance, and a Master Recycler/Composter program. This category also covers the promotion of existing recycling and reuse opportunities for single-family, multifamily, and self-haul customers; C&D debris salvage and green building strategies for C&D commercial and C&D self-haul customers; and organics diversion strategies for single-family and commercial customers.

Operations & Programs

This category is focused on options that ensure sufficient programmatic and physical infrastructure is in place to support the City of Tacoma's diversion efforts. Options within this category include providing adequate recycling infrastructure for multifamily customers and expanding food waste collection and green reuse and purchasing opportunities for commercial customers. In later years, options include expanding the recyclable materials collected curbside for single and multifamily customers; enhancing the floor sorts at the TRTC; designing commercial routes to collect and process highly recoverable waste; and holding neighborhood swap and repair events to serve residential customers.

Capital Investments

The capital investments considered are intended to provide adequate and high-performing collection and processing capacity for Tacoma's recoverable materials. Options include expanding mixed organics processing capabilities and expanding collection to accommodate compostable paper and food serviceware. Capital investments evaluated in later phases of the plan include investing in or contracting new MRF capacity and expanding mixed organics processing capacity. It is important to note here that this investment in new processing capacity could happen in several different ways, including directly by the City, via a public-private partnership, or through a contract arrangement with an existing or new private entity.

Incentives & Rates

Incentives and rates considered included (but were not limited to) providing incentives for self-haul customers to increase diversion at the TRTC and increasing pay-as-you-throw (PAYT) rate differentials for residential customers.

Regulations

Possible mandates, including disposal bans and mandatory recycling, were evaluated. As discussed earlier, these mandates and regulations were considered as a last resort or in selected instances where specific barriers could be cost-effectively overcome with a mandate and where public acceptance was deemed high. Regulations were specifically considered as an alternative to investing in new MRF capacity. Regulations evaluated include requiring adequate infrastructure for recycling by commercial customers; requiring job site recycling for C&D customers; implementing mandatory recycling laws that affect residents; and requiring recycling and composting at large events held on public property.

Phase I (2017-2020): Intensive Education & Outreach; Limited Regulations

The purpose of Phase I is to increase recycling and waste prevention voluntarily with minimal new investment and regulations. These efforts build on existing successful outreach and education initiatives, such as the Knock & Talk campaigns, and take advantage of the excellent collection programs and infrastructure already in place in the city. These efforts also build the groundwork for designing and implementing Phase II and Phase III diversion programs.

The recommended plan calls for implementing 19 types of new programs and initiatives affecting all types of waste generators (**Table 4**). These programs and initiatives are projected to divert an additional 22,800 tons by 2028 and increase in the recycling rate by seven percentage points, from 55 to 62 percent.

> Of the 19 programs that comprise Phase I, the majority are planned to begin in 2017. Most of these have a ramp-up period of 3 to 5 years.

Phase I costs include about $950,000 (2015 $) of capital investment.[6] The estimated operating cost of these new programs will be approximately $950,000 per year beginning in 2017 and will increase to $1.3 million by 2020.

Staffing for these initiatives is calculated to be about 8 FTE, with $300,000 invested in the first year and $100,000 annually in the following four years for contractor support services.

These costs would be offset by annual revenues from marketable commodities starting at about $15,000 and rising to $25,000 per year by 2020, depending on market conditions.

Estimated diversion of these programs by substream when fully implemented are presented in **Table 3** below.

Table 3. Diversion by Substream from Phase I (2017-2020)

Substream	Total Tons
Single-family and Multifamily	2,200
Multifamily only	1,200
Commercial (Non-C&D)	5,600
Self-haul (Non-C&D)	2,800
C&D	4,300
Cross cutting (more than one substream)	6,600
TOTAL	**22,800**

Of the 19 types of programs that comprise Phase I, many are planned to begin in 2017. Most of these have a ramp-up period of 3 to 5 years, allowing time for planning, program design, materials development, and other start-up activities before full implementation. Eight individual programs

[6] All costs in this section are expressed in 2015 dollars.

involving changes in rate structures and operations are scheduled for initial implementation in 2019. Three programs involve implementing new regulations that will take effect in 2020.

Table 4 provides a consolidated summary of these programs. A more detailed discussion of these programs is provided after the table.

Table 4. Phase I (2017-2020) Program Summary

Category	Elements
Waste Reduction/ Extended Producer Responsibility (EPR)	Provide education and outreach on waste reduction and waste prevention
	Promote reuse and supply chain management
	Promote EPR
	Implement campaign to reduce food waste
Education & Outreach	Provide technical assistance (including Master Recycler/Composter program)
	Deliver targeted education and outreach
	Promote reuse and recycling opportunities
	Promote C&D debris salvage and green building practices
	Promote organics diversion strategies
Operations & Programs	Ensure adequate infrastructure for commercial recycling
	Increase reuse and green purchasing
	Expand public space recycling
	Promote plastic bag take-back program
	Promote waste diversion strategies
	Expand food waste collection
Incentives & Rates	Provide incentives to increase diversion at Tacoma Recovery and Transfer Center (TRTC)
	Promote and provide incentives for food grinders
Regulations	Require adequate infrastructure for recycling
	Require use of certified C&D processing facilities and enforce "two-bin rule"

Waste Reduction & Extended Producer Responsibility

Phase I recommends seven new waste reduction and EPR initiatives, which together are estimated to divert 1,100 tons. These include:

- Providing outreach on waste prevention and toxics reduction, with special programs tailored to reach multi-cultural communities.
- Promoting green procurement and supply chain management.
- Expanding waste reduction and recycling education in schools.
- Undertaking a campaign to increase food waste diversion.
- Promoting EPR for hard-to-recycle materials (e.g., mattresses, paint, pharmaceuticals, batteries).
- Promoting thrift stores as an option for discarding unwanted furniture.

The level of effort required to implement these initiatives varies widely, and the benefits are expected to mostly occur over the long term. These programs are, for the most part, more about achieving a sustainable materials management system than increasing diversion. For example, education on toxics is expected to reduce the use of harmful materials but will have a minimal impact on diversion.

Education & Outreach

Phase I recommends a wide range of new, continued, or expanded education and outreach programs– 21 initiatives in total estimated to divert 14,000 tons by 2028. The most significant of these efforts is a continuation of current education and outreach to new and existing customers, which is expected to increase diversion from all generator types by an additional 6,200 tons between now and 2028. Other important programs in terms of diversion include:

- Promoting C&D salvage, reuse, recycling, and exchange to residents.
- Revamping some of the existing education materials to increase their impact.
- Providing targeted education and outreach to the multifamily substream.
- Expanding commercial technical assistance.
- Conducting targeted education and outreach to increase food waste collection.

Operations & Programs

Phase I recommends seven initiatives that involve investing in new facilities or creating and/or expanding collection programs; these initiatives are projected to divert 2,600 tons from the waste stream by 2028. Key efforts include:

- Working with the private sector to expand food waste collection to include compostable paper and food serviceware.
- Ensuring that all multifamily sites have adequate recycling and organics collection infrastructure.
- Promoting and providing incentives for the use of residential food grinders.
- Establishing a voluntary initiative for disposable plastic bag take-back at grocery stores.

Phase-in of these activities begins in 2019, providing time for planning, design, and working out agreements with the private sector as needed.

Incentives & Rates

Phase I recommends rate structures that provide incentives for increased source separation by self-haul customers at the transfer station. These are intended to target the recoverable materials that often, for convenience, end up disposed as waste, such as C&D, yard waste, carpet, and tires. An estimated 2,000 tons of material would be diverted using these incentives by 2028.

Capital Investment

Capital investment requirements for Phase I include: funding for adequate multifamily collection infrastructure, food waste collection, public space recycling, and expansion of the use of food waste grinders. The capital costs are associated with the program and operational changes discussed above total $950,000.

Regulations

Phase I recommends three regulatory initiatives that target the commercial substream and are projected to divert an estimated 3,100 tons by 2028:

- Enforcing the "two-bin" rule for construction sites: sites with a recycling container are required to have a garbage container as well, to prevent contamination of recyclable materials sent for processing.
- Requiring C&D generators to deliver their debris to certified C&D processing facilities.
- Requiring new commercial buildings to have adequate recycling and composting space and enclosures in order to receive a new building permit.

Phase II (2021-2022): Continue Intensive Education; Additional Regulations; Limited Investment

Phase II consists of 10 types of initiatives, with the emphasis on new regulations as well as selected changes to operational practices and a significant investment in processing capacity to increase mixed organics recovery (**Table 5**). The investment in additional organics processing will provide the capacity to process 30,000 tons of organics (yard and limited amounts of food waste) collected through existing programs, plus an estimated additional 30,000 tons of yard waste, food waste, and compostable paper, which will be diverted through new Phase I and II programs. Please see Appendix 6 for a more detailed description of this facility and associated cost estimates.

The new Phase II regulations, investments, operational changes, incentives, and programs, are estimated to divert an additional 31,800 tons by 2028. This will increase the overall recycling rate by six percentage points, from 62 to 68 percent.

Phase II costs include $14.2 million (2015 $) in capital costs for mixed organics processing capable of handling yard and food waste as well as compostable paper. The estimated operating cost of all Phase II programs is approximately $1.1 million (2015 $) per year beginning in 2021 and increasing to $1.7 million by 2022. The annual O&M costs include about $900,000 for the organics processing facility, which will ramp up over time. These costs would be offset by annual revenues from marketable commodities starting at about $60,000 and rising to $100,000 per year by 2022, depending on market conditions. In addition, since this planned investment in expanded organics processing is sized to replace existing processing of yard waste, substantial savings (approximately $2.1 million per year) will be realized.

Table 5 summarizes the elements that comprise Phase II.

Table 5. Phase II (2021-2022) Program Summary

Category	Elements
Waste Reduction/ EPR	Establish reoccurring reuse/drop-off events
Operations & Programs	Expand materials accepted curbside
	Enhance floor sorts at TRTC
Incentives & Rates	Increase pay-as-you-throw rate differentials
Capital Investment	Expand mixed organics processing capacity, and expand collection to accommodate compostable paper and food serviceware
Regulations	Require recycling of recoverable C&D materials
	Require job site recycling and enforce existing two-bin rule
	Require multifamily property owners to provide recycling collection service
	Ensure adequate collection infrastructure for multifamily recycling and organics
	Require separation of recyclables at TRTC

Key elements of Phase II that have the most significant impact on diversion are:

- **Require separation of recyclables at the TRTC.** This regulation is proposed for implementation starting in 2022. It affects all transfer station users and will lead to increased diversion of traditional recyclables and more recovery of organics, C&D, electronics, and other recyclables, such as tires and durable plastics. When fully phased in over five years, the regulation is expected to divert an annual 7,400 tons and cost about $165,000 to implement and enforce.
- **Require recycling of recoverable C&D materials.** This regulation, to take effect in 2021, affects the self-haul and commercial C&D substreams and is anticipated to divert 6,300 tons annually when fully implemented after five years. It targets wood, carpet, furniture, mattresses, and other recoverable components of the C&D stream.
- **Expand mixed organics processing capacity and collection to accommodate compostable paper and food serviceware.** This initiative requires a significant change in how Tacoma handles food waste, resulting in collecting and processing additional material that cannot currently go to existing processors. The recommended new processing capacity is planned to start operations in 2023. The benefit is that customers will be able to compost all of their currently generated and anticipated future organics, including yard and food waste and compostable paper. Investment costs are substantial, estimated at $14 million. All types of generators will be affected, most notably commercial and residential customers, who produce most currently disposed food waste. Note that in the future, all organics processing will need to be robust enough to handle compostable paper and food serviceware. However, the City of Tacoma has several options to make this processing capacity available – via direct investment, a public-private partnership, or through an RFP process and contracting with an existing or new private entity for the capacity paid for on a per-ton basis (with no ownership or capital investment requirements on the City's part).

> In the future, all organics processing will need to be robust enough to handle compostable paper and food serviceware.

- **Enhance floor sorts for bulky reusable and recyclable items at TRTC.** This change to the facilities and operations at the transfer station are anticipated to divert an additional 6,400 tons of recoverable C&D, carpet, organics, wood, yard waste, furniture and mattresses. The recovery of these materials is limited due to the condition of these items and the level of contamination. As such, Cascadia used very conservative estimates (15 percent to 40 percent) of the amounts of these materials that will actually be recycled. The cost of this effort is estimated to start at $345,000 annually with an initial investment of $170,000. The new system would be phased in beginning in 2021 and fully effective by 2023.
- **Increase pay-as-you-throw differentials**. Tacoma already has a tiered pricing system for waste disposal. This would increase in 2021 to provide additional incentives for curbside residential customers to recycle and is expected to result in the diversion of 1,400 tons.
- **Expand materials accepted in curbside recycling to include textiles and additional types of scrap metals and plastics.** This change increases diversion from residential curbside recycling by an estimated 1,100 tons.
- **Require multifamily property owners and managers to provide adequate recycling collection services to residents – establishing a "right to recycle."** This effort will divert an estimated 1,000 tons from the multifamily substream.

The ultimate decision about any MRF investment will depend upon how much additional diversion has actually been achieved and at what cost through the Phase I "voluntary first" approach and the expected impact of Phase II regulations.

The remaining regulations and other initiatives which primarily target C&D, self-haul, and multifamily substreams are expected to divert an estimated 2,600 tons from the waste stream when fully implemented.

In Phase II, ES will need to decide whether to acquire new sorting and mixed waste processing capacity to divert additional materials from the residential, non-C&D commercial, and/or self-haul substreams. Several options are possible, as detailed in the MRF study that is part of the sustainable materials management planning effort. The plan anticipates that an integrated MRF will likely be the best option, as described in Option 4 of the *Volume 3: MRF Feasibility Study*. For Option 4, the MRF would have an integrated equipment line that would process the residential commingled recyclables stream, a high-grade non-C&D commercial waste stream, and a high-grade non-C&D self-haul waste stream. Option 4 assumes that the City would alter collection routes to generate commodity-rich dry commercial loads and expand tip floor sorting of self-haul loads.

The ultimate decision about any MRF investment will depend upon how much additional diversion has actually been achieved and at what cost through the Phase I "voluntary first" approach and the expected impact of Phase II regulations. Tacoma needs to make a decision regarding investment in MRF capacity by 2022-2023 in order to allow enough time for planning, financing, design, and construction of a new facility (either by the City or a private entity) that can be operational by the beginning of 2028 and thus contribute to the City's 70 percent goal.

Alternatively, Tacoma can decide to continue with and expand the mix of regulations, incentives, education, and operational changes as the basis for attaining the 70 percent goal, as further described in the Phase III section below.

Phase III (2023-to 2028): Maximum Regulations & Programs or Acquire MRF Capacity

Though highly speculative at this point, Phase III without a new MRF would consist primarily of new regulations mandating recycling services and practices. The list of potential options includes:

- Authorizing mandatory recycling laws for targeted materials.
- Requiring businesses with outdoor garbage bins for public use to provide adjacent recycling containers.
- Requiring commercial property owners and businesses to provide recycling collection service (subscription or self-haul).
- Mandating that food service establishments use recyclable and/or compostable food serviceware.
- Requiring large events on public property to recycle and compost.

Taken together, these regulations are projected to divert 12,000 tons annually when fully implemented over 3 to 5 years. Other elements of Phase III include creating an award/recognition program for businesses and holding neighborhood swap and repair events; together, these programs would divert an estimated 200 tons. If all other programs are performing as expected, these options would enable Tacoma to achieve a 71 percent recycling rate by 2028.

The heavy regulatory approach that comprises Phase III is a departure from the City's preference for voluntary behaviors and practices. Accordingly, the City will need to decide whether a regulatory or MRF-based approach is preferred in achieving the 70 percent goal or potentially continue to increase focus and investment in voluntary programs, if those appear to be performing better than expected.

Investing in an integrated MRF that processes commingled recycled materials plus dry commercial waste, along with dry waste routing and banning wood at the Tacoma Recovery & Transfer Center, would divert an additional 30,000 tons and achieve a 75 percent recycling rate by 2028.

Additional costs associated with the MRF would include $33 million in capital investments and annual operating costs starting at approximately $5.4 million (2015 $) and increasing with growing volumes. These costs would be offset by revenues starting at an estimated $4.9 million per year based on 10-year average commodity prices, and with the potential to ramp up with increased volumes processed, depending on market conditions.

Table 6 summarizes these Phase III options.

Table 6. Phase III (2023-2028) Program Summary

Category	Elements
Education & Outreach	Implement intensive award and recognition programs
Operations & Programs	Design routes to collect highly recoverable waste
	Hold neighborhood swap and repair events
Capital Investments	Invest in or contract new MRF capacity
Regulations	Authorize mandatory recycling laws
	Ban wood disposal at TRTC
	Require adequate infrastructure for recycling and organics collection
	Mandate food service establishments to use recyclable and/or compostable food serviceware
	Require large events on public property to recycle and compost
	Require subscription to recycling and organic collection service

Phase IV (Beyond 2028): Optional Strategies to Exceed 70 Percent

The strategy presented above – the three-phase approach to implementing education and outreach programs, new regulations and incentives, operational changes, and investments – is designed to achieve the 70 percent goal by 2028. Modeling indicates that Tacoma can achieve 76 percent diversion through new education and outreach programs, new regulation and incentives, and operational changes without investing in or contracting for a mixed waste MRF. Modeling predicts that those strategies combined with investment in a mixed waste MRF could bring Tacoma to 78 percent diversion by 2028.

The City of Tacoma, however, considers the 70 percent goal to be a "waypoint" towards a truly sustainable materials management system that virtually eliminates waste, creates value for discards, and minimizes the negative environmental impact of materials throughout their entire life cycle. To go beyond 70 percent with today's technologies and material economics, the City could consider additional regulations and programs as shown in **Table 7**. Regulations that have the greatest potential impact are:

- Requiring composting for organic materials (including food waste, yard waste, compostable paper, clean wood, and other compostable products) for all generators, potentially diverting an additional 11,300 tons when fully implemented in 2032. Note that this option would require investment in robust new organics processing capacity.
- Mandating recycling of traditional materials for all generators, possibly diverting 10,800 incremental tons when fully implemented in 2032.

These and other policies and programs summarized in the table below could push the recovery rate to over 76 percent without a MRF and to 78 percent with a MRF by 2032. Either of these achievements would put Tacoma in a true leadership position in sustainable materials management and represent an upper-bound in terms of cost-effective, feasible diversion.

Achieving 76 or 78 percent diversion would put Tacoma in a true leadership position in sustainable materials management and represent an upper-bound in terms of cost-effective, feasible diversion.

Table 7. Phase IV (Beyond 2028) Program Summary

Category	Elements
Capital Investments	Co-locate Advanced Recycling Technology at TRTC
	Include a retail reuse and recycling center at TRTC for salvage building materials and other items
Regulations	Require composting for organic materials
	Mandate recycling for traditional recyclables

Substream/Material Specific & Cross-Cutting Strategies

The City of Tacoma defines sustainable materials management as “an approach that includes waste prevention and discard management, while seeking to reduce environmental impacts by managing materials through all stages of their life.” Achieving true sustainability as a community will require addressing the triple bottom line – economics, community, and environment – to ultimately improve the quality of life for all who live and work in Tacoma. This section discusses the issues and strategies specific to materials and substreams that make up significant portions of the waste stream and are essential to achieving this sustainability vision.

Upstream EPR/Reducing Life Cycle Impacts

Material consumption and waste has both upstream and downstream impacts. Environmental degradation, toxics pollution, and large quantities of greenhouse gas emissions are associated with material extraction, processing, manufacturing, and transport to market. Likewise, within Tacoma and at the point of disposal, waste negatively affects the environment, causing litter, stormwater runoff filled with trash, and other related problems.

The City of Tacoma defines sustainable materials management as “an approach that includes waste prevention and discard management, while seeking to reduce environmental impacts by managing materials through all stages of their life.”

The City of Tacoma can mitigate these impacts significantly through effective materials management programs and policies – collecting traditionally recoverable materials such as paper, plastics, cardboard, metals, and glass for recycling and organics for composting; and ensuring that transfer stations, recycling and composting facilities, and landfills meet the highest environmental standards. Tacoma also contributes to a reduction in life cycle impacts by educating the public about waste prevention, thereby eliminating unnecessary consumption and waste.

The purpose of extended producer responsibility is for hard-to-recycle product manufacturers (producers) to step up and take responsibility for the end-of-life management of their materials, including covering some or all of the associated cost.

However, for certain materials and products, the City's ability to effectively manage the waste stream is limited. These include hard-to-recycle materials such as paints, hazardous wastes, batteries, carpet, pharmaceuticals, and electronics. These materials can be costly to collect and handle, often require separate materials collection and handling facilities, and can have weak or limited markets. Solutions for these hard-to-recycle materials often require scale in collection and processing across multiple jurisdictions, scale that does not currently exist for most products.

The purpose of extended producer responsibility (EPR) is for hard-to-recycle product manufacturers (producers) to step up and take responsibility for the end-of-life management of their materials, including covering some or all of the associated cost.

This plan calls for the City of Tacoma to collaborate with other municipalities, governments, and NGOs in Washington and beyond to advance EPR policies and practices for hard-to-recycle materials. Only collective action and public pressure are likely to succeed at engaging producers in EPR and enacting state-level policies that require EPR. The City of Tacoma should continue to engage on this front, including activities such as continuing to be a member of the Northwest Product Stewardship Council and related organizations and having governmental relations staff support relevant legislation. This is a long-term investment, but one that is likely to yield significant benefits in terms of a more sustainably managed material stream and solutions that enable recovery of traditionally non-recyclable discarded products and packaging.

Minimizing Disposable Products/Plastics

A significant percentage of the waste generated in Tacoma is products and packaging that have a short life span – such as single-use, single-serve packaging; food service packaging; plastic bags; flexible plastics packaging; and composite materials. These materials are difficult to recycle and/or create material handling and litter problems, including plastic debris in water bodies. These materials are also increasing in the waste stream, and some believe that we are continuing unabated towards a throw-away society that is ultimately unsustainable.

A significant percentage of the waste generated in Tacoma is products and packaging that have a short life span – such as single-use, single-serve packaging; food service packaging; plastic bags; flexible plastics packaging; and composite materials.

This plan includes policies, programs, and actions to reduce disposable products and, in particular, address the problems with plastics in Tacoma's waste stream. Recommended actions include:

- Banning plastic bags.
- Providing consumer education and outreach.
- Offering education and outreach to food service establishments to encourage a shift to recyclable and/or compostable material.
- Working in coalitions to advance EPR solutions – making manufacturers responsible for end-of-life management of selected packaging and products.
- Banning non-recyclable or non-compostable food serviceware.

Other actions that could be considered in the future include:

- Banning expanded polystyrene.
- Instituting incentives for increased use of recyclable or compostable packaging and/or fees on non-recyclable or non-compostable packaging.

C&D Materials

Tacoma faces several challenges as it tries to increase recovery and reuse of C&D materials:

- Contractors are ignoring the "two-bin" rule requiring a garbage container if a recycling container is also placed on a job site.
- A significant percentage of C&D material that is collected for recycling is likely waste and not, in fact, recyclable.
- Some materials that are collected for recycling and are recyclable are, in fact, not recycled.
- Tacoma has minimal control over the C&D stream. It is virtually impossible to ensure sustainable materials management practices are in place with such limited control.
- A large quantity of recyclable C&D material is received at the transfer station and, rather than being separated for recycling, ends up disposed as garbage in the landfill.

These problems are the same as those faced by jurisdictions throughout Washington. The City of Seattle and King County are addressing similar issues using a regulatory approach, as are many municipalities in California.

Solutions to C&D recovery challenges in Tacoma that are proposed in this plan include:

- Enforcing the "two-bin" rule, issuing citations and assessing fines if needed.
- Requiring that C&D processing facilities be certified, and then requiring that contractors and haulers take their C&D debris to these facilities. To be certified, facilities would need a plan and the ability to document that waste generated as a by-product of recycling at the facility does not exceed a legislated threshold. For example, some jurisdictions have set this threshold at 10 percent.
- Providing financial incentives for source separation of recoverable C&D at the transfer station, initiating more aggressive tip floor sorts at the transfer station and ultimately requiring recycling or banning disposal of C&D materials.

Commercial Substream

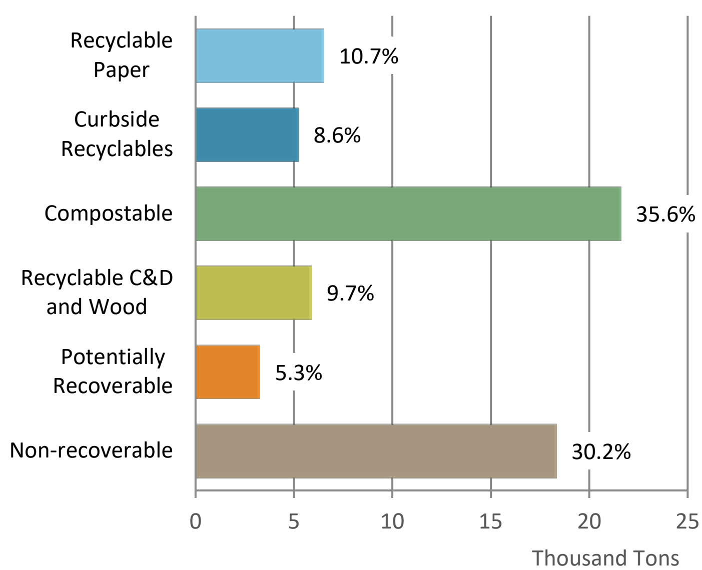
Discards from the commercial substream are a large and growing portion of the overall waste stream: much of this material is recyclable. As of 2014, commercial waste is 37 percent of the total Tacoma waste stream (**Figure 4**), the recycling rate is 42 percent (

Discards from the commercial substream is a large and growing portion of the waste stream, and much of this material is recyclable.

Figure 5), and 70 percent or about 43,000 tons are recoverable (**Figure 6**).

Figure 11 shows the composition of this commercial waste, highlighting the portions that could be recycled or composted, including Compostable materials (35.6 percent), Recyclable Paper (10.7 percent), Recyclable C&D and Wood (9.7 percent), and Curbside Recyclables (8.6%). Challenges businesses face in recycling, especially smaller businesses, include limited service and, for food service establishments, inadequate space or lack of attention to front-of-house food waste recovery. Experience suggests that private recyclers and the City are already capturing the “low-hanging fruit,” but much still needs to change to maximize diversion, including human behavior, facilities, and operating practices.

Figure 11. Summary of Recoverability of Overall Commercial Waste



This plan recommends full implementation of multiple strategies to increase commercial substream diversion. These include:

- Providing intensive education, outreach, and technical assistance to the commercial substream, including Knock & Talk campaigns.

- Expanding the food waste collection program and securing or developing a more robust processing capability in order to accommodate compostable paper and food serviceware.
- Requiring adequate infrastructure at all businesses for recycling and organics collection.
- Implementing high-profile awards and recognition programs.
- Providing adequate price incentives.

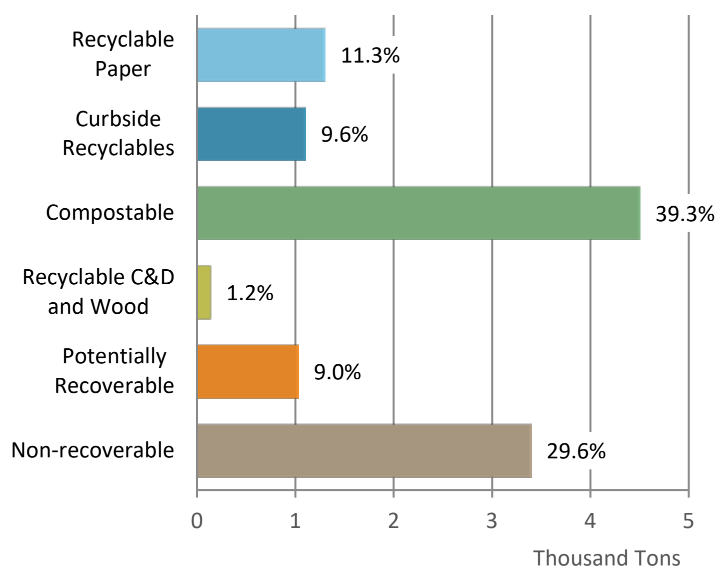
Multifamily Substream

The multifamily substream currently has a 19 percent recycling rate (

Figure 5), and approximately 70 percent of multifamily disposed waste is recoverable (**Figure 6**). While representing only 8 percent of the waste stream (**Figure 6**), the multifamily substream is growing much faster than the single-family substream and houses a large percentage of Tacoma's historically underserved populations. Obstacles to higher diversion in a multifamily environment include lack of a price signal to individual household generators, inadequate space and facilities, inattentive property managers, insufficient recycling service, and a relatively transient population that can be difficult to reach and expensive to educate.

Figure 12 provides more information about the composition of recoverable materials in the multifamily waste stream. Compostable materials make up 39.3 percent of the stream, followed by Recyclable Paper (11.3 percent), Curbside Recyclables (9.6 percent), and Recyclable C&D and Wood (1.2 percent).

Figure 12. Summary of Recoverability of Multifamily Residential Waste



True sustainability requires attending to the triple bottom line – environment, economic, and community. Accordingly, this plan calls for new and intensive efforts by the City to improve recycling in the multifamily substream, especially for historically underserved populations and those that have been traditionally more affected by pollution – lower income communities, communities of color, and immigrant communities. With the goals of achieving equity in both service offerings and participation, recommended programs and initiatives include:

- Providing technical assistance to multifamily property managers and residents.
- Offering innovative education and outreach campaigns to reach and engage diverse communities.
- Increasing investment in and improving collection infrastructure.
- Requiring recycling and organics collection service.
- In Phase II, requiring property managers to provide adequate collection infrastructure.

At a 55 percent recycling rate, the single-family substream is achieving a very high rate of recovery, within range of other waste reduction and diversion leaders like Seattle and San Francisco.

Nonetheless, the City still has room for improvement in this sector. About 63 percent of the single-family disposed waste stream is recoverable, an opportunity of about 21,400 tons in 2014.

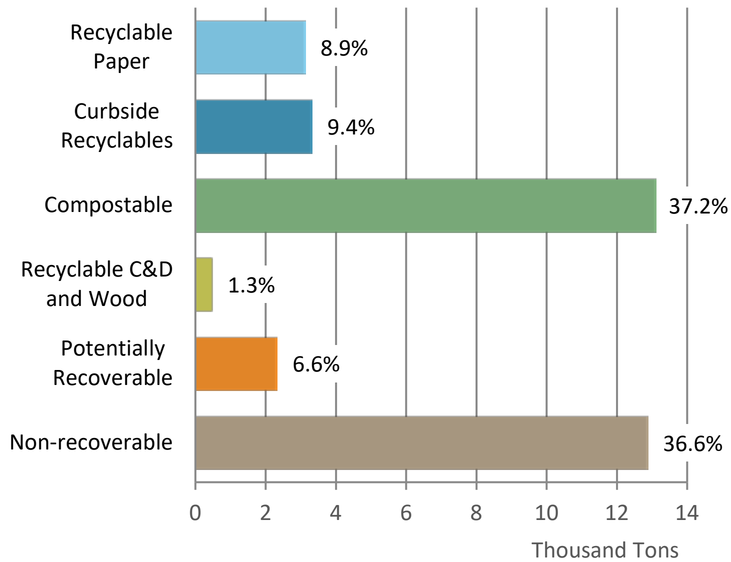
Single-family Residential Substream

At a 55 percent recycling rate (

Figure 5), the single-family substream is achieving a very high rate of recovery, within range of other leaders like Seattle and San Francisco. Tacoma's well-managed roll-out of every-other-week garbage collection and curbside food and yard waste collection with extensive education (including Knock & Talk campaigns), can be credited with a lot of this success. Nonetheless, the City still has room for improvement in this sector. About 63 percent of the single-family disposed waste stream is recoverable, an opportunity of about 21,400 tons in 2014 (**Figure 4**).

Figure 13 provides more information about the composition of recoverable materials in the single-family waste stream. Compostable materials make up 37.2 percent, followed by Curbside Recyclables (9.4 percent), Recyclable Paper (8.9 percent), and Recyclable C&D and Wood (1.3 percent).

Figure 13. Summary of Recoverability of Single-family Residential Waste



Recommended strategies for increasing recycling in the single-family substream that are in this plan include:

- Continuing intensive education and outreach efforts, with periodic Knock & Talk campaigns, the application of CBSM principles, and development of updated, revamped outreach materials.
- Promoting and providing incentives for the use of food grinders.
- Increasing pay-as-you-throw rate differentials.
- Expanding curbside collection to include textiles and additional types of scrap metals and plastic.
- If needed in Phase III and preceded by an extensive education campaign, authorizing mandatory recycling for selected materials.

5. Conclusion and Recommendations

With a combination of new collection programs, processing infrastructure investments, incentives, regulations, and education—all at an affordable net cost—a 70 percent diversion by 2028 is well within the City of Tacoma's reach. Achieving this diversion level will require timely decision-making, up-front investment, a sustained focus on implementing new and innovative strategies, and leadership to ensure the support of the public and key stakeholders.

The consultant team recommends the following process for achieving Tacoma's 70 percent goal in 2028 and then moving beyond that goal toward a zero waste future:

- Fully implement Phase I and II including expanded organics processing capability.
- Assess progress in 2022 and decide whether to pursue the Phase III regulatory-based approach for achieving the 70 percent goal in 2028 or a technology-based approach that relies heavily on a new MRF. Based on cost, the consultant team recommends the Phase III regulatory approach

that is designed to meet the 70 percent goal at a substantially lower cost than investing in a new MRF.

- Assess progress in 2028 and decide whether to implement the more rigorous Phase IV regulations or consider new investments in technology such as an integrated MRF or other alternative technologies that may become available over the next 12 years. The consultant team recommends implementing the Phase IV regulations first.

Regardless of the approach attaining the 70 percent goal will demonstrate the City's commitment to sustainability, providing long-term environmental, economic, and community benefits to residents, businesses, and institutions alike.

6. Appendices

Appendix 1. Glossary

This glossary defines some terms in this plan that may be unfamiliar to the lay reader, or that are defined differently in the context of this work than in typical use.

These terms are listed in alphabetical order.

Capture Rates	For a given recoverable material, the capture rate is the proportion of the material that is recovered for recycling or composting rather than disposed. For this plan, capture rates were calculated by dividing the total tons of recyclables collected in recycling programs by the total tons of recyclables collected in recycling programs plus the amounts disposed.
Commingled Recyclables	Commingled recyclables are the recyclables that the City of Tacoma will accept at the curb from businesses and residences. They are paper, plastics, aluminum, and cardboard, mixed in the same curbside cart for collection.
Construction and Demolition (C&D) Debris	Construction and Demolition (C&D) debris is the waste that results from construction and/or demolition projects. These include materials like wood waste, concrete, asphalt shingles, gypsum board, and other similar materials.
Diversion	Diversion, when used as a solid waste term, refers to any generated waste that is prevented from entering or removed from a stream of materials that are typically disposed of in a landfill.
Downstream Impacts	Downstream impacts of material consumption and waste include things like landfill overfilling and leachate, litter, stormwater runoff filled with trash, and other related problems.
Durable Plastics	Durable plastics means plastic items other than containers or film plastic, that are large (generally larger than a soccer ball) rigid plastic bulky items. These items are made to last for more than one use. Examples include: crates, buckets (including 5-gallon buckets), baskets, totes, large plastic garbage cans, lawn furniture, large plastic toys, tool boxes, first aid boxes, and some sporting goods. These materials are technically recyclable, but are sometimes made of resins with unstable markets, or combined with other materials like metal, which can make them less desirable for recycling.
Efficiency Rates	Efficiency rates indicate the percentage of the waste stream that the participating group would actually divert.
Generators	Generators are the entities that produce the materials in the waste stream. Generators may include individual residents, businesses, institutions, construction and demolition sites, etc.

Hazardous Waste Streams	Hazardous wastes streams are waste streams made up of materials that mortal 7
Life Cycle Costs	Life cycle costs are costs that consider every stage of management of a material or program. When applied to materials, life cycle costs consider all costs of material management, from raw materials mining to manufacturing to end-of-life recovery or disposal.
Materials Recovery Facility (MRF)	A Materials Recovery Facility (MRF) is a processing facility that takes mixed waste or recyclables sorts them and prepares them for sale to recyclables commodity markets. The sorting process at MRFs is usually a combination of manual processes (workers that stand along a conveyor belt and sort material as it flows past them) and automatic processes (optical, air, and other automated sorting systems).
Mixed Organics	Mixed organics means an organics stream that is not just one type of organics material, like food waste or yard waste, alone. Instead, mixed organics includes food waste, yard waste, and compostable paper products. Mixed organics streams require municipal composting systems that can handle the diversity of material; many municipal composting systems are designed to handle only yard waste or only food waste, and need to be upgraded to effectively compost a mixed organics stream.
Participation Rates	Participation rates generated for this plan indicate the percentage of a waste generator group that would engage in the desired waste diversion activity or behavior – for example, the proportion of the total population that would participate in a curbside mixed organics collection program.
Per Capita Generation	Per capita generation means waste generation measured per person in a defined geographical area and a defined time period. Per capita generation is often defined in pounds per person per day, week, or year. For the purposes of this study, per capita generation is equal to citywide generation divided by population to measure trends that are normalized

[7] https://www.epa.gov/sites/production/files/2015-09/documents/hwid05.pdf, p.3.

	for population and employment growth over time.
Potentially Recoverable	Potentially recoverable refers to materials that are technically recyclable but for which recovery may be limited due to excessive contamination or a lack of local/regional processing capability and/or viable markets.
Processors	For the purposes of this report, processors are equivalent to MRFs.
Recoverability Potential	Recovery potential is the percentage and tons of waste that could have been recycled or composted, in total for all materials generated, and by substream.
Recoverable Materials	Recoverable materials are materials that may be diverted from the waste stream for recovery by either recycling, composting or other processes that use these materials as a feedstock for reuse or production of another product These materials may include items that are not normally considered as recyclables such as wood waste used for hog fuel or auto body waste.
Recovery Rates	A recovery rate is the ratio of the total amount of recovered materials over the total amount of waste bound for disposal in a specific geographic area.
Recyclable Materials	Recoverable materials are materials that may be diverted from the waste stream for recovery by recycling.
Recycling Rate	A recycling rate is the ratio of the total amount of recycled, composted or recovered materials from the mixed solid waste (MSW) stream over the total amount of MSW generated in a specific geographic area.
Special Waste Streams	Special waste streams are waste streams that exhibit hazardous qualities similar to hazardous wastes. However, the U.S. EPA determined that special wastes necessitated further investigations before being technically classified as hazardous waste, and “were believed to possess less risk to human health and the environment than the wastes being identified for regulation as hazardous waste.”[8]
Tacoma Recovery and Transfer Center (TRTC)	The Tacoma Recovery and Transfer Center (TRTC) offers a variety of diversion services for Tacoma residents and businesses all in one place. The Tacoma Recycling Center operates within the Tacoma Recovery and Transfer Center, and accepts self-hauled materials including metal items, glass bottles, plastics, cardboard and paper, batteries, electronics, among other difficult-to-handle materials like used motor oil and packing

[8] https://www.epa.gov/hw/special-wastes

	peanuts. The Recycling Center also accepts recyclables that the city's municipal collection system picks up curbside. Goodwill has a semi-permanent presence at the center, accepting unwanted clothing and household items. Center employees working at the garbage dumping floor survey incoming materials and hand remove materials that can be diverted, an effort that has resulted in significant diversion results. The center also features the EnviroHouse that teaches visitors about sustainable behaviors that they can adopt at home.
Triple Bottom Line	Triple bottom line is a method for measuring program, company, or institutional performance. While traditional performance measurement has focused solely on financial performance, triple bottom line assessments consider social, environmental, and financial aspects of success.
Two-bin Rule	The "two-bin" rule is a recycling related rule for construction sites. Construction sites with a recycling container are required to have a garbage container as well, to prevent contamination of recyclable materials sent for processing.
Universal Waste Streams	Universal waste streams are waste streams of widely generated hazardous wastes that the EPA has streamlined management standards for. Universal wastes include batteries, pesticides, mercury-containing equipment, and mercury lamps.[9] [3]
Upstream Impacts	Upstream impacts of material consumption and waste include things like pollution and environmental degradation due to raw materials mining and material production that result from throwing a material away rather than recycling it. Environmental degradation, toxics pollution, and large quantities of greenhouse gas emissions are associated with material extraction, processing, manufacturing, and transport to market.
Upstream Practices	Upstream practices refer to programs, strategies, or methods that reduce the amounts or eliminate waste before it enters the waste stream. Examples include waste prevention, waste reduction, reuse, EPR, and other practices designed to eliminate waste.
Waste Stream	A waste stream is all of the material that a community generates, including garbage, recyclables, and compostables.
Waste Substreams	A waste substream is determined by the particular generation, collection, or composition characteristics that make it a unique portion of the total

[9] https://www.epa.gov/hw/universal-waste

	waste stream. The waste stream is typically made up of many waste substreams.

Appendix 2. Standardized Data Collection and Reduction Goal Calculations Memo

Overview

To inform development of Tacoma's Sustainable Materials Management Plan, Cascadia identified a range of possible metrics and key performance indicators, researched methodologies for municipal solid waste (MSW) recycling rates, and calculated Tacoma's recycling rate using Cascadia's recommended methodology combined with results of a survey of local recyclers. This summary memo is organized in to three primary sections:

- **Materials Management Metrics**
- **Municipal Solid Waste Recycling Rate Methodologies**
- **Recommended Calculation Method for Tacoma**

Materials Management Metrics

This section describes a range of potential metrics and recommends key performance indicators to guide development of the Sustainable Materials Management Plan. The potential metrics include measurement options that can help Tacoma measure progress while accounting for population growth, economic changes, new types of waste materials, and the full lifecycle impacts of material use.

Metrics are usable only when the underlying data are available. To provide context for where the City of Tacoma has complete control over data and where it will need to obtain data from private haulers and facilities, **Table 8** identifies the entities that collect each material stream by substream.

Table 8. Material Collectors by Material Stream and Substream

	Garbage	Recycling	Organics	Self-hauled materials
Single-family residential	Tacoma	Tacoma	Tacoma	Tacoma and private haulers
Multifamily residential	Tacoma	Tacoma	Tacoma	Tacoma and private haulers
Commercial	Tacoma	Tacoma and private haulers	Tacoma and private haulers	Tacoma and private haulers
Construction & demolition (C&D) debris	Tacoma	Tacoma and private haulers	Tacoma and private haulers	Tacoma and private haulers

Potential Metrics

This section identifies and assesses a range of possible metrics that account for population growth, economic changes, new types of waste materials, and—to the extent feasible—lifecycle impacts of material use. Metrics are categorized based on the type of data they require:

- Tonnage-based metrics (**Table 9**) require data only on tons by material stream and substream.

- Composition-based metrics (**Table 10**) require additional data on the composition of material, by material stream and substream.
- Access and participation-based metrics (**Table 11**) collect data on access to recycling and organics service and set-out rates.
- Environmental impact metrics (**Table 12**) require entering tonnage and composition data into specialized modeling tools.
- Waste-prevention or action-based metrics (**Table 13**) require surveying residents, businesses, or program participants or conducting other specialized studies.

Most of these metrics can also be used by an organization, such as City of Tacoma government operations, to track internal performance.

Table 9. Potential Tonnage-Based Metrics

Metric	Why Measure?	How to Measure
Total tons overall and by material stream (garbage, recycling, organics, and self-hauled) and substream (single-family, multifamily, commercial, and C&D debris)	Foundational metric on which most other metrics rely. Most metrics require having an accurate picture of total tons by stream and substream. Drawbacks: does not take into account changes in population, economy, business sectors, or underlying material stream.	Internal tracking (including measuring multifamily material separately). Reporting from private haulers, private facilities, large generators, and construction permit applicants. Ideally, account for contamination in recycling and organics.
Recycling and diversion rates by substream and for City overall	Foundational metric for comparison to Washington State as a whole and to other cities. Tacoma has set a 70 percent diversion rate target. Drawbacks: does not take into account changes in the economy, business sectors, or the underlying material stream.	Divide total tons recycled or composted by total generation. Calculate recycling rates separately from diversion rates. See *Municipal Solid Waste Recycling Rate Methodologies* Section.
Tons of garbage disposed per household, resident, employee, or unit of revenue	The disposal rate measures the results of both recycling and waste prevention while taking into account changes in population and some changes in the economy. Drawbacks: does not take into account changes in the mix of business sectors or changes in the underlying material stream.	Divide garbage tons (by residential substream or business sector) by the relevant unit of measure (such as number of households or employees).
Total generation (garbage, recycling, organics) per household, resident, employee, or unit of revenue	All material generated, even if recycled or composted, creates upstream environmental impacts. Measuring total generation rate is the first step to accounting for the full impact of waste. Even with a high recycling rate, an increasing total generation rate indicates increasing impacts. Drawbacks: does not take into account changes in the mix of business sectors or the underlying material stream.	Divide total tons generated (by residential substream or business sector) by the relevant unit measure (such as household or employee).

Metric	Why Measure?	How to Measure
Business sector-specific tons per employee per year (per unit of revenue is likely not feasible)	Changes in the mix of business sectors (such as from mainly manufacturing to mainly office-based) could affect recycling, disposal, and generation rates, masking or exaggerating the city's progress. Drawbacks: costly to measure.	Conduct generator study to measure material at the place of business and obtain estimated employees counts. (Note: this metric is costly to measure.)

Table 10. Potential Composition-Based Metrics

Metric	Why Measure?	How to Measure
Tons and percentage of materials disposed of as garbage that could have been recycled or composted by substream	Provides context for the recycling rate by measuring the remaining recycling potential—whether many or few additional tons could be recycled.	Conduct waste characterization study of garbage by substream.
Capture rates by material (such as paper)	A more precise measure of how well residents and businesses are recycling accepted material that accounts for changes in the generated material stream (such as increases in non-recyclable flexible packaging or a shift from manufacturing to office-based businesses, which generate more recyclable fiber).	Conduct material characterization study of all disposed and recycled material plus a recycling survey.
Recycling and organics contamination rates and tonnages	Contamination rates provide information on how well residents are separating recyclable and organic materials. Adjusting the recycling and organics rates for contamination presents a more accurate figure, although it may not conform to Ecology's methodology.	Request data from recycling and organics processors. Alternative: conduct material characterization study of recycling and organics streams.

Table 11. Potential Access and Participation-Based Metrics

Metric	Why Measure?	How to Measure
Number and percentage of households and businesses with recycling and organics service	Tracking the percentage of households and businesses subscribed to recycling service and (separately) organics service identifies whether the City should focus on increasing access to service. For multifamily complexes and businesses, tracking the ratio of recycling and organics service to garbage service can also identify unmet service needs. Drawbacks: having recycling or organics collection service does not equate to using the service.	Assuming that 90 percent to 95 percent of single-family residents have access to recycling and organics service, this metric should focus on multifamily and business access. Use City of Tacoma records for assessing multifamily access supplemented by a survey of businesses. Once the service percentage reaches a high threshold (such as 90 percent to 95 percent), regular tracking is not needed.
Number and percentage of households and businesses that actively recycle and compost	Tracking the percentage of households and businesses that actually use their recycling service and (separately) organics service identifies whether the City should focus on increasing use of existing service. Drawbacks: using recycling service does not equate to recycling properly (no contamination) all accepted materials.	Track the set-out rate over a reasonable period (at least 4 weeks or 3 collection cycles, whichever is longer) to record the percentage of customers setting out their recycling and organics containers for collection. (Note: data on households are typically easier to collect than data on businesses. Outside of a business sector study, it is likely not feasible to collect this information for businesses using private recyclers.)

Table 12. Potential Environmental Impact Metrics

Metric	Why Measure?	How to Measure
Greenhouse gas emissions associated with disposal, recycling, and organics	Supplements recycling rates that treat all materials the same by using greenhouse gas emissions (GHGs) to indicate the collective and differing benefits of recycling various materials. For example the GHG benefits of recycling aluminum cans is much higher than the benefits of recycling glass. Drawbacks: This metric would be calculated through the use of the Waste Reduction Model (WARM) developed by the United States Environmental Protection Agency (US EPA). WARM does not include emissions from transporting materials to export markets and is considered less accurate for organics and source reduction; GHGs are not the only environmental impact that matters and WARM's inaccuracies may lead to unintended consequences if management decisions are made solely based on WARM results.	Enter composition and quantity data for material disposed, recycled, and composted into WARM.
Lifecycle energy saved by recycling and organics	Supplements recycling rates that treat all materials the same by using embodied energy to indicate the collective and differing benefits of recycling various materials. For example the lifecycle energy benefits of recycling aluminum cans is much higher than the benefits of recycling glass. Drawbacks: methodology has not been developed yet; energy metrics may have similar drawbacks as WARM.	Once Oregon develops its methodology, adapt to use Tacoma-specific composition and quantity data for material disposed, recycled, and composted.

Metric	Why Measure?	How to Measure
Big-picture environmental impacts of end-of-life management methods (including waste prevention)	Supplements recycling rates that treat all materials the same by using environmental impact data to indicate the collective and differing benefits of recycling various materials. Attempts to indicate the collective impact of the total materials management system. Drawbacks: calculations include many assumptions about both the materials discarded and the impacts of those materials, affecting accuracy (particularly regarding waste prevention and upstream impacts); these tools require substantial effort and/or cost.	Use US EPA's Municipal Solid Waste Decision Support Tool (free but requires staff time to customize and use) or Sound Resource Management's MEBCalc™ (fee-based but the firm can conduct the customization and analysis)
Consumption-based greenhouse gas emissions inventory	Supplements downstream waste measures by estimating the upstream greenhouse gas impacts of material use. Drawbacks: calculations include many assumptions about consumption, affecting accuracy; this method requires substantial effort and/or cost.	Use the method developed by Stockholm Environment Institute for Oregon DEQ to adjust and apply Consumer Expenditure Survey data for Seattle-Tacoma-Bellevue collected by the Bureau of Labor Statistics. Oregon DEQ conducts the inventory every five years.
Consumer Environmental Index	Supplements downstream waste measures by estimating the upstream impacts of material use in multiple environmental areas. Drawbacks: calculations include many assumptions about consumption, affecting accuracy; this method requires substantial effort and/or cost.	Use the Consumer Environmental Index, developed by Sound Resource Management for Ecology.

Table 13. Potential Waste Prevention or Action-Based Metrics

Metric	Why Measure?	How to Measure
Number and percent of households or businesses who report taking a desired action	This metric is used when the City runs a general or targeted outreach and education campaign, such to promote using reusable bags or co-locate recycling bins next to all garbage bins. By measuring the number or percentage of the target audience who take the desired actions, this metric demonstrates the effectiveness of the campaign and indicates when the City can move on to target a new desired behavior.	Conduct a general survey of households or businesses or a targeted survey of participants in an outreach program. Conduct the survey before and after the campaign to measure behavior change.
Reuse based on numbers of reuse organizations, number or value of sold secondhand products, and environmental impact of reuse	If the City focuses on promoting reuse, measuring reuse can show the progress that the City's efforts support.	See "A Study of the Economic Activity of Minnesota's Reuse, Repair, and Rental Sectors" and consult with the Department of Ecology on efforts to estimate environmental impacts by applying results to the Consumer Environmental Index (CEI). An alternative method could involve surveying reuse organizations.
Amount of organics managed through backyard composting and mulch mowing	Estimates prevention of disposal of compostable material. Drawbacks: accuracy is affected by the substantial number of assumptions required to estimate figure.	Similar to Seattle, conduct a household survey to estimate the share of households that backyard compost and mulch mow. Combine survey data with waste characterization data and organics collection data on the amount of yard and food waste generated per household.

Key Performance Indicators

Cascadia recommends that the City of Tacoma tracks performance indicators in the following categories:

- Tons of generated, recycled, and disposed—in total and per unit (such as per household or per employee) for each substream (**Table 15**).
- Recycling and diversion rates—for each substream, with and without contamination if possible (**Table 16**).
- Remaining recycling potential—based on the percentage and tons of garbage that could have been recycled or composted by each substream (**Table 17**).
- Capture rate—for key recyclable and compostable materials from each substream (**Table 18**).

Key performance indicators are listed in **Table 14**, supported by additional performance indicators listed in **Table 15** through **Table 18**. All of the indicators can all be calculated using tonnage and composition data.

Table 14. Key Performance Indicators

<table>
<tr><td colspan="4">Total material (residential, commercial, and C&D debris)
• Total tons of material generated
• Total tons disposed of as garbage
• Diversion rate, adjusted for contamination</td></tr>
<tr><td colspan="3">Total residential and commercial (combined)
• Total tons of material generated
• Total tons disposed of as garbage
• Recycling rate, adjusted for contamination</td><td rowspan="2">C&D debris
• Total tons of material generated per construction-sector employee
• Diversion rate, adjusted for contamination</td></tr>
<tr><td>Single-family residential
• Total tons of material generated per household
• Capture rate for readily recyclable and compostable materials</td><td>Multifamily residential
• Total tons of material generated per household
• Capture rate for readily recyclable and compostable materials</td><td>Commercial
• Total tons of material generated per employee
• Capture rate for readily recyclable and compostable materials</td></tr>
</table>

At this time, Cascadia recommends incorporating environmental impacts by tracking greenhouse gas (GHG) emissions. At this time, the key environmental impact that all entities need to understand and be responsible for is GHG emissions. Use US EPA's WARM to estimate greenhouse gas emissions associated with waste generated, but—because of the drawbacks described in **Table 12**— do not treat the estimate as a *key performance indicator* and ensure WARM results are published only with contextual information regarding potential inaccuracies. Reconsider tracking greenhouse gas emissions as a key performance indicator when WARM is refined to better address organics and source reduction or when a more reliable methodology becomes available.

Table 15 through **Table 18** illustrate several ways Tacoma may capture and record the performance indicators listed in **Table 14**. These tables help build a robust picture of Tacoma's progress on sustainable materials management using bottom-line tonnage figures. However, Tacoma may need additional measures to understand what is driving changes in these indicators.

Table 15. Tons Generated, Recycled, and Disposed

	Total Tons	Tons per Unit*
Single-Family Residential		
Recycling		
Organics		
Recycling + Organics		
Garbage		
TOTAL GENERATION		
Multifamily Residential		
Recycling		
Organics		
Recycling + Organics		
Garbage		
TOTAL GENERATION		
Commercial		
Recycling		
Organics		
Recycling + Organics		
Garbage		
TOTAL GENERATION		
Total (excluding C&D Debris)		
Recycling		NA
Organics		NA
Recycling + Organics		NA
Garbage		NA
TOTAL GENERATION		NA3
C&D Debris		
Recycling		NA
Organics		NA
Recycling + Organics		NA
Garbage		NA
TOTAL GENERATION		NA

Total (including C&D Debris)	
Recycling	NA
Organics	NA
Recycling + Organics	NA
Garbage	NA
TOTAL GENERATION	NA

* Unit could be residents/households or employees/revenues.

Table 16. Recycling and Diversion Rates (with and without contamination)

	Recycling Rate (ECY Method)			Diversion Rate (ECY Method)		
	Raw Rate	Contamination	Adjusted Rate	Raw Rate	Contamination	Adjusted Rate
Single-Family Residential						
Multifamily Residential						
Commercial						
Total (excluding C&D Debris)						
C&D Debris						
Total (including C&D Debris)						

Table 17. Remaining Recycling Potential

	Percent of Garbage that is		Tons of Garbage that are	
	Currently Recyclable or Compostable	Potentially Recyclable or Compostable	Currently Recyclable or Compostable	Potentially Recyclable or Compostable
Single-Family Residential				
Multifamily Residential				
Commercial				
Total (excluding C&D Debris)				
C&D Debris				
Total (including C&D Debris)				

Table 18. Capture Rates

	Traditional Recyclables						Compostable Organics				Total Readily
	Paper	Plastic	Metal	Glass	Total (With Glass)	Total (Without Glass)	Yard Debris	Food Waste	Total	Recoverable C&D Debris	Recoverable Materials
Single-Family Residential										NA	
Multifamily Residential										NA	
Commercial										NA	
Total (excluding C&D)											
C&D	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Total (including C&D)											

Municipal Solid Waste Recycling Rate Methodologies

This section discusses key factors to consider when developing a recycling rate methodology, reviews specific methodologies used by other agencies and jurisdictions, and recommends a methodology for the City of Tacoma.

Key Factors in Recycling Rate Methodologies

When developing a recycling rate calculation methodology, a jurisdiction must consider four key factors to determine the universe of material generated and to define "recycling" and "diversion":

- **Which materials and which substreams are included?**
- **Are materials from both public and private haulers counted?**
- **What materials management methods are considered "recycling" or "diversion" (e.g., recycling of paper and plastics vs. energy recovery)?**
- **Are recycling residuals and contamination counted as recycling or garbage?**

Furthermore, if waste prevention is considered recycling, the jurisdiction must carefully consider how to quantify the waste prevention.

Material Streams and Substreams:

Recycling rates typically include MSW materials from the residential and commercial sectors. Methodologies vary in whether the universe of waste also includes:

- **C&D debris**
- **Industrial process and manufacturing waste**
- **Agricultural waste**
- **Medical waste**
- **Hazardous waste (other than household hazardous, which is MSW)**
- **Vehicles**
- **Other waste not defined by US EPA as MSW**

Haulers

While recycling rates should include all material generated regardless of hauler, it can be difficult for a jurisdiction to obtain data on waste it does not directly control through municipal collection, municipal facilities, or collection under a municipal contract, franchise, or other authority. As a result, jurisdictions vary in whether the universe of waste includes:

- Materials collected by private haulers (who are not under contract or regulated by the jurisdiction) and exported outside the jurisdiction's waste system
- Materials self-hauled outside the jurisdiction's waste system

Management Methods

Recycling rates typically include recycling and commercial composting or organics processing. Recycling means transforming or remanufacturing municipal solid waste into usable or marketable materials; it excludes using recyclable materials in landfills (such as for alternative daily cover), as aggregate (such as in roadbeds), or for energy recovery. For example, recycling glass containers into new containers is, by definition, recycling while using them as alternative daily cover or aggregate is not.

Methodologies vary in whether "recycling" or "diversion" includes:

- Reuse and repair
- Donation, including food donation
- Onsite composting, anaerobic digestion, or other management for diversion
- Other methods of waste prevention
- Combustion for energy recovery
- Down-cycling, such as using glass as aggregate in roadbeds
- Landfill alternative daily cover (ADC)

Residuals and Contamination

Because tonnage data are typically collected as part of collection (rather than after processing), many recycling rates don't account for residuals or contamination:

- Residuals the processor sorted out of materials that the generator recycled; the processor typically sends these materials for landfill or other final disposal.
- Contamination left in commodity bales (after processing at a material recovery facility, or MRF) or finished compost (after processing at a composting facility). Contamination in commodity bales can include recyclable materials that ended up in the wrong bale, such as flattened plastic bottles in a mixed paper bale.

Comparison of Recycling Rate Calculation Methodologies

Cascadia reviewed recycling rate calculation methodologies used by the United States Environmental Protection Agency (U.S. EPA), the Washington State Department of Ecology (Ecology), and other local Washington jurisdictions. These jurisdictions take into account only materials generated within their geographic boundaries. **Table 19** briefly summarizes how each of these jurisdictions addresses the four key factors for defining a recycling rate. Subsequent subsections present additional details on each methodology, including data sources.

Table 19. Summary of Recycling Rate Calculation Methods

Jurisdiction	Materials/Substreams	Haulers	Management Methods	Residuals and Contamination

Jurisdiction	Materials/Substreams	Haulers	Management Methods	Residuals and Contamination
US EPA	Residential, commercial, and institutional material (non-C&D).	All	Only recycling and commercial composting/organics processing	Unclear, but likely not accounted for
Washington Department of Ecology (Recycling Rate)	Residential, commercial, and institutional material (non-C&D). Excludes agricultural and industrial organics.	All (conducts annual survey)	Only recycling and commercial composting/organics processing	Residuals reported by MRFs as sent to landfill are counted as garbage. Contamination in bales is not accounted for.
Washington Department of Ecology (Diversion Rate)	Traditional residential, commercial, and institutional material. Also agricultural and industrial organics, C&D debris	All (conducts annual survey)	Recycling and commercial composting/organics processing In addition, reuse and repair, edible food recovery, energy recovery, and downcycling recyclable materials (such as using glass as aggregate rather than recycling into new bottles and jars)	Residuals reported by MRFs as sent to landfill are counted as garbage. Contamination in bales is not accounted for.
City of Seattle	Residential, commercial, and institutional material. C&D debris recycling is tracked but not counted in the overall rate	All (requires collectors and processors operating in the City to report annually for business permit)	Recycling and commercial composting/organics processing Backyard composting estimated	Residuals reported by MRFs as sent to landfill are counted as garbage. Contamination in bales is not accounted for.
Pierce County	Residential, commercial, and institutional material (non-C&D).	All (uses Ecology data)	Only recycling and commercial composting/organics processing	Residuals reported by MRFs as sent to landfill are counted as garbage. Contamination in bales is not accounted for.

Jurisdiction	Materials/Substreams	Haulers	Management Methods	Residuals and Contamination
King County	Residential, commercial, and institutional material (non-C&D).	All (based on Ecology and Seattle data, with some adjustments)	Recycling and commercial composting/organics processing	Residential contamination is estimated based on single-family recycling characterization data. Commercial residuals are excluded by using Ecology and Seattle data.
City of Olympia	Residential, commercial, and institutional material (non-C&D).	Only City-hauled material	Only recycling and commercial composting/organics processing	Not accounted for.

US Environmental Protection Agency

In 1997, the US Environmental Protection Agency (US EPA) published "Measuring Recycling: A Guide for State and Local Governments."[10] These guidelines define what materials and recycling methods should be included and excluded when calculating a recycling rate. In general, US EPA excluded materials for the following reasons:

- They are not defined as MSW in US EPA's Characterization of MSW.
- They have not historically been disposed of as MSW.
- They are regulated hazardous waste.
- They are generated from pre-consumer sources.
- They are managed using reuse and donation, repair, onsite management (e.g., backyard composting), combustion for energy recovery, or landfill alternative daily cover (ADC).

Additional details on the guidelines are presented in **Table 20**.

[10] United States Environmental Protection Agency, "Measuring Recycling: A Guide for State and Local Governments," 1997, retrieved from http://www.epa.gov/osw/conserve/tools/recmeas/download.htm.

Table 20. Summary of US EPA Guidelines

	Included	Excluded
Material sources	• Residential, commercial, and institutional wastes (most post-consumer wastes) • Tires (consumer cars and trucks) and lead-acid batteries (consumer cars, trucks, and motorcycles) • Household hazardous waste (except used motor oil) and consumer electronics	• C&D, abatement, and natural disaster debris • Waste from vehicles (except tires and batteries, as noted) • Agriculture, manufacturing, and industrial process waste (such as mill scraps, food processing waste, sawdust) • Used motor oil • Medical waste, • Combustion ash, municipal sewage, and industrial sludges • Mining, oil, gas wastes
Recycling Methods	• Recycling of post-consumer waste • Composting of post-consumer food scraps • Composting of yard debris (except from construction and demolition activities) • Recycling of household hazardous waste	• Recycling of excluded materials (including C&D debris; excluded vehicle waste; and pre-consumer, manufacturing, and industrial process waste) • Reuse, repair and other source reduction • Onsite/backyard composting, mulching, and grasscycling (mulch mowing) • Edible food donation • Combustion for energy recovery • Landfill alternative daily cover (ADC)

Note: This table provides a high-level summary and is not intended to capture all the details and nuances of US EPA's guidelines. Section 2B of Worksheet A identifies ADC as excluded from US EPA's standard recycling rate.

Washington Department of Ecology

The Washington State Department of Ecology (Ecology) states that its recycling rate methodology closely aligns with US EPA guidelines, based on reports from haulers and processors.[11] Ecology's *diversion* rate methodology includes additional materials and management methods that US EPA excludes from the standardized recycling rate. These expansions in the diversion rate include:

- Agricultural, industrial, and pre-consumer organics
- C&D debris, including asphalt, concrete, landclearing debris,
- Container glass used as aggregate (rather than recycling into new glass containers or products)[12]
- Reused and repaired clothing, household items, C&D debris, tires, and other materials
- Edible food recovery

---

[11] Washington Department of Ecology, "Waste 2 Resources > Solid Waste and Recycling Data > Recycling," Retrieved July 20, 2015 from http://www.ecy.wa.gov/programs/swfa/solidwastedata/recyclin.html.
[12] Glass collected separately by the City of Tacoma is currently recycled into new glass containers.

- Materials managed through energy recovery (including wood waste, yard waste, landclearing debris, tires, used oil, and other fuels)

The expanded scope of the diversion rate increases both tons diverted and tons generated.

City of Seattle

The City of Seattle's municipal solid waste (MSW) recycling rate methodology largely corresponds to Ecology's methodology. Seattle recycling rate includes an estimate of organics managed through backyard composting and mulch mowing. Seattle MSW tonnages also include some C&D debris disposed of in residential and commercial containers and at Seattle transfer stations. Seattle uses the following data sources to calculate the MSW recycling rate:[13]

- Weekly tonnage reports from contracted haulers and City of Seattle transfer stations on all residential recycling, organics, and garbage; commercial garbage; reports from processors that handle recycling and organics generated in Seattle; and all self-hauled materials delivered to Seattle transfer stations.
- Annual tonnage reports from private haulers, processors, and self-hauling generators who operate in the City of Seattle (required to obtain a City of Seattle business license).
- Waste characterization studies conducted for each substream on a four-year cycle.
- Home Organics Survey conducted every five years to estimate the percentage of residents using backyard composting and mulch mowing.

Seattle also calculates a C&D debris recycling and diversion rates, separate from the MSW recycling rate. The diversion rate includes both recycling and beneficial use, but not materials sent to landfills as alternative daily cover or industrial waste stabilizer. Seattle collects C&D debris data from the following sources:

- Monthly reports from transfer stations, "certified" mixed waste processing facilities, and intermodal facilities that handle C&D debris.
- Waste characterization studies, conducted approximately every seven years.
- Annual recycling reports from the haulers and recycling facilities (both source separated and "mixed waste") that haul or receive C&D from Seattle.

In addition, building permit applicants submit Waste Diversion Reports of quantities of materials hauled to different locations for reuse, recycling and disposal. While Seattle does not use these reports for quantitative data, they serve help ensure that materials are going to "certified" facilities for recycling.

Seattle uses its Seattle Discard Model to compares actual recycling performance to expected amounts of recycling, organics, and garbage that are projected based on factors including:

- Unemployment rate
- Housing prices
- Household size and income

[13] City of Seattle, Solid Waste Management Plan: Chapter 2 – Seattle Solid Waste Trends, 2011.

- Average and marginal collection fees
- Temperature and precipitation (which affect yard waste)

Pierce County

Pierce County uses data provided by Ecology to calculate its recycling rate. Pierce County's Solid Waste Management Plan Supplements from 2008 and 2015 do not indicate that the County makes any adjustments to Ecology-provided data.[14]

King County

King County's recycling rate methodology corresponds to Ecology's methodology. King County calculates its recycling rate using a variety of data sources.[15] Residential tonnages and recycling rates are based on reports from haulers. Commercial data are modeled using the following data sources:

- Department of Ecology recycling database (based on reports from haulers and processors).
- City of Seattle recycling database (based on reports from haulers and processors that collect recyclables and organics generated in Seattle).
- King County transfer station and landfill data.

King County begins with Ecology's recycling database to sum the tons assigned to King County and a portion of statewide tons not allocated to any county (in proportion to King County's share of the statewide population). After removing residential tons, King County compares Ecology data to Seattle data to estimate the commercial tons attributable to King County excluding Seattle.

King County also reduces the tons of metal recycling based on the assumption that approximately one-third is municipal solid waste (residential and commercial recycling) while the other two-thirds are associated with C&D debris and vehicle parts (not counted as recycling according to US EPA's methodology).

King County also calculates a separate C&D debris recycling rate based on reports from C&D debris processors and on Ecology data. King County attempts to align its methodology with the City of Seattle.

Recommended Calculation Method for Tacoma

Cascadia recommends that Tacoma calculate separate recycling and diversion rates consistent with the Washington Department of Ecology methodology for the City as a whole and for individual substreams. The five substreams are:

- Single-family residential
- Multifamily residential

---

[14] Pierce County Department of Public Works, Tacoma-Pierce County Solid Waste Management Plan Supplement, 2015 (page C-3).
Pierce County Department of Public Works and Utilities, "Tacoma-Pierce County Solid Waste Management Plan Supplement 2008," Appendix page 20.

[15] Phone Interview with Bill Reed, Recycling Program Analyst, King County Solid Waste Division, September 16, 2015.

- Commercial and industrial
- Self-haul
- C&D debris

Calculating substream-specific recycling and diversion rates help Tacoma identify where to target recycling efforts and will allow the City to compare its recycling rates to Ecology and Seattle's rates. Consistent with Ecology, Tacoma's recycling rate should count residuals as garbage, which will also help Tacoma assess whether additional education on contamination is needed.

The City should collect tonnage data from private haulers and processors that operate in Tacoma using one of the two methods below:

- Contracting with a trusted third-party firm to collect and aggregate the data.
- Partnering with Pierce County to collect and aggregate the data.

To measure residential, commercial, and self-haul diversion, Tacoma could also include local reuse organizations, such as Goodwill, in the survey. Cascadia also recommends that Tacoma track the performance indicators in the following categories:

- Tonnage metrics, by material stream and substream.
- Composition metrics, by material stream and substream, including capture rates and remaining recycling potential.

Calculation of Tacoma's Recycling Rate

To calculate Tacoma's recycling rate using the recommended method, Cascadia combined tonnage data provided by the City of Tacoma on waste managed by the municipal system with a survey private haulers and processors. These additional tons substantially increased the commercial and C&D debris recycling and diversion rates. In 2014, Tacoma achieved a 41 percent recycling rate (excluding C&D) for residential and commercial waste and a 55 percent recycling rate overall when C&D debris is included.

Table 21. Tacoma Recycling and Disposal Tonnages, 2014

Substream	Recycling			Disposal	Total Generation
	City Data	Survey Data	Total	Total	Total
Single-family	41,764		41,764	33,739	75,503
Multifamily	3,106		3,106	13,346	16,452
Commercial	8,282	37,207	45,489	61,620	107,109
Self-haul	9,191	234	9,425	32,934	42,359
C&D debris	365	105,393	105,758	23,339	129,097
Total citywide	**62,045**	**142,834**	**205,542**	**164,978**	**370,520**

Table 22. Tacoma Recycling Rates, 2014

Substream	Recycling Rate
Single-family	55%
Multifamily	19%
Commercial	42%
Self-haul	22%
Residential and Commercial Subtotal	41%
C&D debris	82%
Total citywide	55%

To conduct the survey, Cascadia worked with the City of Tacoma to identify 24 private haulers and processors that handle recyclables generated within the city of Tacoma and outside of Tacoma's municipal collection system. Cascadia obtained data from 12 companies on tons of commercial, self-haul, and C&D debris materials recycled. To avoid double-counting materials, the confidential survey included questions on tonnages received from and delivered to other haulers and processors. In future surveys, Tacoma should consider including reuse organizations (such as Goodwill), used cooking oil refiners, and other unusual processors to estimate more comprehensive diversion rates for municipal solid waste from the residential and commercial substreams.

Appendix 3. Recycling Potential and Lifecycle Cost Model Methodology

A core element of the Sustainable Materials Management Plan was the creation of a recycling potential assessment and a lifecycle cost model to quantify the impacts and costs of alternative programs, policies and infrastructure enhancements (options). These models, developed by Herrera, calculated diversion rates and life cycle costs of each option and combination of options from 2016 through 2048.

This Appendix summarizes the development and use of the models used by the consultant team. The purpose of the summary is to:

- Provide background information on how the diversion tonnage estimates were developed.
- Describe the cost modeling and assumptions behind the life cycle cost calculations.

The two models are described below. Estimates of the additional diversion produced from individual options at specific points in each Phase, implementation dates, ramp-up periods, maximum marginal recycling rates, and anticipated costs and revenues are presented in Appendix 4.

Recycling Potential Assessment Model

The Recycling Potential Assessment Model development process involved the three steps listed below.

1. Identify Waste Diversion Options and Targeted Materials

In total, the team considered over 100 programmatic, policy, infrastructure investment, and operational options that fall into six different categories, which are described in Section 4, Recommended Strategies:

- Waste Reduction/EPR
- Education & Outreach
- Operations & Programs
- Capital Investments
- Incentives & Rates
- Regulations

The options were qualitatively evaluated by the city and consultant team, and ultimately the highest ranking alternatives were grouped into four phases for modeling.

2. Establish Participation, Efficiency and Recovery Rates

For each option the team established participation, efficiency, and recovery rates. Participation rates indicate the percentage of a waste generator group that would engage in the desired waste diversion activity or behavior. Efficiency rates indicate the percentage of waste that the participating group would actually divert. Recovery rates for an option and its targeted waste materials are the product of participation and efficiency. Rates were based on a combination of:

- Actual results from existing Tacoma programs.
- Actual results from other jurisdictions' programs.
- Research on diversion rates for major program categories.

- Professional judgment of the Project team.

In addition, the team assigned a reasonable implementation year to each option within each phase, based on a sequence moving from voluntary education and outreach to more rigorous regulations and infrastructure investments.

Following the assignment of the implementation date, the team assigned a reasonable ramp up period, defined as the number of years required to achieve the maximum marginal recycling rate. The assignment of this period was again informed by research and current experience regarding complexity of the option; lead time required to minimize risk, engage stakeholders, or pass legislation; available budget; or a combination of all.

Appendix 4 shows the participation and efficiency rates, maximum marginal recovery rates, implementation dates and ramp up period for each of the options analyzed in the phased analysis.

3. Apply Options to Disposed Waste in Sequence of Increasing Intensity and Calculate Tonnage Diversion on Decreasing Balance of Disposed Tons

The spreadsheet model estimates the waste diversion effects of sequential implementation of options for each targeted material, substream and in total for the City. Sequential implementation means that each option's marginal recycle rate would apply to remaining tonnage after the tonnage from previously employed options have been diverted.

The model output provides the following information in order to determine the anticipated diversion rates for each substream and overall:

- Total tonnage shifted to recycling collection
- Total tonnage shifted to organics collection
- Net tonnage shifted to MRF facility
- Total additional diversion by waste class
- Total additional diversion by option type

Lifecycle Cost Model

The team developed planning level implementation costs for staff support, education, fixed operations & maintenance, and capital costs for each option based on assignment of unit costs and quantities for labor, equipment, and marketing/educational materials. Fixed O&M is estimated based on general industry standards for percentage of capital investments for structure maintenance, utilities, and facility maintenance. All labor positions use costs from the 2014 City of Tacoma government employee salary database, or from salaries provided directly from Solid Waste Management. Revenues are based on current prices for marketable commodities net of transportation expenses. Capital costs for MRF option 4 were based on data from the *Volume 3: MRF Feasibility Study*.

The team used life cycle cost analysis to evaluate the various options over the assumed life of each program or infrastructure investment. For each phase and combination of phases, the team calculated net present value by subtracting the present value of the options costs from the present value of the options revenues. The cost model used the following assumptions:

- Base Year of Analysis: 2015
- Final Year of Study Period 2048
- Discount Factor/Cost of Capital (2015) 5.00%
- Construction / Equipment Escalation 4.00%
- O&M Escalation 2.50%

In addition, a levelized cost per disposed ton is calculated for each phase or combination of phases through 2048, assuming a 20-year asset life for major investments. The net present value of cash flows for each phase and combination of phases (including direct and staffing costs for program and education activities, fixed operation and maintenance costs, capital expenditures, and revenues) was calculated from 2017 through 2048, and divided by the discounted total of waste disposed for the same period to calculate a cost per ton metric.

Appendix 4. Baseline Generation, Diversion, & Disposal Projection Methodology

Projected baseline generation, recycling, composting, disposal is current through 2028. We made the following key assumptions.

- Total disposal, recycling, and organic tons from 1992 to 2014 were from the Tacoma Solid Waste Management Overview Data Summary from 2015.
    - Disposal tons were allocated to substream using 2015 waste composition sampling data
    - Recovery tons were allocated to substream based on data from Tacoma tracking records by site and material
- Disposal projections were based on disposal rates from 1992 to 2014
- Recovery projections were based on different time periods depending on program implementation

See below for substream-specific methodologies.

Single-family

- Linear trends were identified from tons per SF household
- SF Household projections were from PSRC land use planning
- In 1998, single stream recycling was initiated. Recycling tons before 1999 were excluded from the trend analysis.
- To reflect the current organic collection infrastructure, organic tons before 2003 were excluded.

Multifamily

- Trends were based on a MF household discard rate
- MF Household projections were from PSRC land use planning.
- In 2002, MF recycling was initiated. Recycling tons before 2003 were excluded from the trend analysis.
- No MF organics collection infrastructure exists as of 2015.

Commercial

- Trends were based on a per employee discard rate
- Employee projections were from the Employment Security Dept.
- In 1998 single stream recycling was initiated. Recycling tons before 1999 were excluded from the trend analysis.
- Other commercial recycling and organics diversion was quantified from Cascadia's 2015 recycling survey data
- 2014 was first year of commercial organics collection.

Self-haul

- Residential SH trends were based on a per capita discard rate
- Commercial SH trends were based on a per employee discard rate

- The same years included for the SF recovery trends were included for the residential SH recovery streams.

C&D

- Both Residential and Commercial C&D trends were based on a per construction employee discard rate
- Construction employee projections were from the Employment Security Dept. for Peirce County. Proportion of construction employees working in Tacoma was provided by the PSRC
- C&D recovery was quantified by Cascadia's 2015 recycling survey data

Appendix 5. Diversion Options

The costs and diversion impacts of programs and initiatives listed in the table below will not necessarily cover the costs or produce the results if considered as a standalone program. Each option was considered as one element of a broader suite of programs and initiatives. This is particularly true for Phase 1 and 2 education and outreach, incentives, and regulatory programs.

Option Name	Orig. Imp. Date	Ramp Up	Orig. Ramp Down	Max Marginal Rec. Rate	Operating - Program Costs (Year 1 - 2015 $)	Fixed O&M Costs (Year 1 - 2015 $)	Capital Expenditures (2015 $)	Phase I (2028) (tons diverted)	Phase I, II (2028) (tons diverted)	Phase I, II, and III-MRF (2028) (tons diverted)	Phase I, II, and III- NO MRF (2028) (tons diverted)	Phase I, II, III-MRF, IV (2032) (tons diverted)	Phase I, II, III-NO MF, IV (2032) (tons diverted)	
Provide education and outreach targeted at reusable bag use. Provide reusable bags for low income residents.	2017	3	2020	4.95%	$12,405	$-	$ -	31	31	31	31	32	32	PHASE I (2017 - 2020)
Continue to provide education and outreach to new and existing customers.	2017	1	2018	5.00%	$ 105,053	$ 200,000	$ -	6,293	6,293	6,293	6,293	6,677	6,677	
Promote supply chain management and green procurement policies.	2017	7	2024	1.00%	$4,992	$-	$ -	364	364	364	364	391	391	
Promote thrift stores as the preferred option for discarding unwanted furniture.	2017	4	2021	3.00%	$32,690	$-	$ -	124	124	124	124	131	131	
Campaign to reduce food waste.	2017	5	2022	0.25%	$7,056	$-	$ -	24	24	24	24	25	25	
Conduct education and outreach on waste prevention and toxics reduction, including tailored outreach to multicultural communities.	2017	4	2021	2.00%	$14,501	$-	$ -	444	444	444	444	453	453	
Offer additional waste reduction and recycling in public school curriculums.	2017	5	2022	0.25%	$5,159	$-	$ -	171	171	171	171	181	181	
Support and promote strong EPR policy adoption by county or state government. For hard-to-recycle materials such as mattresses, paint, pharmaceuticals, and batteries.	2017	7	2024	0.00%	$3,485	$-	$ -	-	-	-	-	-	-	
Lobby for a statewide beverage container deposit system.	2017	7	2024	0.00%	$3,485	$-	$ -	-	-	-	-	-	-	
Create a Master Recycler / Composter program.	2017	5	2022	1.95%	$19,622	$-	$ -	382	382	382	382	390	390	
Establish program to share results of residential food and yard waste organics collection.	2017	5	2022	2.00%	$2,788	$-	$ -	197	197	197	197	201	201	

Option Name	Orig. Imp. Date	Ramp Up	Orig. Ramp Down	Max Marginal Rec. Rate	Operating - Program Costs (Year 1 - 2015 $)	Fixed O&M Costs (Year 1 - 2015 $)	Capital Expenditures (2015 $)	Phase I (2028) (tons diverted)	Phase I, II (2028) (tons diverted)	Phase I, II, and III-MRF (2028) (tons diverted)	Phase I, II, and III- NO MRF (2028) (tons diverted)	Phase I, II, III-MRF, IV (2032) (tons diverted)	Phase I, II, III-NO MF, IV (2032) (tons diverted)	
Manage events or an ongoing shop to exchange reusable HHW items.	2017	4	2021	12.50%	$7,358	$-	$ -	3	3	3	3	3	3	
Promote reuse and thrift stores.	2017	4	2021	2.00%	$10,796	$-	$ -	40	40	40	40	40	40	
Color code the signage system at TRTC for different materials, with consistent color coding in any print or online information or collateral.	2017	2	2019	2.50%	$7,442	$-	$ -	444	444	444	444	468	468	
Conduct periodic Knock & Talk campaigns to multifamily residents.	2017	3	2020	1.50%	$18,296	$-	$ -	118	118	118	118	123	123	
Conduct periodic Knock & Talk campaigns to commercial customers.	2017	3	2020	1.50%	$5,921	$-	$ -	530	530	530	530	569	569	
Conduct targeted education and outreach to increase quantity and quality of food waste collected.	2017	3	2020	5.00%	$98,400	$ 100,000	$ -	878	878	878	878	943	943	
Expand commercial technical assistance.	2017	5	2022	2.50%	$78,334	$-	$ -	1,062	1,062	1,062	1,062	1,141	1,141	
Promote and facilitate pre-consumer food donations by food service businesses.	2017	4	2021	0.75%	$13,472	$-	$ -	122	122	122	122	131	131	
Promote C&D debris salvage, reuse, recycling, and exchange to construction professionals	2017	4	2021	7.50%	$27,968	$-	$ -	198	198	198	198	218	218	
Promote C&D debris salvage, reuse, recycling, and exchange to residents.	2017	5	2022	6.00%	$30,864	$-	$ -	938	938	938	938	1,014	1,014	
Promote green building practices to commercial C&D customers.	2017	5	2022	7.50%	$27,968	$-	$ -	176	176	176	176	194	194	
Promote green building practices to self-haul C&D customers.	2017	5	2022	3.00%	$30,864	$-	$ -	421	421	421	421	455	455	
Promote onsite organics processing at food-generating businesses.	2017	5	2022	1.60%	$11,046	$-	$ -	258	258	258	258	278	278	
Promote recycling drop-off opportunities.	2017	3	2020	2.50%	$4,996	$-	$ -	314	314	314	314	331	331	
Promote use of e-waste recycling drop-off locations.	2017	3	2020	10.00%	$4,996	$-	$ -	45	45	45	45	47	47	
Provide education and outreach targeted at multifamily property managers and tenants to increase recycling and composting.	2017	5	2022	10.00%	$75,146	$-	$ -	763	763	763	763	796	796	

Option Name	Orig. Imp. Date	Ramp Up	Orig. Ramp Down	Max Marginal Rec. Rate	Operating - Program Costs (Year 1 - 2015 $)	Fixed O&M Costs (Year 1 - 2015 $)	Capital Expenditures (2015 $)	Phase I (2028) (tons diverted)	Phase I, II (2028) (tons diverted)	Phase I, II, and III-MRF (2028) (tons diverted)	Phase I, II, and III- NO MRF (2028) (tons diverted)	Phase I, II, III-MRF, IV (2032) (tons diverted)	Phase I, II, III-NO MF, IV (2032) (tons diverted)
Review and update all existing outreach messages to ensure the recycling target/zero waste goals are highly visible. Include recycling guides, welcome packets.	2017	5	2022	3.25%	$13,728	$-	$ -	798	798	798	798	840	840
Establish a voluntary initiative for disposable plastic grocery bag take-back program.	2017	3	2020	25.00%	$14,853	$-	$ -	138	138	138	138	143	143
Adopt a sustainable purchasing policy and develop tools and systems to increase green purchasing by City departments.	2019	3	2022	0.00%	$20,646	$-	$ -	-	-	-	-	-	-
Ensure that all MF sites have adequate recycling and organics collection infrastructure.	2019	5	2024	5.00%	$ 110,263	$-	$191,250	344	344	344	344	359	359
Expand food waste collection program to accept compostable paper and food serviceware. (private haulers)	2019	4	2023	4.00%	$ 110,755	$-	$208,500	875	875	875	875	940	940
Expand public space recycling.	2019	5	2024	0.00%	$10,759	$ 17,500	$175,000	-	-	-	-	-	-
Support reusable transport packaging program.	2019	5	2024	2.00%	$15,929	$-	$ -	111	111	111	111	119	119
Promote and incentivize the use of Residential food grinders. Could include rate incentives similar to KC Surface Water.	2019	5	2024	12.50%	$24,160	$ 112,500	$375,000	1,132	1,132	1,132	1,132	1,154	1,154
Provide financial incentives to self-haul customers increase diversion of materials at TRTC.	2019	3	2022	10.00%	$ -	$-	$ -	1,053	1,053	1,053	1,053	1,109	1,109
Provide financial incentives to self-haul C&D customers increase diversion of materials at TRTC.	2019	3	2022	10.00%	$21,059	$-	$ -	947	947	947	947	1,024	1,024
Enforce state regulations such as the "two-bin rule."	2020	3	2023	15.00%	$34,205	$-	$ -	409	409	409	409	451	451
Require new commercial buildings to have adequate recycling and composting space/enclosures to receive building permit.	2020	4	2024	4.25%	$19,665	$-	$ -	1,421	1,421	1,421	1,421	1,527	1,527
Require owners and contractors to use Certified C&D Processing Facilities.	2020	1	2021	64.00%	$78,198	$-	$ -	1,250	1,250	1,250	1,250	1,379	1,379

CASCADIA CONSULTING GROUP

Option Name	Orig. Imp. Date	Ramp Up	Orig. Ramp Down	Max Marginal Rec. Rate	Operating - Program Costs (Year 1 - 2015 $)	Fixed O&M Costs (Year 1 - 2015 $)	Capital Expenditures (2015 $)	Phase I (2028) (tons diverted)	Phase I, II (2028) (tons diverted)	Phase I, II, and III-MRF (2028) (tons diverted)	Phase I, II, and III- NO MRF (2028) (tons diverted)	Phase I, II, III-MRF, IV (2032) (tons diverted)	Phase I, II, III-NO MF, IV (2032) (tons diverted)	
Establish recurring drop-off event for reuseables - "Use it Again, Tacoma."	2021	3	2024	0.75%	$32,690	$-	$ -		51	51	51	53	53	PHASE II (2021 - 2022)
Enhance floor sorts for bulky reusable and recyclable items at TRTC.	2021	2	2023	15.00%	$3,013	$ 80,000	$ -		2,208	2,208	2,208	2,326	2,326	
Enhance floor sorts for bulky reusable and recyclable items at TRTC.	2021	2	2023	40.00%	$ -	$ 261,145	$170,000		4,223	4,223	4,223	4,563	4,563	
Expand materials accepted in curbside recycling to include textiles, additional types of scrap metal, or plastics.	2021	5	2026	48.00%	$35,326	$-	$ -		1,106	1,106	1,106	1,129	1,129	
Increase Pay-As-You-Throw rate differentials.	2021	3	2024	10.00%	$47,593	$ 7,500	$25,000		1,439	1,439	1,439	1,468	1,468	
A - Expand mixed organics processing capacity, and expand collection to accommodate compostable paper and food serviceware.	2021	3	2051	12.50%	$21,929	$-	$5,435,700		5,753	5,753	5,753	6,073	6,073	
Enforce state regulations such as the “two-bin rule.”	2021	3	2024	5.00%	$34,205	$-	$ -		483	483	483	522	522	
Prohibit disposal of recoverable C&D materials for commercial C&D customers.	2021	5	2026	64.00%	$29,077	$-	$ -		527	527	527	581	581	
Prohibit disposal of recoverable C&D materials for self-haul C&D customers.	2021	5	2026	64.00%	$30,864	$-	$ -		5,817	5,817	5,817	6,286	6,286	
Ban retail disposable plastic bags (with some exemptions) and establish fee on paper bags.	2021	3	2024	76.50%	$14,853	$-	$ -		387	387	387	403	403	
Require multifamily property owners/managers to provide adequate recycling collection service for residents (establishing a “right to recycle”).	2022	4	2026	10.00%	$33,018	$-	$ -		927	927	927	967	967	
Require new buildings to have adequate space and facilities for recycling and organics storage and collection.	2022	4	2026	8.50%	$29,361	$-	$ -		433	433	433	451	451	
Require recycling of C&D Materials at all job sites.	2022	4	2026	54.00%	$34,205	$-	$ -		181	181	181	200	200	
Require recycling at all job sites.	2022	5	2027	27.00%	$30,864	$-	$ -		876	876	876	946	946	
Require self-haul customers to separate recyclables at TRTC.	2022	5	2027	40.00%	$13,890	$ 68,921	$ -		6,526	6,526	6,526	6,874	6,874	
Require self-haul C&D customers to separate recyclables at TRTC.	2022	5	2027	40.00%	$13,890	$ 68,921	$ -		843	843	843	911	911	

Option Name	Orig. Imp. Date	Ramp Up	Orig. Ramp Down	Max Marginal Rec. Rate	Operating - Program Costs (Year 1 - 2015 $)	Fixed O&M Costs (Year 1 - 2015 $)	Capital Expenditures (2015 $)	Phase I (2028) (tons diverted)	Phase I, II (2028) (tons diverted)	Phase I, II, and III-MRF (2028) (tons diverted)	Phase I, II, and III- NO MRF (2028) (tons diverted)	Phase I, II, III-MRF, IV (2032) (tons diverted)	Phase I, II, III-NO MF, IV (2032) (tons diverted)	
Design routes to collect highly recoverable waste for processing at a MRF.	2023	2	2025	18.00%	$22,700	$-	$ -			2,786	-	2,992	-	A
Ban wood at TRTC.	2023	2	2025	81.00%	$13,890	$ 68,921	$ -			2,395	-	2,530	-	
Invest in or contract for a new MRF focused on Commingled SF Residential Recyclables and mixed waste processing for Select High-Grade Non-C&D Commercial Waste and High-grade non-C&D self-haul waste (MRF #4)	2023	7	2053	81.00%	$ -	$4,758,000	$33,000,000			25,020	-	26,760	-	
Implement intensive award and recognition programs for businesses.	2023	5	2028	0.50%	$12,273	$-	$ -				179	-	192	B
Hold neighborhood swap and repair events.	2023	3	2026	1.25%	$35,632	$-	$ -				17	-	17	
Authorize mandatory recycling laws for targeted materials.	2023	4	2027	68.00%	$16,576	$-	$ -				8,214	-	8,380	
Require businesses with outdoor garbage bins for public use to provide adjacent recycling containers.	2024	3	2027	0.00%	$14,075	$-	$ -				-	-	-	
Require commercial property owners and businesses to provide recycling collection service (subscription or self-haul).	2024	5	2029	4.00%	$27,092	$-	$ -				563	-	605	
Require food service establishments to use recyclable and/or compostable food serviceware.	2025	4	2029	17.10%	$13,984	$-	$ -				3,053	-	3,280	
Require large events on public property to recycle and compost.	2024	3	2027	0.00%	$14,075	$-	$ -				-	-	-	
Require single-family residents to subscribe to curbside recyclables and organics collection.	2025	4	2029	5.00%	$12,709	$-	$ -				-	-	207	
Require composting for Organic materials	2028	4	2032	48.00%	$51,382	$-	$ -				-	10,490	11,269	PHASE IV (2028 -2030)
Require recycling for Traditional Recyclables	2028	4	2032	64.00%	$55,154	$-	$ -				-	3,539	10,781	
Co-locate recycled-content product manufacturer at TRTC.	2030	6	2060	32.00%	$15,066	$-	$1,799,000				-	824	881	

Option Name	Orig. Imp. Date	Ramp Up	Orig. Ramp Down	Max Marginal Rec. Rate	Operating - Program Costs (Year 1 - 2015 $)	Fixed O&M Costs (Year 1 - 2015 $)	Capital Expenditures (2015 $)	Phase I (2028) (tons diverted)	Phase I, II (2028) (tons diverted)	Phase I, II, and III-MRF (2028) (tons diverted)	Phase I, II, and III- NO MRF (2028) (tons diverted)	Phase I, II, III-MRF, IV (2032) (tons diverted)	Phase I, II, III-NO MF, IV (2032) (tons diverted)	
Include a retail salvage building materials reuse center at TRTC.	2029	3	2049	9.00%	$ -	$ 203,499	$2,406,250				-	88	104	
Include a retail thrift store, reuse and recycling center at TRTC.	2029	3	2049	12.50%	$ -	$ 232,002	$4,686,500				-	259	259	

CASCADIA CONSULTING GROUP

Appendix 6. Tacoma Compost Facility Options (60,000 tons per year)

Description

Currently, the City collects almost 30,000 tons of organic materials. This includes vegetative and other source separated food waste and yard waste collected from mostly residential customers. The City is considering implementing new programs and services aimed at recovering an additional 25,000 to 30,000 tons of organics from both residential and commercial customers.

Based on estimates made by the Cascadia consulting team in conjunction with the City, new programs could result in collecting 51,000 tons of various organic waste streams by 2020. By 2028, it is projected that almost 60,000 tons of organic materials could be recovered for processing. The organic waste stream is comprised of three primary material types; food waste; compostable paper; and, yard waste which include grass, brush, yard trimmings and woody debris. The estimates are shown in **Table 1**.

Table 1 – Estimated Quantity of Organics

Available Organics (tons per year, tpy)	2020	2028	2028 (tons per day, tpd)
Food Waste	31,250	34,337	132
Compostable Paper	8,778	9,760	38
Yard Waste	11,736	13,048	50
Total Estimated Recovered Organics	**51,764**	**57,145**	**220**

For this analysis it is assumed the materials will delivered to a central processing and composting facility. The exact nature and composition of these different organic waste streams may vary depending on the collection services that are provided. For instance, it is expected that source separated yard waste currently collected will contain food waste from residential customers. As a result it will also contain a certain percentage of compostable paper. Commercial food waste may be collected separately or the mixed organics may be recovered from a MRF.

The new programs and services may generate an estimated 60,000 tpy of mixed organics or 230 tons per day by 2028. Assuming the compost facility will be located in somewhat urbanized setting, the compost facility will need enclosed buildings to receive and process materials. Also, the technology used will require a combination of enclosed and partially enclosed structures and employ technology that can convert the materials into a usable product in lesser time. The options discussed in the following sections represent technologies to convert organics to usable soil amendment products in less than 50 days. These technologies are also scalable so additional units can be constructed to increase capacity. The site must also provide space to cure and temporarily store composted materials.

Receiving and Pre- Processing

To handle 230 tpd of mixed organics it is expected an enclosed receiving building will be required. This is due the fact that certain organics will need to be processed to remove contaminants. The equipment line is expected to handle 40 tons per hour (tphr) requiring up to 6 hours for processing. The receiving building should be sized to handle surges and temporarily store materials when not processing. It may be possible that some of the materials such as those with high amounts of yard waste and less food waste, could be unloaded outdoors if they are processed and place in the compost units on a continuous basis.

To remove the primary contaminants it is assumed some level of pre-processing will be needed. This system will vary depending on the characteristics of the materials being delivered. For the purpose of developing a planning level cost estimate the pre-processing system will include the following:

1. In feed conveyor
2. A screen or trommel to screen fines (2" to 4") from large items mostly plastics and larger fiber
3. Sort Line (Manual sorting) to remove larger plastics, metal and other larger items. Depending on the degree of contamination air density separation and optic sorters could also be used. These were not included in the estimated capital cost.

The larger items removed is expected to be landfilled but would most likely contain high BTU by products that could have energy value.

It is expected that organics materials delivered from the MRF will be largely glass free as the system is assumed to have a state of the art glass recovery system. However, if glass is contained in food waste collected from the commercial routes delivered directly to the compost site, the by-products will need further processing to remove glass and other contaminants in order to meet markets specifications. These costs are not included in the process equipment.

Compost Systems

The compost technology to be employed at the facility can vary greatly from simple aerated windrow to a total in vessel system that is fully enclosed. It is expected the facility might be located at the closed landfill site or a site near the City. With this assumption the system will be use a technology ranging from moderate cost for a Aerated Static Pile system to one that use a Stationary In vessel system at a higher cost. This approach uses up less land and provides greater control of odors and storm water runoff.

<u>Option 1- In Vessel w/ Aerated Static Pile (High Tech)</u>

This approach uses a stationary in vessel system fully enclosed as the primary composting operation. Materials are loaded into the vessel that are fully enclosed and provide an air and temperature control system to compost materials for 18 days. Once completed the materials are moved to a secondary aerated static pile bunker system to finish out the compost process for 22 days. The systems include bio-filter to treat the exhaust air.

The estimated cost of the system is based on the previous estimates provided by Engineered Compost Systems and extrapolated for the larger system to handle 60,000 tpy.

<u>Option 2 – Aerated Static Piles system</u>

This system uses an enhanced Aerated Static Pile system to perform the primary compost estimated to be about 20 to 25 days. The cost of this aerated static pile system in the primary phase is higher because it uses stainless steel ducting and pipes and there are larger motors capable of moving air in both the positive and negative direction. The material is removed and placed in secondary aerated static piles, similar to Option 1, to complete the compost process for another 22 days. Although the system includes a bio filter the Aerated Static Piles in the primary phase is not fully enclosed.

Both systems can be constructed on a 10 acre site assuming the site is relatively flat and is rectangular in shape. The entrance roads and receiving building as assumed to be constructed on 3 acres and the compost units will require another 2 acres. The remaining 5 acres are to be used for curing and product storage for as much as 150 days.

Cost of Compost Systems

The Capital Construction Cost estimates were prepared to be used to compare the cost of recovering and processing organics from the mixed waste stream to other management programs on a programmatic/ planning level. Further refinement of these cost estimates should be made if the City decides to pursue these options and as more detailed information of specific alternatives becomes available.

Option 1- Stationary In-Vessel w/Aerated Static Pile (AEP)	$ 19.0 M
Option 2 – Aerated Static Pile for primary and secondary processing	$ 14.0 M

See attached spreadsheets

Both of the cost estimates include $3.5M to construct a 20,000 sf receiving building, install equipment to process material and provide mobile equipment such as loaders and containers. The process equipment is relatively a low tech necessary to remove small quantities of contaminants.

It is possible to lower the capital cost by constructing an aerated windrow system either covered or uncovered. However, these operations are usually located in rural areas with few neighbors that would not be subject to odors. This approach would also require more land perhaps an additional 5 acres or more.

One other consideration is to construct a Dry Fermentation Anaerobic Digester (AD) system in place of the in-vessel compost unit. The AD units are similar to the in vessel but include a tank to collect and store percolate and a gas storage unit. The benefit of constructing the AD will be to recover the methane gas that can be used to generate electricity or be converted to compressed natural gas (CNG). Once the initial process is complete, usually in about 20 days, the digestate can be removed and processed in contained bunkers with bio – filters to remove obnoxious odors, usually between 4- 8 days. The material can be further cured in windrows or static piles. By investing additional capital in the AD system allows the City to produce both renewable energy and compost

Operating Cost

The cost to operate the compost systems as described is estimated to be $17 to $25 per ton. This is similar to that of operating the system with 30,000 tpy due to the fact the fixed operating costs are similar. Handling the large volume may require some additional labor to handle materials.

Note: Engineered Compost Systems (ECS) of Seattle, a designer/developer of compost systems of various technologies provided information related to the technology and the construction cost for these systems.

Tacoma Compost Facility

Option 1 - In - Vessel Concept Plan - Construction Cost Estimate

Assumptions ***60,000 TPY*** ***230 TPD @ 52 Wks. @5 days /Wk.***

Description	Quantity	Unit	Unit Cost	Total Cost	Comment
Site Work - Estimate 10 acre Site					
Site Clearing & Grading	450,000	SF	$0.50	$225,000	Site is relatively Flat
Site access roads	30,000	SF	$5.00	$150,000	1000 Lin ft. @ 20' + maneuvering areas
Utilities /Electrical	1	Unit	$500,000.00	$500,000	Allowance - Water is within 500 ft of site
Subtotal Site work				**$875,000**	
Buildings & Structures					
Primary Units					
Stationary In- vessel (ECS SV Composter)	1	Unit	NA	$6,500,000	Capacity 230 tpd @365 days per year
SV uses 40,000 SF 18 days					Note- some economies of scale might be achieved in final engineering and design
Secondary					
Aerated Static Piles / Bunkers (ECS ASP)	1	Unit	NA	$3,000,000	Capacity 230 tpd
ASP uses 30,000 SF					Note- some economies of scale might be achieved in final engineering and design
Bio filter	6,000	SF	NA	Included	Included in Compost Unit Cost
Subtotal Buildings and Structures				**$9,500,000**	
Product Storage Area					
Paved Storage	150,000	SF	$4.50	$675,000	Asphalt paved with drainage -150 days
Storm water w/treatment	400,000	1	unit	$400,000	Water recirculation w/ treatment approaches may reduce water supply expenses
Support Buildings and Equipment					
Receiving Building	20,000	SF	$130.00	$2,600,000	Assume - Mixed organics delivered will need to be temporarily stored an processed in enclosed space
Pre-Processing / Clean Up Screening	1	Unit	NA	$500,000	Allowance Screening / conveyors
On site mobile equipment (2 Loaders + containers etc.)	1	Unit	$500,000.00	$500,000	
Subtotal Equipment and Storage Area				**$4,675,000**	
Compost Facility				**$15,050,000**	
Contingency			@ 15%	**$2,257,500**	
Engineering			@ 10%	**$1,505,000**	
Total for Option 1 In -Vessel				**$18,812,500**	**USE $19 M**

Preliminary Cost Estimates for Compost Technology are based on information Provided by ECS - (Engineered Compost Systems)
Planning Level Cost estimates carry +15% / - 15% level of accuracy
All prices are presented in 2016 dollars.
Siting and permitting cost and cost of land not included **9/15/2016**
No marketing and product transportation costs are included

Tacoma Compost Facility

Option 2 - Aerated Static Pile Concept Plan - Construction Cost Estimate

Assumptions ***60,000 TPY*** ***230 TPD @ 52 Wks. @5 days /Wk.***

Description		Quantity	Unit	Unit Cost	Total Cost	Comment
Site Work - Estimate 10 acre Site						
Site Clearing & Grading		450,000	SF	$0.50	$225,000	Site is relatively Flat
Site access roads		30,000	SF	$5.00	$150,000	1000 Lin ft. @ 20' + maneuvering areas
Utilities /Electrical		1	Unit	$500,000.00	$500,000	Allowance - Water is within 500 ft of site
Subtotal Site work					**$875,000**	
Buildings & Structures						
Primary Units						
Aerated Static Pile Units	(ECS Primary ASP Composter)	1	Unit	NA	$4,000,000	Capacity 230 tpd @365 days per year
Primary ASP uses 40,000 SF for 22 days						Note- some economies of scale might be achieved in final engineering and design
Secondary						
Aerated Static Piles / Bunkers (ECS ASP)		1	Unit	NA	$1,500,000	Capacity 230 tpd
ASP uses 30,000 SF for 22 days						Note- some economies of scale might be achieved in final engineering and design
Bio filter		6,000	Unit	NA	Included	Included in Compost Unit Cost
Subtotal Buildings and Structures					**$5,500,000**	
Product Storage Area						
Paved Storage		150,000	SF	$4.50	$675,000	Asphalt paved with drainage -150 days
Storm water w/treatment		400,000	1	unit	$400,000	Water recirculation w/ treatment approaches may reduce water supply expenses
Support Buildings and Equipment						
Receiving Building		20,000	SF	$130.00	$2,600,000	Assume - Mixed organics delivered will need to be temporarily stored an processed in enclosed space
Pre-Processing / Clean Up Screening		1	Unit	NA	$400,000	Allowance Screening / conveyors
On site mobile equipment (2 Loaders + containers etc.)		1	Unit	$500,000.00	$500,000	
Subtotal Equipment and Storage Area					**$4,575,000**	
Compost Facility					**$10,950,000**	
Contingency				@ 15%	**$1,642,500**	
Engineering				@ 10%	**$1,095,000**	
Total for Option 1 In -Vessel					**$13,687,500**	**USE $14 M**

Preliminary Cost Estimates for Compost Technology are based on information Provided by ECS - (Engineered Compost Systems)
Planning Level Cost estimates carry +15% / - 15% level of accuracy
All prices are presented in 2016 dollars.
Siting and permitting cost and cost of land not included **9/15/2016**
No marketing and product transportation costs are included

Volume 2 Waste Stream Composition Study

Sustainable Materials Management Plan

2015

City of Tacoma
WASHINGTON

CASCADIA
CONSULTING GROUP

Table of Contents

List of Tables

List of Figures

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

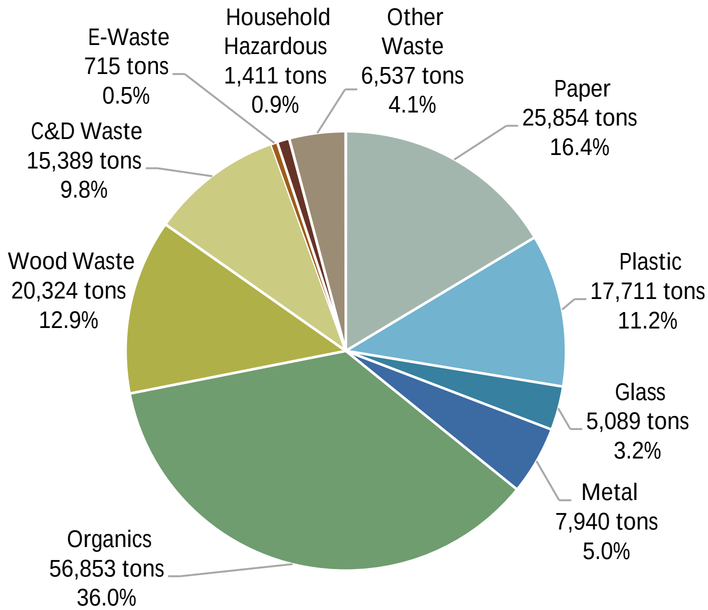
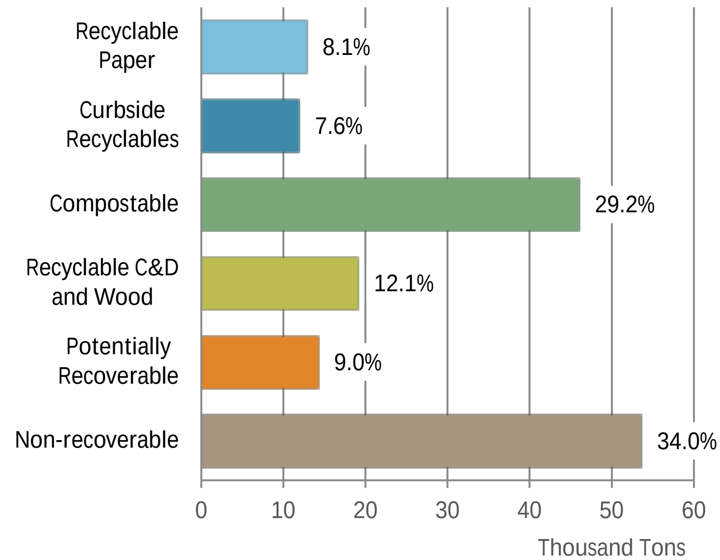


Figure ES-2. Summary of Recoverability of Overall Disposed Waste



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

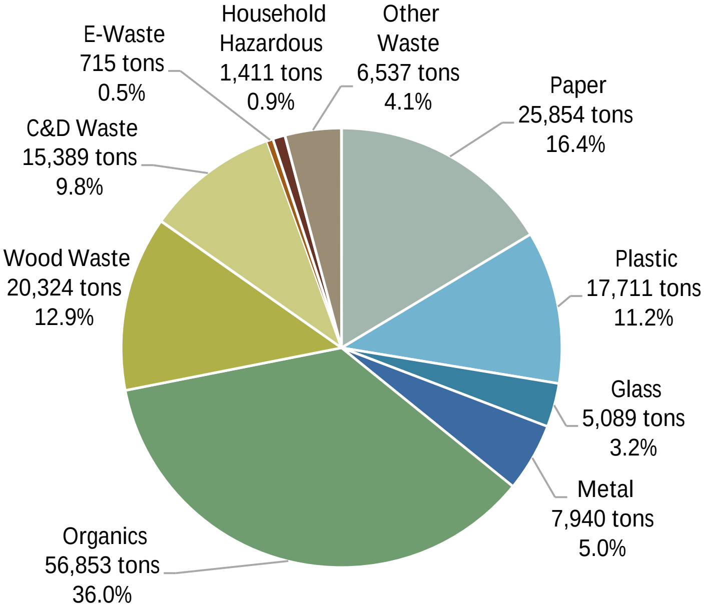
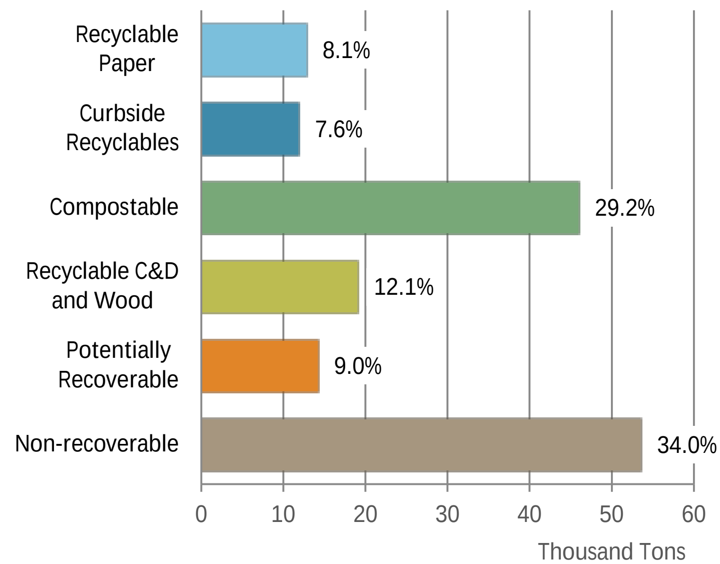


Figure 3-2. Summary of Recoverability of Overall Disposed Waste



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	Material	Est. Percent	+ / -	Est. Tons
Paper	**16.4%**		**25,854**	**Wood Waste**	**12.9%**		**20,324**
Newspaper	1.1%	0.2%	1,704	Dimensional Lumber	4.5%	1.3%	7,051
Uncoated OCC/Kraft Paper	2.8%	0.6%	4,498	Pallets and Crates	1.9%	1.1%	3,048
High-grade Paper	0.9%	0.2%	1,395	Engineered Wood	1.8%	0.9%	2,899
Low-grade Paper	3.3%	0.5%	5,264	Other Untreated Wood	0.5%	0.3%	730
Waxed OCC	0.2%	0.2%	285	Painted Wood	2.4%	0.7%	3,807
Pizza Boxes	0.2%	0.0%	237	Treated Wood	1.0%	0.4%	1,526
Compostable/Soiled Paper	4.2%	0.5%	6,571	Remainder/Composite Wood	0.8%	0.4%	1,264
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	**C&D Waste**	**9.8%**		**15,389**
Remainder/Composite Paper	2.7%	1.0%	4,294	Concrete	0.8%	0.4%	1,341
				Clean Drywall	0.2%	0.2%	362
Plastic	**11.2%**		**17,711**	Other Drywall	1.3%	0.4%	1,982
#1 PET Bottles	0.9%	0.4%	1,404	Asphalt Paving	0.0%	0.0%	19
#2 HDPE Bottles	0.4%	0.1%	610	Asphalt Shingles	0.5%	0.4%	855
#1-#7 Other Containers	0.7%	0.1%	1,099	Other Asphalt Roofing	0.5%	0.4%	845
Expanded Polystyrene Food grade	0.3%	0.1%	501	Insulation	0.1%	0.1%	213
Expanded Polystyrene Non-food Grade	0.2%	0.1%	253	Carpet	1.2%	0.5%	1,844
Pot. Comp. Single-use Food Service Plastic	0.2%	0.1%	243	Carpet Padding	0.2%	0.1%	286
Non-comp. Single-use Food Service Plastic	0.3%	0.1%	473	Soil, Rocks, and Sand	1.4%	0.7%	2,131
Clean Shopping/Dry Cleaning Bags	0.3%	0.0%	534	Ceramics and Brick	0.4%	0.3%	683
Other Clean PE Film	0.7%	0.4%	1,055	Remainder/Composite Construction	3.1%	1.5%	4,829
Other Film	3.9%	0.4%	6,078				
Durable Plastic Products	1.6%	0.5%	2,451	**E-Waste**	**0.5%**		**715**
Remainder/Composite Plastics	1.9%	0.9%	3,011	Televisions and CRTs	0.3%	0.4%	520
				Computers and Flat Monitors	0.0%	0.0%	60
Glass	**3.2%**		**5,089**	Computer Peripherals	0.0%	0.0%	11
Clear Glass Containers	0.9%	0.2%	1,444	Other Consumer Electronics	0.1%	0.1%	123
Green Glass Containers	0.3%	0.1%	487				
Brown Glass Containers	0.6%	0.2%	1,021	**Household Hazardous**	**0.9%**		**1,411**
Plate Glass	0.3%	0.3%	483	Pesticides and Herbicides	0.0%	0.0%	4
Remainder/Composite Glass	1.0%	0.6%	1,653	Fluorescent Lighting	0.0%	0.0%	4
				Asbestos	0.0%	0.0%	0
Metal	**5.0%**		**7,940**	Paints, Solvents, and Adhesives	0.1%	0.1%	119
Aluminum Beverage Cans	0.3%	0.1%	449	Dry-cell Batteries	0.0%	0.0%	65
Aluminum Foil/Containers	0.1%	0.0%	208	Wet-cell Batteries	0.0%	0.0%	15
Other Non-ferrous	0.4%	0.2%	669	Gasoline/Kerosene	0.0%	0.0%	5
Tin Food Cans	0.4%	0.1%	613	Motor Oil	0.0%	0.0%	5
Empty Aerosol Cans	0.2%	0.1%	239	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.4%	0.4%	571	Medical Wastes	0.7%	0.8%	1,063
Oil Filters	0.0%	0.0%	36	Pharmaceuticals	0.0%	0.0%	18
Other Ferrous	2.0%	0.7%	3,092	House Cleaners and Chemicals	0.1%	0.1%	104
Remainder/Composite Metal	1.3%	0.5%	2,064	Other Potentially Hazardous	0.0%	0.0%	9
Organics	**36.0%**		**56,853**	**Other Waste**	**4.1%**		**6,537**
Food Waste, Vegetative	12.6%	1.2%	19,815	Furniture	2.3%	1.1%	3,566
Other Food Waste	5.3%	0.7%	8,338	Tires	0.0%	0.0%	10
Leaves and Grass	4.3%	1.2%	6,774	Mattresses	1.4%	1.2%	2,188
Prunings and Trimmings	1.6%	0.8%	2,562	Non-distinct Fines	0.5%	0.3%	773
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	**Totals**	**100.0%**		**157,824**
Remainder/Composite Organic	1.4%	0.7%	2,179	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**

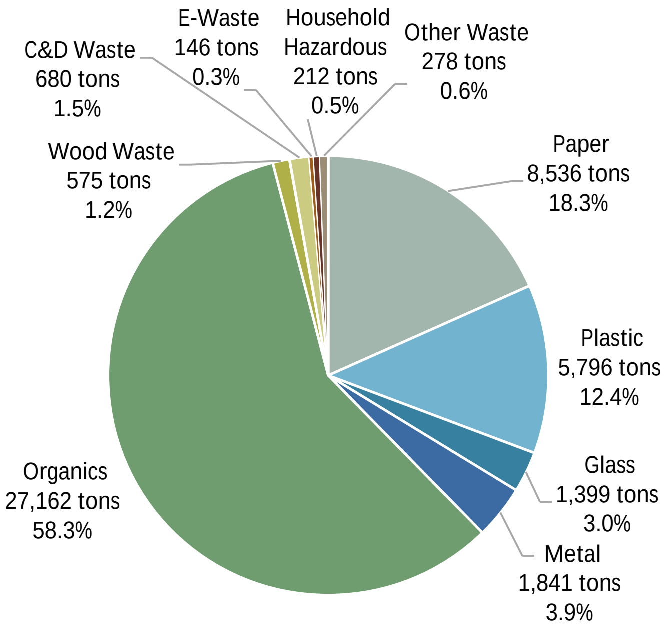
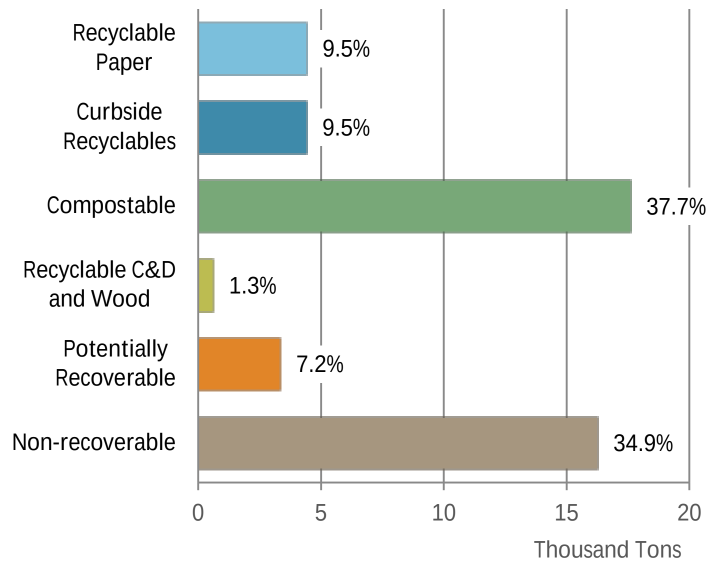


Figure 3-4. Summary of Recoverability of Overall Residential Disposed Waste



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	Material	Est. Percent	+ / -	Est. Tons
Paper	**18.3%**		**8,536**	**Wood Waste**	**1.2%**		**575**
Newspaper	1.6%	0.3%	739	Dimensional Lumber	0.3%	0.1%	117
Uncoated OCC/Kraft Paper	1.7%	0.3%	803	Pallets and Crates	0.0%	0.0%	0
High-grade Paper	1.1%	0.3%	496	Engineered Wood	0.1%	0.1%	50
Low-grade Paper	5.1%	0.4%	2,375	Other Untreated Wood	0.2%	0.1%	87
Waxed OCC	0.0%	0.0%	4	Painted Wood	0.4%	0.2%	172
Pizza Boxes	0.3%	0.1%	150	Treated Wood	0.1%	0.1%	62
Compostable/Soiled Paper	6.0%	0.5%	2,794	Remainder/Composite Wood	0.2%	0.2%	87
Pot. Comp. Single-use Food Service Paper	1.0%	0.2%	446				
Non-comp. Single-use Food Service Paper	0.5%	0.1%	222	**C&D Waste**	**1.5%**		**680**
Remainder/Composite Paper	1.1%	0.2%	509	Concrete	0.0%	0.0%	0
				Clean Drywall	0.0%	0.0%	0
Plastic	**12.4%**		**5,796**	Other Drywall	0.3%	0.4%	140
#1 PET Bottles	1.1%	0.1%	529	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.6%	0.1%	293	Asphalt Shingles	0.1%	0.2%	65
#1-#7 Other Containers	1.4%	0.2%	630	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.6%	0.1%	261	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.1%	0.0%	50	Carpet	0.2%	0.1%	89
Pot. Comp. Single-use Food Service Plastic	0.2%	0.0%	73	Carpet Padding	0.1%	0.1%	37
Non-comp. Single-use Food Service Plastic	0.3%	0.1%	146	Soil, Rocks, and Sand	0.4%	0.4%	207
Clean Shopping/Dry Cleaning Bags	0.8%	0.1%	394	Ceramics and Brick	0.2%	0.1%	80
Other Clean PE Film	0.1%	0.0%	24	Remainder/Composite Construction	0.1%	0.1%	62
Other Film	5.3%	0.4%	2,467				
Durable Plastic Products	1.1%	0.2%	531	**E-Waste**	**0.3%**		**146**
Remainder/Composite Plastics	0.9%	0.3%	399	Televisions and CRTs	0.1%	0.2%	60
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**3.0%**		**1,399**	Computer Peripherals	0.0%	0.0%	11
Clear Glass Containers	1.3%	0.2%	595	Other Consumer Electronics	0.2%	0.1%	75
Green Glass Containers	0.5%	0.1%	229				
Brown Glass Containers	0.8%	0.2%	381	**Household Hazardous**	**0.5%**		**212**
Plate Glass	0.0%	0.0%	9	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.4%	0.1%	185	Fluorescent Lighting	0.0%	0.0%	4
				Asbestos	0.0%	0.0%	0
Metal	**3.9%**		**1,841**	Paints, Solvents, and Adhesives	0.2%	0.2%	114
Aluminum Beverage Cans	0.4%	0.1%	207	Dry-cell Batteries	0.0%	0.0%	19
Aluminum Foil/Containers	0.3%	0.1%	147	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.2%	0.1%	93	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.8%	0.1%	360	Motor Oil	0.0%	0.0%	5
Empty Aerosol Cans	0.2%	0.1%	80	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.3%	0.5%	133	Medical Wastes	0.1%	0.1%	28
Oil Filters	0.0%	0.0%	4	Pharmaceuticals	0.0%	0.0%	9
Other Ferrous	1.0%	0.3%	454	House Cleaners and Chemicals	0.1%	0.0%	33
Remainder/Composite Metal	0.8%	0.2%	363	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**58.3%**		**27,162**	**Other Waste**	**0.6%**		**278**
Food Waste, Vegetative	19.3%	1.0%	8,997	Furniture	0.1%	0.1%	41
Other Food Waste	8.8%	1.0%	4,121	Tires	0.0%	0.0%	5
Leaves and Grass	2.1%	0.9%	979	Mattresses	0.1%	0.1%	31
Prunings and Trimmings	0.0%	0.0%	11	Non-distinct Fines	0.4%	0.2%	201
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	**Totals**	**100.0%**		**46,625**
Remainder/Composite Organic	1.2%	0.3%	541	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

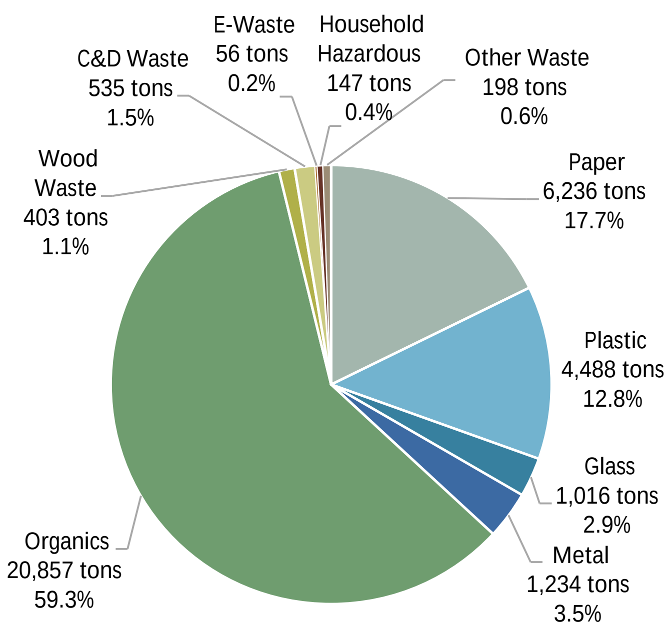
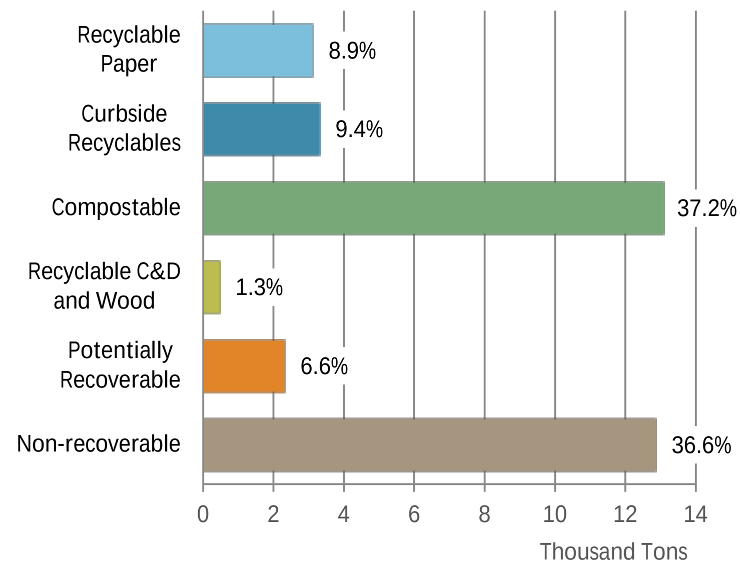


Figure 3-6. Summary of Recoverability of Single-family Residential Disposed Waste



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

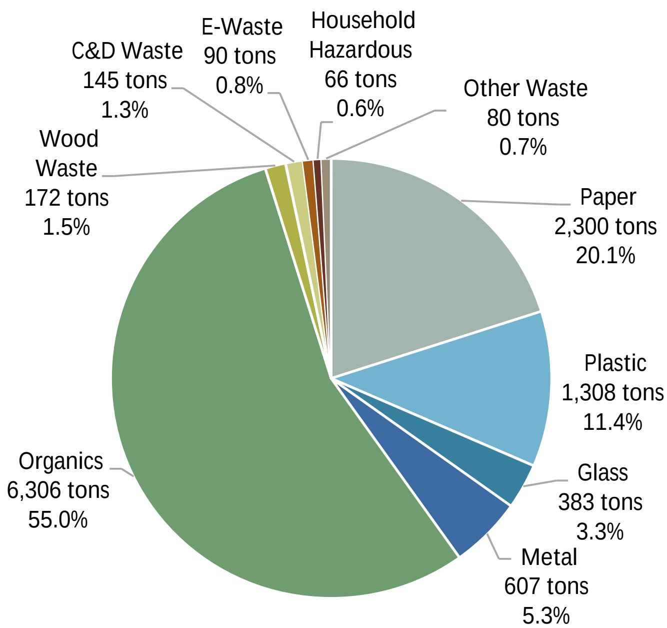


Figure 3-8. Summary of Recoverability of Multifamily Residential Disposed Waste

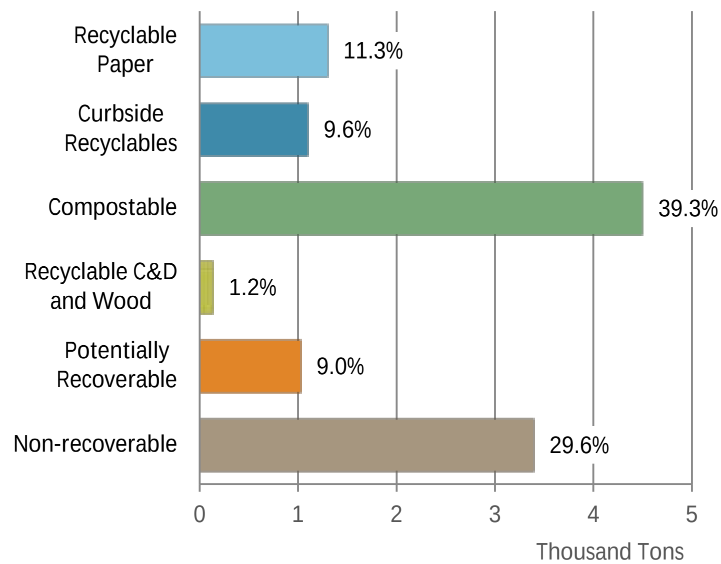


Table 3-12 shows that the largest *material type*, *food waste, vegetative,* constituted nearly one-fifth (19.4%) of the multifamily residential disposed waste by weight. The other two largest *material types* found in multifamily waste were *disposable diapers* (10.6%) and *other food waste* (8.6%).

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

Material	Est. Percent	+ / -	Est. Tons
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

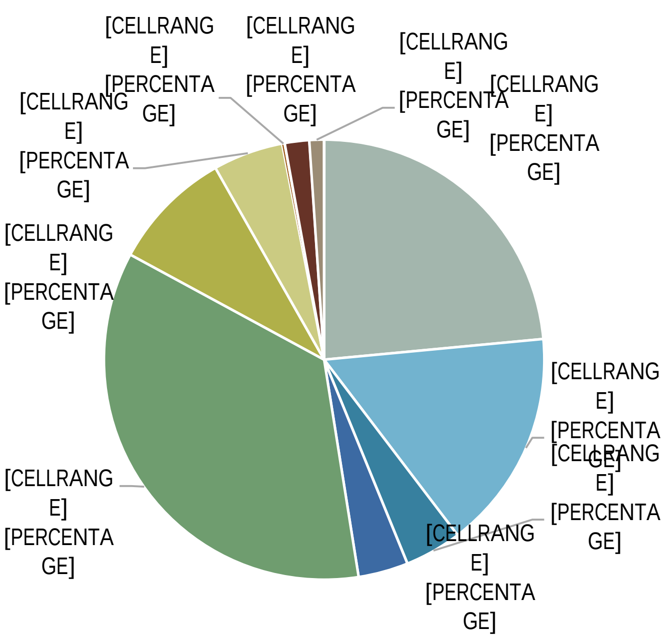


Figure 3-10. Summary of Recoverability of Overall Commercial Disposed Waste

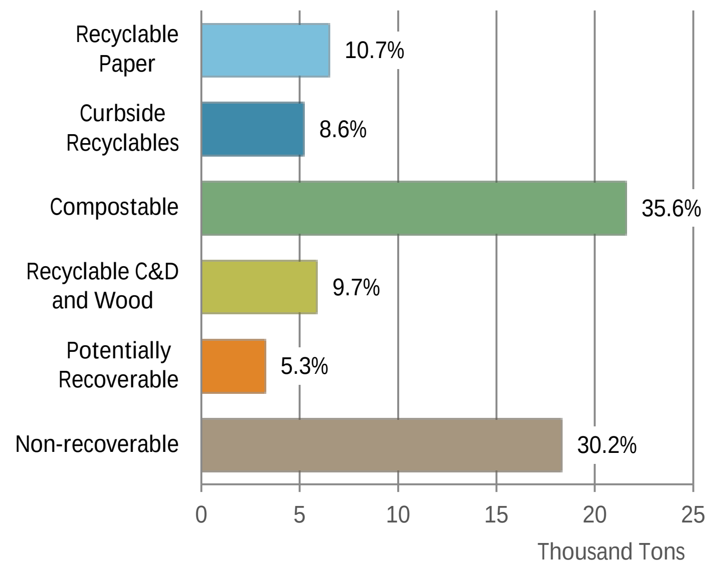


Table 3-14 demonstrates the the ten most prevalent *material types* in the overall commercial substream. *Food waste, vegetative* and *other food waste* accounted for almost a quarter (23.4%) of the commercial disposed waste by weight.

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

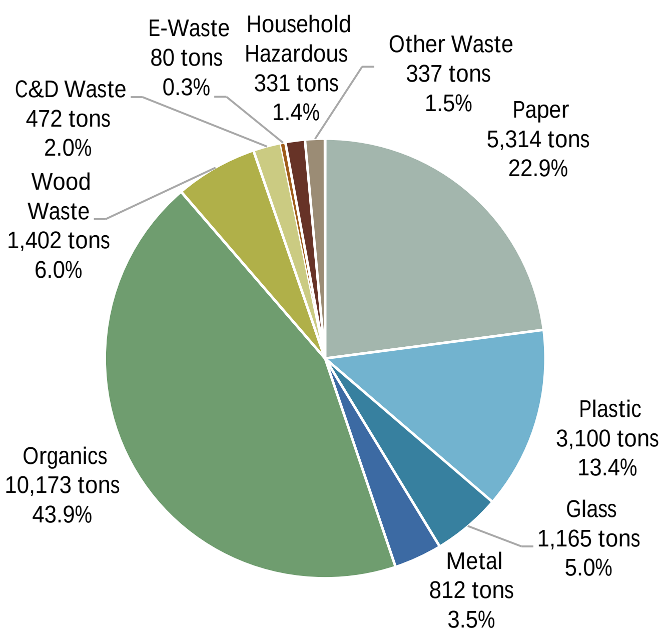
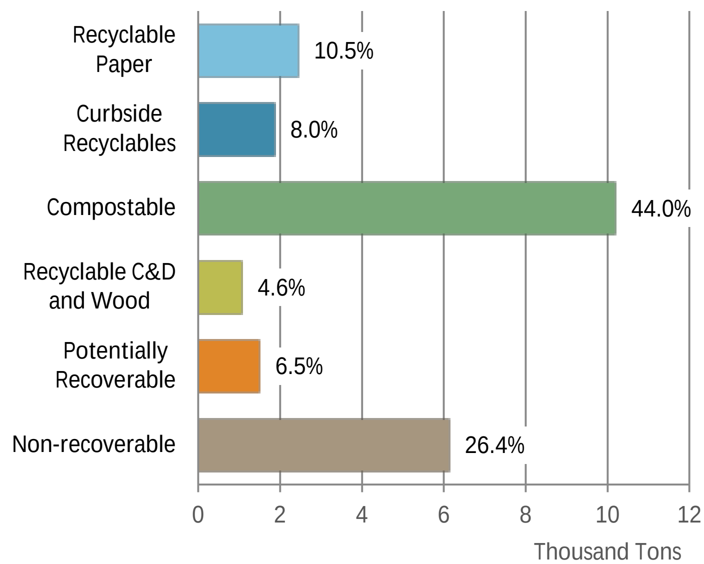


Figure 3-12. Summary of Recoverability of Commercial Packer Disposed Waste



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	Material	Est. Percent	+ / -	Est. Tons
Paper	**22.9%**		**5,314**	**Wood Waste**	**6.0%**		**1,402**
Newspaper	1.1%	0.5%	261	Dimensional Lumber	1.6%	1.9%	373
Uncoated OCC/Kraft Paper	3.8%	1.1%	888	Pallets and Crates	0.5%	0.8%	115
High-grade Paper	1.1%	0.6%	265	Engineered Wood	1.3%	1.2%	297
Low-grade Paper	4.4%	1.3%	1,027	Other Untreated Wood	0.0%	0.0%	6
Waxed OCC	0.7%	1.0%	151	Painted Wood	1.9%	2.3%	442
Pizza Boxes	0.2%	0.1%	42	Treated Wood	0.4%	0.4%	98
Compostable/Soiled Paper	6.4%	1.8%	1,488	Remainder/Composite Wood	0.3%	0.3%	71
Pot. Comp. Single-use Food Service Paper	1.0%	0.4%	232				
Non-comp. Single-use Food Service Paper	0.7%	0.6%	165	**C&D Waste**	**2.0%**		**472**
Remainder/Composite Paper	3.4%	2.4%	794	Concrete	0.6%	0.7%	142
				Clean Drywall	0.0%	0.0%	0
Plastic	**13.4%**		**3,100**	Other Drywall	0.7%	1.0%	164
#1 PET Bottles	0.7%	0.2%	174	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.6%	0.2%	140	Asphalt Shingles	0.0%	0.0%	0
#1-#7 Other Containers	0.8%	0.4%	185	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.3%	0.2%	68	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.2%	0.1%	50	Carpet	0.1%	0.2%	33
Pot. Comp. Single-use Food Service Plastic	0.2%	0.1%	41	Carpet Padding	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.6%	0.2%	132	Soil, Rocks, and Sand	0.6%	0.7%	132
Clean Shopping/Dry Cleaning Bags	0.3%	0.1%	58	Ceramics and Brick	0.0%	0.0%	0
Other Clean PE Film	1.5%	1.1%	355	Remainder/Composite Construction	0.0%	0.0%	0
Other Film	5.9%	1.3%	1,364				
Durable Plastic Products	0.9%	0.5%	214	**E-Waste**	**0.3%**		**80**
Remainder/Composite Plastics	1.4%	0.6%	321	Televisions and CRTs	0.1%	0.1%	16
				Computers and Flat Monitors	0.3%	0.3%	60
Glass	**5.0%**		**1,165**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	1.4%	0.7%	318	Other Consumer Electronics	0.0%	0.0%	4
Green Glass Containers	0.5%	0.3%	114				
Brown Glass Containers	1.0%	0.8%	231	**Household Hazardous**	**1.4%**		**331**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	2.2%	2.9%	502	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**3.5%**		**812**	Paints, Solvents, and Adhesives	0.0%	0.0%	6
Aluminum Beverage Cans	0.4%	0.1%	82	Dry-cell Batteries	0.0%	0.0%	2
Aluminum Foil/Containers	0.1%	0.1%	31	Wet-cell Batteries	0.1%	0.1%	15
Other Non-ferrous	0.0%	0.0%	4	Gasoline/Kerosene	0.0%	0.0%	5
Tin Food Cans	0.6%	0.3%	132	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.2%	0.1%	40	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	1.2%	1.3%	272
Oil filters	0.0%	0.1%	9	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	1.5%	1.0%	352	House Cleaners and Chemicals	0.1%	0.1%	22
Remainder/Composite Metal	0.7%	0.4%	162	Other Potentially Hazardous	0.0%	0.1%	9
Organics	**43.9%**		**10,173**	**Other Waste**	**1.5%**		**337**
Food Waste, Vegetative	20.3%	3.8%	4,698	Furniture	0.0%	0.0%	0
Other Food Waste	8.2%	2.4%	1,911	Tires	0.0%	0.0%	0
Leaves and Grass	6.7%	4.9%	1,553	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.2%	0.3%	44	Non-distinct Fines	1.5%	1.7%	337
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	**Totals**	**100.0%**		**23,186**
Remainder/Composite Organic	1.4%	0.5%	314	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

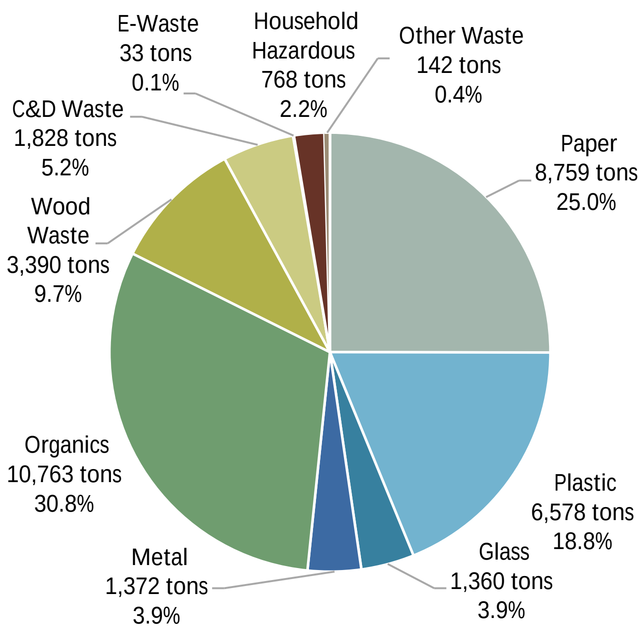
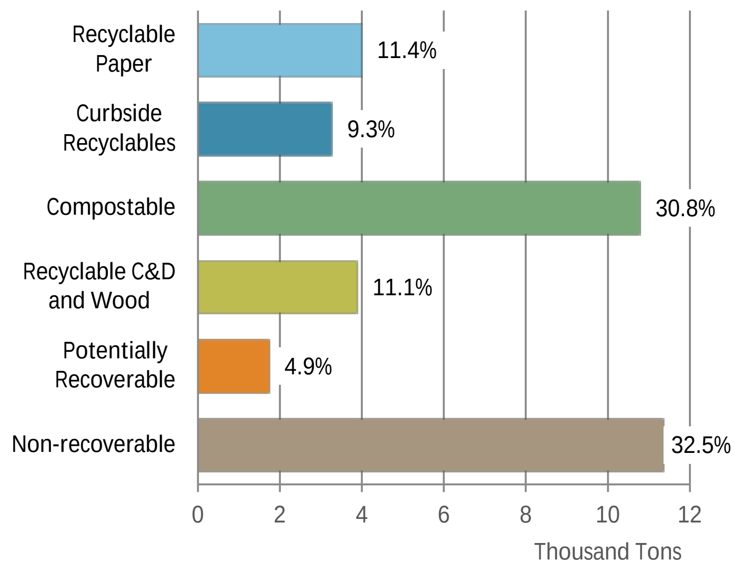


Figure 3-14. Summary of Recoverability of Commercial Roll-Off Disposed Waste



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	Material	Est. Percent	+ / -	Est. Tons
Paper	**25.0%**		**8,759**	**Wood Waste**	**9.7%**		**3,390**
Newspaper	1.5%	0.8%	523	Dimensional Lumber	3.4%	4.3%	1,195
Uncoated OCC/Kraft Paper	3.9%	1.4%	1,360	Pallets and Crates	3.5%	4.4%	1,207
High-grade Paper	1.6%	1.0%	568	Engineered Wood	1.6%	1.7%	555
Low-grade Paper	4.4%	1.7%	1,535	Other Untreated Wood	0.1%	0.1%	27
Waxed OCC	0.2%	0.4%	87	Painted Wood	0.8%	1.0%	270
Pizza Boxes	0.1%	0.1%	25	Treated Wood	0.2%	0.4%	79
Compostable/Soiled Paper	6.0%	1.8%	2,096	Remainder/Composite Wood	0.2%	0.3%	58
Pot. Comp. Single-use Food Service Paper	1.0%	0.6%	367				
Non-comp. Single-use Food Service Paper	0.4%	0.2%	124	**C&D Waste**	**5.2%**		**1,828**
Remainder/Composite Paper	5.9%	3.6%	2,076	Concrete	0.0%	0.0%	0
				Clean Drywall	0.0%	0.0%	0
Plastic	**18.8%**		**6,578**	Other Drywall	0.0%	0.0%	0
#1 PET Bottles	1.9%	1.6%	662	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.5%	0.3%	158	Asphalt Shingles	1.3%	1.8%	445
#1-#7 Other Containers	0.7%	0.2%	236	Other Asphalt Roofing	0.0%	0.0%	3
Expanded Polystyrene Food grade	0.5%	0.2%	166	Insulation	0.2%	0.4%	75
Expanded Polystyrene Non-food Grade	0.3%	0.3%	89	Carpet	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	0.4%	0.5%	124	Carpet Padding	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.5%	0.3%	191	Soil, Rocks, and Sand	1.3%	1.8%	449
Clean Shopping/Dry Cleaning Bags	0.2%	0.1%	77	Ceramics and Brick	0.0%	0.0%	0
Other Clean PE Film	1.9%	1.8%	660	Remainder/Composite Construction	2.4%	3.1%	856
Other Film	5.3%	1.1%	1,869				
Durable Plastic Products	2.2%	1.4%	781	**E-Waste**	**0.1%**		**33**
Remainder/Composite Plastics	4.5%	3.7%	1,565	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**3.9%**		**1,360**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	1.4%	1.0%	491	Other Consumer Electronics	0.1%	0.2%	33
Green Glass Containers	0.4%	0.3%	136				
Brown Glass Containers	1.1%	0.9%	369	**Household Hazardous**	**2.2%**		**768**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	1.0%	1.6%	364	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**3.9%**		**1,372**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.4%	0.2%	147	Dry-cell Batteries	0.0%	0.0%	5
Aluminum Foil/Containers	0.1%	0.0%	27	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.0%	0.1%	16	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.2%	0.1%	71	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.2%	0.3%	74	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	2.2%	3.5%	762
Oil filters	0.0%	0.0%	9	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	2.3%	1.8%	791	House Cleaners and Chemicals	0.0%	0.0%	0
Remainder/Composite Metal	0.7%	0.5%	236	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**30.8%**		**10,763**	**Other Waste**	**0.4%**		**142**
Food Waste, Vegetative	15.3%	4.7%	5,338	Furniture	0.0%	0.0%	0
Other Food Waste	5.5%	2.4%	1,937	Tires	0.0%	0.0%	0
Leaves and Grass	2.3%	1.8%	805	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.0%	0.0%	2	Non-distinct Fines	0.4%	0.5%	142
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	**Totals**	**100.0%**		**34,992**
Remainder/Composite Organic	3.5%	2.9%	1,231	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

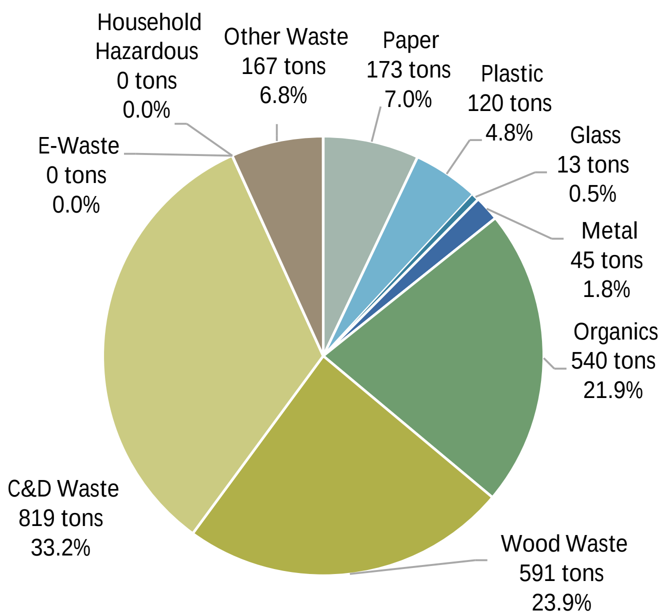
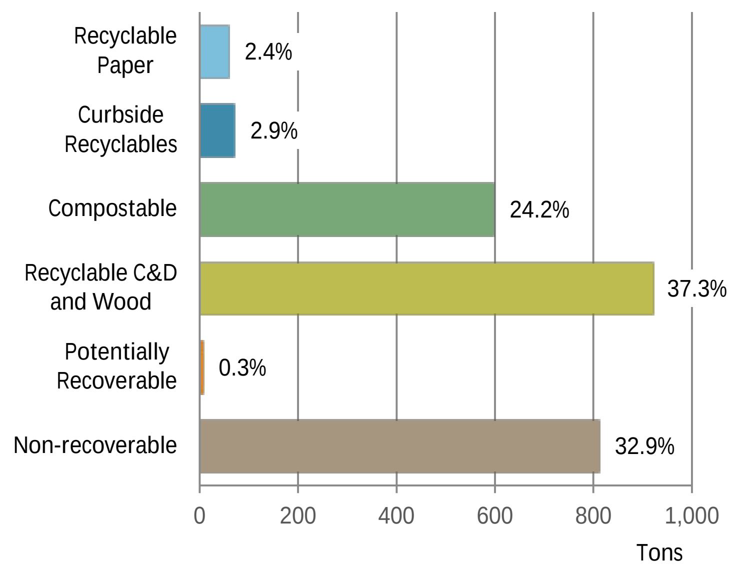


Figure 3-16. Summary of Recoverability of School Disposed Waste



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	Material	Est. Percent	+ / -	Est. Tons
Paper	**7.0%**		**173**	**Wood Waste**	**23.9%**		**591**
Newspaper	0.0%	0.0%	0	Dimensional Lumber	6.1%	0.8%	150
Uncoated OCC/Kraft Paper	0.7%	0.5%	17	Pallets and Crates	0.0%	0.0%	0
High-grade Paper	0.3%	0.3%	8	Engineered Wood	0.0%	0.0%	0
Low-grade Paper	1.4%	1.1%	34	Other Untreated Wood	8.2%	1.0%	201
Waxed OCC	0.0%	0.0%	0	Painted Wood	9.7%	1.3%	239
Pizza Boxes	0.1%	0.1%	3	Treated Wood	0.0%	0.0%	0
Compostable/Soiled Paper	2.2%	1.6%	53	Remainder/Composite Wood	0.0%	0.1%	1
Pot. Comp. Single-use Food Service Paper	0.6%	0.7%	14				
Non-comp. Single-use Food Service Paper	0.5%	0.7%	12	**C&D Waste**	**33.2%**		**819**
Remainder/Composite Paper	1.3%	1.1%	32	Concrete	11.0%	14.2%	270
				Clean Drywall	0.0%	0.0%	0
Plastic	**4.8%**		**120**	Other Drywall	9.9%	1.3%	243
#1 PET Bottles	0.2%	0.2%	5	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.1%	0.2%	3	Asphalt Shingles	0.0%	0.0%	0
#1-#7 Other Containers	0.3%	0.3%	7	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.0%	0.0%	0	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.0%	0.0%	1	Carpet	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	0.1%	0.2%	3	Carpet Padding	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.0%	0.1%	1	Soil, Rocks, and Sand	12.1%	15.9%	300
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	1	Ceramics and Brick	0.0%	0.0%	0
Other Clean PE Film	0.0%	0.0%	0	Remainder/Composite Construction	0.2%	0.1%	5
Other Film	1.6%	1.2%	39				
Durable Plastic Products	2.1%	1.9%	52	**E-Waste**	**0.0%**		**0**
Remainder/Composite Plastics	0.3%	0.3%	7	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**0.5%**		**13**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	0.2%	0.2%	4	Other Consumer Electronics	0.0%	0.0%	0
Green Glass Containers	0.1%	0.1%	2				
Brown Glass Containers	0.2%	0.2%	4	**Household Hazardous**	**0.0%**		**0**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.1%	0.2%	2	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**1.8%**		**45**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.0%	0.0%	1	Dry-cell Batteries	0.0%	0.0%	0
Aluminum Foil/Containers	0.0%	0.0%	1	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	1.6%	2.1%	39	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.1%	0.1%	3	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.0%	0.0%	0	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	0.0%	0.0%	1	House Cleaners and Chemicals	0.0%	0.0%	0
Remainder/Composite Metal	0.0%	0.0%	0	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**21.9%**		**540**	**Other Waste**	**6.8%**		**167**
Food Waste, Vegetative	4.5%	3.5%	110	Furniture	6.7%	3.6%	166
Other Food Waste	7.6%	5.8%	187	Tires	0.0%	0.0%	0
Leaves and Grass	9.2%	11.6%	227	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.0%	0.0%	0	Non-distinct Fines	0.0%	0.1%	1
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	**Totals**	**100.0%**		**2,468**
Remainder/Composite Organic	0.1%	0.1%	2	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**

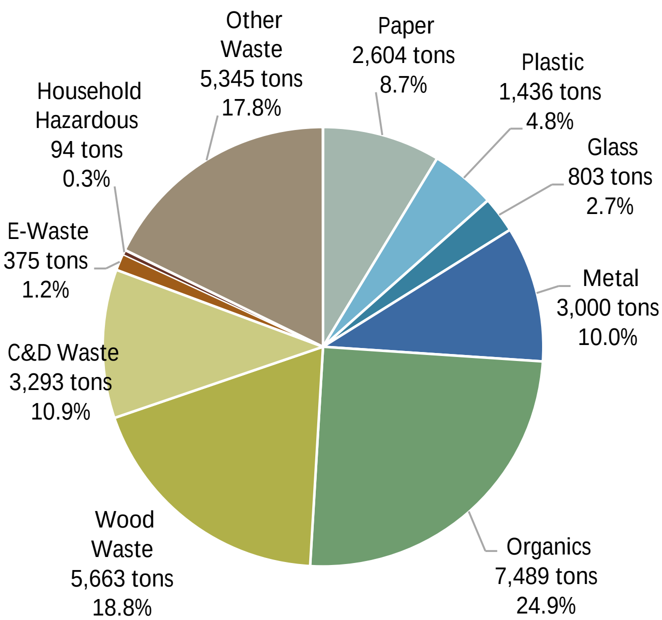
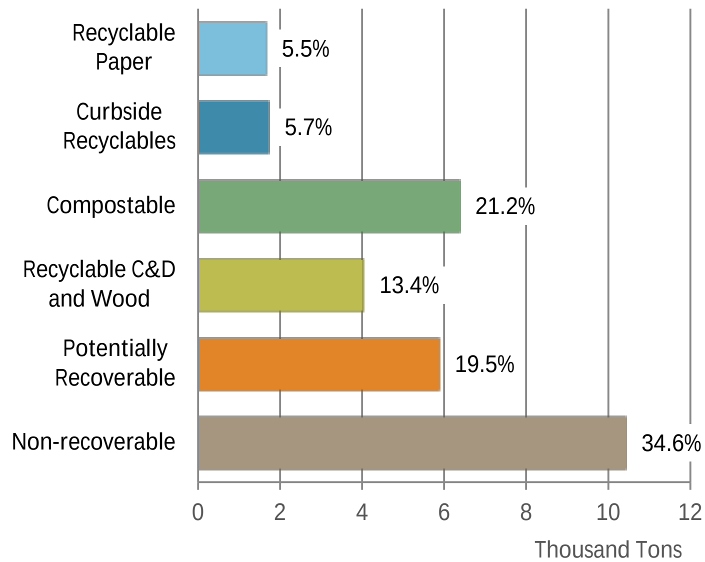


Figure 3-18. Summary of Recoverability of Overall Self-haul Disposed Waste



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	Material	Est. Percent	+ / -	Est. Tons
Paper	**8.7%**		**2,604**	**Wood Waste**	**18.8%**		**5,663**
Newspaper	0.6%	0.4%	179	Dimensional Lumber	7.1%	2.9%	2,134
Uncoated OCC/Kraft Paper	3.9%	2.8%	1,166	Pallets and Crates	0.6%	0.7%	176
High-grade Paper	0.2%	0.1%	53	Engineered Wood	3.1%	2.5%	928
Low-grade Paper	0.9%	0.4%	262	Other Untreated Wood	0.3%	0.3%	84
Waxed OCC	0.1%	0.2%	42	Painted Wood	3.4%	2.0%	1,020
Pizza Boxes	0.1%	0.0%	19	Treated Wood	1.7%	1.6%	511
Compostable/Soiled Paper	0.4%	0.2%	111	Remainder/Composite Wood	2.7%	1.9%	810
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	7				
Non-comp. Single-use Food Service Paper	0.1%	0.0%	18	**C&D Waste**	**10.9%**		**3,293**
Remainder/Composite Paper	2.5%	1.9%	748	Concrete	1.2%	1.1%	368
				Clean Drywall	0.3%	0.5%	89
Plastic	**4.8%**		**1,436**	Other Drywall	0.8%	0.8%	235
#1 PET Bottles	0.1%	0.1%	32	Asphalt Paving	0.0%	0.0%	2
#2 HDPE Bottles	0.0%	0.0%	14	Asphalt Shingles	0.1%	0.2%	40
#1-#7 Other Containers	0.1%	0.1%	26	Other Asphalt Roofing	0.0%	0.1%	13
Expanded Polystyrene Food grade	0.0%	0.0%	3	Insulation	0.1%	0.2%	38
Expanded Polystyrene Non-food Grade	0.0%	0.0%	6	Carpet	3.2%	2.5%	954
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	2	Carpet Padding	0.2%	0.3%	64
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	3	Soil, Rocks, and Sand	0.7%	0.8%	216
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	2	Ceramics and Brick	0.0%	0.0%	0
Other Clean PE Film	0.0%	0.0%	1	Remainder/Composite Construction	4.2%	4.4%	1,274
Other Film	0.6%	0.4%	186				
Durable Plastic Products	2.2%	1.5%	670	**E-Waste**	**1.2%**		**375**
Remainder/Composite Plastics	1.6%	1.1%	490	Televisions and CRTs	1.2%	1.9%	371
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**2.7%**		**803**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	0.1%	0.1%	34	Other Consumer Electronics	0.0%	0.0%	4
Green Glass Containers	0.0%	0.0%	6				
Brown Glass Containers	0.1%	0.1%	34	**Household Hazardous**	**0.3%**		**94**
Plate Glass	1.4%	1.3%	431	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	1.0%	0.8%	298	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**10.0%**		**3,000**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.0%	0.0%	10	Dry-cell Batteries	0.1%	0.2%	38
Aluminum Foil/Containers	0.0%	0.0%	2	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	1.4%	1.2%	412	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.1%	0.1%	30	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.1%	0.2%	44	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	1.4%	1.7%	436	Medical Wastes	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.0%	0.0%	8
Other Ferrous	3.5%	2.2%	1,041	House Cleaners and Chemicals	0.2%	0.2%	48
Remainder/Composite Metal	3.4%	2.4%	1,025	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**24.9%**		**7,489**	**Other Waste**	**17.8%**		**5,345**
Food Waste, Vegetative	2.2%	1.3%	665	Furniture	10.9%	5.8%	3,281
Other Food Waste	0.6%	0.4%	172	Tires	0.0%	0.0%	0
Leaves and Grass	9.5%	4.4%	2,867	Mattresses	6.6%	6.0%	1,987
Prunings and Trimmings	8.0%	4.2%	2,415	Non-distinct Fines	0.3%	0.3%	76
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	**Totals**	**100.0%**		**30,103**
Remainder/Composite Organic	0.2%	0.1%	72	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

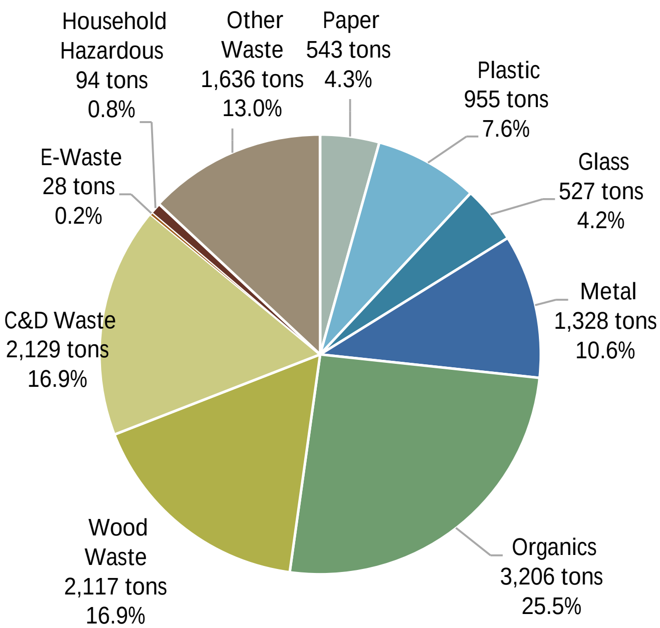
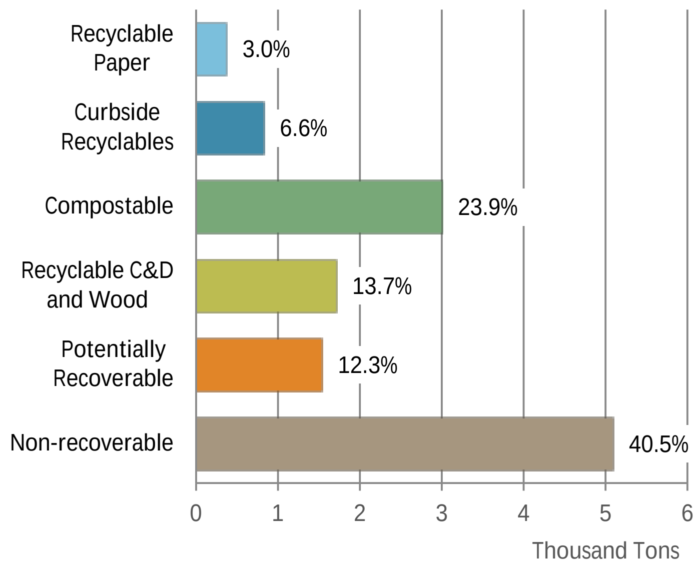


Figure 3-20. Summary of Recoverability of Residential Self-haul Disposed Waste



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	Material	Est. Percent	+ / -	Est. Tons
Paper	**4.3%**		**543**	**Wood Waste**	**16.9%**		**2,117**
Newspaper	0.7%	0.8%	93	Dimensional Lumber	8.2%	5.5%	1,035
Uncoated OCC/Kraft Paper	0.9%	0.6%	118	Pallets and Crates	0.8%	1.2%	101
High-grade Paper	0.2%	0.1%	24	Engineered Wood	0.7%	0.6%	84
Low-grade Paper	1.1%	0.7%	141	Other Untreated Wood	0.1%	0.1%	7
Waxed OCC	0.0%	0.0%	0	Painted Wood	3.0%	3.2%	379
Pizza Boxes	0.0%	0.0%	5	Treated Wood	3.2%	3.7%	402
Compostable/Soiled Paper	0.2%	0.1%	29	Remainder/Composite Wood	0.9%	0.7%	111
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	5				
Non-comp. Single-use Food Service Paper	0.0%	0.0%	3	**C&D Waste**	**16.9%**		**2,129**
Remainder/Composite Paper	1.0%	0.6%	125	Concrete	2.6%	2.6%	321
				Clean Drywall	0.7%	1.2%	89
Plastic	**7.6%**		**955**	Other Drywall	1.4%	1.7%	175
#1 PET Bottles	0.1%	0.1%	18	Asphalt Paving	0.0%	0.0%	2
#2 HDPE Bottles	0.0%	0.0%	6	Asphalt Shingles	0.3%	0.4%	40
#1-#7 Other Containers	0.1%	0.1%	14	Other Asphalt Roofing	0.1%	0.2%	13
Expanded Polystyrene Food grade	0.0%	0.0%	1	Insulation	0.3%	0.5%	37
Expanded Polystyrene Non-food Grade	0.0%	0.0%	1	Carpet	3.1%	3.0%	395
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	1	Carpet Padding	0.4%	0.6%	47
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	1	Soil, Rocks, and Sand	0.3%	0.3%	38
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	0	Ceramics and Brick	0.0%	0.0%	0
Other Clean PE Film	0.0%	0.0%	0	Remainder/Composite Construction	7.7%	10.4%	973
Other Film	0.9%	0.8%	112				
Durable Plastic Products	4.4%	3.5%	550	**E-Waste**	**0.2%**		**28**
Remainder/Composite Plastics	2.0%	2.1%	251	Televisions and CRTs	0.2%	0.3%	24
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**4.2%**		**527**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	0.2%	0.2%	20	Other Consumer Electronics	0.0%	0.0%	4
Green Glass Containers	0.0%	0.0%	0				
Brown Glass Containers	0.2%	0.2%	21	**Household Hazardous**	**0.8%**		**94**
Plate Glass	3.2%	3.1%	406	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.6%	0.9%	80	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**10.6%**		**1,328**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.0%	0.0%	5	Dry-cell Batteries	0.3%	0.4%	38
Aluminum Foil/Containers	0.0%	0.0%	1	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.2%	0.2%	26	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.1%	0.1%	6	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.0%	0.0%	1	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	3.5%	4.1%	436	Medical Wastes	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.1%	0.1%	8
Other Ferrous	5.4%	4.8%	676	House Cleaners and Chemicals	0.4%	0.6%	48
Remainder/Composite Metal	1.4%	1.3%	176	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**25.5%**		**3,206**	**Other Waste**	**13.0%**		**1,636**
Food Waste, Vegetative	2.8%	2.2%	354	Furniture	10.3%	5.7%	1,295
Other Food Waste	0.7%	0.7%	92	Tires	0.0%	0.0%	0
Leaves and Grass	10.7%	5.9%	1,345	Mattresses	2.2%	1.7%	277
Prunings and Trimmings	8.8%	5.9%	1,106	Non-distinct Fines	0.5%	0.7%	64
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	**Totals**	**100.0%**		**12,564**
Remainder/Composite Organic	0.1%	0.1%	7	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

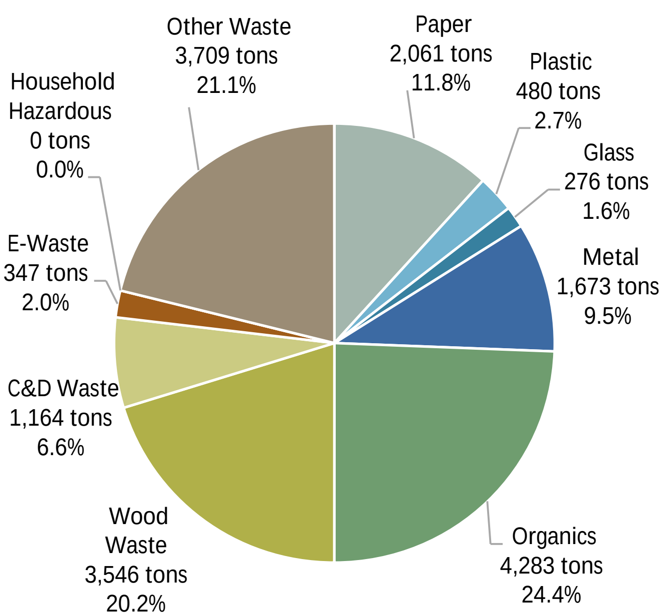
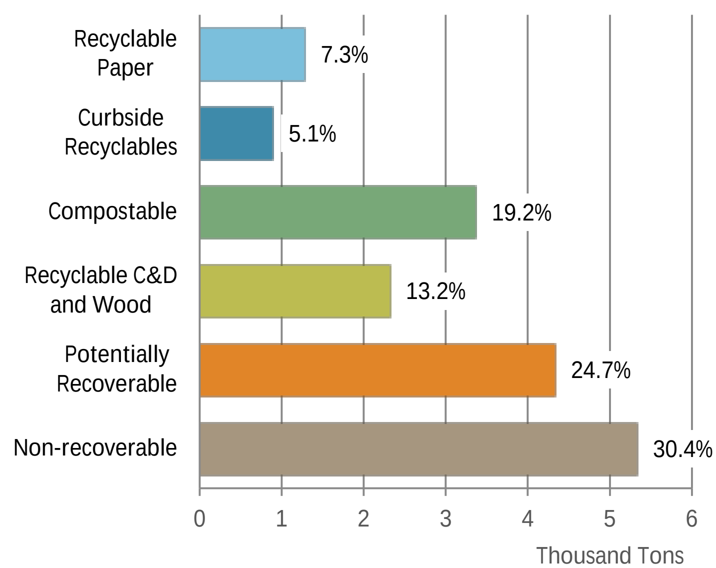


Figure 3-22. Summary of Recoverability of Commercial Self-haul Disposed Waste



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

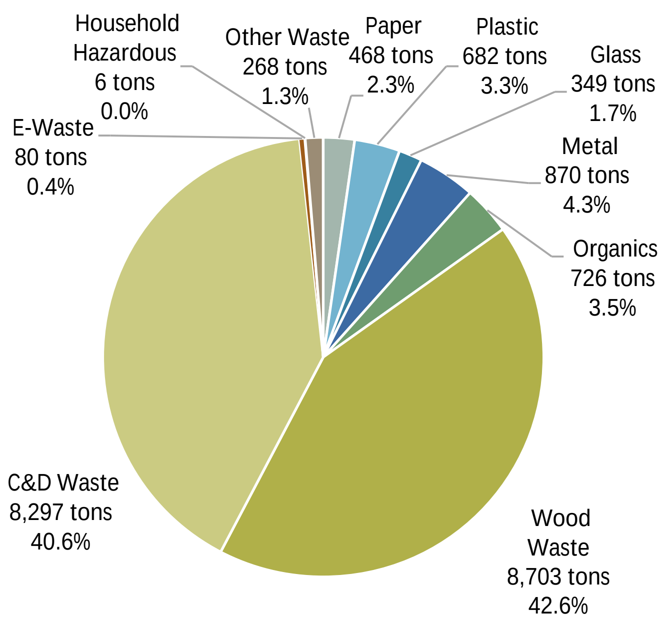


Figure 3-24. Summary of Recoverability of Overall C&D Disposed Waste

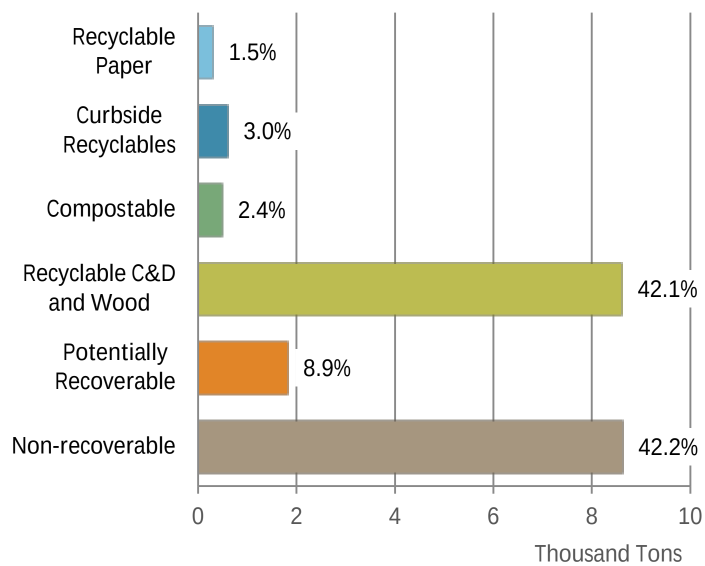


Table 3-28 shows that the three most commonly observed *material types – dimensional lumber, remainder/composite construction,* and *painted wood* – accounted for more than a third (36.1%) of overall C&D disposed waste by weight.

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	Material	Est. Percent	+/-	Est. Tons
Paper	**2.3%**		**468**	**Wood Waste**	**42.6%**		**8,703**
Newspaper	0.0%	0.0%	1	Dimensional Lumber	15.1%	5.0%	3,083
Uncoated OCC/Kraft Paper	1.3%	0.6%	263	Pallets and Crates	7.6%	4.3%	1,550
High-grade Paper	0.0%	0.0%	7	Engineered Wood	5.2%	5.4%	1,069
Low-grade Paper	0.2%	0.2%	31	Other Untreated Wood	1.6%	2.1%	324
Waxed OCC	0.0%	0.0%	0	Painted Wood	8.1%	3.2%	1,665
Pizza Boxes	0.0%	0.0%	0	Treated Wood	3.8%	1.7%	775
Compostable/Soiled Paper	0.1%	0.2%	29	Remainder/Composite Wood	1.2%	0.5%	237
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	1				
Non-comp. Single-use Food Service Paper	0.0%	0.0%	0	**C&D Waste**	**40.6%**		**8,297**
Remainder/Composite Paper	0.7%	0.3%	135	Concrete	2.7%	1.6%	561
				Clean Drywall	1.3%	1.2%	273
Plastic	**3.3%**		**682**	Other Drywall	5.9%	2.1%	1,200
#1 PET Bottles	0.0%	0.0%	3	Asphalt Paving	0.1%	0.1%	18
#2 HDPE Bottles	0.0%	0.0%	1	Asphalt Shingles	1.5%	1.3%	304
#1-#7 Other Containers	0.1%	0.1%	17	Other Asphalt Roofing	4.1%	3.1%	829
Expanded Polystyrene Food grade	0.0%	0.0%	3	Insulation	0.5%	0.7%	100
Expanded Polystyrene Non-food Grade	0.3%	0.4%	57	Carpet	3.8%	1.9%	767
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0	Carpet Padding	0.9%	0.6%	185
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	0	Soil, Rocks, and Sand	4.0%	3.3%	827
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	2	Ceramics and Brick	2.9%	2.1%	602
Other Clean PE Film	0.1%	0.1%	16	Remainder/Composite Construction	12.9%	7.5%	2,632
Other Film	0.7%	0.6%	152				
Durable Plastic Products	1.0%	1.2%	204	**E-Waste**	**0.4%**		**80**
Remainder/Composite Plastics	1.1%	0.9%	228	Televisions and CRTs	0.4%	0.4%	73
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**1.7%**		**349**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	0.0%	0.0%	2	Other Consumer Electronics	0.0%	0.1%	7
Green Glass Containers	0.0%	0.0%	0				
Brown Glass Containers	0.0%	0.0%	3	**Household Hazardous**	**0.0%**		**6**
Plate Glass	0.2%	0.4%	43	Pesticides and Herbicides	0.0%	0.0%	4
Remainder/Composite Glass	1.5%	0.8%	301	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**4.3%**		**870**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.0%	0.0%	2	Dry-cell Batteries	0.0%	0.0%	1
Aluminum Foil/Containers	0.0%	0.0%	0	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.5%	0.4%	105	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.1%	0.1%	15	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.0%	0.0%	0	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	2	Medical Wastes	0.0%	0.0%	0
Oil filters	0.1%	0.1%	13	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	2.2%	2.0%	453	House Cleaners and Chemicals	0.0%	0.0%	0
Remainder/Composite Metal	1.4%	0.6%	278	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**3.5%**		**726**	**Other Waste**	**1.3%**		**268**
Food Waste, Vegetative	0.0%	0.1%	7	Furniture	0.4%	0.3%	78
Other Food Waste	0.0%	0.1%	9	Tires	0.0%	0.0%	5
Leaves and Grass	1.7%	1.9%	343	Mattresses	0.8%	1.2%	169
Prunings and Trimmings	0.4%	0.4%	90	Non-distinct Fines	0.1%	0.1%	15
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	**Totals**	**100.0%**		**20,449**
Remainder/Composite Organic	0.1%	0.1%	20	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

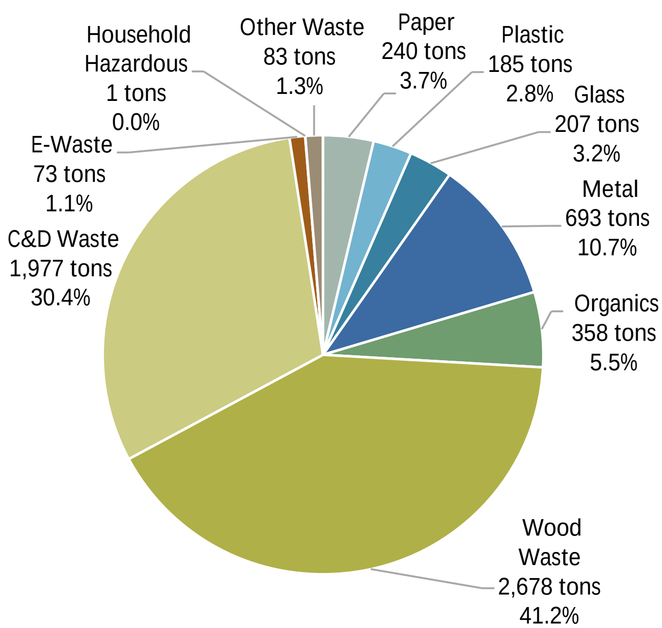
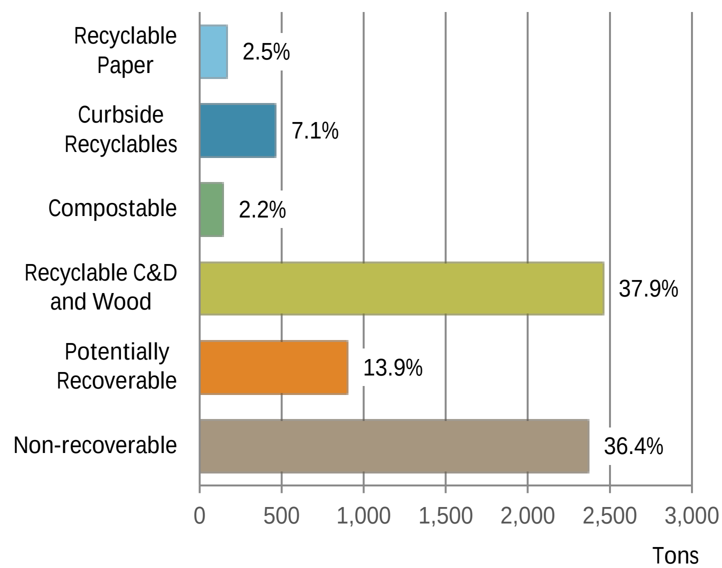


Figure 3-26. Summary of Recoverability of Commercial Roll-off (C&D) Disposed Waste



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	Material	Est. Percent	+ / -	Est. Tons
Paper	**3.7%**		**240**	**Wood Waste**	**41.2%**		**2,678**
Newspaper	0.0%	0.0%	1	Dimensional Lumber	13.2%	7.6%	857
Uncoated OCC/Kraft Paper	2.1%	1.2%	133	Pallets and Crates	8.5%	8.6%	551
High-grade Paper	0.1%	0.1%	5	Engineered Wood	2.7%	1.5%	175
Low-grade Paper	0.4%	0.5%	26	Other Untreated Wood	0.1%	0.1%	8
Waxed OCC	0.0%	0.0%	0	Painted Wood	11.2%	6.7%	730
Pizza Boxes	0.0%	0.0%	0	Treated Wood	3.5%	2.9%	227
Compostable/Soiled Paper	0.4%	0.7%	27	Remainder/Composite Wood	2.0%	1.2%	130
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	0				
Non-comp. Single-use Food Service Paper	0.0%	0.0%	0	**C&D Waste**	**30.4%**		**1,977**
Remainder/Composite Paper	0.7%	0.6%	47	Concrete	3.5%	2.4%	227
				Clean Drywall	0.6%	0.7%	39
Plastic	**2.8%**		**185**	Other Drywall	3.8%	1.7%	248
#1 PET Bottles	0.0%	0.0%	2	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.0%	0.0%	1	Asphalt Shingles	2.3%	2.4%	151
#1-#7 Other Containers	0.0%	0.0%	2	Other Asphalt Roofing	1.9%	2.2%	125
Expanded Polystyrene Food grade	0.0%	0.0%	0	Insulation	0.3%	0.4%	20
Expanded Polystyrene Non-food Grade	0.1%	0.1%	3	Carpet	3.7%	3.0%	242
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0	Carpet Padding	1.3%	1.4%	82
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	0	Soil, Rocks, and Sand	4.9%	5.2%	317
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	0	Ceramics and Brick	2.1%	1.6%	134
Other Clean PE Film	0.2%	0.2%	12	Remainder/Composite Construction	6.0%	3.0%	393
Other Film	0.8%	0.6%	49				
Durable Plastic Products	0.8%	0.7%	49	**E-Waste**	**1.1%**		**73**
Remainder/Composite Plastics	1.0%	1.0%	65	Televisions and CRTs	1.1%	1.2%	73
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**3.2%**		**207**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	0.0%	0.0%	2	Other Consumer Electronics	0.0%	0.0%	0
Green Glass Containers	0.0%	0.0%	0				
Brown Glass Containers	0.0%	0.0%	0	**Household Hazardous**	**0.0%**		**1**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	3.2%	2.1%	205	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**10.7%**		**693**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.0%	0.0%	1	Dry-cell Batteries	0.0%	0.0%	1
Aluminum Foil/Containers	0.0%	0.0%	0	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	1.6%	1.1%	102	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.2%	0.4%	14	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.0%	0.0%	0	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.1%	2	Medical Wastes	0.0%	0.0%	0
Oil filters	0.2%	0.3%	13	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	5.2%	6.1%	336	House Cleaners and Chemicals	0.0%	0.0%	0
Remainder/Composite Metal	3.5%	1.8%	224	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**5.5%**		**358**	**Other Waste**	**1.3%**		**83**
Food Waste, Vegetative	0.1%	0.2%	7	Furniture	0.8%	0.7%	51
Other Food Waste	0.1%	0.1%	6	Tires	0.1%	0.1%	5
Leaves and Grass	0.9%	0.7%	58	Mattresses	0.3%	0.3%	19
Prunings and Trimmings	0.7%	0.9%	43	Non-distinct Fines	0.1%	0.1%	8
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	**Totals**	**100.0%**		**6,494**
Remainder/Composite Organic	0.3%	0.3%	17	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**

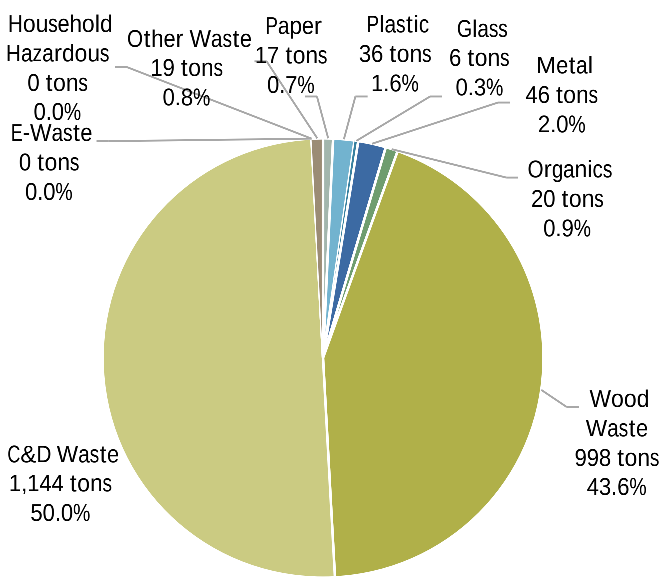


Figure 3-28. Summary of Recoverability of Residential Self-haul (C&D) Disposed **Waste**

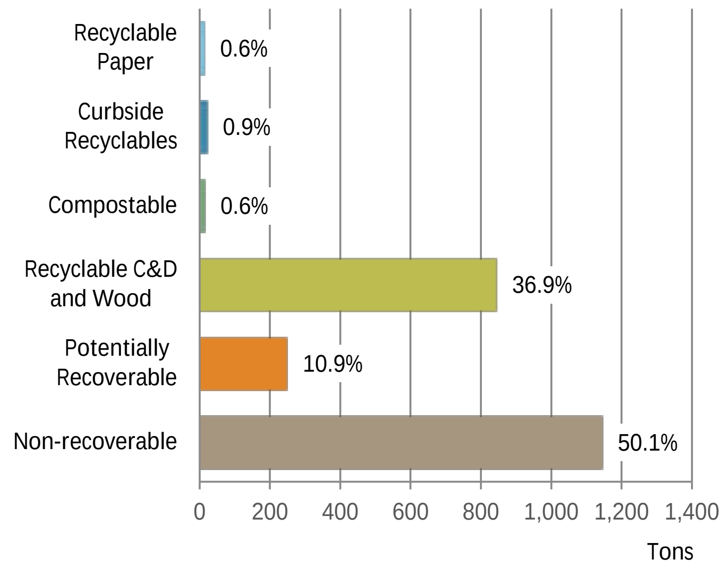


Table 3-32 demonstrates that the two most prevalent *material types– remainder/composite construction* and *dimensional lumber* – accounted for over half (52.0%) of residential self-haul C&D disposed waste by weight.

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

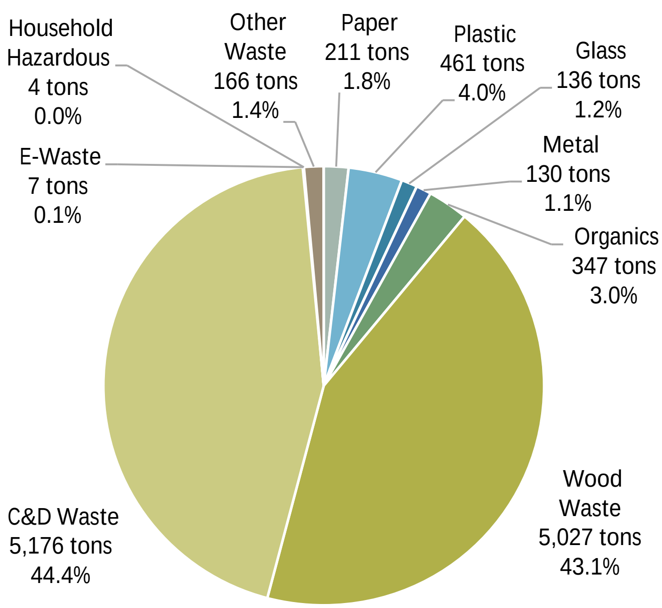


Figure 3-30. Summary of Recoverability of Commercial Self-haul (C&D) Disposed Waste

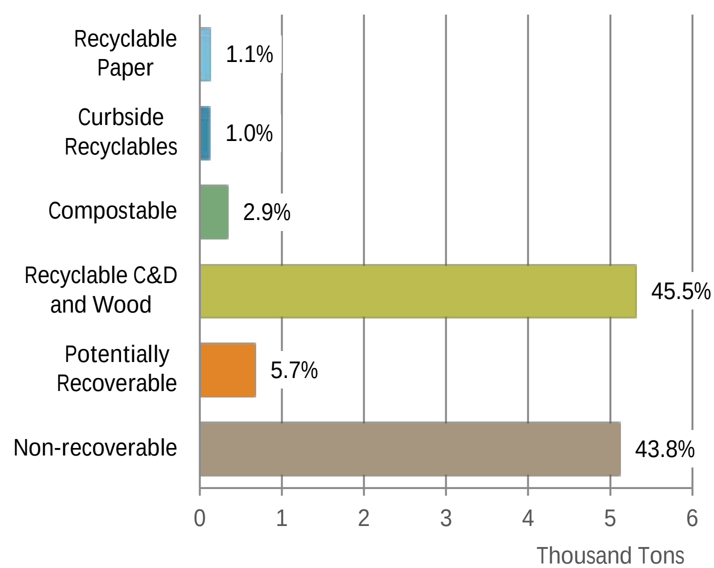


Table 3-34 shows that the top three *material types– dimensional lumber, remainder/composite construction,* and *pallets and crates* – made up more than one third (36.6%) of commercial self-haul C&D disposed waste.

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	Material	Est. Percent	+/-	Est. Tons
Paper	**1.8%**		**211**	**Wood Waste**	**43.1%**		**5,027**
Newspaper	0.0%	0.0%	1	Dimensional Lumber	14.6%	7.1%	1,709
Uncoated OCC/Kraft Paper	1.0%	0.9%	118	Pallets and Crates	8.5%	5.8%	989
High-grade Paper	0.0%	0.0%	1	Engineered Wood	7.1%	9.4%	833
Low-grade Paper	0.0%	0.0%	4	Other Untreated Wood	2.4%	3.7%	283
Waxed OCC	0.0%	0.0%	0	Painted Wood	6.9%	4.2%	801
Pizza Boxes	0.0%	0.0%	0	Treated Wood	2.8%	1.9%	324
Compostable/Soiled Paper	0.0%	0.0%	2	Remainder/Composite Wood	0.8%	0.6%	89
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	1				
Non-comp. Single-use Food Service Paper	0.0%	0.0%	0	**C&D Waste**	**44.4%**		**5,176**
Remainder/Composite Paper	0.7%	0.3%	85	Concrete	2.9%	2.5%	333
				Clean Drywall	1.3%	1.8%	149
Plastic	**4.0%**		**461**	Other Drywall	7.9%	3.6%	917
#1 PET Bottles	0.0%	0.0%	0	Asphalt Paving	0.2%	0.3%	18
#2 HDPE Bottles	0.0%	0.0%	0	Asphalt Shingles	1.3%	1.8%	153
#1-#7 Other Containers	0.1%	0.1%	11	Other Asphalt Roofing	6.0%	5.3%	703
Expanded Polystyrene Food grade	0.0%	0.0%	2	Insulation	0.7%	1.2%	79
Expanded Polystyrene Non-food Grade	0.5%	0.7%	54	Carpet	2.9%	2.4%	336
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0	Carpet Padding	0.7%	0.6%	79
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	0	Soil, Rocks, and Sand	4.4%	5.0%	510
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	1	Ceramics and Brick	2.8%	3.0%	331
Other Clean PE Film	0.0%	0.0%	4	Remainder/Composite Construction	13.4%	12.1%	1,568
Other Film	0.8%	0.9%	93				
Durable Plastic Products	1.3%	2.1%	155	**E-Waste**	**0.1%**		**7**
Remainder/Composite Plastics	1.2%	1.4%	142	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**1.2%**		**136**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	0.0%	0.0%	0	Other Consumer Electronics	0.1%	0.1%	7
Green Glass Containers	0.0%	0.0%	0				
Brown Glass Containers	0.0%	0.0%	3	**Household Hazardous**	**0.0%**		**4**
Plate Glass	0.4%	0.7%	43	Pesticides and Herbicides	0.0%	0.1%	4
Remainder/Composite Glass	0.8%	0.9%	90	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**1.1%**		**130**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.0%	0.0%	0	Dry-cell Batteries	0.0%	0.0%	0
Aluminum Foil/Containers	0.0%	0.0%	0	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.0%	0.0%	2	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.0%	0.0%	0	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.0%	0.0%	0	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.0%	0.0%	0
Oil filters	0.0%	0.0%	1	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	0.9%	0.8%	103	House Cleaners and Chemicals	0.0%	0.0%	0
Remainder/Composite Metal	0.2%	0.2%	24	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**3.0%**		**347**	**Other Waste**	**1.4%**		**166**
Food Waste, Vegetative	0.0%	0.0%	0	Furniture	0.1%	0.2%	15
Other Food Waste	0.0%	0.0%	3	Tires	0.0%	0.0%	0
Leaves and Grass	2.4%	3.3%	277	Mattresses	1.3%	2.1%	151
Prunings and Trimmings	0.4%	0.3%	41	Non-distinct Fines	0.0%	0.0%	0
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	**Totals**	**100.0%**		**11,667**
Remainder/Composite Organic	0.0%	0.0%	1	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

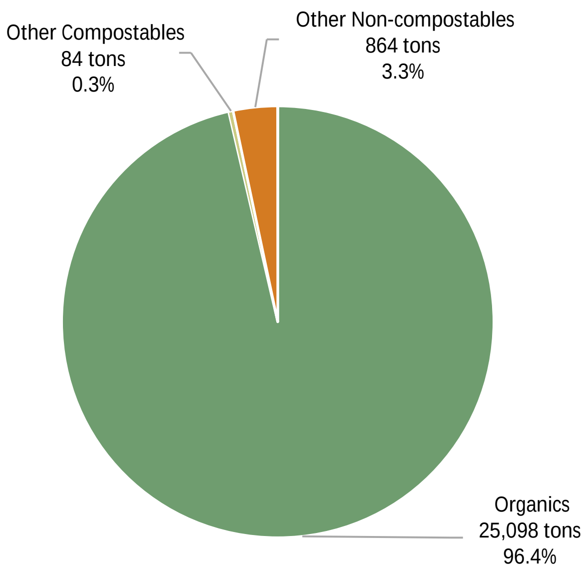
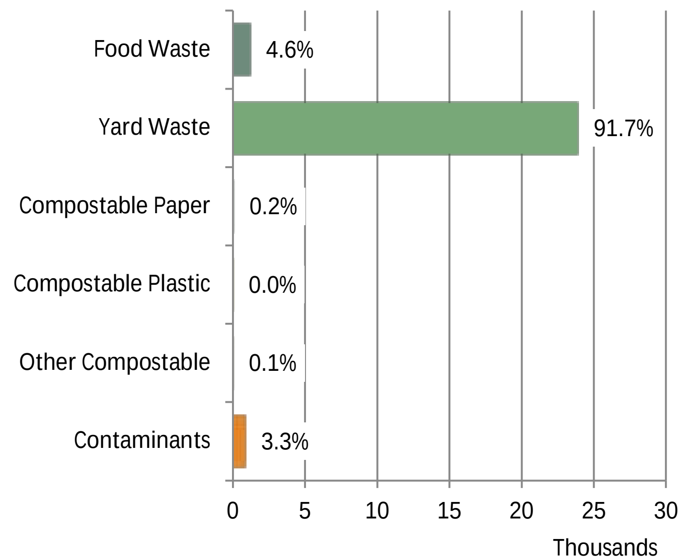


Figure 3-32. Summary of Recoverability of the Overall Single-family Organics Stream



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 <u>non-construction</u> 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 <u>non-construction</u> 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 <u>construction activity</u> 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

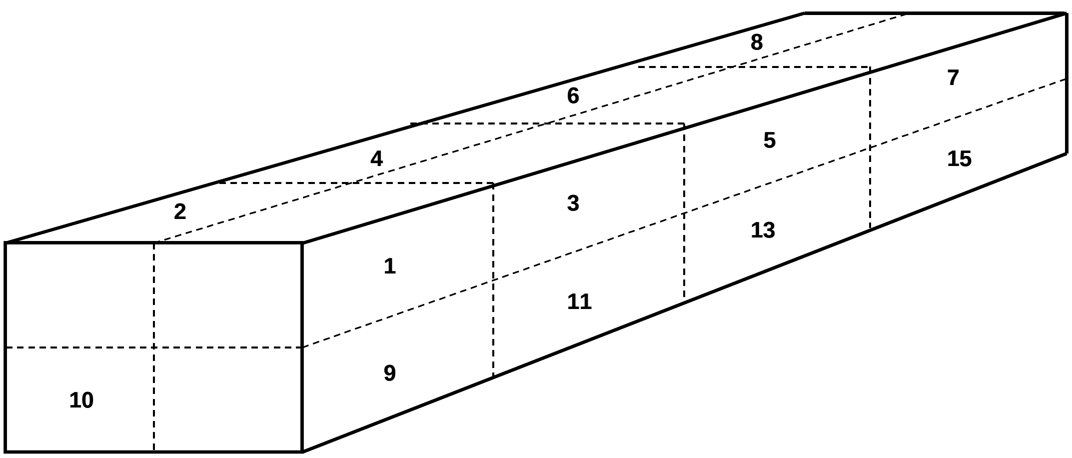
Waste Substream		Hand	Visual
RESIDENTIAL	Single Family	x	
	Multifamily	x	
COMMERICAL	Commercial Packer MSW	x	
	Commercial Roll-off MSW	x	
	Commercial Roll-off C&D		x
SELF-HAUL	Residential MSW Self-haul		x
	Residential C&D Self-haul		x
	Commercial MSW Self-haul		x
	Commercial C&D Self-haul		x
	School 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:

$$\hat{V}_{r_j} = \left(\frac{1}{n}\right) \cdot \left(\frac{1}{\overline{w}^2}\right) \cdot \left(\frac{\sum_i \left(c_{ij} - r_j w_i\right)^2}{n-1}\right)$$

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:

$$r_j \pm \left(t \cdot \sqrt{\hat{V}_{r_j}}\right)$$

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	Material	Est. Percent	+ / -	Est. Tons
Paper	**18.3%**		**2,061**	**Wood Waste**	**0.9%**		**107**
Newspaper	1.8%	0.8%	198	Dimensional Lumber	0.1%	0.1%	13
Uncoated OCC/Kraft Paper	0.9%	0.5%	96	Pallets and Crates	0.0%	0.0%	0
High-grade Paper	1.5%	0.6%	165	Engineered Wood	0.1%	0.1%	8
Low-grade Paper	5.1%	1.1%	575	Other Untreated Wood	0.2%	0.3%	28
Waxed OCC	0.0%	0.0%	0	Painted Wood	0.1%	0.2%	16
Pizza Boxes	0.3%	0.2%	37	Treated Wood	0.3%	0.5%	33
Compostable/Soiled Paper	5.7%	1.0%	640	Remainder/Composite Wood	0.1%	0.1%	9
Pot. Comp. Single-use Food Service Paper	0.9%	0.4%	106				
Non-comp. Single-use Food Service Paper	0.8%	0.3%	85	**C&D Waste**	**0.6%**		**69**
Remainder/Composite Paper	1.4%	0.6%	158	Concrete	0.0%	0.0%	0
				Clean Drywall	0.0%	0.0%	0
Plastic	**16.0%**		**1,806**	Other Drywall	0.0%	0.0%	0
#1 PET Bottles	1.6%	0.4%	179	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.8%	0.2%	89	Asphalt Shingles	0.0%	0.0%	0
#1-#7 Other Containers	1.8%	0.4%	201	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	1.0%	0.2%	108	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.1%	0.0%	6	Carpet	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	0.4%	0.1%	47	Carpet Padding	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.3%	0.2%	34	Soil, Rocks, and Sand	0.3%	0.5%	32
Clean Shopping/Dry Cleaning Bags	1.5%	0.4%	167	Ceramics and Brick	0.3%	0.4%	33
Other Clean PE Film	0.1%	0.2%	12	Remainder/Composite Construction	0.0%	0.1%	4
Other Film	6.2%	1.1%	701				
Durable Plastic Products	1.2%	0.7%	141	**E-Waste**	**0.3%**		**38**
Remainder/Composite Plastics	1.1%	1.1%	122	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**3.3%**		**376**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	1.2%	0.4%	139	Other Consumer Electronics	0.3%	0.4%	38
Green Glass Containers	0.5%	0.2%	61				
Brown Glass Containers	1.2%	0.4%	138	**Household Hazardous**	**0.6%**		**71**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.3%	0.2%	38	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**3.6%**		**400**	Paints, Solvents, and Adhesives	0.6%	0.9%	63
Aluminum Beverage Cans	0.4%	0.1%	50	Dry-cell Batteries	0.0%	0.0%	2
Aluminum Foil/Containers	0.3%	0.1%	34	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.2%	0.2%	26	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	1.0%	0.3%	117	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.1%	0.1%	16	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.0%	0.0%	1
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.0%	0.1%	4
Other Ferrous	0.9%	0.6%	103	House Cleaners and Chemicals	0.0%	0.0%	1
Remainder/Composite Metal	0.5%	0.3%	53	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**56.0%**		**6,302**	**Other Waste**	**0.2%**		**24**
Food Waste, Vegetative	16.1%	2.2%	1,811	Furniture	0.0%	0.0%	0
Other Food Waste	13.5%	2.7%	1,521	Tires	0.0%	0.0%	0
Leaves and Grass	2.9%	1.9%	328	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.0%	0.0%	0	Non-distinct Fines	0.2%	0.3%	24
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	**Totals**	**100.0%**		**11,253**
Remainder/Composite Organic	0.6%	0.5%	69	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**16.4%**		**1,930**	**Wood Waste**	**1.8%**		**208**
Newspaper	1.3%	0.3%	154	Dimensional Lumber	0.5%	0.4%	59
Uncoated OCC/Kraft Paper	1.5%	0.3%	175	Pallets and Crates	0.0%	0.0%	0
High-grade Paper	0.6%	0.3%	67	Engineered Wood	0.0%	0.0%	2
Low-grade Paper	4.7%	0.7%	555	Other Untreated Wood	0.3%	0.2%	34
Waxed OCC	0.0%	0.0%	3	Painted Wood	0.8%	0.6%	96
Pizza Boxes	0.3%	0.1%	38	Treated Wood	0.0%	0.1%	5
Compostable/Soiled Paper	5.7%	0.6%	677	Remainder/Composite Wood	0.1%	0.2%	12
Pot. Comp. Single-use Food Service Paper	1.2%	0.2%	146				
Non-comp. Single-use Food Service Paper	0.2%	0.1%	20	**C&D Waste**	**1.8%**		**212**
Remainder/Composite Paper	0.8%	0.2%	95	Concrete	0.0%	0.0%	0
				Clean Drywall	0.0%	0.0%	0
Plastic	**9.6%**		**1,134**	Other Drywall	0.2%	0.2%	21
#1 PET Bottles	0.8%	0.1%	95	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.5%	0.1%	61	Asphalt Shingles	0.4%	0.6%	46
#1-#7 Other Containers	0.9%	0.1%	108	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.3%	0.1%	40	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.1%	0.0%	9	Carpet	0.5%	0.5%	58
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	1	Carpet Padding	0.1%	0.2%	14
Non-comp. Single-use Food Service Plastic	0.4%	0.1%	43	Soil, Rocks, and Sand	0.2%	0.4%	27
Clean Shopping/Dry Cleaning Bags	0.8%	0.1%	99	Ceramics and Brick	0.1%	0.2%	16
Other Clean PE Film	0.0%	0.0%	4	Remainder/Composite Construction	0.3%	0.4%	30
Other Film	3.7%	0.5%	438				
Durable Plastic Products	1.2%	0.4%	139	**E-Waste**	**0.1%**		**11**
Remainder/Composite Plastics	0.8%	0.3%	97	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**2.6%**		**301**	Computer Peripherals	0.1%	0.1%	11
Clear Glass Containers	1.2%	0.2%	139	Other Consumer Electronics	0.0%	0.0%	0
Green Glass Containers	0.4%	0.2%	51				
Brown Glass Containers	0.8%	0.3%	91	**Household Hazardous**	**0.3%**		**38**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.2%	0.1%	21	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**3.9%**		**457**	Paints, Solvents, and Adhesives	0.1%	0.1%	9
Aluminum Beverage Cans	0.3%	0.1%	34	Dry-cell Batteries	0.1%	0.1%	11
Aluminum Foil/Containers	0.2%	0.1%	27	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.5%	0.2%	60	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.4%	0.1%	51	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.2%	0.1%	18	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.0%	0.0%	0
Oil filters	0.0%	0.1%	4	Pharmaceuticals	0.0%	0.0%	3
Other Ferrous	1.0%	0.6%	123	House Cleaners and Chemicals	0.1%	0.1%	15
Remainder/Composite Metal	1.2%	0.6%	140	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**62.4%**		**7,356**	**Other Waste**	**1.1%**		**134**
Food Waste, Vegetative	21.4%	1.7%	2,520	Furniture	0.0%	0.0%	0
Other Food Waste	6.0%	1.0%	704	Tires	0.0%	0.1%	5
Leaves and Grass	0.8%	0.6%	93	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.0%	0.0%	1	Non-distinct Fines	1.1%	0.3%	130
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	**Totals**	**100.0%**		**11,782**
Remainder/Composite Organic	1.6%	0.5%	189	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**18.5%**		**2,245**	**Wood Waste**	**0.7%**		**87**
Newspaper	1.5%	0.6%	184	Dimensional Lumber	0.2%	0.2%	23
Uncoated OCC/Kraft Paper	1.4%	0.3%	167	Pallets and Crates	0.0%	0.0%	0
High-grade Paper	1.2%	0.7%	148	Engineered Wood	0.1%	0.1%	11
Low-grade Paper	5.2%	0.7%	630	Other Untreated Wood	0.1%	0.1%	7
Waxed OCC	0.0%	0.0%	0	Painted Wood	0.3%	0.2%	33
Pizza Boxes	0.3%	0.2%	39	Treated Wood	0.0%	0.0%	2
Compostable/Soiled Paper	5.8%	1.6%	701	Remainder/Composite Wood	0.1%	0.1%	10
Pot. Comp. Single-use Food Service Paper	1.0%	0.4%	121				
Non-comp. Single-use Food Service Paper	0.7%	0.4%	88	**C&D Waste**	**2.1%**		**254**
Remainder/Composite Paper	1.4%	0.5%	167	Concrete	0.0%	0.0%	0
				Clean Drywall	0.0%	0.0%	0
Plastic	**12.8%**		**1,548**	Other Drywall	1.0%	1.4%	116
#1 PET Bottles	0.9%	0.2%	106	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.5%	0.1%	63	Asphalt Shingles	0.2%	0.3%	20
#1-#7 Other Containers	1.6%	0.4%	199	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.5%	0.2%	63	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.1%	0.0%	14	Carpet	0.0%	0.1%	4
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	3	Carpet Padding	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.3%	0.1%	41	Soil, Rocks, and Sand	0.9%	1.4%	104
Clean Shopping/Dry Cleaning Bags	0.3%	0.1%	40	Ceramics and Brick	0.0%	0.1%	5
Other Clean PE Film	0.0%	0.0%	3	Remainder/Composite Construction	0.0%	0.1%	6
Other Film	6.9%	1.2%	838				
Durable Plastic Products	0.9%	0.4%	103	**E-Waste**	**0.1%**		**7**
Remainder/Composite Plastics	0.6%	0.2%	75	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**2.8%**		**339**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	1.1%	0.3%	132	Other Consumer Electronics	0.1%	0.1%	7
Green Glass Containers	0.5%	0.3%	60				
Brown Glass Containers	1.0%	0.4%	118	**Household Hazardous**	**0.3%**		**38**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.2%	0.1%	29	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**3.1%**		**377**	Paints, Solvents, and Adhesives	0.2%	0.3%	20
Aluminum Beverage Cans	0.5%	0.2%	56	Dry-cell Batteries	0.0%	0.0%	4
Aluminum Foil/Containers	0.4%	0.2%	48	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.0%	0.0%	0	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	1.0%	0.2%	117	Motor Oil	0.0%	0.1%	5
Empty Aerosol Cans	0.2%	0.2%	29	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.0%	0.0%	3
Other Ferrous	0.4%	0.4%	47	House Cleaners and Chemicals	0.0%	0.1%	5
Remainder/Composite Metal	0.7%	0.4%	79	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**59.3%**		**7,199**	**Other Waste**	**0.3%**		**39**
Food Waste, Vegetative	20.2%	2.2%	2,447	Furniture	0.0%	0.0%	0
Other Food Waste	7.5%	1.6%	913	Tires	0.0%	0.0%	0
Leaves and Grass	1.4%	0.9%	170	Mattresses	0.3%	0.4%	31
Prunings and Trimmings	0.1%	0.1%	6	Non-distinct Fines	0.1%	0.1%	8
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	**Totals**	**100.0%**		**12,134**
Remainder/Composite Organic	0.8%	0.3%	92	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**17.8%**		**1,180**	**Wood Waste**	**1.6%**		**104**
Newspaper	1.8%	1.0%	117	Dimensional Lumber	0.3%	0.3%	19
Uncoated OCC/Kraft Paper	1.1%	0.4%	72	Pallets and Crates	0.0%	0.0%	0
High-grade Paper	0.9%	0.8%	61	Engineered Wood	0.0%	0.0%	1
Low-grade Paper	4.4%	0.8%	290	Other Untreated Wood	0.1%	0.1%	4
Waxed OCC	0.0%	0.0%	0	Painted Wood	1.2%	0.9%	77
Pizza Boxes	0.4%	0.3%	25	Treated Wood	0.0%	0.0%	0
Compostable/Soiled Paper	6.1%	0.8%	406	Remainder/Composite Wood	0.0%	0.1%	3
Pot. Comp. Single-use Food Service Paper	1.7%	0.7%	116				
Non-comp. Single-use Food Service Paper	0.1%	0.1%	6	**C&D Waste**	**0.7%**		**45**
Remainder/Composite Paper	1.3%	0.8%	88	Concrete	0.0%	0.0%	0
				Clean Drywall	0.0%	0.0%	0
Plastic	**10.0%**		**661**	Other Drywall	0.1%	0.2%	8
#1 PET Bottles	0.8%	0.3%	55	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.5%	0.1%	36	Asphalt Shingles	0.0%	0.0%	0
#1-#7 Other Containers	1.1%	0.5%	75	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.2%	0.1%	14	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.1%	0.1%	5	Carpet	0.1%	0.1%	4
Pot. Comp. Single-use Food Service Plastic	0.1%	0.1%	7	Carpet Padding	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.2%	0.1%	15	Soil, Rocks, and Sand	0.5%	0.7%	30
Clean Shopping/Dry Cleaning Bags	0.5%	0.2%	34	Ceramics and Brick	0.0%	0.0%	1
Other Clean PE Film	0.0%	0.0%	0	Remainder/Composite Construction	0.0%	0.0%	1
Other Film	3.9%	1.1%	257				
Durable Plastic Products	0.8%	0.4%	51	**E-Waste**	**0.0%**		**0**
Remainder/Composite Plastics	1.7%	1.8%	111	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**4.2%**		**280**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	1.3%	0.6%	86	Other Consumer Electronics	0.0%	0.0%	0
Green Glass Containers	0.9%	0.4%	63				
Brown Glass Containers	1.8%	0.5%	117	**Household Hazardous**	**0.1%**		**7**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.2%	0.1%	14	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**3.3%**		**221**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.3%	0.1%	22	Dry-cell Batteries	0.0%	0.0%	2
Aluminum Foil/Containers	0.2%	0.1%	13	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.1%	0.2%	10	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.6%	0.1%	39	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.1%	0.0%	5	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.1%	0.1%	4
Other Ferrous	1.4%	0.9%	93	House Cleaners and Chemicals	0.0%	0.0%	1
Remainder/Composite Metal	0.6%	0.4%	41	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**62.4%**		**4,140**	**Other Waste**	**0.0%**		**0**
Food Waste, Vegetative	15.2%	2.9%	1,006	Furniture	0.0%	0.0%	0
Other Food Waste	10.4%	2.2%	692	Tires	0.0%	0.0%	0
Leaves and Grass	2.3%	1.4%	151	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.1%	0.2%	6	Non-distinct Fines	0.0%	0.0%	0
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	**Totals**	**100.0%**		**6,638**
Remainder/Composite Organic	1.1%	0.8%	73	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**17.6%**		**1,193**	**Wood Waste**	**1.1%**		**75**
Newspaper	2.0%	1.2%	136	Dimensional Lumber	0.2%	0.2%	15
Uncoated OCC/Kraft Paper	1.4%	0.7%	96	Pallets and Crates	0.0%	0.0%	0
High-grade Paper	1.4%	0.7%	94	Engineered Wood	0.1%	0.1%	4
Low-grade Paper	5.0%	1.3%	339	Other Untreated Wood	0.1%	0.1%	6
Waxed OCC	0.0%	0.0%	0	Painted Wood	0.2%	0.3%	17
Pizza Boxes	0.3%	0.1%	18	Treated Wood	0.5%	0.8%	34
Compostable/Soiled Paper	5.1%	1.3%	348	Remainder/Composite Wood	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Paper	1.1%	0.5%	72				
Non-comp. Single-use Food Service Paper	0.2%	0.2%	13	**C&D Waste**	**3.7%**		**253**
Remainder/Composite Paper	1.1%	0.6%	77	Concrete	0.0%	0.0%	0
				Clean Drywall	0.0%	0.0%	0
Plastic	**11.4%**		**774**	Other Drywall	1.6%	2.4%	108
#1 PET Bottles	0.8%	0.5%	56	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.5%	0.2%	33	Asphalt Shingles	0.3%	0.5%	20
#1-#7 Other Containers	1.1%	0.2%	72	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.6%	0.2%	41	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.1%	0.0%	6	Carpet	0.0%	0.0%	1
Pot. Comp. Single-use Food Service Plastic	0.1%	0.0%	6	Carpet Padding	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.3%	0.1%	17	Soil, Rocks, and Sand	1.5%	2.4%	101
Clean Shopping/Dry Cleaning Bags	0.7%	0.3%	47	Ceramics and Brick	0.3%	0.4%	20
Other Clean PE Film	0.2%	0.3%	12	Remainder/Composite Construction	0.1%	0.1%	4
Other Film	5.3%	1.4%	359				
Durable Plastic Products	1.2%	0.6%	80	**E-Waste**	**0.0%**		**0**
Remainder/Composite Plastics	0.7%	0.2%	45	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**2.1%**		**145**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	1.0%	0.3%	69	Other Consumer Electronics	0.0%	0.0%	0
Green Glass Containers	0.3%	0.2%	23				
Brown Glass Containers	0.6%	0.5%	38	**Household Hazardous**	**0.3%**		**22**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.2%	0.2%	16	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**4.5%**		**304**	Paints, Solvents, and Adhesives	0.1%	0.2%	9
Aluminum Beverage Cans	0.4%	0.1%	25	Dry-cell Batteries	0.1%	0.1%	7
Aluminum Foil/Containers	0.3%	0.1%	18	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.1%	0.2%	10	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.8%	0.4%	53	Motor Oil	0.1%	0.1%	5
Empty Aerosol Cans	0.1%	0.1%	7	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.0%	0.0%	1
Oil filters	0.1%	0.1%	4	Pharmaceuticals	0.0%	0.0%	1
Other Ferrous	1.2%	1.0%	85	House Cleaners and Chemicals	0.0%	0.0%	0
Remainder/Composite Metal	1.5%	1.1%	102	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**58.8%**		**3,987**	**Other Waste**	**0.4%**		**28**
Food Waste, Vegetative	18.3%	2.2%	1,244	Furniture	0.0%	0.0%	0
Other Food Waste	5.7%	1.7%	387	Tires	0.1%	0.1%	5
Leaves and Grass	2.6%	2.1%	175	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.0%	0.0%	0	Non-distinct Fines	0.3%	0.6%	24
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	**Totals**	**100.0%**		**6,782**
Remainder/Composite Organic	1.2%	0.8%	80	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
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	Material	Est. Percent	+/-	Est. Tons
Paper	**18.3%**		**1,323**	**Wood Waste**	**0.9%**		**68**
Newspaper	1.1%	0.7%	77	Dimensional Lumber	0.2%	0.1%	12
Uncoated OCC/Kraft Paper	1.0%	0.3%	70	Pallets and Crates	0.0%	0.0%	0
High-grade Paper	1.3%	0.6%	97	Engineered Wood	0.2%	0.2%	13
Low-grade Paper	6.8%	1.5%	490	Other Untreated Wood	0.4%	0.5%	32
Waxed OCC	0.0%	0.0%	0	Painted Wood	0.0%	0.1%	3
Pizza Boxes	0.5%	0.3%	33	Treated Wood	0.1%	0.1%	5
Compostable/Soiled Paper	5.4%	2.4%	389	Remainder/Composite Wood	0.0%	0.0%	3
Pot. Comp. Single-use Food Service Paper	0.9%	0.3%	67				
Non-comp. Single-use Food Service Paper	0.6%	0.5%	43	**C&D Waste**	**0.5%**		**36**
Remainder/Composite Paper	0.8%	0.3%	58	Concrete	0.0%	0.0%	0
				Clean Drywall	0.0%	0.0%	0
Plastic	**15.1%**		**1,086**	Other Drywall	0.0%	0.0%	0
#1 PET Bottles	1.5%	0.2%	109	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.7%	0.2%	52	Asphalt Shingles	0.0%	0.0%	0
#1-#7 Other Containers	1.7%	0.3%	122	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.9%	0.3%	66	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.1%	0.0%	5	Carpet	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	0.2%	0.2%	16	Carpet Padding	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.4%	0.3%	31	Soil, Rocks, and Sand	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	1.0%	0.5%	72	Ceramics and Brick	0.1%	0.1%	6
Other Clean PE Film	0.0%	0.0%	1	Remainder/Composite Construction	0.4%	0.7%	30
Other Film	7.2%	1.2%	518				
Durable Plastic Products	0.7%	0.3%	52	**E-Waste**	**0.6%**		**44**
Remainder/Composite Plastics	0.6%	0.3%	40	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**3.5%**		**255**	Computer Peripherals	0.1%	0.1%	5
Clear Glass Containers	1.8%	0.3%	127	Other Consumer Electronics	0.5%	0.6%	39
Green Glass Containers	0.3%	0.2%	23				
Brown Glass Containers	1.3%	0.6%	91	**Household Hazardous**	**1.0%**		**70**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.2%	0.2%	14	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**2.4%**		**176**	Paints, Solvents, and Adhesives	0.9%	1.4%	63
Aluminum Beverage Cans	0.5%	0.1%	37	Dry-cell Batteries	0.1%	0.1%	5
Aluminum Foil/Containers	0.2%	0.1%	16	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.1%	0.2%	9	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.9%	0.3%	68	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.2%	0.1%	11	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	0.2%	0.1%	17	House Cleaners and Chemicals	0.0%	0.0%	1
Remainder/Composite Metal	0.3%	0.3%	18	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**57.1%**		**4,121**	**Other Waste**	**0.4%**		**32**
Food Waste, Vegetative	20.6%	3.0%	1,482	Furniture	0.0%	0.0%	0
Other Food Waste	6.8%	1.3%	493	Tires	0.0%	0.0%	0
Leaves and Grass	0.5%	0.5%	36	Mattresses	0.4%	0.7%	31
Prunings and Trimmings	0.0%	0.0%	0	Non-distinct Fines	0.0%	0.0%	1
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	**Totals**	**100.0%**		**7,211**
Remainder/Composite Organic	1.3%	0.4%	93	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**19.5%**		**1,317**	**Wood Waste**	**1.4%**		**94**
Newspaper	1.9%	0.5%	125	Dimensional Lumber	0.6%	0.7%	41
Uncoated OCC/Kraft Paper	1.2%	0.3%	82	Pallets and Crates	0.0%	0.0%	0
High-grade Paper	1.3%	1.0%	90	Engineered Wood	0.0%	0.0%	0
Low-grade Paper	4.5%	0.9%	304	Other Untreated Wood	0.2%	0.2%	16
Waxed OCC	0.0%	0.0%	0	Painted Wood	0.5%	0.4%	33
Pizza Boxes	0.2%	0.1%	14	Treated Wood	0.0%	0.0%	0
Compostable/Soiled Paper	7.6%	1.6%	512	Remainder/Composite Wood	0.1%	0.1%	3
Pot. Comp. Single-use Food Service Paper	0.1%	0.1%	5				
Non-comp. Single-use Food Service Paper	1.3%	0.5%	90	**C&D Waste**	**1.9%**		**128**
Remainder/Composite Paper	1.4%	0.5%	94	Concrete	0.0%	0.0%	0
				Clean Drywall	0.0%	0.0%	0
Plastic	**12.9%**		**871**	Other Drywall	0.2%	0.4%	15
#1 PET Bottles	0.9%	0.2%	62	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.7%	0.2%	44	Asphalt Shingles	0.7%	1.0%	45
#1-#7 Other Containers	1.8%	0.6%	121	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.5%	0.2%	34	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.1%	0.1%	8	Carpet	0.7%	0.8%	50
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	2	Carpet Padding	0.2%	0.4%	14
Non-comp. Single-use Food Service Plastic	0.5%	0.1%	32	Soil, Rocks, and Sand	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.9%	0.3%	59	Ceramics and Brick	0.0%	0.0%	0
Other Clean PE Film	0.0%	0.0%	2	Remainder/Composite Construction	0.1%	0.1%	4
Other Film	5.1%	1.2%	348				
Durable Plastic Products	1.7%	1.1%	114	**E-Waste**	**0.1%**		**6**
Remainder/Composite Plastics	0.7%	0.2%	47	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**2.2%**		**149**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	0.7%	0.2%	51	Other Consumer Electronics	0.1%	0.2%	6
Green Glass Containers	0.5%	0.4%	31				
Brown Glass Containers	0.6%	0.2%	43	**Household Hazardous**	**0.2%**		**16**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.4%	0.2%	24	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**3.5%**		**234**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.2%	0.1%	13	Dry-cell Batteries	0.0%	0.0%	2
Aluminum Foil/Containers	0.2%	0.1%	16	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.8%	0.3%	57	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.6%	0.2%	40	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.1%	0.0%	9	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	0.6%	0.6%	40	House Cleaners and Chemicals	0.2%	0.2%	14
Remainder/Composite Metal	0.9%	0.6%	59	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**56.5%**		**3,823**	**Other Waste**	**1.9%**		**130**
Food Waste, Vegetative	18.1%	3.0%	1,225	Furniture	0.0%	0.0%	0
Other Food Waste	11.2%	3.4%	761	Tires	0.0%	0.0%	0
Leaves and Grass	1.3%	1.1%	90	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.0%	0.0%	0	Non-distinct Fines	1.9%	0.6%	130
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	**Totals**	**100.0%**		**6,768**
Remainder/Composite Organic	1.0%	0.4%	67	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**18.8%**		**744**	**Wood Waste**	**2.4%**		**97**
Newspaper	1.7%	0.8%	67	Dimensional Lumber	0.1%	0.1%	4
Uncoated OCC/Kraft Paper	3.2%	0.8%	125	Pallets and Crates	0.0%	0.0%	0
High-grade Paper	1.1%	0.9%	43	Engineered Wood	0.7%	0.8%	28
Low-grade Paper	5.7%	2.1%	224	Other Untreated Wood	0.4%	0.4%	15
Waxed OCC	0.0%	0.0%	0	Painted Wood	0.2%	0.2%	7
Pizza Boxes	0.4%	0.3%	18	Treated Wood	0.0%	0.0%	0
Compostable/Soiled Paper	5.5%	1.2%	219	Remainder/Composite Wood	1.1%	1.6%	44
Pot. Comp. Single-use Food Service Paper	0.4%	0.3%	16				
Non-comp. Single-use Food Service Paper	0.3%	0.2%	12	**C&D Waste**	**0.7%**		**30**
Remainder/Composite Paper	0.5%	0.2%	21	Concrete	0.0%	0.0%	0
				Clean Drywall	0.0%	0.0%	0
Plastic	**9.5%**		**378**	Other Drywall	0.1%	0.1%	3
#1 PET Bottles	1.2%	0.3%	47	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.6%	0.2%	24	Asphalt Shingles	0.0%	0.0%	0
#1-#7 Other Containers	0.8%	0.3%	33	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.4%	0.1%	15	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.2%	0.2%	9	Carpet	0.7%	1.1%	27
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	1	Carpet Padding	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.2%	0.1%	9	Soil, Rocks, and Sand	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.4%	0.2%	16	Ceramics and Brick	0.0%	0.0%	0
Other Clean PE Film	0.0%	0.0%	1	Remainder/Composite Construction	0.0%	0.0%	0
Other Film	4.0%	1.4%	158				
Durable Plastic Products	1.1%	0.7%	45	**E-Waste**	**0.7%**		**30**
Remainder/Composite Plastics	0.5%	0.3%	21	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**3.2%**		**126**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	2.0%	0.8%	81	Other Consumer Electronics	0.7%	1.2%	30
Green Glass Containers	0.1%	0.1%	5				
Brown Glass Containers	0.6%	0.3%	22	**Household Hazardous**	**0.9%**		**34**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.5%	0.3%	19	Fluorescent Lighting	0.0%	0.0%	1
				Asbestos	0.0%	0.0%	0
Metal	**3.5%**		**138**	Paints, Solvents, and Adhesives	0.1%	0.1%	3
Aluminum Beverage Cans	0.7%	0.3%	27	Dry-cell Batteries	0.0%	0.0%	0
Aluminum Foil/Containers	0.3%	0.1%	11	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.0%	0.0%	0	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.7%	0.2%	27	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.1%	0.0%	3	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.6%	0.9%	23
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	0.8%	0.7%	31	House Cleaners and Chemicals	0.2%	0.3%	8
Remainder/Composite Metal	1.0%	0.7%	40	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**58.8%**		**2,332**	**Other Waste**	**1.4%**		**54**
Food Waste, Vegetative	18.9%	3.6%	749	Furniture	1.0%	1.7%	41
Other Food Waste	8.1%	3.0%	321	Tires	0.0%	0.0%	0
Leaves and Grass	6.2%	7.7%	246	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.1%	0.1%	4	Non-distinct Fines	0.3%	0.6%	14
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	**Totals**	**100.0%**		**3,964**
Remainder/Composite Organic	2.2%	2.0%	86	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**24.0%**		**901**	**Wood Waste**	**1.3%**		**50**
Newspaper	2.0%	1.0%	75	Dimensional Lumber	0.4%	0.6%	16
Uncoated OCC/Kraft Paper	3.3%	2.1%	123	Pallets and Crates	0.0%	0.0%	0
High-grade Paper	1.4%	0.8%	53	Engineered Wood	0.0%	0.0%	0
Low-grade Paper	5.1%	1.8%	192	Other Untreated Wood	0.0%	0.0%	0
Waxed OCC	0.0%	0.0%	0	Painted Wood	0.0%	0.0%	0
Pizza Boxes	0.3%	0.1%	12	Treated Wood	0.6%	1.0%	23
Compostable/Soiled Paper	9.8%	1.5%	366	Remainder/Composite Wood	0.3%	0.5%	11
Pot. Comp. Single-use Food Service Paper	0.7%	0.4%	26				
Non-comp. Single-use Food Service Paper	0.3%	0.3%	10	**C&D Waste**	**2.3%**		**87**
Remainder/Composite Paper	1.1%	0.8%	43	Concrete	0.0%	0.0%	0
				Clean Drywall	0.0%	0.0%	0
Plastic	**15.2%**		**571**	Other Drywall	0.0%	0.0%	0
#1 PET Bottles	1.6%	0.6%	62	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.9%	0.4%	35	Asphalt Shingles	0.0%	0.0%	0
#1-#7 Other Containers	1.6%	0.7%	61	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.5%	0.3%	21	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.1%	0.1%	2	Carpet	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	0.5%	0.4%	20	Carpet Padding	0.6%	1.0%	23
Non-comp. Single-use Food Service Plastic	0.1%	0.1%	3	Soil, Rocks, and Sand	0.9%	1.2%	35
Clean Shopping/Dry Cleaning Bags	1.1%	0.5%	43	Ceramics and Brick	0.2%	0.3%	7
Other Clean PE Film	0.1%	0.1%	2	Remainder/Composite Construction	0.6%	1.0%	22
Other Film	5.8%	1.2%	216				
Durable Plastic Products	1.1%	0.6%	43	**E-Waste**	**1.6%**		**60**
Remainder/Composite Plastics	1.7%	1.6%	62	Televisions and CRTs	1.6%	2.7%	60
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**3.0%**		**112**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	1.3%	0.6%	48	Other Consumer Electronics	0.0%	0.0%	0
Green Glass Containers	1.0%	1.1%	37				
Brown Glass Containers	0.2%	0.2%	7	**Household Hazardous**	**0.1%**		**4**
Plate Glass	0.1%	0.1%	3	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.4%	0.3%	17	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**7.7%**		**288**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.7%	0.4%	24	Dry-cell Batteries	0.0%	0.0%	0
Aluminum Foil/Containers	0.4%	0.3%	15	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.1%	0.1%	2	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.7%	0.2%	26	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.3%	0.2%	11	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	3.5%	5.8%	133	Medical Wastes	0.1%	0.1%	3
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	1.1%	0.9%	41	House Cleaners and Chemicals	0.0%	0.0%	0
Remainder/Composite Metal	1.0%	0.9%	36	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**44.7%**		**1,677**	**Other Waste**	**0.0%**		**0**
Food Waste, Vegetative	13.6%	2.6%	511	Furniture	0.0%	0.0%	0
Other Food Waste	11.1%	4.2%	417	Tires	0.0%	0.0%	0
Leaves and Grass	2.5%	2.7%	94	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.0%	0.0%	0	Non-distinct Fines	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	**Totals**	**100.0%**		**3,751**
Remainder/Composite Organic	1.6%	1.2%	61	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**17.5%**		**655**	**Wood Waste**	**0.7%**		**25**
Newspaper	1.6%	0.5%	61	Dimensional Lumber	0.0%	0.0%	1
Uncoated OCC/Kraft Paper	3.1%	1.4%	116	Pallets and Crates	0.0%	0.0%	0
High-grade Paper	0.5%	0.5%	20	Engineered Wood	0.0%	0.0%	0
Low-grade Paper	5.3%	1.0%	199	Other Untreated Wood	0.1%	0.1%	3
Waxed OCC	0.0%	0.1%	2	Painted Wood	0.5%	0.4%	19
Pizza Boxes	0.2%	0.1%	6	Treated Wood	0.0%	0.0%	0
Compostable/Soiled Paper	5.1%	0.7%	190	Remainder/Composite Wood	0.0%	0.1%	2
Pot. Comp. Single-use Food Service Paper	0.8%	0.3%	29				
Non-comp. Single-use Food Service Paper	0.2%	0.1%	6	**C&D Waste**	**0.7%**		**28**
Remainder/Composite Paper	0.7%	0.3%	25	Concrete	0.0%	0.0%	0
				Clean Drywall	0.0%	0.0%	0
Plastic	**9.6%**		**359**	Other Drywall	0.0%	0.0%	0
#1 PET Bottles	1.1%	0.4%	40	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.6%	0.1%	21	Asphalt Shingles	0.0%	0.0%	0
#1-#7 Other Containers	0.8%	0.2%	29	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.4%	0.1%	14	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.2%	0.2%	9	Carpet	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0	Carpet Padding	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.4%	0.2%	15	Soil, Rocks, and Sand	0.2%	0.3%	9
Clean Shopping/Dry Cleaning Bags	0.8%	0.2%	29	Ceramics and Brick	0.5%	0.8%	19
Other Clean PE Film	0.1%	0.1%	2	Remainder/Composite Construction	0.0%	0.0%	0
Other Film	3.1%	0.2%	117				
Durable Plastic Products	1.6%	0.6%	60	**E-Waste**	**0.0%**		**0**
Remainder/Composite Plastics	0.6%	0.3%	23	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**3.9%**		**144**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	1.5%	0.6%	58	Other Consumer Electronics	0.0%	0.0%	0
Green Glass Containers	0.4%	0.3%	15				
Brown Glass Containers	0.1%	0.1%	4	**Household Hazardous**	**0.7%**		**27**
Plate Glass	0.2%	0.3%	6	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	1.6%	0.9%	61	Fluorescent Lighting	0.0%	0.1%	2
				Asbestos	0.0%	0.0%	0
Metal	**4.8%**		**180**	Paints, Solvents, and Adhesives	0.5%	0.7%	18
Aluminum Beverage Cans	0.4%	0.1%	16	Dry-cell Batteries	0.0%	0.0%	1
Aluminum Foil/Containers	0.3%	0.1%	11	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.1%	0.1%	4	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.6%	0.2%	22	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.1%	0.1%	4	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.0%	0.0%	1
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	2.9%	2.9%	108	House Cleaners and Chemicals	0.1%	0.2%	6
Remainder/Composite Metal	0.4%	0.3%	15	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**61.4%**		**2,297**	**Other Waste**	**0.7%**		**26**
Food Waste, Vegetative	25.6%	4.5%	959	Furniture	0.0%	0.0%	0
Other Food Waste	6.5%	3.3%	245	Tires	0.0%	0.0%	0
Leaves and Grass	1.3%	1.0%	48	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.0%	0.0%	0	Non-distinct Fines	0.7%	1.1%	26
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	**Totals**	**100.0%**		**3,741**
Remainder/Composite Organic	1.2%	0.3%	44	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**17.7%**		**1,414**	**Wood Waste**	**2.8%**		**227**
Newspaper	0.9%	0.5%	74	Dimensional Lumber	0.2%	0.3%	20
Uncoated OCC/Kraft Paper	3.6%	1.3%	292	Pallets and Crates	1.4%	2.4%	115
High-grade Paper	0.7%	0.4%	59	Engineered Wood	0.6%	0.9%	46
Low-grade Paper	3.6%	1.8%	288	Other Untreated Wood	0.1%	0.1%	6
Waxed OCC	0.1%	0.1%	11	Painted Wood	0.0%	0.0%	2
Pizza Boxes	0.1%	0.1%	10	Treated Wood	0.3%	0.4%	25
Compostable/Soiled Paper	5.0%	1.7%	404	Remainder/Composite Wood	0.2%	0.3%	13
Pot. Comp. Single-use Food Service Paper	0.5%	0.5%	39				
Non-comp. Single-use Food Service Paper	1.7%	1.6%	135	**C&D Waste**	**2.0%**		**158**
Remainder/Composite Paper	1.3%	0.7%	104	Concrete	0.6%	1.0%	48
				Clean Drywall	0.0%	0.0%	0
Plastic	**13.6%**		**1,091**	Other Drywall	0.2%	0.4%	18
#1 PET Bottles	0.6%	0.3%	47	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.4%	0.2%	32	Asphalt Shingles	0.0%	0.0%	0
#1-#7 Other Containers	1.2%	1.0%	94	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.3%	0.1%	21	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.2%	0.1%	15	Carpet	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0	Carpet Padding	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.6%	0.3%	46	Soil, Rocks, and Sand	1.1%	1.9%	91
Clean Shopping/Dry Cleaning Bags	0.2%	0.1%	16	Ceramics and Brick	0.0%	0.0%	0
Other Clean PE Film	1.6%	2.0%	127	Remainder/Composite Construction	0.0%	0.0%	0
Other Film	5.9%	2.5%	472				
Durable Plastic Products	1.2%	1.1%	94	**E-Waste**	**0.0%**		**2**
Remainder/Composite Plastics	1.6%	1.3%	127	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**8.7%**		**697**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	2.0%	1.9%	162	Other Consumer Electronics	0.0%	0.0%	2
Green Glass Containers	0.5%	0.3%	37				
Brown Glass Containers	1.0%	1.2%	77	**Household Hazardous**	**0.4%**		**29**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	5.2%	8.3%	420	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**4.7%**		**374**	Paints, Solvents, and Adhesives	0.0%	0.1%	4
Aluminum Beverage Cans	0.4%	0.2%	32	Dry-cell Batteries	0.0%	0.0%	1
Aluminum Foil/Containers	0.1%	0.1%	7	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.0%	0.0%	0	Gasoline/Kerosene	0.1%	0.1%	5
Tin Food Cans	0.1%	0.1%	10	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.1%	0.1%	6	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.2%	0.4%	20
Oil filters	0.1%	0.2%	9	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	2.7%	2.4%	219	House Cleaners and Chemicals	0.0%	0.0%	0
Remainder/Composite Metal	1.1%	1.0%	92	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**46.1%**		**3,694**	**Other Waste**	**4.0%**		**323**
Food Waste, Vegetative	18.5%	6.4%	1,479	Furniture	0.0%	0.0%	0
Other Food Waste	7.5%	4.0%	602	Tires	0.0%	0.0%	0
Leaves and Grass	12.2%	12.3%	976	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.0%	0.0%	0	Non-distinct Fines	4.0%	5.1%	323
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	**Totals**	**100.0%**		**8,008**
Remainder/Composite Organic	1.2%	0.6%	96	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**28.0%**		**2,111**	**Wood Waste**	**8.5%**		**642**
Newspaper	1.1%	0.7%	79	Dimensional Lumber	0.5%	0.8%	36
Uncoated OCC/Kraft Paper	3.8%	2.6%	287	Pallets and Crates	0.0%	0.0%	0
High-grade Paper	1.5%	1.3%	110	Engineered Wood	2.3%	3.5%	172
Low-grade Paper	4.1%	1.7%	307	Other Untreated Wood	0.0%	0.0%	0
Waxed OCC	1.9%	3.0%	141	Painted Wood	5.0%	7.0%	374
Pizza Boxes	0.3%	0.2%	22	Treated Wood	0.7%	1.1%	51
Compostable/Soiled Paper	7.3%	4.8%	550	Remainder/Composite Wood	0.1%	0.2%	8
Pot. Comp. Single-use Food Service Paper	1.1%	0.9%	82				
Non-comp. Single-use Food Service Paper	0.3%	0.5%	25	**C&D Waste**	**0.4%**		**33**
Remainder/Composite Paper	6.7%	7.4%	508	Concrete	0.0%	0.0%	0
				Clean Drywall	0.0%	0.0%	0
Plastic	**12.5%**		**940**	Other Drywall	0.0%	0.0%	0
#1 PET Bottles	0.7%	0.4%	55	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.9%	0.6%	70	Asphalt Shingles	0.0%	0.0%	0
#1-#7 Other Containers	0.6%	0.3%	43	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.5%	0.6%	36	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.1%	0.1%	11	Carpet	0.4%	0.7%	33
Pot. Comp. Single-use Food Service Plastic	0.5%	0.4%	40	Carpet Padding	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.2%	0.2%	12	Soil, Rocks, and Sand	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.1%	0.1%	9	Ceramics and Brick	0.0%	0.0%	0
Other Clean PE Film	0.4%	0.7%	30	Remainder/Composite Construction	0.0%	0.0%	0
Other Film	6.9%	2.8%	521				
Durable Plastic Products	0.4%	0.5%	32	**E-Waste**	**0.2%**		**18**
Remainder/Composite Plastics	1.1%	1.3%	80	Televisions and CRTs	0.2%	0.4%	16
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**3.3%**		**247**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	1.1%	0.5%	85	Other Consumer Electronics	0.0%	0.0%	2
Green Glass Containers	0.4%	0.3%	29				
Brown Glass Containers	1.6%	2.1%	119	**Household Hazardous**	**0.6%**		**45**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.2%	0.2%	14	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**1.4%**		**104**	Paints, Solvents, and Adhesives	0.0%	0.0%	2
Aluminum Beverage Cans	0.3%	0.2%	23	Dry-cell Batteries	0.0%	0.0%	0
Aluminum Foil/Containers	0.2%	0.1%	13	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.0%	0.0%	2	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.6%	0.3%	47	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.1%	0.1%	9	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.5%	0.7%	40
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	0.1%	0.1%	6	House Cleaners and Chemicals	0.0%	0.1%	2
Remainder/Composite Metal	0.0%	0.1%	3	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**45.0%**		**3,395**	**Other Waste**	**0.1%**		**5**
Food Waste, Vegetative	23.9%	7.8%	1,801	Furniture	0.0%	0.0%	0
Other Food Waste	12.1%	5.7%	911	Tires	0.0%	0.0%	0
Leaves and Grass	6.2%	7.6%	470	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.6%	1.0%	44	Non-distinct Fines	0.1%	0.1%	5
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	**Totals**	**100.0%**		**7,541**
Remainder/Composite Organic	0.6%	0.5%	46	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**23.4%**		**1,789**	**Wood Waste**	**7.0%**		**533**
Newspaper	1.4%	1.1%	108	Dimensional Lumber	4.1%	5.8%	317
Uncoated OCC/Kraft Paper	4.1%	1.7%	310	Pallets and Crates	0.0%	0.0%	0
High-grade Paper	1.3%	1.0%	96	Engineered Wood	1.0%	0.9%	78
Low-grade Paper	5.7%	3.0%	432	Other Untreated Wood	0.0%	0.0%	1
Waxed OCC	0.0%	0.0%	0	Painted Wood	0.9%	1.0%	66
Pizza Boxes	0.1%	0.1%	10	Treated Wood	0.3%	0.5%	22
Compostable/Soiled Paper	7.0%	1.6%	534	Remainder/Composite Wood	0.7%	0.9%	50
Pot. Comp. Single-use Food Service Paper	1.5%	0.7%	111				
Non-comp. Single-use Food Service Paper	0.1%	0.1%	6	**C&D Waste**	**3.7%**		**281**
Remainder/Composite Paper	2.4%	1.2%	183	Concrete	1.2%	2.0%	93
				Clean Drywall	0.0%	0.0%	0
Plastic	**14.0%**		**1,069**	Other Drywall	1.9%	3.2%	147
#1 PET Bottles	0.9%	0.3%	71	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.5%	0.2%	38	Asphalt Shingles	0.0%	0.0%	0
#1-#7 Other Containers	0.6%	0.3%	47	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.1%	0.1%	11	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.3%	0.3%	24	Carpet	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	1	Carpet Padding	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	1.0%	0.6%	74	Soil, Rocks, and Sand	0.5%	0.9%	41
Clean Shopping/Dry Cleaning Bags	0.4%	0.2%	33	Ceramics and Brick	0.0%	0.0%	0
Other Clean PE Film	2.6%	2.5%	197	Remainder/Composite Construction	0.0%	0.0%	0
Other Film	4.9%	0.9%	371				
Durable Plastic Products	1.1%	0.6%	87	**E-Waste**	**0.8%**		**60**
Remainder/Composite Plastics	1.5%	0.6%	114	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.8%	0.9%	60
Glass	**2.9%**		**221**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	0.9%	0.9%	71	Other Consumer Electronics	0.0%	0.0%	0
Green Glass Containers	0.6%	0.9%	48				
Brown Glass Containers	0.5%	0.3%	35	**Household Hazardous**	**3.4%**		**257**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.9%	0.5%	68	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**4.4%**		**334**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.3%	0.1%	27	Dry-cell Batteries	0.0%	0.0%	1
Aluminum Foil/Containers	0.1%	0.1%	10	Wet-cell Batteries	0.2%	0.3%	15
Other Non-ferrous	0.0%	0.0%	2	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	1.0%	0.8%	75	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.3%	0.2%	25	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	2.8%	3.7%	213
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	1.7%	1.5%	127	House Cleaners and Chemicals	0.3%	0.4%	20
Remainder/Composite Metal	0.9%	0.6%	68	Other Potentially Hazardous	0.1%	0.2%	9
Organics	**40.4%**		**3,083**	**Other Waste**	**0.1%**		**9**
Food Waste, Vegetative	18.6%	5.4%	1,418	Furniture	0.0%	0.0%	0
Other Food Waste	5.2%	1.8%	398	Tires	0.0%	0.0%	0
Leaves and Grass	1.4%	1.4%	107	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.0%	0.0%	0	Non-distinct Fines	0.1%	0.2%	9
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	**Totals**	**100.0%**		**7,637**
Remainder/Composite Organic	2.3%	1.1%	172	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**34.7%**		**3,533**	**Wood Waste**	**0.6%**		**65**
Newspaper	2.1%	2.1%	211	Dimensional Lumber	0.0%	0.1%	4
Uncoated OCC/Kraft Paper	6.7%	3.3%	683	Pallets and Crates	0.0%	0.0%	0
High-grade Paper	2.0%	2.2%	203	Engineered Wood	0.6%	0.7%	56
Low-grade Paper	8.4%	5.4%	853	Other Untreated Wood	0.1%	0.1%	5
Waxed OCC	0.1%	0.2%	13	Painted Wood	0.0%	0.0%	0
Pizza Boxes	0.0%	0.0%	0	Treated Wood	0.0%	0.0%	0
Compostable/Soiled Paper	8.6%	4.8%	872	Remainder/Composite Wood	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Paper	0.6%	0.8%	57				
Non-comp. Single-use Food Service Paper	0.7%	0.6%	67	**C&D Waste**	**9.9%**		**1,004**
Remainder/Composite Paper	5.6%	6.1%	574	Concrete	0.0%	0.0%	0
				Clean Drywall	0.0%	0.0%	0
Plastic	**24.4%**		**2,484**	Other Drywall	0.0%	0.0%	0
#1 PET Bottles	0.6%	0.4%	58	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.3%	0.2%	27	Asphalt Shingles	3.7%	6.1%	381
#1-#7 Other Containers	0.8%	0.6%	84	Other Asphalt Roofing	0.0%	0.1%	3
Expanded Polystyrene Food grade	0.6%	0.5%	61	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.6%	1.0%	64	Carpet	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	1	Carpet Padding	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.7%	0.7%	72	Soil, Rocks, and Sand	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.1%	0.1%	13	Ceramics and Brick	0.0%	0.0%	0
Other Clean PE Film	3.5%	5.9%	361	Remainder/Composite Construction	6.1%	10.1%	620
Other Film	9.2%	3.0%	932				
Durable Plastic Products	1.0%	0.7%	99	**E-Waste**	**0.0%**		**0**
Remainder/Composite Plastics	7.0%	10.2%	712	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**0.6%**		**61**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	0.5%	0.5%	50	Other Consumer Electronics	0.0%	0.0%	0
Green Glass Containers	0.0%	0.0%	2				
Brown Glass Containers	0.1%	0.1%	9	**Household Hazardous**	**0.0%**		**0**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.0%	0.0%	0	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**3.4%**		**342**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.2%	0.2%	25	Dry-cell Batteries	0.0%	0.0%	0
Aluminum Foil/Containers	0.1%	0.1%	11	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.1%	0.2%	10	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.2%	0.1%	16	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.1%	0.1%	5	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	1.5%	2.4%	154	House Cleaners and Chemicals	0.0%	0.0%	0
Remainder/Composite Metal	1.2%	1.3%	122	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**26.4%**		**2,683**	**Other Waste**	**0.0%**		**0**
Food Waste, Vegetative	15.7%	10.1%	1,599	Furniture	0.0%	0.0%	0
Other Food Waste	4.0%	3.5%	412	Tires	0.0%	0.0%	0
Leaves and Grass	0.0%	0.0%	0	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.0%	0.0%	0	Non-distinct Fines	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	**Totals**	**100.0%**		**10,173**
Remainder/Composite Organic	4.1%	4.6%	412	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**26.0%**		**3,077**	**Wood Waste**	**16.9%**		**2,002**
Newspaper	0.9%	0.6%	101	Dimensional Lumber	1.8%	2.7%	219
Uncoated OCC/Kraft Paper	3.4%	2.7%	399	Pallets and Crates	10.2%	13.0%	1,207
High-grade Paper	2.4%	2.1%	288	Engineered Wood	4.0%	5.0%	475
Low-grade Paper	3.3%	1.8%	388	Other Untreated Wood	0.1%	0.2%	14
Waxed OCC	0.0%	0.0%	0	Painted Wood	0.2%	0.3%	29
Pizza Boxes	0.1%	0.1%	11	Treated Wood	0.0%	0.0%	0
Compostable/Soiled Paper	3.8%	2.3%	452	Remainder/Composite Wood	0.5%	0.8%	58
Pot. Comp. Single-use Food Service Paper	0.4%	0.3%	42				
Non-comp. Single-use Food Service Paper	0.4%	0.5%	52	**C&D Waste**	**5.8%**		**685**
Remainder/Composite Paper	11.4%	9.3%	1,345	Concrete	0.0%	0.0%	0
				Clean Drywall	0.0%	0.0%	0
Plastic	**13.2%**		**1,567**	Other Drywall	0.0%	0.0%	0
#1 PET Bottles	0.5%	0.3%	62	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.5%	0.2%	56	Asphalt Shingles	0.0%	0.0%	0
#1-#7 Other Containers	0.8%	0.4%	89	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.3%	0.3%	40	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.1%	0.1%	10	Carpet	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	1.0%	1.4%	122	Carpet Padding	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.1%	0.1%	15	Soil, Rocks, and Sand	3.8%	5.4%	449
Clean Shopping/Dry Cleaning Bags	0.2%	0.1%	21	Ceramics and Brick	0.0%	0.0%	0
Other Clean PE Film	2.2%	1.8%	264	Remainder/Composite Construction	2.0%	2.7%	236
Other Film	3.4%	1.3%	397				
Durable Plastic Products	1.6%	1.9%	186	**E-Waste**	**0.3%**		**33**
Remainder/Composite Plastics	2.6%	1.6%	306	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**3.6%**		**427**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	2.1%	2.5%	244	Other Consumer Electronics	0.3%	0.5%	33
Green Glass Containers	0.4%	0.5%	49				
Brown Glass Containers	0.9%	0.9%	110	**Household Hazardous**	**6.4%**		**763**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.2%	0.2%	23	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**2.7%**		**321**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.4%	0.2%	46	Dry-cell Batteries	0.0%	0.0%	0
Aluminum Foil/Containers	0.0%	0.0%	0	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.0%	0.0%	0	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.2%	0.2%	29	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.1%	0.1%	9	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	6.4%	10.4%	762
Oil filters	0.1%	0.1%	9	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	1.5%	2.1%	180	House Cleaners and Chemicals	0.0%	0.0%	0
Remainder/Composite Metal	0.4%	0.4%	48	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**24.5%**		**2,901**	**Other Waste**	**0.5%**		**63**
Food Waste, Vegetative	8.0%	4.3%	943	Furniture	0.0%	0.0%	0
Other Food Waste	6.4%	5.6%	761	Tires	0.0%	0.0%	0
Leaves and Grass	4.5%	4.8%	536	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.0%	0.0%	0	Non-distinct Fines	0.5%	0.9%	63
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	**Totals**	**100.0%**		**11,839**
Remainder/Composite Organic	1.7%	1.8%	199	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**16.6%**		**2,149**	**Wood Waste**	**10.2%**		**1,323**
Newspaper	1.6%	1.2%	211	Dimensional Lumber	7.5%	11.3%	972
Uncoated OCC/Kraft Paper	2.1%	0.7%	278	Pallets and Crates	0.0%	0.0%	0
High-grade Paper	0.6%	0.4%	77	Engineered Wood	0.2%	0.3%	23
Low-grade Paper	2.3%	1.2%	294	Other Untreated Wood	0.1%	0.1%	8
Waxed OCC	0.6%	0.9%	73	Painted Wood	1.9%	2.7%	240
Pizza Boxes	0.1%	0.2%	14	Treated Wood	0.6%	1.0%	79
Compostable/Soiled Paper	5.9%	2.3%	771	Remainder/Composite Wood	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Paper	2.1%	1.3%	268				
Non-comp. Single-use Food Service Paper	0.0%	0.1%	5	**C&D Waste**	**1.1%**		**139**
Remainder/Composite Paper	1.2%	0.7%	157	Concrete	0.0%	0.0%	0
				Clean Drywall	0.0%	0.0%	0
Plastic	**19.5%**		**2,526**	Other Drywall	0.0%	0.0%	0
#1 PET Bottles	4.2%	4.4%	542	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.6%	0.7%	75	Asphalt Shingles	0.5%	0.8%	64
#1-#7 Other Containers	0.5%	0.3%	62	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.5%	0.4%	65	Insulation	0.6%	0.9%	75
Expanded Polystyrene Non-food Grade	0.1%	0.1%	15	Carpet	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	1	Carpet Padding	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.8%	0.7%	104	Soil, Rocks, and Sand	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.3%	0.2%	44	Ceramics and Brick	0.0%	0.0%	0
Other Clean PE Film	0.3%	0.4%	35	Remainder/Composite Construction	0.0%	0.0%	0
Other Film	4.2%	1.4%	540				
Durable Plastic Products	3.8%	3.4%	496	**E-Waste**	**0.0%**		**0**
Remainder/Composite Plastics	4.2%	5.8%	548	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**6.7%**		**873**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	1.5%	1.3%	197	Other Consumer Electronics	0.0%	0.0%	0
Green Glass Containers	0.7%	0.8%	85				
Brown Glass Containers	1.9%	2.3%	250	**Household Hazardous**	**0.0%**		**5**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	2.6%	4.2%	341	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**5.5%**		**709**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.6%	0.6%	77	Dry-cell Batteries	0.0%	0.1%	5
Aluminum Foil/Containers	0.1%	0.1%	15	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.0%	0.1%	6	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.2%	0.2%	26	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.5%	0.8%	60	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	3.5%	4.0%	458	House Cleaners and Chemicals	0.0%	0.0%	0
Remainder/Composite Metal	0.5%	0.5%	66	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**39.9%**		**5,179**	**Other Waste**	**0.6%**		**79**
Food Waste, Vegetative	21.5%	9.0%	2,796	Furniture	0.0%	0.0%	0
Other Food Waste	5.9%	3.2%	765	Tires	0.0%	0.0%	0
Leaves and Grass	2.1%	2.3%	269	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.0%	0.0%	2	Non-distinct Fines	0.6%	1.0%	79
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	**Totals**	**100.0%**		**12,981**
Remainder/Composite Organic	4.8%	6.8%	620	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**1.2%**		**12**	**Wood Waste**	**58.7%**		**575**
Newspaper	0.0%	0.0%	0	Dimensional Lumber	14.7%	1.9%	144
Uncoated OCC/Kraft Paper	0.2%	0.4%	2	Pallets and Crates	0.0%	0.0%	0
High-grade Paper	0.0%	0.0%	0	Engineered Wood	0.0%	0.0%	0
Low-grade Paper	0.2%	0.3%	2	Other Untreated Wood	20.5%	2.6%	201
Waxed OCC	0.0%	0.0%	0	Painted Wood	23.5%	3.0%	230
Pizza Boxes	0.1%	0.1%	1	Treated Wood	0.0%	0.0%	0
Compostable/Soiled Paper	0.4%	0.9%	4	Remainder/Composite Wood	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Paper	0.1%	0.2%	1				
Non-comp. Single-use Food Service Paper	0.3%	0.7%	3	**C&D Waste**	**25.4%**		**249**
Remainder/Composite Paper	0.0%	0.0%	0	Concrete	0.0%	0.0%	0
				Clean Drywall	0.0%	0.0%	0
Plastic	**2.3%**		**23**	Other Drywall	24.8%	3.2%	243
#1 PET Bottles	0.0%	0.1%	0	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.0%	0.1%	0	Asphalt Shingles	0.0%	0.0%	0
#1-#7 Other Containers	0.1%	0.1%	1	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.0%	0.0%	0	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.0%	0.0%	0	Carpet	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0	Carpet Padding	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.0%	0.1%	0	Soil, Rocks, and Sand	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	0	Ceramics and Brick	0.0%	0.0%	0
Other Clean PE Film	0.0%	0.0%	0	Remainder/Composite Construction	0.5%	0.2%	5
Other Film	0.6%	1.1%	6				
Durable Plastic Products	1.5%	0.2%	14	**E-Waste**	**0.0%**		**0**
Remainder/Composite Plastics	0.1%	0.1%	1	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**0.0%**		**0**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	0.0%	0.0%	0	Other Consumer Electronics	0.0%	0.0%	0
Green Glass Containers	0.0%	0.0%	0				
Brown Glass Containers	0.0%	0.0%	0	**Household Hazardous**	**0.0%**		**0**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.0%	0.0%	0	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**0.1%**		**1**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.0%	0.0%	0	Dry-cell Batteries	0.0%	0.0%	0
Aluminum Foil/Containers	0.0%	0.0%	0	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.0%	0.0%	0	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.1%	0.2%	1	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.0%	0.0%	0	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	0.0%	0.0%	0	House Cleaners and Chemicals	0.0%	0.0%	0
Remainder/Composite Metal	0.0%	0.0%	0	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**3.6%**		**36**	**Other Waste**	**8.7%**		**85**
Food Waste, Vegetative	1.8%	3.8%	18	Furniture	8.7%	1.1%	85
Other Food Waste	0.5%	1.0%	5	Tires	0.0%	0.0%	0
Leaves and Grass	0.8%	2.0%	7	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.0%	0.0%	0	Non-distinct Fines	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	**Totals**	**100.0%**		**981**
Remainder/Composite Organic	0.0%	0.0%	0	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**17.6%**		**138**	**Wood Waste**	**0.0%**		**0**
Newspaper	0.1%	0.1%	0	Dimensional Lumber	0.0%	0.0%	0
Uncoated OCC/Kraft Paper	0.8%	0.7%	6	Pallets and Crates	0.0%	0.0%	0
High-grade Paper	0.6%	0.6%	5	Engineered Wood	0.0%	0.0%	0
Low-grade Paper	3.6%	3.1%	28	Other Untreated Wood	0.0%	0.0%	0
Waxed OCC	0.0%	0.0%	0	Painted Wood	0.0%	0.0%	0
Pizza Boxes	0.2%	0.4%	2	Treated Wood	0.0%	0.0%	0
Compostable/Soiled Paper	6.0%	4.8%	47	Remainder/Composite Wood	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Paper	1.7%	2.1%	13				
Non-comp. Single-use Food Service Paper	1.2%	1.9%	9	**C&D Waste**	**36.7%**		**288**
Remainder/Composite Paper	3.4%	3.2%	27	Concrete	34.4%	44.6%	270
				Clean Drywall	0.0%	0.0%	0
Plastic	**7.4%**		**58**	Other Drywall	0.0%	0.0%	0
#1 PET Bottles	0.6%	0.7%	5	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.3%	0.4%	2	Asphalt Shingles	0.0%	0.0%	0
#1-#7 Other Containers	0.8%	1.0%	6	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.0%	0.1%	0	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.1%	0.2%	1	Carpet	0.0%	0.0%	0
Pot. Comp. Single-use Food Service Plastic	0.4%	0.7%	3	Carpet Padding	0.0%	0.0%	0
Non-comp. Single-use Food Service Plastic	0.1%	0.1%	1	Soil, Rocks, and Sand	2.3%	2.9%	18
Clean Shopping/Dry Cleaning Bags	0.0%	0.1%	0	Ceramics and Brick	0.0%	0.0%	0
Other Clean PE Film	0.0%	0.0%	0	Remainder/Composite Construction	0.0%	0.0%	0
Other Film	4.2%	3.4%	33				
Durable Plastic Products	0.4%	0.5%	3	**E-Waste**	**0.0%**		**0**
Remainder/Composite Plastics	0.6%	0.6%	4	Televisions and CRTs	0.0%	0.0%	0
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**1.6%**		**12**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	0.5%	0.6%	4	Other Consumer Electronics	0.0%	0.0%	0
Green Glass Containers	0.3%	0.4%	2				
Brown Glass Containers	0.5%	0.7%	4	**Household Hazardous**	**0.0%**		**0**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.3%	0.5%	2	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**0.5%**		**4**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.1%	0.1%	1	Dry-cell Batteries	0.0%	0.0%	0
Aluminum Foil/Containers	0.1%	0.1%	1	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.0%	0.0%	0	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.2%	0.3%	2	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.0%	0.0%	0	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	0.0%	0.1%	0	House Cleaners and Chemicals	0.0%	0.0%	0
Remainder/Composite Metal	0.1%	0.1%	0	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**36.3%**		**285**	**Other Waste**	**0.0%**		**0**
Food Waste, Vegetative	11.6%	9.8%	91	Furniture	0.0%	0.0%	0
Other Food Waste	23.2%	18.3%	182	Tires	0.0%	0.0%	0
Leaves and Grass	0.4%	0.5%	3	Mattresses	0.0%	0.0%	0
Prunings and Trimmings	0.1%	0.1%	0	Non-distinct Fines	0.0%	0.0%	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	**Totals**	**100.0%**		**786**
Remainder/Composite Organic	0.2%	0.2%	1	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**13.0%**		**1,507**	**Wood Waste**	**10.9%**		**1,267**
Newspaper	0.6%	0.5%	75	Dimensional Lumber	3.0%	2.1%	349
Uncoated OCC/Kraft Paper	4.8%	3.7%	562	Pallets and Crates	0.0%	0.1%	5
High-grade Paper	0.3%	0.2%	33	Engineered Wood	2.6%	3.5%	304
Low-grade Paper	1.2%	0.8%	143	Other Untreated Wood	0.7%	0.7%	78
Waxed OCC	0.3%	0.5%	40	Painted Wood	2.7%	3.3%	310
Pizza Boxes	0.1%	0.1%	6	Treated Wood	0.6%	0.6%	66
Compostable/Soiled Paper	0.4%	0.3%	50	Remainder/Composite Wood	1.3%	1.7%	154
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	0				
Non-comp. Single-use Food Service Paper	0.1%	0.1%	9	**C&D Waste**	**9.0%**		**1,048**
Remainder/Composite Paper	5.1%	4.8%	591	Concrete	1.3%	1.7%	157
				Clean Drywall	0.0%	0.0%	0
Plastic	**8.2%**		**954**	Other Drywall	0.0%	0.0%	0
#1 PET Bottles	0.1%	0.1%	9	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.1%	0.1%	8	Asphalt Shingles	0.1%	0.1%	10
#1-#7 Other Containers	0.2%	0.2%	18	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.0%	0.0%	1	Insulation	0.3%	0.5%	36
Expanded Polystyrene Non-food Grade	0.0%	0.0%	3	Carpet	3.7%	5.5%	429
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0	Carpet Padding	0.1%	0.3%	17
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	2	Soil, Rocks, and Sand	1.2%	2.1%	141
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	1	Ceramics and Brick	0.0%	0.0%	0
Other Clean PE Film	0.0%	0.0%	1	Remainder/Composite Construction	2.2%	2.2%	257
Other Film	1.3%	0.9%	146				
Durable Plastic Products	3.9%	3.7%	458	**E-Waste**	**0.2%**		**28**
Remainder/Composite Plastics	2.6%	2.5%	307	Televisions and CRTs	0.2%	0.3%	24
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**4.0%**		**461**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	0.1%	0.1%	12	Other Consumer Electronics	0.0%	0.0%	4
Green Glass Containers	0.0%	0.1%	4				
Brown Glass Containers	0.1%	0.1%	12	**Household Hazardous**	**0.0%**		**0**
Plate Glass	2.7%	3.2%	309	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	1.1%	1.1%	123	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**4.3%**		**497**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.0%	0.0%	1	Dry-cell Batteries	0.0%	0.0%	0
Aluminum Foil/Containers	0.0%	0.0%	0	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.0%	0.0%	2	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.0%	0.0%	1	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.0%	0.0%	0	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	3.7%	3.4%	434	House Cleaners and Chemicals	0.0%	0.0%	0
Remainder/Composite Metal	0.5%	0.4%	59	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**20.8%**		**2,414**	**Other Waste**	**29.7%**		**3,457**
Food Waste, Vegetative	2.7%	2.5%	318	Furniture	17.9%	14.2%	2,082
Other Food Waste	0.6%	0.6%	70	Tires	0.0%	0.0%	0
Leaves and Grass	9.8%	7.9%	1,146	Mattresses	11.8%	15.3%	1,374
Prunings and Trimmings	2.0%	3.2%	231	Non-distinct Fines	0.0%	0.0%	0
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	**Totals**	**100.0%**		**11,634**
Remainder/Composite Organic	0.1%	0.1%	16	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**5.7%**		**653**	**Wood Waste**	**14.9%**		**1,699**
Newspaper	0.7%	0.9%	83	Dimensional Lumber	8.0%	5.9%	906
Uncoated OCC/Kraft Paper	4.2%	6.2%	477	Pallets and Crates	1.5%	1.7%	172
High-grade Paper	0.0%	0.0%	0	Engineered Wood	0.2%	0.3%	20
Low-grade Paper	0.4%	0.6%	48	Other Untreated Wood	0.0%	0.0%	0
Waxed OCC	0.0%	0.0%	0	Painted Wood	0.4%	0.6%	46
Pizza Boxes	0.0%	0.0%	1	Treated Wood	0.7%	0.9%	78
Compostable/Soiled Paper	0.0%	0.0%	3	Remainder/Composite Wood	4.2%	4.4%	478
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	1				
Non-comp. Single-use Food Service Paper	0.0%	0.0%	1	**C&D Waste**	**14.2%**		**1,620**
Remainder/Composite Paper	0.3%	0.4%	39	Concrete	1.9%	2.4%	212
				Clean Drywall	0.0%	0.0%	0
Plastic	**3.2%**		**367**	Other Drywall	0.5%	0.9%	60
#1 PET Bottles	0.2%	0.2%	17	Asphalt Paving	0.0%	0.0%	2
#2 HDPE Bottles	0.0%	0.0%	3	Asphalt Shingles	0.0%	0.0%	0
#1-#7 Other Containers	0.0%	0.0%	2	Other Asphalt Roofing	0.0%	0.0%	0
Expanded Polystyrene Food grade	0.0%	0.0%	0	Insulation	0.0%	0.0%	0
Expanded Polystyrene Non-food Grade	0.0%	0.0%	0	Carpet	3.3%	2.9%	375
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0	Carpet Padding	0.4%	0.7%	47
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	0	Soil, Rocks, and Sand	0.0%	0.0%	0
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	0	Ceramics and Brick	0.0%	0.0%	0
Other Clean PE Film	0.0%	0.0%	0	Remainder/Composite Construction	8.1%	11.4%	925
Other Film	0.1%	0.1%	15				
Durable Plastic Products	1.4%	1.1%	162	**E-Waste**	**3.1%**		**347**
Remainder/Composite Plastics	1.5%	1.7%	168	Televisions and CRTs	3.1%	5.0%	347
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**1.7%**		**195**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	0.0%	0.0%	3	Other Consumer Electronics	0.0%	0.0%	0
Green Glass Containers	0.0%	0.0%	2				
Brown Glass Containers	0.0%	0.0%	3	**Household Hazardous**	**0.0%**		**0**
Plate Glass	0.5%	0.6%	60	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	1.1%	1.8%	128	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**17.0%**		**1,935**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.0%	0.0%	4	Dry-cell Batteries	0.0%	0.0%	0
Aluminum Foil/Containers	0.0%	0.0%	0	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	3.3%	3.2%	372	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.1%	0.1%	8	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.3%	0.5%	34	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	2.4%	3.9%	269	Medical Wastes	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	3.6%	4.3%	411	House Cleaners and Chemicals	0.0%	0.0%	0
Remainder/Composite Metal	7.4%	6.3%	837	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**29.8%**		**3,388**	**Other Waste**	**10.3%**		**1,172**
Food Waste, Vegetative	1.3%	1.6%	145	Furniture	7.2%	4.7%	814
Other Food Waste	0.0%	0.0%	0	Tires	0.0%	0.0%	0
Leaves and Grass	6.9%	6.5%	783	Mattresses	3.1%	2.7%	358
Prunings and Trimmings	16.6%	10.5%	1,884	Non-distinct Fines	0.0%	0.0%	0
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	**Totals**	**100.0%**		**11,376**
Remainder/Composite Organic	0.3%	0.3%	35	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	Material	Est. Percent	+/-	Est. Tons
Paper	**4.3%**		**274**	**Wood Waste**	**43.0%**		**2,760**
Newspaper	0.0%	0.0%	1	Dimensional Lumber	15.2%	8.2%	977
Uncoated OCC/Kraft Paper	2.6%	1.3%	165	Pallets and Crates	8.6%	8.7%	550
High-grade Paper	0.1%	0.1%	6	Engineered Wood	3.0%	2.0%	191
Low-grade Paper	0.4%	0.5%	26	Other Untreated Wood	0.1%	0.2%	7
Waxed OCC	0.0%	0.0%	0	Painted Wood	11.8%	6.8%	758
Pizza Boxes	0.0%	0.0%	0	Treated Wood	3.0%	2.9%	189
Compostable/Soiled Paper	0.4%	0.7%	27	Remainder/Composite Wood	1.4%	1.0%	88
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	0				
Non-comp. Single-use Food Service Paper	0.0%	0.0%	0	**C&D Waste**	**27.6%**		**1,773**
Remainder/Composite Paper	0.8%	0.6%	50	Concrete	3.6%	3.4%	233
				Clean Drywall	2.3%	3.4%	149
Plastic	**5.0%**		**323**	Other Drywall	3.8%	2.9%	245
#1 PET Bottles	0.0%	0.0%	2	Asphalt Paving	0.3%	0.5%	18
#2 HDPE Bottles	0.0%	0.0%	0	Asphalt Shingles	0.0%	0.0%	0
#1-#7 Other Containers	0.1%	0.1%	4	Other Asphalt Roofing	1.3%	2.1%	84
Expanded Polystyrene Food grade	0.0%	0.0%	0	Insulation	0.1%	0.1%	5
Expanded Polystyrene Non-food Grade	0.1%	0.1%	3	Carpet	6.0%	4.5%	386
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0	Carpet Padding	2.1%	1.7%	135
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	0	Soil, Rocks, and Sand	3.2%	4.9%	205
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	1	Ceramics and Brick	1.2%	1.4%	76
Other Clean PE Film	0.2%	0.3%	12	Remainder/Composite Construction	3.7%	2.6%	237
Other Film	1.1%	0.8%	72				
Durable Plastic Products	1.0%	0.8%	63	**E-Waste**	**1.2%**		**75**
Remainder/Composite Plastics	2.6%	2.7%	165	Televisions and CRTs	1.1%	1.2%	68
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**3.5%**		**222**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	0.0%	0.0%	0	Other Consumer Electronics	0.1%	0.2%	7
Green Glass Containers	0.0%	0.0%	0				
Brown Glass Containers	0.0%	0.1%	3	**Household Hazardous**	**0.1%**		**4**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.1%	0.1%	4
Remainder/Composite Glass	3.4%	2.2%	219	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**9.7%**		**623**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.0%	0.0%	2	Dry-cell Batteries	0.0%	0.0%	0
Aluminum Foil/Containers	0.0%	0.0%	0	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.6%	0.8%	39	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.2%	0.4%	15	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.0%	0.0%	0	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.0%	0	Medical Wastes	0.0%	0.0%	0
Oil filters	0.2%	0.3%	13	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	5.4%	6.3%	344	House Cleaners and Chemicals	0.0%	0.0%	0
Remainder/Composite Metal	3.3%	1.8%	209	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**5.0%**		**324**	**Other Waste**	**0.6%**		**36**
Food Waste, Vegetative	0.1%	0.2%	7	Furniture	0.4%	0.5%	26
Other Food Waste	0.1%	0.2%	9	Tires	0.1%	0.1%	5
Leaves and Grass	0.8%	0.8%	49	Mattresses	0.1%	0.1%	6
Prunings and Trimmings	0.3%	0.4%	17	Non-distinct Fines	0.0%	0.0%	0
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	**Totals**	**100.0%**		**6,413**
Remainder/Composite Organic	0.2%	0.3%	15	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	Material	Est. Percent	+ / -	Est. Tons
Paper	**1.1%**		**67**	**Wood Waste**	**44.3%**		**2,690**
Newspaper	0.0%	0.0%	0	Dimensional Lumber	21.9%	9.7%	1,332
Uncoated OCC/Kraft Paper	0.5%	0.3%	31	Pallets and Crates	0.4%	0.4%	25
High-grade Paper	0.0%	0.0%	0	Engineered Wood	1.9%	1.4%	116
Low-grade Paper	0.0%	0.0%	3	Other Untreated Wood	4.9%	7.1%	298
Waxed OCC	0.0%	0.0%	0	Painted Wood	7.4%	6.7%	448
Pizza Boxes	0.0%	0.0%	0	Treated Wood	5.6%	3.4%	342
Compostable/Soiled Paper	0.0%	0.0%	0	Remainder/Composite Wood	2.1%	1.3%	129
Pot. Comp. Single-use Food Service Paper	0.0%	0.0%	0				
Non-comp. Single-use Food Service Paper	0.0%	0.0%	0	**C&D Waste**	**47.0%**		**2,855**
Remainder/Composite Paper	0.5%	0.5%	32	Concrete	5.1%	4.1%	307
				Clean Drywall	1.9%	1.9%	118
Plastic	**1.4%**		**84**	Other Drywall	10.1%	5.4%	615
#1 PET Bottles	0.0%	0.0%	1	Asphalt Paving	0.0%	0.0%	0
#2 HDPE Bottles	0.0%	0.0%	1	Asphalt Shingles	3.1%	3.6%	187
#1-#7 Other Containers	0.0%	0.0%	0	Other Asphalt Roofing	7.7%	7.6%	469
Expanded Polystyrene Food grade	0.0%	0.1%	2	Insulation	0.3%	0.4%	16
Expanded Polystyrene Non-food Grade	0.8%	1.3%	51	Carpet	1.6%	1.4%	94
Pot. Comp. Single-use Food Service Plastic	0.0%	0.0%	0	Carpet Padding	0.2%	0.2%	9
Non-comp. Single-use Food Service Plastic	0.0%	0.0%	0	Soil, Rocks, and Sand	6.5%	8.2%	392
Clean Shopping/Dry Cleaning Bags	0.0%	0.0%	0	Ceramics and Brick	5.4%	5.6%	328
Other Clean PE Film	0.0%	0.0%	0	Remainder/Composite Construction	5.3%	4.1%	320
Other Film	0.2%	0.2%	15				
Durable Plastic Products	0.1%	0.0%	4	**E-Waste**	**0.1%**		**5**
Remainder/Composite Plastics	0.2%	0.1%	9	Televisions and CRTs	0.1%	0.1%	5
				Computers and Flat Monitors	0.0%	0.0%	0
Glass	**0.7%**		**43**	Computer Peripherals	0.0%	0.0%	0
Clear Glass Containers	0.0%	0.0%	2	Other Consumer Electronics	0.0%	0.0%	0
Green Glass Containers	0.0%	0.0%	0				
Brown Glass Containers	0.0%	0.0%	0	**Household Hazardous**	**0.0%**		**0**
Plate Glass	0.0%	0.0%	0	Pesticides and Herbicides	0.0%	0.0%	0
Remainder/Composite Glass	0.7%	0.9%	41	Fluorescent Lighting	0.0%	0.0%	0
				Asbestos	0.0%	0.0%	0
Metal	**2.4%**		**143**	Paints, Solvents, and Adhesives	0.0%	0.0%	0
Aluminum Beverage Cans	0.0%	0.0%	0	Dry-cell Batteries	0.0%	0.0%	0
Aluminum Foil/Containers	0.0%	0.0%	0	Wet-cell Batteries	0.0%	0.0%	0
Other Non-ferrous	0.5%	0.6%	33	Gasoline/Kerosene	0.0%	0.0%	0
Tin Food Cans	0.0%	0.0%	0	Motor Oil	0.0%	0.0%	0
Empty Aerosol Cans	0.0%	0.0%	0	Vehicle and Equipment Fluids	0.0%	0.0%	0
Major Appliances	0.0%	0.1%	2	Medical Wastes	0.0%	0.0%	0
Oil filters	0.0%	0.0%	0	Pharmaceuticals	0.0%	0.0%	0
Other Ferrous	1.0%	0.9%	58	House Cleaners and Chemicals	0.0%	0.0%	0
Remainder/Composite Metal	0.8%	0.6%	50	Other Potentially Hazardous	0.0%	0.0%	0
Organics	**1.8%**		**112**	**Other Waste**	**1.2%**		**73**
Food Waste, Vegetative	0.0%	0.0%	0	Furniture	0.6%	0.6%	37
Other Food Waste	0.0%	0.0%	0	Tires	0.0%	0.0%	0
Leaves and Grass	1.2%	1.2%	71	Mattresses	0.4%	0.4%	25
Prunings and Trimmings	0.4%	0.4%	24	Non-distinct Fines	0.2%	0.2%	10
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	**Totals**	**100.0%**		**6,071**
Remainder/Composite Organic	0.0%	0.0%	2	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:

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

where:

- $\bar{w} = \frac{\sum_i w_i}{n}$.
- **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:

$$t = \frac{\left(r_{j,d_a} - r_{j,d_b}\right) - 0}{\sqrt{\dfrac{\mathrm{Var}\left(r_{j,d_a}\right)}{n_{d_a}} + \dfrac{\mathrm{Var}\left(r_{j,d_b}\right)}{n_{d_b}}}}$$

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 $\alpha=0.001$, $\pm\ t_{\alpha/2}$ 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."

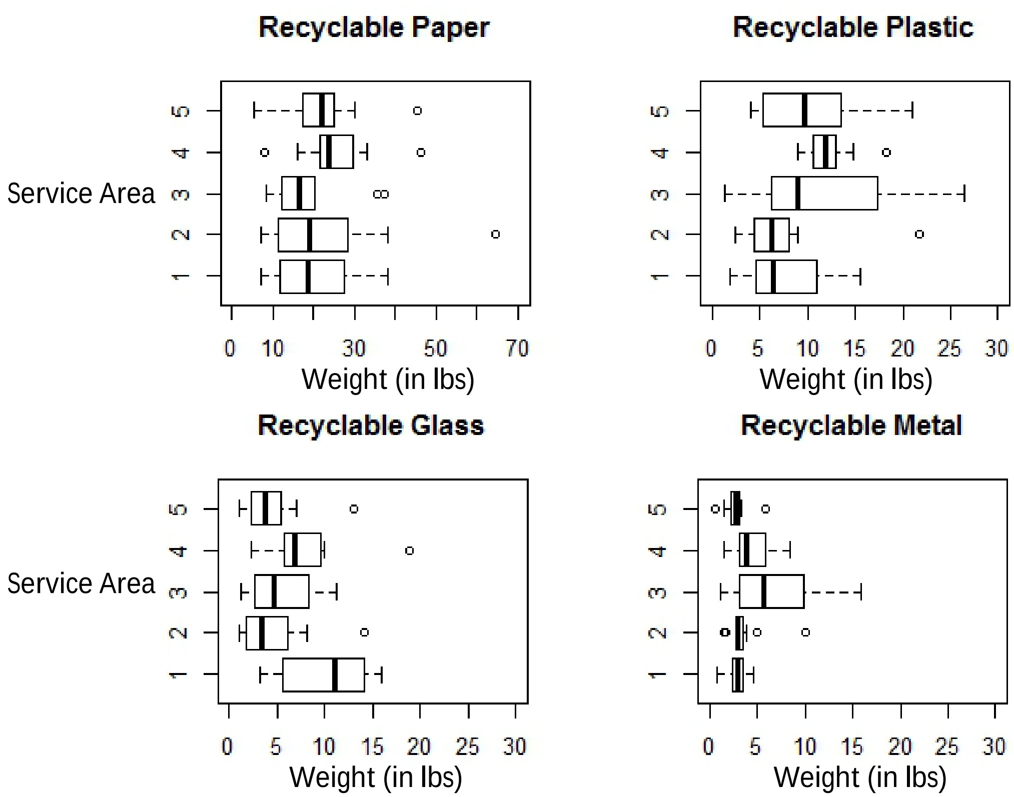
For example, if the t-statistic was calculated to be -25.96, it does not lie between the critical values -3.29 and 3.29. Hence, at 0.001 significance level, we can *reject* the null hypothesis that the true composition estimates of a particular material category are the same for each of two service areas. 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)

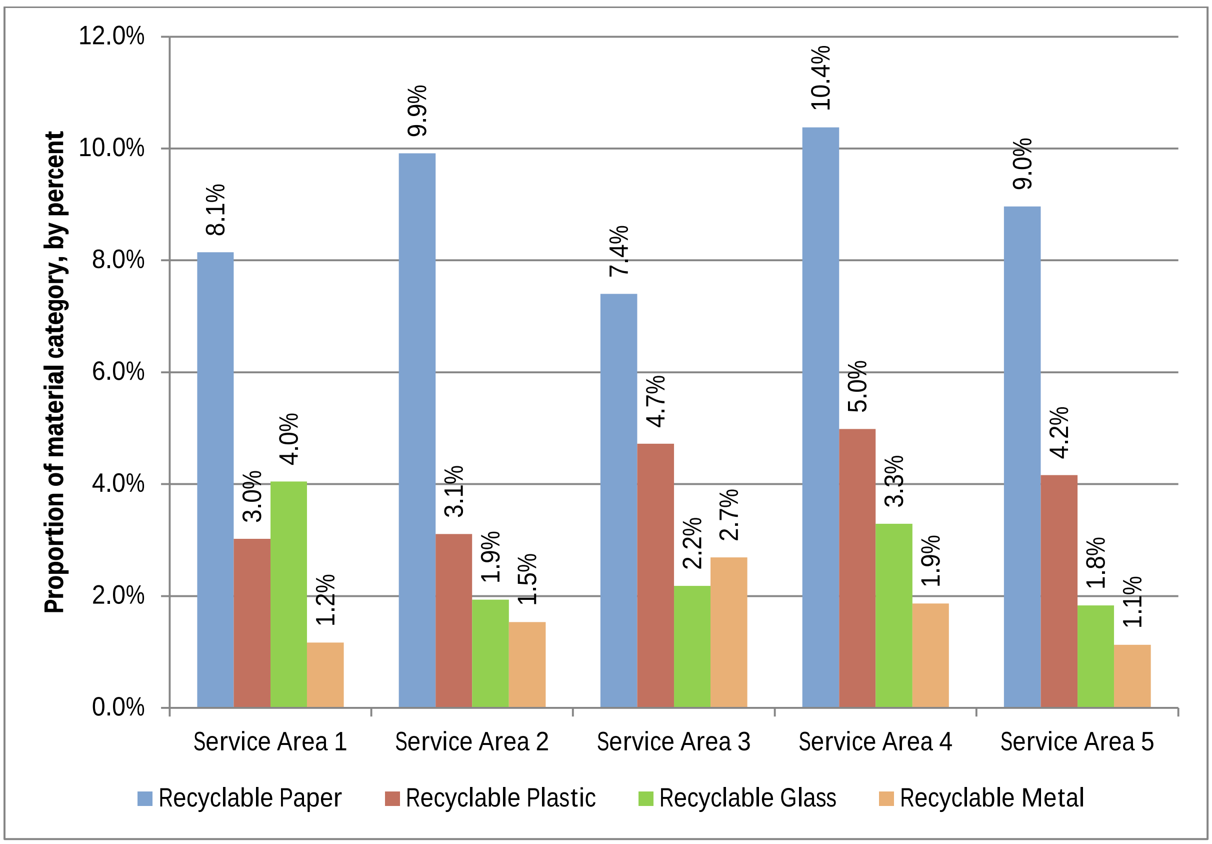


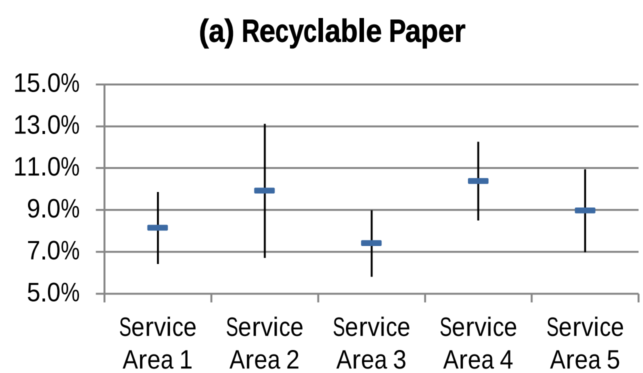
Table E-3 and **Figure E-2** show that:

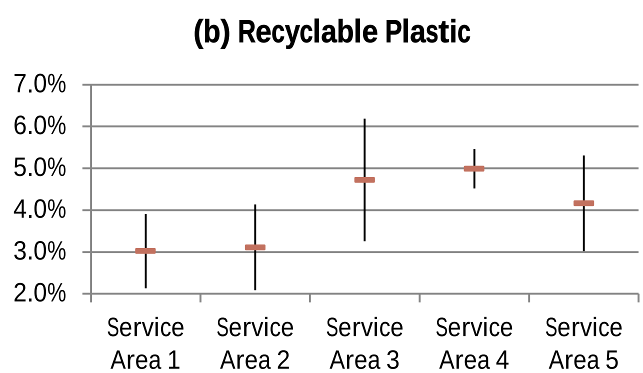
1. The “Other” material category, which represents all non-recyclable materials in the samples, makes up between 80% and 84% of the total sample weight in all service areas.

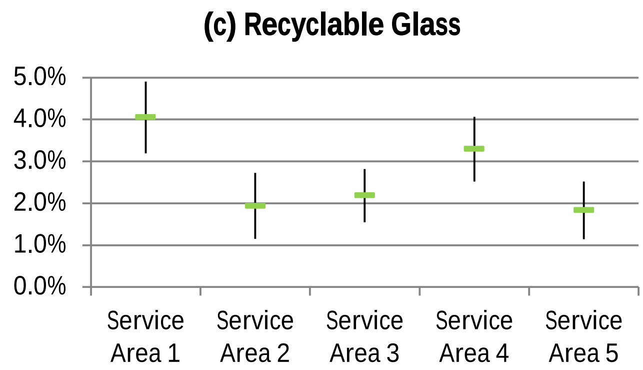
2. In other words, the recyclable portion of the disposed waste samples was around 16% to 20% in the samples analyzed across the five service area.
3. The composition percentages for the recyclable categories appear similar across the five service areas.
4. Recyclable paper is the largest recyclable 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.

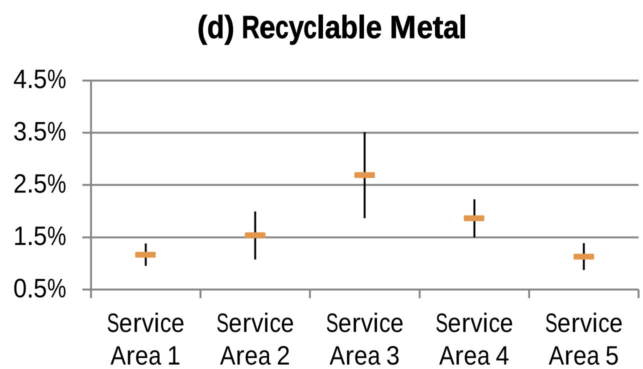
Figure E-3a-d presents the percent composition estimates and their corresponding confidence intervals for each individual recyclable material category, by service area. A visual comparison of the position of the percent composition estimates and the confidence interval bar overlaps indicates the likelihood 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

Tally Sheet - Page 1

2015 Tacoma Waste Composition Study

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

Tally Sheet - Page 2

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:

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	RL - Rear Loader
P - Pickups	FL - Front Loader
V - Van	SL - Side Loader
T - Other	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

Sampler ________ Day ________ Route ________ Totals: SO ________ Samples ________

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

Truck Number: **RA1003**

Load: 2

Route Number: **G002**

SF-1

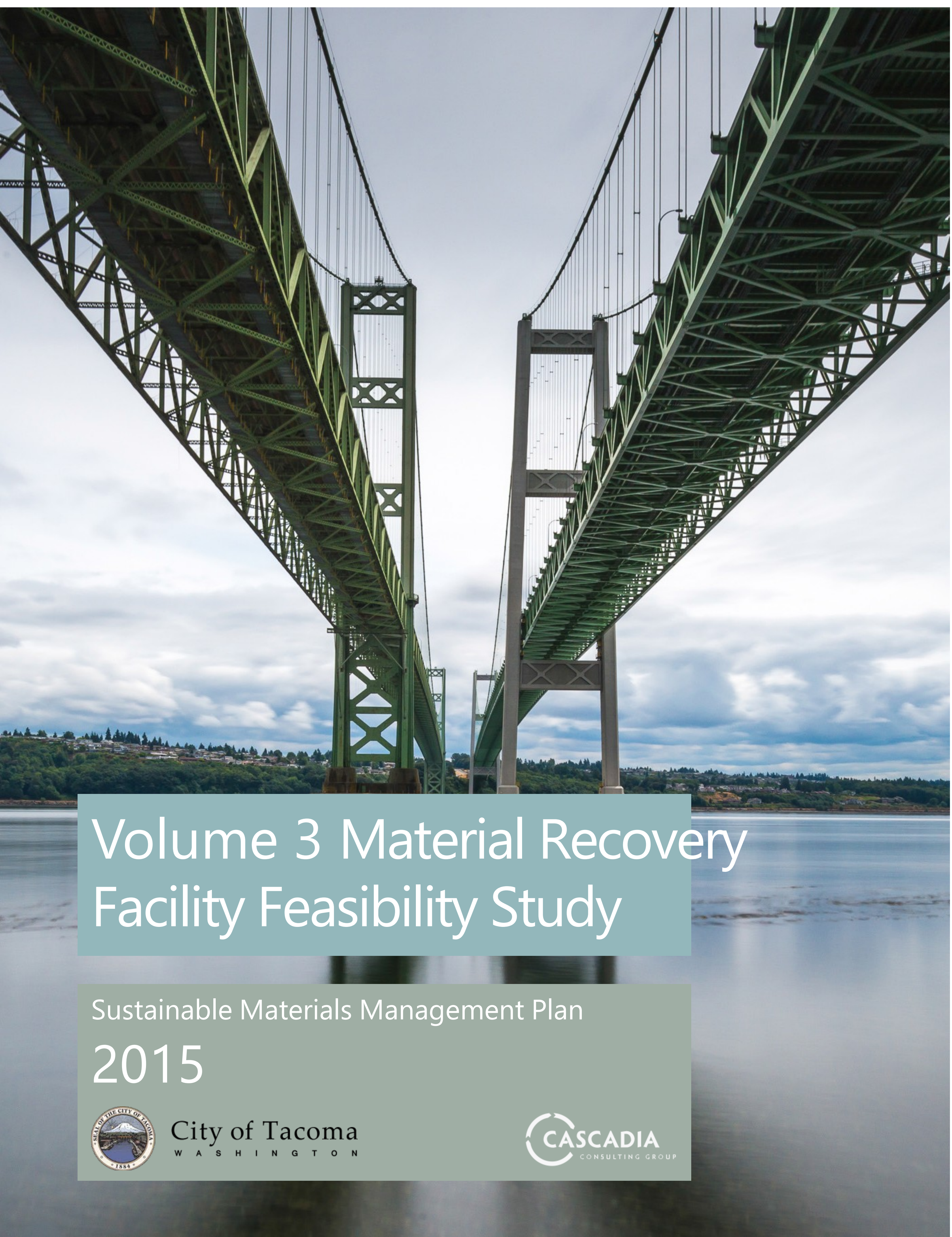
SINGLE FAMILY RESIDENTIAL

5/11/2015

Cell Number: 14

Figure F-8. Net Weight Cards

1	**2**
Net Weight:______________	**Net Weight:**______________
3	**4**
Net Weight:______________	**Net Weight:**______________
5	**6**
Net Weight:______________	**Net Weight:**______________



Volume 3 Material Recovery Facility Feasibility Study

Sustainable Materials Management Plan

2015

City of Tacoma
WASHINGTON

CASCADIA
CONSULTING GROUP

Table of Contents

List of Tables

List of Figures

Chapter 1. Introduction

The City of Tacoma (City) provides a full range of solid waste and recycling services to residences and businesses. These services include curbside garbage, recycling, and yard waste collection, as well as options for self-haul customers, including household hazardous waste (HHW) drop-off located at the Tacoma Recovery and Transfer Center (TRTC). Collection and facility operations are provided by the City's Solid Waste Management Division (SWM), which operates as part of the City's Environment Services Department.

The City's SWM is committed to:

- Providing prompt, considerate, and reliable customer service in a professional manner.
- Implementing processes and technologies to make their services fiscally sound and environmentally sustainable.

The City has maintained its commitment to sustainable waste management by providing a wide range of waste prevention, reduction, reuse, and recycling services to residences and businesses. SWM supports these services with a comprehensive public education and promotional information program.

1.1 Purpose

Consistent with its sustainability policies, the City has adopted a goal to achieve a 70% recycling rate by 2028. The results of this feasibility report will be considered in conjunction with sustainability programs to determine the best approach for attaining this goal. This report focuses on the amount of material that could be recovered in an advanced (mixed waste) material recovery facility (MRF). The City already collects source-separated recyclables from residential customers and processes those recyclables at Waste Management's JMK MRF. To achieve higher recycling rates, the City would need to process non-construction and demolition (C&D) waste (also known as mixed commercial waste) to recover additional materials discarded by businesses and institutions. This can also include multifamily residences. Another waste stream that could be processed at an advanced MRF is waste delivered by self-haul customers.

The purpose of this report is to evaluate employing an advanced MRF to recycle and/or divert from disposal at landfills increased quantities of materials. The evaluation involves determining the cost of building, equipping, and operating a facility as well as estimating how much material can be recycled. Using waste composition data from the 2015 spring and fall sampling programs conducted by Cascadia Consulting Group, the project team has identified and evaluated the following four MRF options for processing different waste streams:

1. Commingled residential recyclables
2. Commingled residential recyclables, non-C&D commercial waste, and multifamily waste
3. Commingled residential recyclables and high-grade non-C&D commercial waste
4. Commingled residential recyclables, high-grade non-C&D commercial waste, and high-grade non-C&D self-haul waste

Option 1 evaluates whether it is cost effective to build a stand-alone commingled MRF. Options 2 through 4, on the other hand, consider separately processing both clean commingled recyclables and mixed waste on an integrated processing line. This approach is consistent with current trends to install equipment that can handle various waste streams.

1.2 Background

Before evaluating MRF options to help the City meet its recycling goals for the future, it is important to consider the current collection system, the current processing system, and the markets for commodities.

1.2.1 Current Collection System

SWM provides curbside recycling to single-family residences, multifamily residences, and businesses, as discussed below.

1.2.1.1 SINGLE-FAMILY CURBSIDE RECYCLING

SWM provides single-family residences, including duplexes, with separate carts in which to place garbage, recyclable materials, recyclable glass, and yard debris. Garbage, commingled recyclables, and glass are collected every other week. Yard waste is picked up in a separate cart during the opposite weeks. Residential garbage collection service is mandatory in the City of Tacoma, but recycling and yard debris collection service are voluntary. In 2014, SWM provided garbage service to 54,346 residential customers. Of these customers, about 97% (52,636 residences) participated in the recycling collection program. This represents a high voluntary participation rate when compared to many other cities where between 70% and 80% of residences voluntarily participate in recycling collection programming.

SWM provides single-family residential customers with two containers for their recyclables: one for glass and one for all other commingled recyclables. Drivers currently pick up commingled materials using an automated side-loader and manually unload glass into a separate compartment in the same truck. SWM keeps glass out of the commingled recycling stream to maintain the quality and value of both glass and other commingled recyclables.

At TRTC, SWM operates a recycling center that offers customers the option to drop off source-separated recyclables, appliances, metal, electronics batteries, and other materials.

1.2.1.2 MULTIFAMILY CURBSIDE RECYCLING

SWM provides curbside collection of recyclable materials for tri-plexes and four-plexes. Larger complexes within SWM's service area have also expressed interest in recycling program participation, so SWM designs and delivers programs for apartment complexes and condominiums upon request.

The recycling services provided to multifamily residences is the same as that provided to single-family residences: one container for glass and another container for all other commingled recyclables. This program has been popular, and in 2014, 1,089 customers in multifamily apartment or condominium complexes subscribed to recycling services.

1.2.1.3 COMMERCIAL CUSTOMER CURBSIDE RECYCLING

SWM also offers curbside collection of recyclable materials to commercial customers on a voluntary basis. SWM provides commercial recycling customers with one container for glass and another container for all other commingled recyclables.

In 2014, SWM collected approximately 2,000 tons from 2,170 commercial customers. Note that commercial customers can subscribe to services with private recycling companies. These companies pick up recyclables such as old corrugated cardboard (OCC) and mixed paper from commercial customers. SWM does not have tonnage records related to those transactions. SWM is currently collecting yard waste from a small number of commercial customers and food waste on a pilot basis from about 70 businesses.

1.2.1.4 CURBSIDE RECYCLING PROGRAM EVALUATION

For the City of Tacoma, recovering more materials depends on implementing programs aimed at educating customers and encouraging them to participate in recycling. Programs for providing incentives or encouraging more recycling could increase recovery rates. A complementary approach could include targeting waste streams that contain larger amounts of recyclable materials and developing the infrastructure to process and sort materials to divert from disposal. This might include adding more single-family households to collection or expanding multifamily and commercial recycling. In addition, it is important to consider front end programs aimed at eliminating or reducing recyclable materials from the waste stream.

There may be sustainability programs and policies that can encourage higher participation in recycling collection programs, particularly in the multifamily and commercial sectors. Most communities do not provide direct collection services. SWM has potential to offer more collection services to businesses and institutions and to develop an integrated system.

1.2.2 Current Processing System

After collecting recyclables from residences and businesses, SWM delivers all commingled recyclables to Waste Management's JMK MRF. However, this MRF processes only source-separated materials from residential and commercial generators.

Waste Management purchased JMK in 2013 and retrofitted the existing JMK MRF with updated technology and added a glass removal system. Given these improvements, Waste Management informed SWM that collecting glass separately was no longer necessary. However, SWM continues to collect glass separately: they have a well-established two-stream collection system with high participation rates, and customers have grown accustomed to separating glass. Also, SWM had concerns that commingling the glass with the rest of the recycling stream could contaminate the commingled stream and impact commodity values.

A feasibility study completed in June 2015 indicated that it was not cost effective for SWM to build a dedicated MRF for processing the current recycling stream. It did show that if the amount materials to be processed increased to over 30,000 tons per year, building and operating a MRF might be cost effective for the City. Another factor that might determine the feasibility for SWM to move forward with building a MRF is the future of SWM's contractual agreement with Waste Management to process the materials at the JMK MRF.

1.2.3 Markets for Commodities

Recycling programs throughout the Pacific Northwest have been in place for over 20 years. As such, markets for most materials from local MRFs are established. Some of these markets are local, and others are overseas. These markets are fairly stable, but are subject to variations in domestic and international commodity prices. The feasibility analysis estimated potential revenue from materials recovered by averaging commodity prices for key recyclables over the past 10 years. These prices were based on reports from local processors to the City of Seattle. However, the prices for recycled commodities have been depressed over the past 2 years. Lower oil prices have contributed to a reduction in markets for recycled plastics, and recycled metal has been at a low. Mixed paper and OCC prices have also been affected. For the feasibility study, the 10-year average market price was used. In addition, the financial analysis was performed considering the average market price minus 3 years of the highest market prices. This approach presents a more realistic picture of the recycled commodities market if a recession were to occur. Market conditions will always have ups and downs, but most materials have established markets, and prices vary within certain ranges.

The average prices are shown in **Table 1**.

Table 1. Commodity Prices Averaged Over the Past 10 Years

Commodity	10-Year Average Scenario ($ per ton)	Low Price Scenario ($ per ton)
Baled Aluminum	1,540.00	1,200.00
OCC	115.00	100.00
Mixed Paper	80.00	60.00
Baled Old Newsprint (ONP)	80.00	65.00
Plastic	390.00	260.00
Tin	215.00	110.00
Brown Glass	20.00	17.50
Clear Glass	23.00	17.50
Green Glass	2.50	2.50
Average Glass	16.00	16.00

Although using average market price is appropriate for estimating the potential revenue from the sale of materials, it is important to acknowledge the volatility of the market prices. In 2009, the average market price across all commodities was 25% lower than the average for the prior 6-year period. Similarly, 2015 prices were about 30% lower than the average for the prior 6-year period. Over the past 10 years, the markers appear to be stable but fluctuate significantly over short periods of time. MRF operators need to plan cash flow to account for such events.

1.2.3.1 OFFSHORE MARKETS AND "GREEN FENCE"

China's "Green Fence" was a national policy imposed by the Chinese government Customs Bureau from February to November 2013. This policy, which resulted in the rejection of incoming bales of recyclables that did not meet China's recyclable material acceptance standards, was based on Chinese reports that countries had been sending highly contaminated bales of material to China under the classification of recyclables. The policy prohibited the following:

- Arriving recovered fiber products (paper, cardboard) with more than 1.5% contamination in the form of rejected paper materials
- Arriving materials with a moisture content greater than 12% on an air-dry basis
- Arriving recovered plastics with more than 2% contamination in the form of rejected plastic materials

The policy resulted in a short-term but dramatic shift in the commodity price that China paid for recyclables, particularly fiber products, as well as a shift in the behavior of recyclers worldwide. Conversations with several recycling company representatives and Unites States government officials indicated that recycling practices have changed as a result of the prohibition. China accepted baled fiber shipments containing relatively high quantities of soiled or moist paper and fiber bales containing rejects (primarily film plastics but also mixed plastics and some organics) before the Green Fence, but rejected them once the Green Fence was in place. To assess Green Fence compliance, Chinese port inspectors visually scanned shipping container contents to assess the condition of the load, rejecting those that appeared to exceed allowable levels of contamination. According to United States officials, the Chinese inspectors used foul odor as a key indicator for the high moisture content parameter. As a consequence, recyclers whose practice had been to allow moist or soiled paper or cardboard in bales of paper sent to overseas markets were some of the hardest impacted by the Green Fence.

China was able to impose its Green Fence prohibition because it is one of the largest global users of recyclable products. The International Solid Waste Association reports that China plays a key role in the acceptance of United States recycling materials:

- In scrap commodities, China accounts for 42% of all Unites States exports—at a value of about $9.5 billion.
- In 2012, China bought 68% of the United States' exports of aluminum scrap, 70% of its recovered paper, and 58% of its plastics scrap.
- China receives 70% of the world's plastic waste exports.

Green Fence prohibitions officially ended in November 2013. However, United States recyclers need to expect that China will continue to use methods similar to the Green Fence if commodity quality declines again. Recyclers should plan on modifying operations to produce bales of recyclable products with the least amount of contamination possible, particularly moisture, soiled paper, or organic waste in fiber products. Due to this situation, the following key findings should inform the design of any new MRF:

- Mixed (single stream and/or mixed waste) processing facilities need to remove contaminants (broken glass, film plastics, organics) to the maximum extent possible. Consequently, the infeed rate of the processing line, particularly the initial screening mechanism, needs to be operated to allow thorough screening of these materials. Overloading the screen with too high a throughput will likely result in the screen being "blinded" by the excess quantity of material and thereby unable to perform its mechanical function of separating two-dimensional (fibers) from three-dimensional (rejects) materials.

- Following the screening mechanism, manual observation and removal of moist or organic soiled fibers is necessary to prohibit the transmission of high moisture content fibers. Again, the Chinese officials use foul odor as the key indicator for the presence of high moisture. Removal of soiled paper is necessary to prevent the biological degradation of the fibers during the shipping process.
- Similar mechanical and manual processes are needed for plastic products. Plastics containing liquids will need to be removed, or the facility will need to employ a perforating process to remove as much of the liquid as possible. Baled plastics containing glass, ceramics, or mixtures of non-spec plastics (film or lower grade) are more likely to be rejected than uniformly graded plastics.

In summary, markets for recycled commodities are established and are fairly mature in the both the United States and abroad. For plastics, markets abroad are stronger, with the United States plastics market continuing to grow. Markets are increasing demand for cleaner materials with stricter rules for less contamination. The Institute of Scrap Recycling Industries (ISRE) has recently issued new guidance reducing the percentage of prohibitives (i.e., contaminants) in recyclable materials, and as mentioned, Asia has enforced the "Green Fence" policies for cleaner materials from MRFs. Many of the MRFs with newer technologies can meet these challenges.

Chapter 2. Material Recovery Facility Design

2.1 Typical MRF Equipment

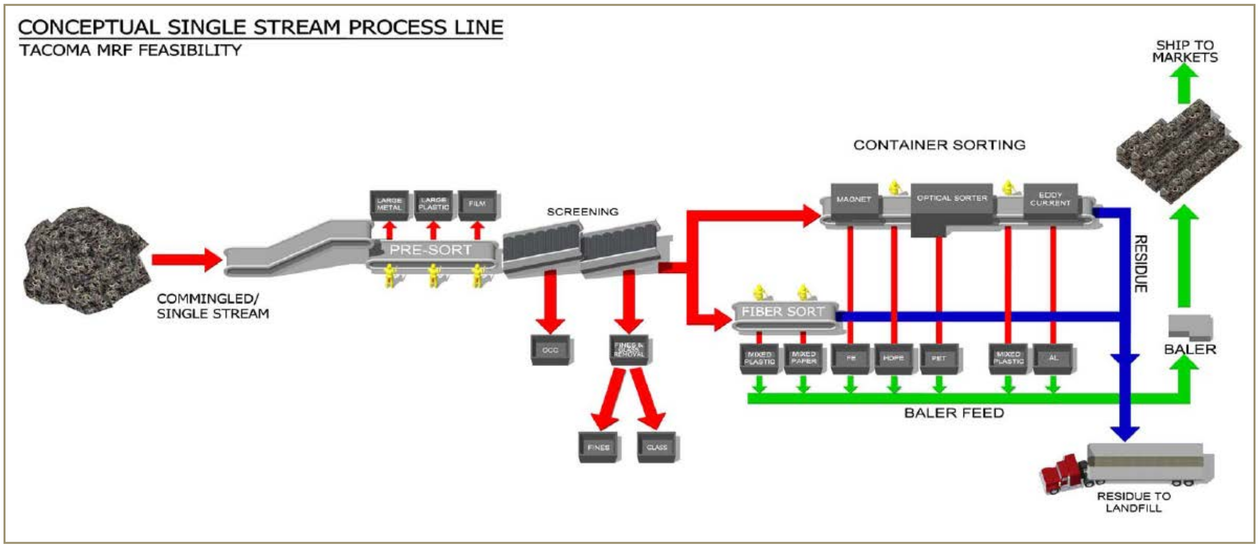
One of the key factors in developing a successful recycling program and building a MRF is to ensure that the collection programs being implemented are compatible or in sync with the process technology installed at the MRF. The following provides an overview of the typical equipment that might be used in a MRF to maximize the recovery of materials.

2.1.1 Conceptual Plan for MRF

The MRF technology used to process commingled recyclables from residential and commercial customers is fairly advanced. Processing waste and recyclables has been commonplace for over 25 years. As such, the basic conveyors, screens, magnets, and eddy current separators are developed and tested technologies. In particular, screening equipment is now designed to reduce plugging and wrapping from plastics, wire, cables, etc., and can be easily maintained.

Advances are continually being made and new technologies developed to increase separation efficiencies and reduce labor costs. One such technology is optical sorters, which identify different grades of paper or various resin types in plastic and can instantly separate these from the other materials. Air density and flexibility separators are also used to sort two-dimensional and three-dimensional items. Current technologies being used throughout the industry are described below for each step of the separation process. **Figure 1** shows key components of a typical single-stream recyclables processing line.

Figure 1. Typical Commingled Process Equipment



Step 1. Tipping Floor

City collection trucks deliver commingled recyclables to the MRF and pile the recyclables on the tipping floor. The MRF operators check the pile to ensure that no oversized or problematic objects are among the recyclables. Operators then load recyclable materials onto an in-ground conveyor belt or feed an above-ground hopper that feeds the conveyor belt. After loading, operators can add a drum feeder or leveling bar to the system to equalize distribution of material. While this is an optional feature, a drum feeder or leveling bar is highly recommended for larger systems to ensure that the material loads are equally distributed. This allows sorting staff to receive a more consistent supply of material to maximize process line production while the front end loader operator is able to charge the infeed conveyor as well as address other tasks such as staging incoming material or removing a bulky object.

Step 2. Pre-Sorting

The commingled recyclables are fed onto a pre-sort platform area; sorters extract materials such as large rigid plastics, metals, film, and other large pieces that cannot pass through the single-stream recycling processing equipment. Plastic bags, film plastic, fabric, hoses, or other contaminants should also be removed during pre-sorting because they can wrap around the processing equipment, creating jams or influencing the performance of the screens. The sorters may be able to open the occasional plastic bag to extract recyclables.

Step 3. Screening

Old Corrugated Cardboard Screening

Next, the recyclable materials pass through an OCC screening process in which bulky cardboard and mixed paper are removed from the waste stream. The OCC screening process uses screens that contain large gaps where small material can fall through and large cardboard materials flow on top. These large cardboard materials are then collected, cleaned at a quality control station, and baled.

Fines and Glass Removal

During the initial screening process, smaller materials (i.e., less than 2 to 3 inches in diameter) fall through onto a separate conveyor and are removed from the larger containers and fiber materials. Also during this process, glass bottles are broken and fall through the screen. The materials referred to as fines are made up of dirt, grit, and some small pieces of plastics and shredded paper. In most cases, the inert fines and glass materials can be used as alternative daily cover at landfills or possibly as clean fill for select uses. In California, where the state has a bottle deposit law, clean glass from containers has a redemption value credit. This factor, along with the fact that mills are more stringently monitoring the amount of outthrows in bales, including glass, have led to development of equipment to remove glass. Therefore, many MRFs throughout the country either include equipment to recover the glass from the fines or design the processing line such that glass removal systems can be easily added. In these MRFs, the fines and glass are conveyed to a secondary screening process to remove the glass using various technologies. One approach is to use micro screens in combination with air density separation. After the glass has been removed, it may be recycled.

Step 4. Fibers Sorting

As the commingled materials continue over the remaining screens, larger flat materials and fibrous materials continue to ride on top of the screens and are then conveyed to a sort line. The plastic containers, tin cans, and aluminum cans fall through the screens onto a separate conveyor. Fibrous materials include white ledger, mixed paper, old newspaper, cardboard, and other various grades of paper. These materials are conveyed to a platform that contains several stations to manually sort the different paper streams to meet market conditions. Some MRFs, particularly ones that handle large throughputs (i.e., greater than 30 tons per hour) might use optical sorting equipment to separate the various grades. Optical sorting equipment is expensive, but it is very efficient and can accurately identify and sort specific grades of paper to increase quality control. This reduces potential contamination and can also improve market quality. Optical sorters are beginning to be able to identify moisture content as well, thus further improving product quality.

Step 5. Container Sorting

The screening process separates the containers from the fibers. The container sorting process uses a variety of equipment such as magnets, eddy currents, and optical sorters to further separate the various containers. Many types of plastics have a market value. PET (such as water and soda bottles), HPDE (such as milk jugs), and PP or #5 plastic containers have a fairly high value in market place. Other plastics such as film and rigid plastics can be recycled, but the markets as less predictable. To maximize revenue, these less valuable plastics must be separated from higher value plastics and containers. The following describes some of the technologies employed to separate the containers to achieve maximum recycling rates.

Magnetic Separator

Magnets are used to separate metal containers or other items from the sort line conveyor. There are a few types of magnets. Belt magnets run at a 90 degree angle to the sort conveyor, pick up ferrous metal items, and transfer them to a hopper or container. A drum magnet is used at the end of the sort conveyor and will pick ferrous metal objects off and drop them onto a secondary transfer conveyor. The arrangement of the magnet and proximity to the conveyor are important for efficient operation. This technology is well developed and a part of almost all MRF equipment lines.

Eddy Current Separator

The eddy current separator uses different magnetic field technology to recover aluminum materials. The eddy current separator employs a magnetic field that induces electrons in aluminum, creating another magnetic field known as an eddy field. When the eddy field interacts with the separator's magnetic field, it causes the aluminum material to be pushed off the main conveyor onto another conveyor that leads to a collection bin. Like the standard magnets, the eddy current separation unit is well developed, and because of the value of recycled aluminum, it is a key piece of equipment even in places where bottle bills have been adopted. Due to the light weight of the aluminum containers and the ejection action of the eddy current separator, often it is best to place the separator after the point of recovery of most other containers on the sorting line.

Optical Sorter

An optical sorter uses a series of laser sensors and/or cameras that span the entire conveyor to scan and read the characteristics of the materials as they pass under them. The optical sorter identifies the items by the chemical composition and uses air blast to dislodge those items from the main conveyor. This technology evolved from the agricultural industry where it was used to separate damaged products and prevent them from being delivered to markets. The advance of micro-processors has allowed this technology to advance to where it can be used most effectively and efficiently in MRF operations.

The value of the optical sorter is that it can accurately identify materials and pick them off the line four to six times faster than manual sorters, and it does not get tired or lose efficiency across the shift. The transport conveyor used for optical sorters is generally much wider and faster than conveyors for manual sorters to allow for better display of each individual container. Thus, optical sorters allow more consistent material screening, and because it is a mechanical process, it reduces the risk of injury to sort line laborers.

Optical sorting is typically used more frequently for sorting PET and HDPE plastics from the container lines because these items have a higher market value than other recyclables. In recent years, optical units have begun being used on the fiber sort line also because of accuracy and efficiency. Optical sorting is more common in larger MRFs because of the need to increase throughput. The bottom line is that optical sorting can be used to sort any materials because the sorters can be adjusted to identify whatever materials are being targeted.

Manual Sorting

While the various magnets, eddy current separators, and optical sorters have made significant inroads in MRF processing, there are still facilities and situations where manual sorters are used extensively. Often manual sorters provide quality control and remove the occasional contaminant from an optical sorter misfire or remove non-beverage can aluminum from the aluminum product stream to significantly increase the product quality and value. In addition, manual sorters still play a major role in recovery of missed materials in residue lines. Containers with a percentage of the fluid remaining may be too heavy for the optical sorter to eject, or the sorter may identify an issue with a particular optical sorter before significant quantities of product are lost. Smaller MRFs may still operate with all manual sorting for fiber and containers because the cost of the optical sorters may be higher than the increased revenue.

Step 6. Baled Materials / Shipping

The recovered material, such as aluminum, PET, HDPE, mixed plastic, or mixed paper, is fed to a baler. A single bale is approximately 5 feet by 4 feet by 3 feet with the weight varying from 1,000 to as much as 1,500 pounds or more depending on the material and the size and type of baler. These bales of materials are loaded onto trucks or placed in containers to ship to local mills or to overseas markets.

Step 7. Residue Disposal

When processing commingled materials, there is always a residue: materials that either are contaminated or do not have market value. The amount of residue can vary greatly depending on the community and city. Programs that have been in place for many years and are supported by a well-managed education and promotional information base tend to have fewer residues. This is true for most cities in the Pacific Northwest, like Tacoma where the amount of residue averages less than 7% of incoming recyclables overall. Other cities can see as much as 25% to 30% residue in the residential commingled recyclables stream. The national average is 15%, as reported by the United States Environmental Protection Agency. This residue is loaded into trucks or containers and is transported to a solid waste disposal site.

2.1.2 Equipment and Cost

The cost for equipment and installation for a typical single stream or commingled process line is estimated to range from $5.5 M to $7.5 M for the processing equipment. The difference in the cost depends on several factors, including throughput requirements and unit processes, such as screens, air separators, and optical sorters. The decision of how much equipment is installed includes weighing the benefits of added capital cost against the cost of operations and how much labor is needed. For instance, if the MRF is designed to process 35 to 40 tons per hour, there will need to be more equipment and therefore added capital cost. If the MRF is designed to process 20 to 30 tons per hour, the initial capital cost may be less, but labor cost may be more. Owners and operators need to evaluate these factors to decide what system is best suited for their situation.

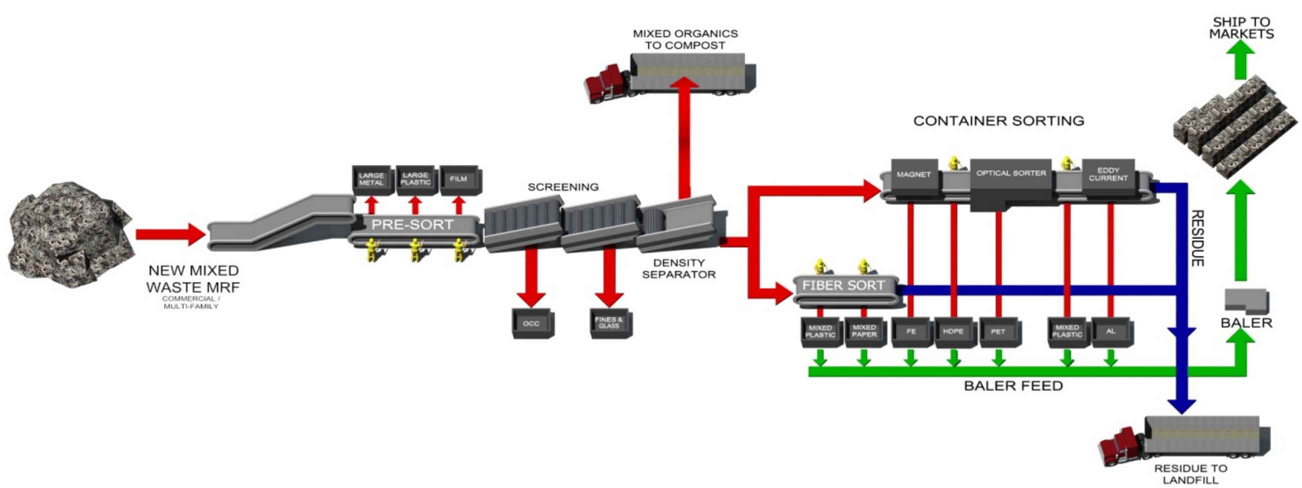
2.2 Mixed Waste MRF Equipment

The following provides an overview of the equipment that might be used for an integrated mixed waste MRF.

2.2.1 Conceptual Plan for Integrated Mixed Waste MRF

An integrated MRF system is designed to process both commingled and mixed waste. The integrated MRF system would use many of the same components as does a commingled or single stream recovery system. The main difference between the two is that the integrated line would include additional screening in the initial phase or would be front end designed to remove the wet organics fraction from the mixed waste stream. In a typical commingled waste stream, the amount of organics in the waste stream is minimal or none, so including screens to remove organics is unnecessary. However, in a mixed waste MRF, the waste streams have a significant amount of organics (estimated to be between 25% and 35%) that must be removed in the initial screening process to avoid contamination to fibers and containers that have a higher market value. Glass that is mixed with the organics can be removed with additional equipment or can be further processed at the compost site. **Figure 2** shows a typical mixed waste MRF with organics being removed immediately after the pre-sort screen. Some mixed waste MRFs are designed to remove the dense fines made up of food waste and wet mixed organic materials prior to the pre-sort. By removing the heavy organic fraction first, the material on the sort line is less dense, making it easier for sorters to remove larger items such metal, wood, or other bulky items. Mixed waste MRFs are common and are in operation across the United States.

Figure 2. Typical Mixed Waste Process Equipment



As shown in **Figure 2**, after the front-end screening and pre-sort operations, the back end of the equipment line is similar to that of a commingled sort line. The process line would typically include additional air separation and optical sorters to separate the various commodities for sale to markets. Because most of the equipment is interchangeable for processing different waste streams, there is a trend to build integrated MRF equipment to process mixed waste or commingled materials on a single system.

2.2.2 Equipment and Cost

The cost for equipment and installation for an integrated MRF processing line is estimated to range from $13 M to $16 M (2016 dollars). The difference in the cost depends on several factors, including throughput requirements and unit processes, such as screens, air separators, and optical sorters. The decision of how much equipment is installed includes weighing the benefits of added capital cost against the cost of operations and how much labor is needed. However, with the increasing pressure from markets to produce higher quality materials, more technology is desirable. In this case, a system that costs $13 M will have much of the equipment needed to meet the demand for high quality materials. However, if the process line needs to operate with higher throughput, then additional equipment would be needed, increasing the cost. The equipment line to process both commingled and mixed waste must include technology that is effective in removing the organics in the early stages of the process to prevent contamination.

Chapter 3. Material Recovery Facility Options

Chapter 1 listed four MRF options that would provide the highest potential for recovering recyclable materials from various waste streams. An important consideration when developing these options was to maintain the quality of the recovered material to increase its marketability. Using the advanced MRF technology available in 2016, the project team analyzed the potential recovery of materials from each waste stream or a combination of waste streams considering an integrated processing equipment line. This chapter summarizes the results of that analysis.

The summary focuses on the system performance and the estimated amount of materials recovered. It also includes the financial performance of each MRF option. The buildings and the equipment to be used for each MRF option would be similar, but the amount of materials processed and recovered would vary. Therefore, the operating parameters for each option would be different, as would the cost and revenue. The operating parameters and assumptions as well as financial information for each MRF option are presented in the *Basis of MRF Design Technical Memorandum* in **Appendix A**.

The results for each MRF option are used in conjunction with material recovery estimates from the sustainability plan scenarios to inform the decision as to the most feasible and practical approach for meeting the City's goals.

3.1 Waste Composition Analysis

The four MRF options were evaluated using the waste composition data from the spring and fall sampling events conducted in 2015. Waste data were compiled and analyzed from each of the major waste streams collected by SWM, including the following:

1. Commingled / single stream from residential, multifamily, and commercial accounts as reported by Waste Management
2. Commercial non-C&D waste as collected by SWM
3. Multifamily waste streams as collected by SWM
4. Self-haul waste delivered by public vehicles to the TRTC

The raw data were combined from the two sampling periods for 84 different material classifications. These data were then compressed into 31 materials in the following six categories:

- Traditional recyclables – mostly commodities with higher market values
- Other recyclables – materials that also are marketable but at less value
- Organics / food waste
- Organics – Yard waste, green waste, and compostables
- Construction and demolition – mostly wood and inerts
- Non-recyclables

Once the data were compressed into these primary categories, the data were used to evaluate different MRF options.

The waste composition data from the 2015 spring and fall sampling programs were combined with recovery rates reported from industry experience to evaluate the estimated quantities of potential recyclable materials from each of the waste streams. The main categories addressed were paper, plastics, glass, metals, wood, and organics including food waste, mixed organics, compostable paper, and yard waste.

The analysis of the waste composition also provides a potential range of recovery with different options. It is assumed that due to a combination of load selection and contamination, a portion of the material in both waste streams will not be fully recoverable. The detailed tables for the waste composition and estimated recovery rates are presented in **Appendix A**.

3.2 Option 1: Commingled Residential Recyclables

The initial feasibility evaluation for Option 1 was completed on June 30, 2015. It is based on previous waste data and analysis of the City's current collection practices. Factors that may contribute to increases in residential commingled materials, such as new programs or services identified in the City's sustainability plan, can be taken into account in Option 1 if needed.

3.2.1 Potential Material Recovery

SWM collects just over 17,000 tons of commingled materials from residential and commercial customers. In addition, SWM receives another 5,000 tons of recyclable materials at the TRTC. Glass from residences, which is currently collected separately, represents almost 3,000 tons per year. As indicated in a *MRF Feasibility Report* prepared for the Department of Ecology in June 2015, it is possible to install equipment to effectively remove glass from the commingled stream without causing a significant impact on the price of the commodities. SWM can elect to continue to collect glass separately, but for this analysis, it is assumed that glass would be processed and recovered in the MRF.

Assuming that all materials are processed, the MRF would have a nominal capacity to process 25,000 tons per year. If the MRF operates 5 days per week, then it would process 92 tons per day. The process rate can vary depending on the technology used and level of sorting labor. For instance, MRFs using high levels of technology can operate at a throughput of 35 to 40 tons per hour, while a MRF operating at a smaller scale with less material could range from 20 to 30 tons per hour. For this analysis, it is assumed that the MRF throughput would be 25 tons per hour.

Currently, SWM delivers collected residential and commercial commingled recyclables to Waste Management's JMK MRF. Recyclable materials that the City recovered in 2014 are summarized in **Table 2**. These amounts include both material the City collected from residential and commercial curbside customers, and material dropped off at the TRTC. The residential and commercial curbside recycling tons are based on reports from Waste Management's JMK MRF provided to SWM. For this feasibility study, these quantities were modified using recovery rates for a typical MRF, so only the estimated recovered and residual amounts are reported below. The TRTC sends mixed fibers and containers to Waste Management's JMK MRF to bale and ship, whereas the TRTC markets other materials, like metal, directly to recyclers.

As shown in **Table 2**, cardboard, mixed paper, and ONP made up almost 70% of the tons collected for recycling in 2014. Glass also made up a large portion (13%) of the total.

Table 2. Recycling Material Recovered by the City of Tacoma in 2014

Recyclables	Tons	% of Total
Cardboard	2,273	9
Mixed Paper	11,424	46
ONP	3,455	14
Glass Containers in Commingled	191	1
Glass Collected Separately	2,954	12
PET Plastics	329	1
HDPE Plastics	199	1
Ferrous Metal	1,392	6
Aluminum	209	1
Wood/Lumber	0	0
Mixed Plastics #3–#7	284	1
Plastic Film	259	1
Other	0	0
Mixed Plastics	279	1
Residue	1,651	7
Total	**24,900**	**100**

As shown, the current JMK MRF is recovering about 93% of the materials being collected by SWM. With only 7% residue in the commingled stream, the level of contamination is well below the national average of 16% for residential single streams processed at MRFs nationwide. If a new MRF is constructed, it stands to reason that the recovery of materials would be similar or even slightly improved over the current MRF provided that the condition of the materials delivered are comparable.

3.2.2 Financial Results

For Option 1, where commingled residential recyclable materials would be processed, the estimated diversion rate is 94%, with 20,267 tons of material being recycled. The market value of the materials recovered could range from $80 to $116 per ton based on the 10-year average of all commodity prices in the Pacific Northwest. The lower price in the range reflects the average over this same period but discounts the 3 years with the highest market prices. The reason is that periods of recessionary prices do occur and should be recognized when considering the financial risk associated with operating a MRF.

Table 3 shows the estimated cost of Option 1.

Table 3. Option 1 Revenue Summary

	Option 1
Material Recovery	
Tons Recycled	20,267
Tons Composted	0
Tons Landfilled	1,267
Total Tons Processed	**21,534**
Diversion Rate	94%
Revenue Requirements	
MRF Operations	$1,578,508
Debt Services	$1,492,794
Total Expenses	**$3,071,302**
Expenses per Ton	$143
Revenue	
Tip Fee Revenue	$0
Material Sales	$2,270,109
Average Net Sale Price	$112
Organics to Compost	$0
Total Revenue	**$2,270,109**
Revenue per Ton Processed	$105
Net Revenue	**$ (801,193)**
Per Ton	$ (37)

For Option 1, the cost to build a new MRF to process commingled residential recyclables is estimated to be over $800,000 per year or $37 per ton. Currently, the City has a contract with Waste Management to process at the JMK MRF for about $41 per ton. However, the City has a revenue sharing agreement that in 2014 provided a return of $24 per ton. Thus, the net revenue to the City historically has been about $300,000 per year or $17 per ton. Unless the business terms of this arrangement change or services are discontinued, Option 1 is not practical to implement. It does not offer opportunity to increase recovery over present recycling rates.

3.3 Option 2: Commingled Residential Recyclables, Non-C&D Commercial Waste, and Multifamily Waste

Option 2 considers processing the non-C&D commercial and multifamily waste stream in addition to commingled residential recyclables using an integrated material recovery equipment line. The analysis considers waste from multifamily and commercial/institutional customers that is primarily delivered by automated front loaders.

3.3.1 Potential Material Recovery

Under Option 2, SWM would process all of the commingled residential, multifamily, and non-C&D commercial material currently disposed of. SWM collects about 58,000 tons of mixed commercial waste generated by businesses and institutional customers. These results represent data from two quarters of the year. Based on waste composition data, this waste stream was found to contain between 25% and 30% of traditional and other recyclable materials, including wood waste. (Note: This does not include C&D waste.) In addition to the traditional and other recyclable material, the commercial waste contains over 30% of food waste, compostable paper, and green waste. This material can be separated by processing on a mixed waste MRF line. Assuming a market can be developed for the food waste and mixed organics, then between 55% and 64% of the commercial waste could be diverted from landfill disposal. Likewise, the composition of the waste collected from multifamily residences shows similar opportunities.

Using these data, the analysis evaluated processing both the non-C&D commercial waste and multifamily waste streams. This is a practical assumption because many of SWM's automated front load routes collect from both commercial and multifamily units in the same trucks.

Table 4 presents the estimated amount of materials to be recovered from the mixed commercial and multifamily waste stream.

Table 4. Non-C&D Commercial and Multifamily Waste Stream Summary

Recovery of Recyclables	Tons	% Recyclables
Newspaper	524	0.9
OCC/Cardboard	1,848	2.9
Paper (Mixed)	3,791	6.3
#1 and #2 Bottles	956	1.5
#1–#7 Other Containers	319	0.5
Clean Bags and Film	637	1.0
Durable Plastics (Rigids)	1,338	2.1
Recyclable Glass (Containers)	1,147	1.8
Aluminum/Beverage Cans	202	0.3
Other Aluminum	67	0.1
Other Non-Ferrous	64	0.1
Tin Food Cans	336	0.5
Other Ferrous	1,479	2.2
Metals	0	0.0
Wood/Lumber	5,210	9.2
Total Commodities	**12,724**	**71**
Total Recyclables	**17,934**	**100**
Recovery of Organics/Compostables	**Tons**	**% Compostables**
Food Waste	13,138	68%
Mixed Organic	4,587	24
Green Waste / Yard Waste	1,586	82
Total Compostables	**19,310**	**100**
Non-Recoverable/Trash	33,542	47
Total	**70,786**	**100**

Of the recovered material, almost 19,000 tons (27%) would be compostable organics, and higher-value commodities would make up about 13,000 tons (19%). The waste data show that potentially 5,000 tons of clean wood waste could also be recovered. This represents untreated woody debris that can be ground up for mulch. Total potential diversion is estimated to be about 53% of the commercial material.

In addition to processing mixed waste, the MRF is designed to process the commingled materials. Therefore, in total, the MRF would have the capacity to process 100,000 tons of waste per year or 380 tons per day. In order to process this waste stream, the MRF would need to operate over 16 hours or in two 8-hour shifts.

3.3.2 Financial Results

For Option 2, the MRF would be an integrated equipment line that would process over 90,000 tons per year. The MRF equipment needed to process these materials are estimated to cost between $13 M and $16 M. The building and other facility capital costs are estimated at $26 M. These initial capital costs are amortized (debt service expenditures) over the operating life and included in the financial analysis.

The integrated MRF process line for Option 2 would be capable of processing 400 tons per day over two shifts. The annual labor and operating expenditures are shown in **Table 5**.

Table 5. Option 2 Revenue Summary

	Option 2
Material Recovery	
Tons Recycled	38,201
Tons Composted	19,310
Tons Landfilled	34,809
Total Tons Processed	**92,320**
Diversion Rate	62%
Revenue Requirements	
MRF Operations	$5,212,583
Debt Services	$3,338,757
Total Expenses	**$8,551,340**
Expenses per Ton	$93
Revenue	
Tip Fee Revenue	$0
Material Sales	$4,039,511
Average Net Sale Price	$106
Organics to Compost	$0
Total Revenue	**$4,039,511**
Revenue per Ton Processed	$44
Net Revenue	**$(4,511,829)**
Per Ton	$ (49)

The total gross operating expenses for Option 2 would be $8.5 M or $93 per ton for processing 92,000 tons per year.

Because Option 2 would process both commingled recyclables and mixed waste, an estimated 38,000 tons or 41% of marketable commodities are estimated to be recovered from the process line. This includes commingled materials collected from the City's residential recycling program. Assuming a 10-year average market value for these materials, revenues are estimated to be $4 M per year.

The integrated MRF system is expected to recover 19,000 tons per year or 21% of food waste and mixed organics that could potentially be composted or processed in an anaerobic digester (AD) system to recover renewable energy. This is a common practice in Europe, and several AD facilities are being developed in California. In this financial analysis, no cost or revenue is assigned to processing the mixed organic stream. However, this material has the potential to be processed and to increase the overall recycling rate for the City.

In summary, it is estimated that it would cost the City about $50 per ton to recycle an additional 18,000 tons of recyclables from the commercial and multifamily waste streams. (Note that 20,000 tons are already recycled from the commingled waste stream.) If the organics can be recycled, then this would increase to almost 40,000 tons. This cost is net of revenue from the sale of recovered commodities.

The financial analysis does not account for any expected avoided cost the City might experience under Option 2. Currently, the 70,000 tons of mixed waste processed at the MRF is being accepted at the TRTC and transported to a landfill. If this material were to be processed at the MRF, then the total tons transported to the landfill would about 35,000 tons per year or half that without the MRF. The financial analysis did not include this potential savings. However, if the City would actually avoid transporting and paying the disposal cost for the estimated 35,000 tons per year, then this would present an additional cost benefit that should be considered.

3.4 Option 3: Commingled Residential Recyclables and High-Grade Non-C&D Commercial Waste

Option 3 is similar to Option 2 in that it is designed to process both the commingled residential and non-C&D commercial waste currently disposed of. However, Option 3 assumes that the City would alter commercial collection routes to generate commodity-rich or dry loads that would contain less food waste. An example would be for a front load truck to be scheduled to collect waste from businesses such as banks and office complexes, which generate waste with less food waste, separate from restaurants or places with cafeteria waste. The result would be a higher graded load that would contain a higher percentage of recoverable materials and less wet or organic waste.

3.4.1 Potential Material Recovery

3.4.1.1 HIGH-GRADE GENERATOR BACKGROUND

Certain business sectors generate waste that contains higher percentages of recyclable materials. Waste from generator types such as education, hotel/motel, manufacturing, office, and retail contains higher proportions of recyclable commodities like paper, metal, and plastics, while waste from generators like healthcare and restaurants contains larger proportions of food waste and other organics. Collection trucks could be encouraged to collect loads with high percentages of recyclable content separate from those containing large amounts of food waste or wet waste. These high-grade loads could be delivered to a MRF for processing. This material would be of higher value due to the reduced volume of organic waste.

For Option 3, the waste composition for the high-grade non-C&D commercial waste stream was estimated using non-C&D commercial waste generator data from Seattle Public Utility. As shown in **Table 6**, the data retrieved from the Seattle Public Utility present the breakdown of the waste stream by commercial generator types. The waste composition of the high-grade material waste stream was based on six of these generators whose waste might be collected on separate routes due to their higher percentage of commodities and lower portion of food waste.

Table 6. Non-C&D Commercial Generator Data[1]

Generator	Samples	Paper (%)	Plastic (%)	Metal (%)	Commodities (%)	Food (%)
CDL	2	13	23	0	36	1.20
Education	4	31	9	1	41	20.60
Healthcare	21	16	7	1	24	15.80
Hotel/Motel	6	41	9	3	52	17.50
Manufacturing	7	15	26	5	46	12.30
Office	15	44	15	3	62	21.80
Other Service	19	34	13	3	50	18.50
Restaurants	3	28	14	2	44	53.40
Retail	38	25	15	5	46	30.50
Transportation	8	29	10	5	44	11.70
Wholesale	6	23	18	1	41	55.40
Mixed Commercial Generators	128	24	11	3	38	35.80
Total	**257**					

Note:

1. Obtained from Seattle Public Utility

By selecting the high-grade generators based on a percentage of commodities (>40%) and low percentages of food waste (<25%), the portion that each commodity and the residual food waste would contribute to the high-grade commercial waste stream was estimated. This was obtained by averaging each commodity and food waste portion from all the values of the selected high-grade generators. As shown in **Table 6**, the generators that were selected as high-grade generators were education, hotel/motel, manufacturing, office, transportation, and other service facilities (highlighted in green). The addition and omission of the retail facilities generator was compared due to the large portion of possibly viable commodities generated from retail facilities. **Table 7** compares the results from including or omitting the retail generator to determine if it would significantly increase the percentage of commodity materials while insignificantly changing the portion of food waste in the high-grade commercial waste stream.

Table 7. Comparison of Results from adding or omitting Retail Generator

Select High-Grade Generator	Paper (%)	Plastic (%)	Metal (%)	Commodities (%)	Food (%)
Without Retail Generator	32	14	3	49	17
With Retail Generator	31	14	4	49	19

As shown in **Table 7**, the addition of the retail generator did not offer any significant increase in commodities, but it did increase the portion of food waste. Although the retail facilities can provide additional commodity tonnage as a generator, it was omitted from the selected high-grade generators due to its fairly large portion of food waste that may cause a significant decrease in material grade by contaminating commodity materials. The large portion of food waste from the retail generator may be indicative of retail employee and customer food waste generation in malls and other large retail establishments that are in close proximity to restaurants.

3.4.1.2 HIGH-GRADE POTENTIAL MATERIAL RECOVERY

For Option 3, an assumption was made that 50% of the commercial waste stream could be collected by systematically modifying routes to produce higher-value loads. The reason is that commercial routes, like residential routes, need to involve the least travel distance to fill the truck to be efficient. Whereas, it is possible to set up certain routes to pass by customers to pick up loads from select generators, it may not always be most cost effective to do so. More analysis is needed to evaluate how adjustments could be implemented to generate high-grade loads in the City. Assuming that 50% of the commercial waste would be high-grade through modified collection, 34,000 tons per year would be processed at an integrated MRF. **Table 8** presents the estimated amount of materials to be recovered from the high-grade non-C&D commercial waste stream.

Table 8. High-Grade Non-C&D Commercial Waste Stream Summary

Recovery of Recyclables	Tons	% Recyclables
Newspaper	289	1.0
OCC/Cardboard	1,836	6.0
Paper (Mixed)	3,468	12.0
#1 and #2 Bottles	428	1.4
#1–#7 Other Containers	306	1.0
Clean Bags and Film	367	1.2
Durable Plastics (Rigids)	1,224	4.0
Recyclable Glass (Containers)	612	2.0
Aluminum/Beverage Cans	97	0.3
Other Aluminum	39	0.1
Other Non-Ferrous	0	0.0
Tin Food Cans	162	0.5

Other Ferrous	485	1.5
Metals	0	0.0
Wood/Lumber	3,101	11.4
Total Commodities	**9,312**	**75**
Total Recyclables	**12,413**	**100**
Recovery of Organics/Compostables	**Tons**	**% Compostables**
Food Waste	5,440	20.0
Mixed Organic	2,448	9.0
Green Waste / Yard Waste	408	1.5
Total Compostables	**8,296**	**100**
Non-Recoverable/Trash	13,291	39
Total	**34,000**	**100%**

Based on waste composition data, the high-grade waste stream was found to contain about 40% of traditional and other recyclable materials, including wood waste. (Note: This does not include C&D waste.) Of this 40%, 12% is paper, which remains less contaminated in dry loads and returns a higher value in the market. As discussed above, collection of commingled and high-grade materials reduces the amount of organics and thus wet contamination of all the recoverable materials. Because both loads are dry, they would be processed on the same MRF equipment.

3.4.2 Financial Results

For Option 3, the MRF would have an integrated equipment line that would process a high-grade non-C&D commercial waste stream along with the residential commingled recyclables stream. Option 3 assumes that the City would alter collection routes to generate commodity-rich dry loads. In this case, the process line would optimize recovery of fibers from high-grade non-C&D commercial loads. The MRF would process an estimated one-third to one-half of the City's commercial waste stream. The design capacity for processing residential commingled recyclables would be 25,000 tons per year or 100 tons per day, unchanged from Option 2, Commingled Residential Recyclables, Non-C&D Commercial Waste, and Multifamily Waste.

The MRF equipment needed to process these materials would be similar to Option 2 and therefore is estimated to cost between $13 M and $16 M. The front end of the process line would be designed to remove food waste and heavy fines as it would in any mixed waste processing system. The building and other facility capital costs are estimated at $26 M. These initial capital costs are amortized (debt service expenditures) over the operating life and included in the financial analysis.

The integrated MRF process line for Option 3 would be capable of processing 225 tons per day over a single shift. Because less material would be processed each day, the annual operating expenses would be lower than in Option 2. The annual labor and operating expenditures are shown in **Table 9**.

Table 9. Option 3 Revenue Summary

	Option 3
Material Recovery	
Tons Recycled	32,680
Tons Composted	8,296
Tons Landfilled	14,558
Total Tons Processed	**55,534**
Diversion Rate	74%
Revenue Requirements	
MRF Operations	$3,704,583
Debt Services	$3,338,757
Total Expenses	**$7,043,340**
Expenses per Ton	$127
Revenue	
Tip Fee Revenue	$0
Material Sales	$3,363,328
Average Net Sale Price	$103
Organics to Compost	$0
Total Revenue	**$3,363,328**
Revenue per Ton Processed	$61
Net Revenue	**$(3,680,012)**
Per Ton	$ (66)

The net cost to the City for Option 3 would be $3.6 M or $66 per ton. Although the net unit cost is higher than the other options, the amount of materials recycled as a percentage processed is 74%, which is higher than the other options. The amount recycled and diverted does assume that mixed organics are processed and recycled.

As with Option 2, the financial analysis does not account for any expected avoided cost the City might experience under Option 3. If Option 3 is considered, then an evaluation of the potential of avoided cost to the solid waste system should be conducted.

3.5 Option 4: Commingled Residential Recyclables, High-Grade Non-C&D Commercial Waste, and High-Grade Non-C&D Self-Haul Waste

Option 4 builds on Option 3, which includes commingled residential recyclables and select high-grade non-C&D commercial waste, with the addition of high-grade non-C&D self-haul waste. Self-haul loads include those taken to the TRTC and unloaded from cars, pickups, and vehicles with trailers. This waste stream contains many recyclable materials that are processed in a MRF and could be recovered.

3.5.1 Potential Material Recovery

Waste composition data from two quarters of the year has shown that the self-haul waste stream contains a relatively high percentage of paper, cardboard, metals, and plastics as well as other materials that could be diverted from the landfill. Of these materials, wood, yard waste, and metal together represented between 30% and 40% of the total waste stream. It is assumed that because these materials are not as desirable to process in a MRF, nor is it the most effective way to recover the materials, the City will embark on a program to reduce the amount of wood and metal at the TRTC. This is a way to improve the quality of the self-haul waste stream. Currently, SWM does floor sorting to remove OCC and wood, so this program could be expanded. When removed, a majority of the remaining materials could be delivered to the MRF to be processed.

For Option 4, commingled residential recyclables, high-grade non-C&D commercial waste, and selected high-grade non-C&D self-haul waste were analyzed. This reflects a scenario in which all possible clean recyclable materials from each waste stream would undergo processing, resulting in a higher waste volume as well as higher recovery potential. Adding high-grade non-C&D self-haul waste to the recovery stream of the other options would result in an additional 6,781 tons of recoverable recyclables. **Table 10** shows the breakout of recyclable materials in the high-grade non-C&D self-haul waste stream.

Table 10. High-Grade Non-C&D Self-Haul Waste Stream Summary

Recovery of Recyclables	Tons	% Recyclables
OCC/Cardboard	924	4.2
Paper (Mixed)	242	1.1
Newspaper	176	0.8
Recyclable Glass Containers	308	1.4
#1 and #2 Bottles	46	0.2
#1–#7 Other Containers	23	0.1
Clean Bags and Film	0	0.0
Tin Food Cans	46	0.2
Other Ferrous	3,461	14.9
Aluminum Cans	23	0.1
Other Aluminum	0	0.0
Other Non-Ferrous	395	1.9
Wood/Lumber	782	4.0
Durable Plastics	353	1.7
Total Commodities	**5,999**	**88**
Total Recyclables	**6,781**	**100**
Recovery of Organics/Compostables	**Tons**	**% Compostables**
Food Waste	724	96.0
Mixed Organic	0	0.0
Green Waste / Yard Waste	27	4.0
Total Compostables	**751**	**100**
Non-Recoverable/Trash	16,918	69
Total	**24,451**	**100**

As **Table 10** shows, of the total 24,000 tons that would be processed, roughly 30% would be recovered. Although the total amount of commodities recovered would be minimal, the material itself would be relatively high in value because the organics/food waste would be very low. **Table 11** shows the total waste stream summary for Option 4, which includes commingled residential recyclables, high-grade non-C&D commercial waste, and high-grade non-C&D self-haul waste.

Table 11. Option 4 Waste Stream Summary

Recovery of Recyclables	Tons	% Recyclables
Newspaper	3,816	9.7
OCC/Cardboard	4,964	12.6

Paper (Mixed)	14,893	37.7
#1 and #2 Bottles	1,044	2.6
#1–#7 Other Containers	823	2.1
Clean Bags and Film	629	1.6
Durable Plastics (Rigids)	1,577	4.0
Recyclable Glass (Containers)	1,106	2.8
Aluminum/Beverage Cans	348	0.1
Other Aluminum	71	0.2
Other Non-Ferrous	671	1.7
Tin Food Cans	266	0.7
Other Ferrous	5,369	13.6
Wood/Lumber	3,883	9.8
Total Commodities	**35,579**	**90.2**
Total Recyclables	**39,462**	**100**
Recovery of Organics/Compostables	**Tons**	**% Compostables**
Food Waste	6,164	68
Mixed Organic	2,448	27
Green Waste / Yard Waste	435	5
Total Compostables	**9,047**	**100**
Non-Recoverable/Trash	31,477	38
Total	**79,985**	**100**

Processing the high-grade non-C&D commercial and self-haul waste streams would produce over 15,000 tons of high-quality materials while processing less than 60,000 tons per year. When accounting for the commingled residential recyclables, the amount of recovered materials increases. Under Option 4, the estimated diversion rate is 61%, with 39,462 tons of material being recycled and an additional 9,047 tons of compostable organics, as shown in **Table 11**. The effect of implementing the high-grade non-C&D commercial waste collection in combination with removing the wood and yard waste from the self-haul would result in a much higher percentage of recoverable commodities. While total recovery under Option 4 would be less than under Option 3, it is important to note that quality of recoverable materials would be higher.

3.5.2 Financial Results

For Option 4, the MRF would have an integrated equipment line that would process the residential commingled recyclables stream, a high-grade non-C&D commercial waste stream, and a high-grade non-C&D self-haul waste stream. As in Option 3, Option 4 assumes that the City would alter collection routes to generate commodity-rich dry loads. In this case, the process line would optimize recovery of fibers from high-grade non-C&D commercial loads, and the large wood and metal would be removed on the tipping floor prior to delivery at the MRF. The MRF would process an estimated one-third to one-half of the City's commercial waste stream. The design capacity for processing residential commingled recyclables would be 25,000 tons per year or 100 tons per day, unchanged from Option 2, Commingled Residential Recyclables, Non-C&D Commercial Waste, and Multifamily Waste.

The MRF equipment needed to process these materials would be similar to Option 2 and therefore is estimated to cost between $13 M and $16 M. The building and other facility capital costs are estimated at $26 M. These initial capital costs are amortized (debt service expenditures) over the operating life and included in the financial analysis.

The integrated MRF process line for Option 4 would be capable of processing 300 tons per day over a single shift. The annual labor and operating expenditures are shown in **Table 12**.

Table 12. Option 4 Revenue Summary

	Option 4
Material Recovery	
Tons Recycled	39,462
Tons Composted	9,047
Tons Landfilled	31,477
Total Tons Processed	**79,985**
Diversion Rate	61%
Revenue Requirements	
MRF Operations	$4,206,083
Debt Services	$3,338,757
Total Expenses	**$7,544,840**
Expenses per Ton	$94
Revenue	
Tip Fee Revenue	$0
Material Sales	$3,438,492
Average Net Sale Price	$87
Organics to Compost	$0
Total Revenue	**$3,438,492**
Revenue per Ton Processed	$43
Net Revenue	**$(4,106,349)**
Per Ton	$ (51)

The net cost to the City for Option 4 is estimated to be slightly more than $4.0 M per year or $51 per ton of waste processed.

As with Options 2 and 3, the financial analysis does not account for any expected avoided cost the City might experience under Option 4. If Option 4 is considered, then an evaluation of the potential of avoided cost to the solid waste system should be conducted.

3.6 Summary of Financial Results

The financial results for Options 1 through 4 are influenced by two main factors. The first factor is throughput, which determines the amount of material being processed in the MRF. As explained in Chapter 2, MRFs using a high level of technology can operate a throughput of 35 to 40 tons per hour. A MRF operating at a smaller scale with less material could range from 20 to 30 tons per hour. Thus the MRF processing the same quantity and quality of material that has a larger throughput per hour will have fewer operating hours. The second factor influencing financial results is the amount of commodities recovered. Recovering and selling more high-quality recyclable material would lead to increased revenues. Of course this can be influenced by market prices, but in the end, the more materials that are recovered, the more revenue that is generated. **Table 13** summarizes revenue for each of the MRF options.

Table 13. Revenue Summary for All MRF Options

	Option 1	Option 2	Option 3	Option 4
Material Recovery				
Tons Recycled	20,267	38,201	32,680	39,462
Tons Composted	0	19,310	8,296	9,047
Tons Landfilled	1,267	34,809	14,558	31,477
Total Tons Processed	**21,534**	**92,320**	**55,534**	**79,985**
Diversion Rate	94%	62%	74%	61%
Revenue Requirements				
MRF Operations	$1,578,508	$5,212,583	$3,704,583	$4,206,083
Debt Services	$1,492,794	$3,338,757	$3,338,757	$3,338,757
Total Expenses	**$3,071,302**	**$8,551,340**	**$7,043,340**	**$7,544,840**
Expenses per Ton	$143	$93	$127	$94
Revenue				
Tip Fee Revenue	$0	$0	$0	$0
Material Sales	$2,270,109	$4,039,511	$3,363,328	$3,438,492
Average Net Sale Price	$112	$106	$103	$87
Organics to Compost	$0	$0	$0	$0
Total Revenue	**$2,270,109**	**$4,039,511**	**$3,363,328**	**$3,438,492**
Revenue per Ton Processed	$105	$44	$61	$43
Net Revenue	**$ (801,193)**	**$ (4,511,829)**	**$ (3,680,012)**	**$ (4,106,349)**
Per Ton	$ (37)	$ (49)	$ (66)	$ (51)

As mentioned for Option 1, the cost to build a MRF for the purposes of processing only the commingled residential recyclables is not feasible as long as the City has the ability to have materials processed at a local privately operated MRF. Construction of a single-purpose MRF may make sense if the financial arrangement with local processors is changed or relocated and the City has to transport materials further, or if the City is able to divert more materials to the MRF. This could be a result of getting more materials from the City or attracting materials from other jurisdictions.

Comparing Options 2, 3, and 4 allows the City to consider a variety of strategies for meeting its recycling goals. Option 3 would recover a higher percentage of the materials processed than other options. However, Options 2 and 4 would recover more materials because a higher volume waste would be processed at the integrated MRF. The unit cost to operate either Option 2 or 4 is similar, but the net annual operating expenses for Option 4 are 10% less.

Chapter 4. Sustainability Programs and MRF Option 4

The City of Tacoma is implementing a variety of sustainability programs, and expects these programs to divert additional materials from landfill through recycling and composting, including wood and yard waste. However, even if these programs reach maximum success, projections indicate that an appreciable quantity of recyclable materials will remain in the waste stream. A MRF could recover a large portion of these remaining recyclable materials from the waste stream.

Rather than investing in building additional MRF capacity at this time, the City's preferred approach to increasing diversion is to implement a series of diversion and sustainability programs targeting different waste generation sectors. Since implementing new programs and changing behavior takes time, Tacoma will monitor the impacts of these programs over the next 5 or 6 years to determine their effectiveness. The results of this program monitoring will contribute to Tacoma's decision to invest in a MRF.

This chapter presents the projected diversion results of implementing selected sustainability programs over the next 5 to 6 years, and the associated impact on the amount of MRF capacity needed in 2028. Section 4.1 quantifies projected sustainability program impacts on waste diversion and disposal through 2028. Section 4.2 presents costs and other considerations related to investing in additional MRF capacity in 2028, along with projected diversion that would result from this increased capacity.

The project team modeled anticipated 2028 material recovery resulting from the selected planned sustainability programs. In addition, the modeling estimated the amount of recoverable materials that would remain in the landfilled waste stream in 2028. This section presents modeling results.

4.1 Expansion of Commingled Collection Programs

The City's sustainability plan indicates that Tacoma will target expansion of its commingled collection programs to multifamily residences and commercial customers. Although commingled collection is currently available to these customers, the participation rate is low. Tacoma predicts that expanding commingled collection programs for multifamily and commercial customers will also encourage increased commingled collection program participation among single-family residences. **Table 14** shows the estimated additional materials that expanded commingled collection programs would collect and recover.

Table 14. Estimated New Commingled Materials in Year 2028

Source	Collected	Commodities Recovered
Residential SF	2,590	1,616
Residential MF	1,510	1,418
Commercial	2,802	1,055
Self-Haul	NA	NA
Total	**6,902**	**4,089**

Tacoma's sustainability plan also suggests targeting self-haul customers to reduce the amount of recyclable items that these customers delivered to the TRTC for disposal. The plan estimates that as many as 2,000 tons of material could be diverted from the landfill by encouraging self-haul customers to recycle those materials rather than delivering them to the TRTC for disposal.

Table 15 considers the impact that expanded commingled collection programs and outreach to self-haul customers would have on the commingled waste stream, and estimates the composition of this new waste stream. This stream would be processed at the advanced MRF in 2028, when the system would go into service.

Table 15. Total Commingled Materials in the Year 2028

Material Processing	Tons
Current Residential Commingled	24,266
Commingled + Sustainability Program	**31,177**
Recovery of Recyclables	**Tons**
OCC/Cardboard	2,946
Paper (Mixed)	13,674
Newspaper	4,050
Recyclable Glass (Containers)	666
#1 and #2 Bottles	968
#1–#7 Other Containers	751
Clean Bags and Film	795
Tin Food Cans	177
Other Ferrous	1,857
Aluminum/Beverage Cans	338
Other Aluminum	82

Other Non-Ferrous	336
Wood/Lumber	85
Durable Plastics (Rigids)	287
Total Commodities	**26,926**
Total Recyclables	**27,011**
Recovery of Organics/Compostables	**Tons**
Food Waste	1,208
Mixed Organic	215
Green Waste / Yard Waste	161
Total AD/Compostables	**1,584**
Landfilled Material	2,582

The amount of materials available for processing at the new MRF is expected to increase to 31,000 tons per year in 2028. Because of the new sustainability programs, 86% of this material is estimated to be recyclable commodities, and about 1,500 tons is projected to be compostable organics.

4.2 Recoverable Materials in Disposed Waste

This modeling effort also produced a projection that identifies what materials will still remain in the disposed waste stream in 2028. A substantial amount of these materials could be targeted for recovery by building or acquiring new integrated MRF capacity.

Table 16 shows the estimated quantities of materials that might be processed and recovered from the high-grade non-C&D commercial waste stream in 2028.

Table 16. High-Grade Non-C&D Commercial Materials in the Year 2028

Material Processing	**Tons**
High-Grade Commercial	33,237
Recovery of Recyclables	**Tons**
OCC/Cardboard	1,538
Paper (Mixed)	2,202
Newspaper	502
Recyclable Glass (Containers)	1,133
#1 and #2 Bottles	775
#1–#7 Other Containers	290
Clean Bags and Film	698
Tin Food Cans	148

Other Ferrous	1,218
Aluminum/Beverage Cans	164
Other Aluminum	42
Other Non-Ferrous	41
Wood/Lumber	2,552
Durable Plastics (Rigids)	770
Total Commodities	**9,520**
Total Recyclables	**12,072**
Recovery of Organics/Compostables	**Tons**
Food Waste	5,113
Mixed Organic	1,916
Green Waste / Yard Waste	2,121
Total AD/Compostables	**9,149**
Landfilled Material	12,015

The amount of high-grade commercial waste is estimated to be about the same as shown previously for Option 4. However, the model indicates that about 20% of this waste stream will be marketable commodities in 2028, which is down from 28% in 2016. The reason for this decrease is that new sustainability programs would drive more recyclables into the commercial commingled collection system.

Table 17 shows the estimated quantities of materials that might be recovered from self-haul waste in 2028. The model that generated these estimates considers new sustainability programs in its estimates. By the model's predictions, many of the higher value materials would be recycled prior to arriving at the MRF, and a large portion of the wood waste and yard debris generated would be diverted through financial incentives and tip floor sorts.

Table 17. Non-C&D Self-Haul Materials in the Year 2028

Material Processing	**Tons**
Self-Haul Mixed Waste	24,327
Recovery of Recyclables	**Tons**
OCC/Cardboard	759
Paper (Mixed)	194
Newspaper	110
Recyclable Glass (Containers)	49
#1 and #2 Bottles	30
#1–#7 Other Containers	17
Clean Bags and Film	1

Tin Food Cans		21
Other Ferrous		715
Aluminum/Beverage Cans		7
Other Aluminum		1
Other Non-Ferrous		268
Wood/Lumber		0
Durable Plastics (Rigids)		439
Total Commodities		**2,611**
Total Recyclables		**2,611**
Recovery of Organics/Compostables	**Tons**	
Food Waste		163
Mixed Organic		114
Green Waste / Yard Waste		1,687
Total AD/Compostables		**1,963**
Landfilled Material		19,753

4.3 Analysis of MRF Option 4 in the Year 2028

This analysis assumes that the City of Tacoma will pursue the concept described in Section 3.5 (Option 4: Commingled Residential Recyclables, High-Grade Non-C&D Commercial Waste, and High-Grade Non-C&D Self-Haul Waste). The process to site, design, and construct the advanced MRF is expected to take several years, with the goal to have the plant operational by 2028. This date is consistent with the City's goals: full operation of an integrated MRF by 2028 would support the City's progress towards meeting the 70% diversion by 2028 goal.

The City would embark on developing an advanced MRF that could either be publically owned and operated or be constructed and operated through a public-private partnership. The analysis in this section assumes an integrated MRF capable of processing commingled materials and high-grade non-C&D commercial and self-haul waste. The MRF would not have the capacity to process wood and yard waste: although some wood would remain in the waste stream, the model assumes that new programs would greatly reduce the amount in the mixed waste streams. The MRF would also process commingled materials collected from all generators, including single-family residences, multifamily residences, and commercial customers.

Using the waste data from the *Volume 2 Municipal Waste Composition Study* and performance information from recently operational advanced MRFs in other North American locations, it is estimated that an additional 41,700 tons of commodities and 12,700 tons of compostables may be recovered in 2028 using the MRF described in Option 4. This represents 61% of the total waste processed at the MRF.

The cost to operate the MRF in 2028 is estimated to be $136 per ton, with revenue estimated to be $63 per ton. Therefore, the net cost to operate the MRF in 2028 is estimated to be $72 per ton. **Table 18** summarizes the amount of material processed and the associated costs projected for the year 2028.

Table 18. Option 4 Costs in the Year 2028

	Option 4
Material Recovery	
Tons Recycled	41,695
Tons Composted	12,696
Tons Landfilled	34,350
Total Tons Processed	**88,740**
Diversion Rate	61%
Revenue Requirements	
MRF Operations	$7,473,319
Debt Services	$4,574,540
Total Expenses	**$12,047,858**
Expenses per Ton	$136
Revenue	
Tip Fee Revenue	$0
Material Sales	$5,621,935
Average Net Sale Price	$135
Organics to Compost	$0
Total Revenue	**$5,621,935**
Revenue per Ton Processed	$63
Net Revenue	**$(6,425,924)**
Per Ton	$ ($72)

This analysis is based on current composition data and current advanced MRF technology. The composition of the waste that the City of Tacoma generates will change over time as consumer habits and packaging innovations evolve. For example, in recent years, the amount of newspaper has decreased while the amount of plastics has increased. Sustainability program implementation will also influence changes in composition. The technology used to recover materials from the waste stream is also constantly evolving. In the past 5 years alone, advances in screening technology, air density separation, and optics have vastly improved the ability of MRFs to recover clean marketable materials from the mixed waste stream.

This MRF feasibility analysis provides the City with information to help plan for the future. Prior to moving forward with any investment in an advanced MRF, it is recommended that the City complete an updated feasibility analysis using new waste composition data and consider evaluating the latest processing technology.

Appendices

Appendix A: Basis of MRF Design Technical Memorandum

Appendix A: Basis of MRF Design Technical Memorandum

In the course of evaluating approaches to increase the recycling rate for the City of Tacoma, four material recovery facility (MRF) options were examined. The amounts of materials are based on sampling events conducted in May 2015 and are used to define the overall parameters for building a MRF(s). Additional waste sampling events will be conducted that will be used to evaluate the overall feasibility for different options. But the data from spring 2015 is used to establish the primary capital and operating parameters for this basis of design (BOD). These parameters are then used to develop the capital and operating cost for completing the feasibility analysis.

The analysis takes into account cost and operational elements (e.g., number of sorters) from recent MRF proposals of similar systems, operations, capacities, and waste streams. The MRF assumes that an equipment line may consist of trommels, a variety of screens, manual sort stations, a ferrous magnet, an eddy current separator, and several optical sorters placed on the both the fiber and plastics lines to enhance quality and throughput that is experienced in the latest facilities. The process lines shown are similar to MRF equipment installed in recent facilities processing similar types of materials. However, the equipment shown and the cost estimates are planning-level schematics, and the actual equipment used may be different depending on the final waste stream to be processed and the selected vendor**.** Technology advances will continue, and vendors are expected to provide the latest technology appropriate for the anticipated material mix determined at the time the project advances.

Recovery rates for the sort lines are included in the model and are based on performance information for mixed waste and commingled MRFs installed and operating over the past few years. The latest technology using a series of optical sorting provides higher throughput rates, lower labor, and enhanced quality of recovered materials.

MRF Options

Option 1: Commingled Residential Recyclables

The initial feasibility evaluation was completed on June 30, 2015. It is based on previous waste data and analysis of the City's current collection practices. This option was updated as necessary to consider factors that may contribute to increasing the amount of source-separated materials from residential or other customers resulting from new programs or additional services identified in preparing the sustainability plan.

See Attachment A, Figure 1, for a process flow diagram.

Table 19 presents estimates of the potential material recovery quantities for Option 1. The estimated quantities reflect the current recovery rates of over 90% for the materials as reported by Waste Management for processing at the JMK MRF. This plant was upgraded with additional equipment by Waste Management recently. A new MRF constructed to handle the material would be expected to achieve similar or perhaps better recovery, but the BOD will use the current data. Note that 2,954 tons of glass is currently collected separately based on the information provided.

Table 19. Option 1 Potential Recovery Range

Commingled Residential	Year 1
Material Processing	
Commingled Materials	17,125
Other Recyclables	4,409
Recovery of Recyclables	
OCC/Cardboard	2,204
Paper	11,183
Newspaper	3,351
Recyclable Glass Containers	186
#1 and #2 Bottles	569
#1–#7 Other Containers	493
Clean Bags and Film	262
Tin Food Cans	58
Other Ferrous	1,423
Aluminum Cans	228
Other Aluminum	33
Other Non-Ferrous	277
Wood/Lumber	0
Durable Plastics (Rigids)	0
Total Commodities	**20,267**
Total Recyclables	**20,267**
Recovery of Compostables	
Food Waste	0
Mixed Organic	0
Yard Waste / Green Waste	0
Total AD/Compostables	**0**
Landfilled Material	**1,267**
Commingled Residential	
Recovery Rate Range	

Recyclables Recovery Rate (of Overall Tons)	94%
Recyclables Recovery Rate (of Recyclable Tons)	100%

BOD INFORMATION

Table 20 and Table 21 summarize the potential processing rate as well as anticipated labor requirements for the processing line.

Table 20. Option 1 Material Process Rate

Option 1 Process Rate	Material Processed (Tons per Year) [1]	Process Rate (Tons per Day) [2]
Commingled Residential Recyclables	17,000	
Recycle Drop Off	4,800	
Glass	3,000	
Total	**25,000**	**100**

Notes:

1. Values are rounded.

2. Assumes operation 5 days per week.

Option 1 Operation Duration	Typical Equipment Processing Rate (Tons per Hr)	System Availability	Operation Duration (Hrs per Day)
Commingled Line	25	90%	5

Table 21. Option 1 Process Line Labor Requirements

Option 1 Labor Requirements	Full Time Equivalents (FTE)	Notes
Supervisor	0.5	
Operators	0.75	Includes forklift, baling
Sort Labor		
Laborer 1	12	
Laborer 2	8	
Total Sort Laborers	20	
MRF Maintenance	1.5	

Note:

1. Labor totals do not include material resale, product delivery, or building maintenance.

Option 2: Commingled Residential Recyclables, Non-C&D Commercial Waste, and Multi-Family Waste

Option 2 includes installation of an integrated equipment line with capabilities to process a mixed waste stream and commingled. These materials would be processed at separate times to maximize recovery efficiency of the single stream material. The analysis considers waste delivered primarily with automated front loaders that typically collect from commercial/institutional and multi-family customers. Based on the spring sort data, there are about 56,000 tons of commercial waste and 14,000 tons of multi-family waste per year. The capacity of the facility might be about 92,000 tpy or 354 tpd. Further evaluation of the waste streams will determine what materials would be processed.

The equipment would likewise be capable of processing about 25,000 tpy or 100 tpd of single stream. At other times, select loads from non-C&D commercial routes and multi-family routes would be processed.

See Attachment A, Figure 2, for a process flow diagram.

System recovery rates would vary depending on several factors, such as the final equipment arrangement/selection, number of sorts, composition of waste, and quality of waste/recyclables. Table 22 provides a range of potential material recovery for the non-C&D commercial and multi-family waste line. See Option 1 for commingled potential material recovery.

Table 22. Option 2 Potential Recovery Range

Non-CD Commercial and Multifamily	**Year 1**	
Material Processing		
Commercial Waste	70,786	
Recovery of Recyclables	**High**	**Low**
OCC/Cardboard	1,848	1,756
Paper	3,791	3,601
Newspaper	542	515
Recyclable Glass Containers	1,147	1,090
#1 and #2 Bottles	956	908
#1–#7 Other Containers	319	303
Clean Bags and Film	637	605
Tin Food Cans	336	319
Other Ferrous	1,479	1,405
Aluminum Cans	202	192
Other Aluminum	67	64
Other Non-Ferrous	64	61
Wood/Lumber	5,210	4,950
Durable Plastics (Rigids)	1,338	1,271
Total Commodities	**12,724**	**12,088**

Total Recyclables	**17,934**	**17,037**
Recovery of Compostables		
Food Waste	13,138	12,481
Mixed Organic	4,587	4,358
Yard Waste / Green Waste	1,586	1,507
Total AD/Compostables	**19,310**	**18,345**
Landfilled Material	**33,542**	**31,865**
Non-CD Commercial and Multi-Family		
Recovery Rate Range	**High**	**Low**
Recyclables/Organics Recovery Rate (of Overall Tons)	53%	50%
Recyclables/Organics Recovery Rate (of Rec/Org Tons)	86%	82%
Commodities Recovery Rate (of Overall Tons)	18%	17%
Commodities Recovery Rate (of Commodity Tons)	89%	85%
Recyclables Recovery Rate (of Overall Tons)	25%	24%
Recyclables Recovery Rate (of Recyclable Tons)	88%	69%
Compostables Recovery Rate (of Overall Tons)	18%	17%
Compostables Recovery Rate (of Compostables Tons)	80%	78%

BOD INFORMATION

Table 23 and Table 24 summarize the potential processing rate as well as anticipated labor requirements for the processing line.

Table 23. Option 2 Material Process Rate

Option 2 Process Rate	Material Processed (Tons per Year) (1)	Process Rate (Tons per Day) (2)
Option 1 Material	25,000	100
Non-C&D Commercial & Multi-Family	76,000	300
Total	**101,000**	**400**

Notes:

1. Values are rounded.

2. Assumes operation 5 days per week.

Option 2 Operation Duration	Typical Equipment Processing Rate (Tons per Hr)	System Availability	Operation Duration (Hrs per Day) (1)
Commingled Line	30	90%	3.8
Commercial Stream Line	35	90%	9.6
Total			**14.4**

Notes:
1. Includes 1 hour break time.
2. Assume 2 shifts.

Table 24. Option 2 Process Line Labor Requirements

Option 2 Labor Requirements	Full Time Equivalents (FTE)	Notes
Supervisor	1.5	
Operators	4	Includes 3 loaders & forklift + 1 baling. Does not include drivers for organics/residue.
Sort Labor		
Laborer 1	12	
Laborer 2	8	
Total Sort Laborers (Per Shift)	20	
Pre-Sort	*6*	
Fibers Post-Sort	*6*	
Containers Line	*6*	
Floaters (QA)	*2*	
MRF Maintenance	5	
MRF Maintenance Sup	*1*	
Mechanical/Electrical	*2*	
Laborers	*2*	

Note:
1. Labor totals do not include material resale, product delivery, or building maintenance.

As shown in Table 23 and Table 24, in order for the MRF to process the amount of materials under Option 2, it would need to operate over two shifts. The financial analysis will account for these labor requirements.

FACILITY PARAMETERS

The facility would require systems to support the material recovery line. These systems may include thickened floor slab or enhanced foundations, power, lighting, compressed air, HVAC, etc. Sort station areas may also require focused lighting and HVAC systems.

A new MRF would require an overall footprint of approximately 400 FT x 200 FT plus office and other employee space (e.g., lockers, restrooms, and break area) of approximately 40 FT x 80 FT. Based on the waste stream projections for Option 2, the MRF would require areas for the following:

- Exterior vehicle maneuvering – 10,000 – 15,000 SF

- Infeed – ~2,000 SF
- Processing equipment line and bin storage – ~15,000 – 25,000 SF
- Tipping floor for commingled (not including exterior maneuvering) – ~3,000 SF
- Tipping floor for commercial/multi-family (not including exterior maneuvering) – ~4,000 SF
- Storage space for commingled – ~3,000 SF
- Storage space for commercial/multi-family – ~6,700 SF
- Bale loading dock / shipping (not including exterior maneuvering) – ~2,500 SF
- Bale storage – ~6,000 SF
- Interior forklift / front loader maneuvering

See Attachment B, Figure 1, for a Generic Conceptual Level Floor Plan.

Option 3: Commingled Residential Recyclables and High-Grade Non-C&D Commercial Waste

Option 3 includes installation of an integrated equipment line with capabilities to process mixed waste and commingled materials. Under this Option 3, it is expected that the City would implement a means to alter collection routes to generate commodity-rich loads. This assumes that waste from commercial customers that might generate a higher percentage of paper, plastics, metals, etc., could be picked up by selectively routing trucks. Waste from customers that generate a higher percentage of food waste or less desirable materials would be collected in separate trucks. Although the commercial waste stream is expected to have less organics and more commodities, the equipment used to process the waste streams under Option 3 are similar to the equipment used under Option 2.

The amount of material that could be collected assuming the City implements a high-grade collection strategy was developed using data from the City of Seattle waste composition study. In this study, Cascadia sampled various commercial generators and found that manufacturing, offices, retail, education, and hotel/motel facilities contain a higher percentage of paper on average than health care, restaurants, and wholesale outlets. The result of selecting certain customers that generate higher amounts of paper, plastics, cardboard, etc., means less food waste and less contamination.

For Option 3, it is assumed that the City would collect 50% of commercial customers to generate high-grade loads to process. In this case, the process line would focus on recovery of fibers from commodity-rich loads. Therefore, 34,000 tons per year (130 tons per day) would be delivered to the mixed waste MRF to process. The equipment would likewise be capable of processing about 25,000 tpy (100 tpd) of commingled. These materials would be processed at different times, therefore allowing staffing adjustments to be made to optimize recovery.

The equipment line would be the same as in Option 2; however, the process line operation duration would be reduced due to reduced tonnage. See Attachment A, Figure 2, for a process flow diagram.

System recovery rates would vary depending on several factors, such as the final equipment arrangement/selection, number of sorts, composition of waste, and quality of waste/recyclables. Table 25 provides a range of potential material recovery for the select high-grade non-C&D commercial waste line. See Option 1 for commingled potential material recovery.

Table 25. Option 3 Potential Recovery Range

High-Grade Non-C&D Commercial	**Year 1**	
Material Processing		
High-Grade Commercial	34,000	
Recovery of Recyclables	**High**	**Low**
OCC/Cardboard	1,836	1,744
Paper	3,468	3,294
Newspaper	289	275
Recyclable Glass Containers	612	581
#1 and #2 Bottles	428	407
#1–#7 Other Containers	306	291
Clean Bags and Film	367	349
Tin Food Cans	162	153
Other Ferrous	485	460
Aluminum Cans	97	92
Other Aluminum	39	37
Other Non-Ferrous	0	0
Wood/Lumber	3,101	2,946
Durable Plastics (Rigids)	1,224	1,163
Total Commodities	**9,312**	**8,847**
Total Recyclables	**12,413**	**11,792**
Recovery of Compostables		
Food Waste	5,440	5,168
Mixed Organic	2,448	2,326
Yard Waste / Green Waste	408	388
Total AD/Compostables	**8,296**	**7,881**
Landfilled Material	**13,291**	**12,626**
High-Grade Non-C&D Commercial		
Recovery Rate Range	**High**	**Low**
Recyclables/Organics Recovery Rate (of Overall Tons)	60%	58%
Recyclables/Organics Recovery Rate (of Rec/Org Tons)	84%	79%

Commodities Recovery Rate (of Overall Tons)	27%	26%
Commodities Recovery Rate (of Commodity Tons)	88%	80%
Recyclables Recovery Rate (of Overall Tons)	36%	35%
Recyclables Recovery Rate (of Recyclable Tons)	86%	81%
Compostables Recovery Rate (of Overall Tons)	27%	26%
Compostables Recovery Rate (of Compostables Tons)	80%	76%

BOD INFORMATION

Table 26 and Table 27 summarize the potential processing rate as well as anticipated labor requirements for the processing line.

Table 26. Option 3 Material Process Rate

Option 3 Process Rate	Material Processed (Tons per Year) (1)	Process Rate (Tons per Day) (2)
Option 1 Material	25,000	100
High-Grade Non-C&D Commercial	34,000	130
Total	**59,000**	**230**

Note:

1. Values are rounded.

2. Assumes operation 5 days per week.

Option 3 Operation Duration	Typical Equipment Processing Rate (Tons per Hr)	System Availability	Operation Duration (Hrs per Day) (1)
Commingled Line	30	90%	3.8
Commercial Stream Line	35	90%	4.2
Total			**9.0**

Note:

1. Includes 1 hour break time.

Table 27. Option 3 Process Line Labor Requirements

Option 3 Labor Requirements	Full Time Equivalents (FTE)	Notes
Supervisor	1.5	
Operators	4	Includes 3 loaders & forklift + 1 baling. Does not include drivers for organics/residue.
Sort Labor		

Laborer 1	12
Laborer 2	8
Total Sort Laborers	20
Pre-Sort	*6*
Fibers Post-Sort	*6*
Containers Line	*6*
Floaters (QA)	*2*
MRF Maintenance	5
MRF Maintenance Sup	*1*
Mechanical/Electrical	*2*
Laborers	*2*

Note:

1. Labor totals do not include material resale, product delivery, or building maintenance.

FACILITY PARAMETERS

The facility would require systems to support the material recovery line. These systems may include thickened floor slab or enhanced foundations, power, lighting, compressed air, HVAC, etc. Sort station areas may also require focused lighting and HVAC systems.

A new MRF would require an overall footprint of approximately 400 FT x 200 FT plus office and other employee space (e.g., lockers, restrooms, and break area) of approximately 40 FT x 80 FT. Based on the waste stream projections for Option 3, the MRF would require areas for the following:

- Exterior vehicle maneuvering – ~10,000 – 15,000 SF
- Infeed - ~2,000 SF
- Processing equipment line and bin storage – ~25,000 SF
- Tipping floor for commingled (not including exterior maneuvering) – ~3,000 SF
- Tipping floor for commercial/multi-family (not including exterior maneuvering) – ~4,000 SF
- Storage space for commingled – ~3,000 SF
- Storage space for high-grade commercial – ~3,000 SF
- Bale loading dock / shipping (not including exterior maneuvering) – ~2,500 SF
- Bale storage – ~6,000 SF
- Interior forklift / front loader maneuvering

See Attachment B, Figure 1, for a Generic Conceptual Level Floor Plan.

Option 4: Commingled Residential Recyclables, High-Grade Non-C&D Commercial Waste, and High-Grade Non-C&D Self-Haul Waste

Option 4 is similar to Option 3 but would also process select materials received from self-haul customers. Waste composition data show that the self-haul waste stream contains a high percentage of wood and metal. These items represent a high percentage of recoverable materials; however, it is not desirable to process over a mixed waste sort line. Based on discussions with Cascadia, it was assumed that 80% of the yard debris and wood waste would be removed from self-haul waste through a variety of efforts. This might include rate incentives, more education and promotion, or other programs. When excluding this material and balancing the percentage of discards, the MRF line is assumed to process 24,000 tons per year of the total 34,000 tons.

The 24,000-ton waste stream is somewhat high-grade material without most wood and yard waste. The material can be processed over the integrated mixed waste and commingled processing equipment. Because most of the waste is largely dry materials, it can be processed along with commingled materials and separate from processing the mixed high-grade commercial wastes.

The equipment line would be the same as in Option 2; however, the process line operation duration would be minimized due to reduced tonnage. See Attachment A, Figure 2, for a process flow diagram.

System recovery rates would vary depending on several factors, such as the final equipment arrangement/selection, number of sorts, composition of waste, and quality of waste/recyclables. Table 28 provides a range of potential material recovery for the high-grade non-C&D commercial and high-grade self-haul waste line. See Option 1 for commingled potential material recovery.

Table 28. Option 4 Potential Recovery Range

Commingled Residential Recyclables, High-Grade Non-C&D Commercial Waste, and High-Grade Non-C&D Self Haul Waste	**Year 1**	
Material Processing		
Commingled, Commercial, and Self-Haul	75,576	
Recovery of Recyclables	**High**	**Low**
OCC/Cardboard	4,964	4,716
Paper	14,893	14,148
Newspaper	3,816	3,625
Recyclable Glass Containers	1,106	1,051
#1 and #2 Bottles	1,044	992
#1–#7 Other Containers	823	781
Clean Bags and Film	629	598
Tin Food Cans	266	253
Other Ferrous	5,369	5,101
Aluminum Cans	348	330
Other Aluminum	71	68
Other Non-Ferrous	671	638
Wood/Lumber	3,883	3,689
Durable Plastics (Rigids)	1,577	1,498
Total Commodities	**35,579**	**33,800**
Total Recyclables	**39,462**	**37,489**
Recovery of Compostables		
Food Waste	6,164	5,856
Mixed Organic	2,448	2,326
Yard Waste / Green Waste	435	414
Total AD/Compostables	**9,047**	**8,595**
Landfilled Material	**31,477**	**29,903**
Commingled, Commercial, and Self Haul		
Recovery Rate Range	**High**	**Low**
Recyclables/Organics Recovery Rate (of Overall Tons)	64%	61%
Recyclables/Organics Recovery Rate (of Rec/Org Tons)	91%	86%
Commodities Recovery Rate (of Overall Tons)	47%	45%
Commodities Recovery Rate (of Commodity Tons)	92%	87%
Recyclables Recovery Rate (of Overall Tons)	52%	50%

Recyclables Recovery Rate (of Recyclable Tons)	91%	86%
Compostables Recovery Rate (of Overall Tons)	47%	45%
Compostables Recovery Rate (of Compostables Tons)	80%	76%

BOD INFORMATION

Table 29 and Table 30 summarize the potential processing rate as well as anticipated labor requirements for the processing line.

Table 29. Option 4 Material Process Rate

Option 4 Process Rate	Material Processed (Tons per Year) (1)	Process Rate (Tons per Day) (2)
Option 1 Material	25,000	100
High-Grade Non-C&D Commercial	34,000	130
High-Grade Non-C&D Self Haul	24,000	90
Total	**83,000**	**320**

Note:

1. Values are rounded.

2. Assumes operation 5 days per week.

Option 4 Operation Duration	Typical Equipment Processing Rate (Tons per Hr)	System Availability	Operation Duration (Hrs per Day) (1)
Commingled Line	30	90%	3.8
Commercial Stream Line	35	90%	4.2
Self-Haul Stream Line	30	90%	2.5
Total			**11.5**

Note:

1. Includes 1 hour break time.

2. Assume staggered 8-hour shift for sorters. Therefore, total labor is based on 1.4 operating times to account for additional labor hours per day.

Table 30. Option 4 Process Line Labor Requirements

Option 4 Labor Requirements	Full Time Equivalents (FTE)	Notes
Supervisor	1.5	
Operators	4	Includes 3 loaders & forklift + 1 baling. Does not include drivers for organics/residue.
Sort Labor		
Laborer 1	12	
Laborer 2	8	
Total Sort Laborers (Per Shift)	20	
Pre-Sort	*6*	
Fibers Post-Sort	*6*	
Containers Line	*6*	
Floaters (QA)	*2*	
MRF Maintenance	5	
MRF Maintenance Sup	*1*	
Mechanical/Electrical	*2*	
Laborers	*2*	

Note:
1. Labor totals do not include material resale, product delivery, or building maintenance.

The amount of labor required to process the materials under Option 4 is similar to the amount of labor required under Option 3. However, because an additional 65 tons of self-haul waste would be processed, the line would need to operate for an additional 2 hours. This will be accounted for in the financial analysis.

FACILITY PARAMETERS

The facility would require systems to support the material recovery line. These systems may include thickened floor slab or piles under major equipment, power, lighting, compressed air, HVAC, etc. Sort station areas may also require focused lighting and HVAC systems.

A new MRF would require an overall footprint of approximately 400 FT x 200 FT plus office and other employee space (e.g., lockers, restrooms, and break area) of approximately 40 FT x 80 FT. Based on the waste stream projections for Option 3, the MRF would require areas for the following:

- Exterior vehicle maneuvering – ~10,000 – 15,000 SF
- Infeed - ~2,000 SF
- Processing equipment line and bin storage – ~25,000 SF
- Tipping floor for commingled (not including exterior maneuvering) – ~3,000 SF

- Tipping floor for commercial/multi-family (not including exterior maneuvering) – ~4,000 SF
- Storage space for commingled – ~3,000 SF
- Storage space for high grade commercial/self-haul – ~4,800 SF
- Bale loading dock / shipping (not including exterior maneuvering) – ~2,500 SF
- Bale storage – ~6,000 SF
- Interior forklift / front loader maneuvering

See Attachment B, Figure 1, for a Generic Conceptual Level Floor Plan and building plan. This plan depicts an integrated mixed waste and commingled MRF that might be constructed on a new site. The concept plan would be similar for Options 2, 3, and 4.

Capital Cost Estimates

Equipment Cost

The capital cost for equipment can vary depending on the waste stream being processed and other factors that are related to a specific waste stream, system performance requirements, the level of technology selected, and general requirements of individual projects.

Under Option 1, based on recent projects, the cost of equipment for commingled or clean commingled recycled materials from residential customers may range from $5,500,000 to $7,500,000. The differences in cost may be how much technology is employed versus the labor cost. For instance, sort lines may incorporate more optical sorters to reduce the number of manual sorters on the line. Another example is that additional screens could be used to provide flexibility in sorting a wider range of materials. However, adding different unit processes would cost capital, and the number of units required would vary depending on the waste composition.

The City's commingled stream is fairly clean, with 10% or less residue. Therefore, due to the quantity of material to be processed, the equipment cost used in Option 1 is assumed to be $5,500,000.

For Options 2 through 4, the equipment line would process a mixture of mixed waste collected from primarily commercial accounts and commingled on the same line in batches. The different material streams would not be processed at the same time. The arrangement of the sorters and other adjustments may be completed as needed to adjust operations for the period when the commingled material is processed and the period when the selected mixed waste is processed. This approach uses an integrated equipment line that would allow both dry and clean recyclables on the same process line as a mixed waste stream. This is a more recent development in MRF equipment lines. Currently, there are several lines operating in the United States (primarily California) that have been installed in recent years to successfully process multiple types of materials.

The cost of installing a process system that can operate at throughput rates of 30 to 40 tons per hour ranges from $13,000,000 to $16,000,000. Similar to the comingled MRF processing equipment, the cost varies depending on the number of unit processes such screens, air separators and optical sorters that are installed. For the purposes of the feasibility study, the cost of $13,000,000 was assumed. This estimate is based on a recent system installed that requires processing similar waste streams and quantities of material as Option 2, which processes the greatest amount of waste. Because Options 3 and 4 would operate with less material, this is a reasonable assumption. Equipment costs may be higher if operating parameters are different.

Capital Cost of MRF Building

The options for constructing a new MRF can range from expanding the current transfer station to retrofitting an existing structure to building a new structure to house the new equipment.

For Option 1, it is possible to expand the existing transfer station. This is shown in Attachment B, Figure 1. However, expanding the transfer station makes several assumptions as to whether the City would want to co-locate the MRF or even wish to operate the facility. For the feasibility study, it is assumed a separate MRF will be built. Cost of construction is estimated to be $12,000,000. This would include a 60,000 SF building, scalehouse, and scale system.

For Options 2 through 4, the MRF building would need to be expanded to provide more tip floor space to receive more materials. Similarly, the equipment line would also need to be larger. The MRF building for the integrated MRF would be 80,000 SF. It would also include a scale complex. The estimated cost of the building is $26,000,000.

The construction costs are planning-level estimates and carry accuracy of +30% and -15%. The estimates are provided in Attachment C.

Revenue - Market Prices for Recovered Materials

Recycling programs throughout the Pacific Northwest have been in place for over 20 years. As such, markets for most materials from local MRFs are established. Some of these markets are local, and others are overseas. Although these markets are fairly stable, the value varies considering both domestic and international commodity prices. To estimate the potential revenue from materials recovered, the feasibility analysis used the average price for materials over the past 10 years. The prices were reported to the City of Seattle from local processers.

Considering the data from the last 10 years provides a longer period, but is not necessarily reflective of current trends. To more accurately portray current trends in commodity prices, spot prices reported from Northwest brokers for 2015 were added to the data. To reflect potential impacts of lower prices, the years of the highest prices were not included. The result is that the low price is an average of the lowest prices for each commodity. This approach demonstrates what effect the market has on the total revenue. While prices do fluctuate, it is important to note that down periods or recessionary prices will rebound with the economy. Table 31 shows the average commodity prices used in the financial analysis.

Table 31. SPU Residential Survey Market Prices

				SPU Residential Survey Market Prices						
				10- Year Average - 2006- 2015						
Year	**Baled Aluminum**	**OCC**	**Mixed Paper**	**Baled ONP**	**Plastic**	**Tin**	**Brown Glass**	**Clear Glass**	**Green Glass**	**Average Glass**
2015	$1,380.00	$110.00	$65.00	$73.00	$560.00	$236.67	$17.50	$17.50	$2.50	
2014	$1,670.00	$117.08	$72.50	$77.50	$467.00	$352.92	$17.50	$17.50	$2.50	
2013	$1,550.50	$130.00	$85.00	$97.50	$420.00	$345.00	$17.50	$17.50	$2.50	$12.50
2012	$1,510.00	$143.54	$105.63	$99.58	$463.33	$379.50	$17.50	$17.50	$2.92	$12.64
2011	$1,730.00	$182.50	$143.33	$133.96	$473.33	$415.42	$17.50	$17.50	$2.50	$12.50
2010	$1,515.83	$164.17	$111.46	$105.21	$383.33	$328.75	$17.50	$17.50	$2.50	$12.50
2009	$1,113.13	$102.22	$61.04	$63.33	$300.83	$190.00	$18.33	$20.83	$4.17	$14.44
2008	$1,587.50	na	$97.92	$86.25	$297.50	$71.88	$25.00	$37.50	na	$20.83
2007	$1,700.00	na	$63.75	$60.00	$319.17	$78.33	$25.00	$37.50	na	$20.83
2006	$1,701.67	na	$26.25	$27.50	$259.17	$77.92	$23.00	$33.88	na	$18.96
2005	$1,306.67	na	$27.92	$34.17	$486.67	$87.29	$17.00	$23.00	na	$13.33
2004	$1,227.92	na	$12.50	$30.42	$193.33	$67.50	$17.00	$23.00	na	$13.33
Total - 10 yrs	$15,458.63	$832.43	$831.88	$823.83	$3,943.66	$2,476.39	$196.33	$234.71	$14.59	$151.88
10 Yr - Ave. Price (2006-2015)	$1,545.86	$118.92	$83.19	$82.38	$394.37	$247.64	$19.63	$23.47	$2.92	$15.19
USE 10 YR Ave Scenario	**$1,540.00**	**$115.00**	**$80.00**	**$80.00**	**$390.00**	**$215.00**	**$20.00**	**$23.00**	**$2.50**	**$16.00**
Low Prices	$1,269.62	$102.33	$62.42	$64.91	$258.17	$116.63				
Low Price Scenario	**$1,200.00**	**$100.00**	**$60.00**	**$65.00**	**$260.00**	**$110.00**	**$17.50**	**$17.50**	**$2.50**	

In the feasibility study, the 10-year average was used because it portrays the most accurate account of commodity prices over the past 10 years.

Financial Model

Using the information presented above, JRMA prepared a financial model to evaluate various options. The analysis uses a building block approach that considers each element of the financial aspects of operating a MRF. These include the following steps:

Step 1. Estimate recovery of materials from various waste streams. Waste composition data are from the 1st and 2nd quarter sampling events in 2015. Waste streams include:

- Commingled residential/commercial
- Non-C&D commercial – mixed waste
- Non-C&D commercial – high-grade
- Self-haul waste

Step 2. Estimate the quantity of materials recovered using MRF performance information from the most recent technology being applied to processing waste to recover materials.

Step 3. Estimate revenue from the sale of recovered materials using the average 10-year market price for each commodity.

Step 4. Estimate operational expenses associated with various options. Table 21, Table 24, Table 27, and Table 30 presented the estimated labor requirements for each option. Current labor rates for the City of Tacoma were used to arrive at annual costs. The operating hours for each option were adjusted based on the throughput for each option.

Other operating expenses for maintenance, parts, power, etc., were estimated based on similar operations.

Step 5. Estimate capital costs for the two MRF systems that are used in the feasibility analysis. It is assumed these would be financed with bonds and the debt retired over 15 years for the equipment and 20 years for the buildings.

Step 6. Determine the unit operating cost for each option. This step uses all of the capital and operating expenses and the total waste processed to arrive at the unit operating cost for the different options and excludes revenues.

Step 7. Prepare a Summary of Financial Performance, which is a composite of the all information that shows the total materials being processed, the estimated recovery rate, the estimated annual expenses and revenues, and the net unit cost of each option.

The financial results are presented in the feasibility report.

ATTACHMENT A – FLOW DIAGRAMS

Attachment A, Figure 1

OPTION 1
FLOW DIAGRAM

MATERIAL RECOVERY FACILITY

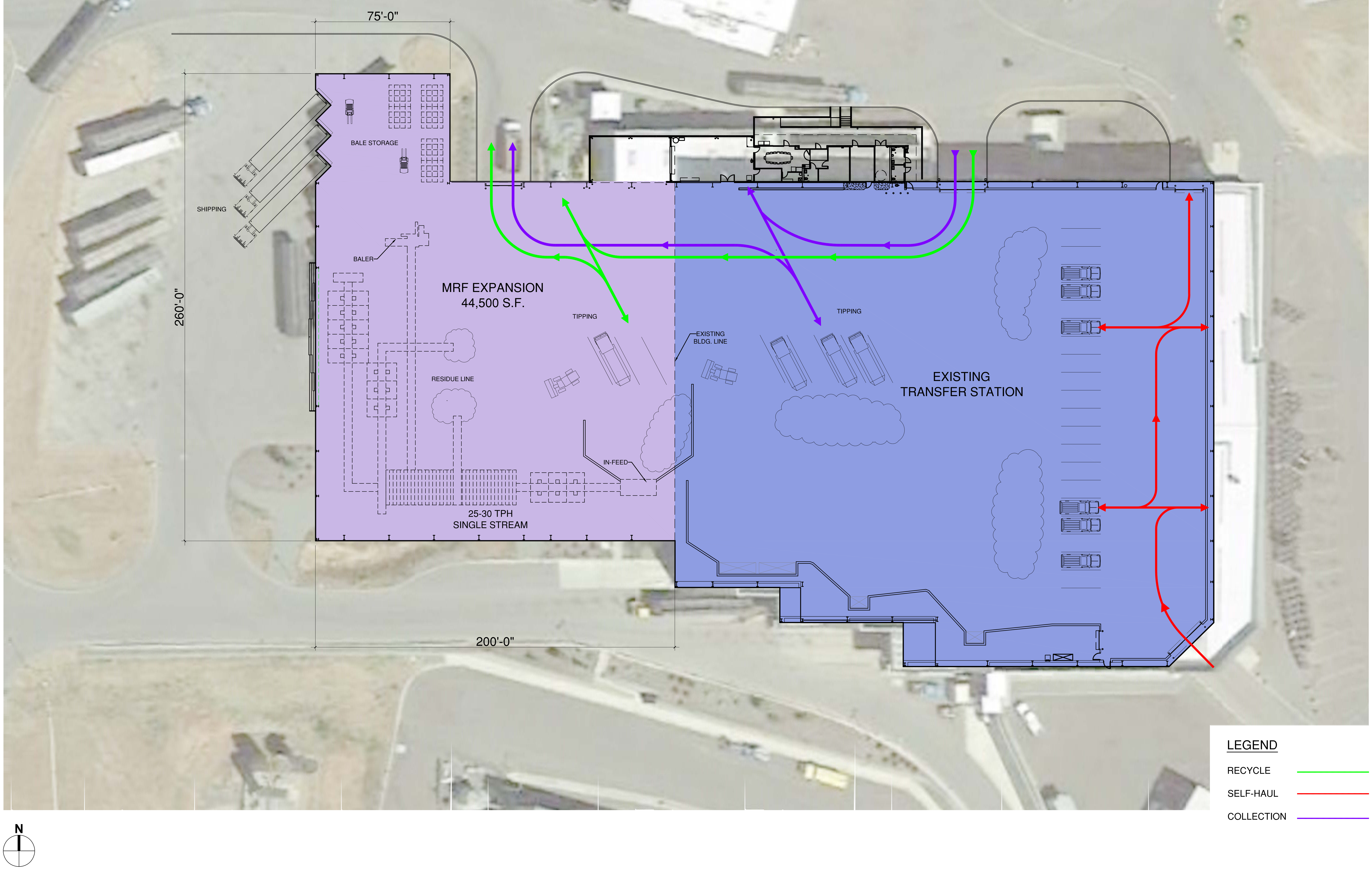
Attachment A, Figure 2

OPTION 2
FLOW DIAGRAM

MATERIAL RECOVERY FACILITY

ATTACHMENT B – CONCEPTUAL PLAN

Attachment B, Figure 1



Option 1

TACOMA Materials Recovery Facility (MRF)

JRMA ARCHITECTS ENGINEERS PLANNERS

JOB # 4980-0

JUNE 25, 2015

Attachment B, Figure 2

Option 2

1. COMMERCIAL + MF - 76,000 TPY
   300 TPD @ 18 lb/ft³ @ 10' HEIGHT = 3,300 S.F.
   2 DAY STORAGE ≈ 6,700 S.F.

2. COMMINGLED
   100 TPD @ 14lb/ft³ @ 10' HEIGHT ≈ 1,500 S.F.
   2 DAY STORAGE ≈ 3,000 S.F.

Option 3

1. SELECT MIXED COMMERCIAL - 34,000 TPY
   130 TPD @ 18 lb/ft³ @ 10' HEIGHT ≈ 1,500 S.F.
   2 DAY STORAGE ≈ 3,000 S.F.

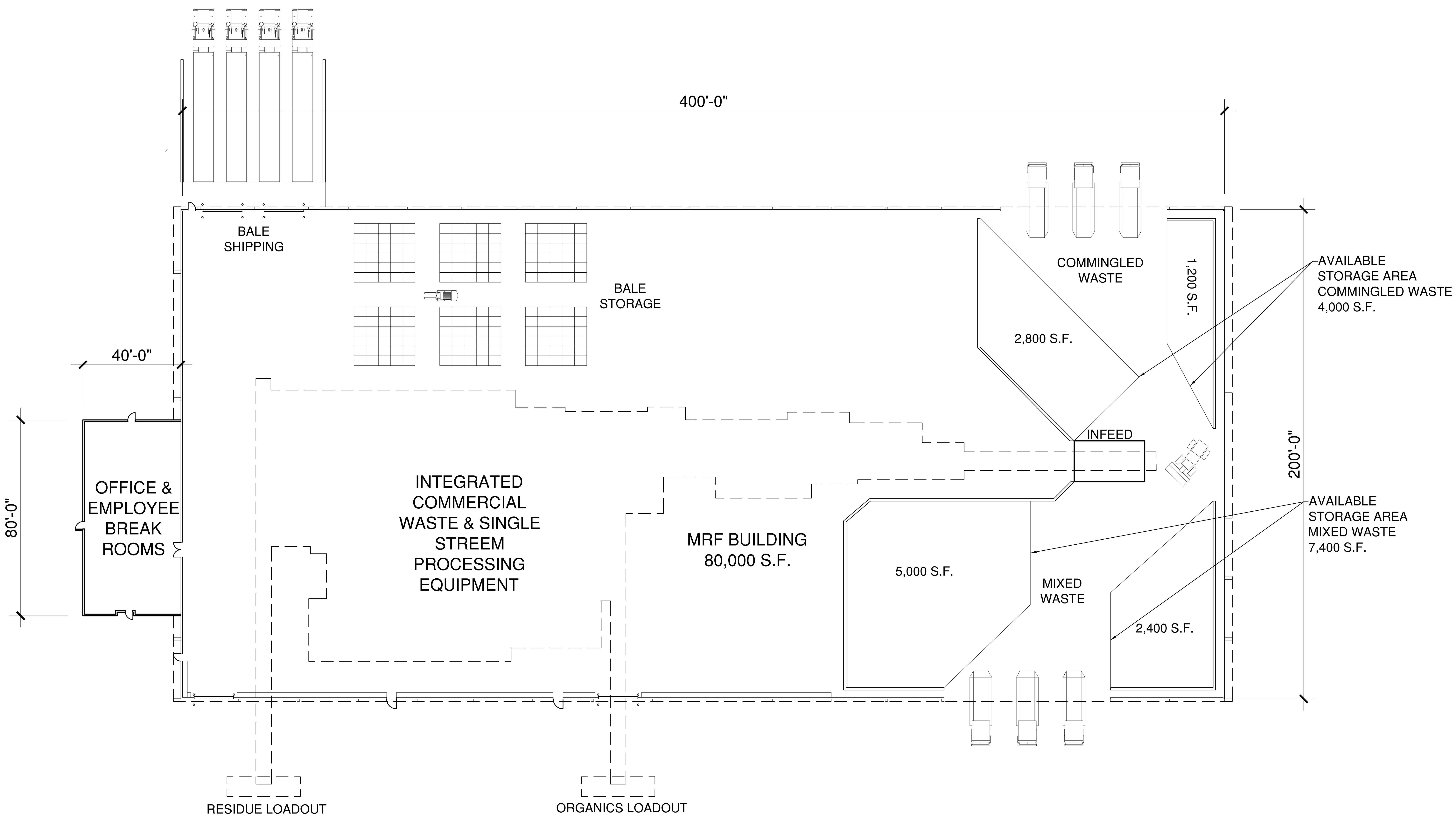
2. COMMINGLED
   100 TPD @ 14lb/ft³ @ 10' HEIGHT ≈ 1,500 S.F.
   2 DAY STORAGE ≈ 3,000 S.F.

Option 4

1. MIXED WASTE - 34,000 TPY
   130 TPD @ 18 lb/ft³ @ 10' HEIGHT ≈ 1,500 S.F.
   2 DAY STORAGE ≈ 3,000 S.F.

2. SELF HAUL - 17,000 TPY
   65 TPD @ 15 lb/ft³ @ 10' HEIGHT = 900 S.F.
   2 DAY STORAGE = 1,800 S.F.

3. COMMINGLED
   100 TPD @ 14lb/ft³ @ 10' HEIGHT ≈ 1,500 S.F.
   2 DAY STORAGE ≈ 3,000 S.F.



N

0' 10' 20' 40' 80'

Generic Concept Plan
Integrated Mixed Waste & SS/Commingled MRF

Materials Recovery Facility (MRF)

JRM&A ARCHITECTS ENGINEERS PLANNERS

JOB # 4980-0

NOVEMBER 6, 2015

ATTACHMENT C – CAPITAL COSTS

Attachment C, Table 1

City of Tacoma

COMMINGLED MRF

Planning Level Construction Costs Estimate

Note: Planning Level cost estimates carry a +30 / -15 range of accuracy. Cost estimates should be used for evaluating and planning options.

EXPANSION OF TACOMA TRANSFER AND RECYCLING CENTER						
BUILDING/ SITE AREA		**DESCRIPTION OF WORK**	**QUANTITY**	**SF / LF**	**UNIT COST**	**EXTENDED VALUE**
SITE GRADING AND UTILITIES						
	Site work	Site Demolition	1	LS	$30,000	$30,000
		Site grading	20,000	SF	$0.50	$10,000
		Paving Roadway and Drive Areas	20,000	SF	$6.00	$120,000
		Paving Roadway and Drive Areas	1	LS	$30,000.00	$30,000
		Misc Expenses	1	LS	$50,000.00	$50,000
		Power/ Electrical	1	LS	$100,000.00	$100,000
TOTAL SITE GRADING AND UTILITIES						**$310,000**
MRF EXPANSION						
	New MRF Building	New MRF	60,000	SF	$120.00	$7,200,000
		Office/employee	5,000	SF	$200.00	$1,000,000
	Scalehouse	8'x20'	160	SF	$250.00	$40,000
	Scales	2 @ 70"	2	Ea	$80,000.00	$160,000
SUBTOTAL						**$8,400,000**
TOTAL NEW MRF BUILDING						**$8,400,000**
SUBTOTAL CONSTRUCTION COST						
	General				12%	$1,008,000
	Permitting and Entitlements					$300,000
	Engineering and Construction Support				12%	$1,008,000
	Sales /Service Tax				5%	$420,000
	Contingency				10%	$840,000
SUBTOTAL CONSTRUCTION COST						**$3,576,000**
TOTAL ESTIMATED CONSTRUCTION COST						**$11,976,000**
MRF EQUIPMENT						
TOTAL CONSTRUCTION COST						**$11,976,000**
					USE	**$12,000,000**

JRMA ***March 2016***

Attachment C, Table 2 <u>City of Tacoma</u>

INTEGRATED MIXED WASTE + COMMINGLED MRF - 35 TPH

Planning Level Construction Costs Estimate

Note: Planning Level cost estimates carry a +30 / -15 range of accuracy. Cost estimates should be used for evaluating and planning options.

New Mixed Waste /Commingled MRF							
BUILDING/ SITE AREA		DESCRIPTION OF WORK	QUANTITY	SF / LF	UNIT COST	EXTENDED VALUE	COMMENTS/ASSUMPTIONS
SITE GRADING AND UTILITIES							
	Site work						
		Site grading	100,000	SF	$5.00	$500,000	
		Paving Roadway and Drive Areas	80,000	SF	$7.00	$560,000	
		Utilities	1	LS	$300,000.00	$300,000	Utilies are in street (Water/ Sewer/Fire)
		Power/ Electrical	1	LS	$200,000.00	$200,000	Power in available locally
		Stormwater	1	LS	$100,000.00	$100,000	
TOTAL SITE GRADING AND UTILITIES						**$1,660,000**	
MRF BUILDING AND OFICCE							
	New MRF Building	200'x 400' PEMB	80,000	SF	$175.00	$14,000,000	Includes: Foundations, Push walls, HVAC, Electrical
	Office Employee	2 -Sty 40' x 80' -	6,400	SF	$250.00	$1,600,000	2 sty office with Employee space for 50 staff
	Scalehouse	8'x20'	160	SF	$250.00	$40,000	2 sty office with Employee space for 50 staff
	Scales	2 @ 70"	2	Ea	$80,000.00	$160,000	
SUBTOTAL						**$15,800,000**	
TOTAL NEW MRF BUILDING						**$15,800,000**	
SUBTOTAL CONSTRUCTION COST						**$17,460,000**	
	General				12%	$2,095,200	
	Permitting and Entitlements					$300,000	
	Engineering and Construction Support				12%	$2,095,200	
	Sales /Service Tax				7%	$1,222,200	
	Contingency				15%	$2,619,000	
SUBTOTAL CONSTRUCTION COST						**$8,331,600**	
TOTAL ESTIMATED CONSTRUCTION COST						**$25,791,600**	
MRF EQUIPMENT							
Total CONSTRUCTION COST W/ MRF EQUIPMENT						**$25,791,600**	
						USE	**$26,000,000**

JRMA ***March 2016***

ATTACHMENT D – FINANCIAL MODEL

Summary of MRF Options

10/20/2015

(Option 1)- Commingled Residential Recyclables	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
			100%													
Material Recovery																
Tons Recycled	20,267	20,470	20,675	20,881	21,090	21,301	21,514	21,729	21,947	22,166	22,388	22,612	22,838	23,066	23,297	23,530
Tons Composted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tons Landfilled	1,267	1,280	1,293	1,306	1,319	1,332	1,345	1,359	1,372	1,386	1,400	1,414	1,428	1,442	1,457	1,471
Total Tons Processed	**21,534**	**21,750**	**21,967**	**22,187**	**22,409**	**22,633**	**22,859**	**23,088**	**23,319**	**23,552**	**23,787**	**24,025**	**24,266**	**24,508**	**24,753**	**25,001**
Diversion Rate	*94%*	*94%*	*94%*	*94%*	*94%*	*94%*	*94%*	*94%*	*94%*	*94%*	*94%*	*94%*	*94%*	*94%*	*94%*	*94%*
Revenue Requirements																
MRF Operations	$ 1,578,508	$ 1,603,662	$ 1,629,318	$ 1,655,488	$ 1,682,181	$ 1,709,408	$ 1,737,180	$ 1,765,507	$ 1,794,400	$ 1,823,871	$ 1,853,932	$ 1,884,594	$ 1,915,869	$ 1,947,770	$ 1,980,309	$ 2,013,498
Debt Services	$ 1,492,794	$ 1,492,794	$ 1,492,794	$ 1,492,794	$ 1,492,794	$ 1,492,794	$ 1,492,794	$ 1,492,794	$ 1,492,794	$ 1,492,794	$ 1,492,794	$ 1,492,794	$ 1,492,794	$ 1,492,794	$ 1,492,794	$ 1,492,794
Total Expenses	**$ 3,071,302**	**$ 3,096,455**	**$ 3,122,112**	**$ 3,148,282**	**$ 3,174,975**	**$ 3,202,202**	**$ 3,229,973**	**$ 3,258,300**	**$ 3,287,194**	**$ 3,316,665**	**$ 3,346,726**	**$ 3,377,388**	**$ 3,408,663**	**$ 3,440,564**	**$ 3,473,102**	**$ 3,506,292**
Expenses per Ton	*$ 143*	*$ 142*	*$ 142*	*$ 142*	*$ 142*	*$ 141*	*$ 141*	*$ 141*	*$ 141*	*$ 141*	*$ 141*	*$ 141*	*$ 140*	*$ 140*	*$ 140*	*$ 140*
Revenue																
Tip Fee Revenue	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Material Sales	$ 2,270,109	$ 2,315,738	$ 2,362,285	$ 2,409,766	$ 2,458,203	$ 2,507,613	$ 2,558,016	$ 2,609,432	$ 2,661,881	$ 2,715,385	$ 2,769,964	$ 2,825,641	$ 2,882,436	$ 2,940,373	$ 2,999,474	$ 3,059,764
Average Net Sale Price	*$ 112*	*$ 113*	*$ 114*	*$ 115*	*$ 117*	*$ 118*	*$ 119*	*$ 120*	*$ 121*	*$ 123*	*$ 124*	*$ 125*	*$ 126*	*$ 127*	*$ 129*	*$ 130*
Organics to Compost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenue	**$ 2,270,109**	**$ 2,315,738**	**$ 2,362,285**	**$ 2,409,766**	**$ 2,458,203**	**$ 2,507,613**	**$ 2,558,016**	**$ 2,609,432**	**$ 2,661,881**	**$ 2,715,385**	**$ 2,769,964**	**$ 2,825,641**	**$ 2,882,436**	**$ 2,940,373**	**$ 2,999,474**	**$ 3,059,764**
Revenue per Ton Processed	*$ 105*	*$ 106*	*$ 108*	*$ 109*	*$ 110*	*$ 111*	*$ 112*	*$ 113*	*$ 114*	*$ 115*	*$ 116*	*$ 118*	*$ 119*	*$ 120*	*$ 121*	*$ 122*
Net Revenue	**$ (801,193)**	**$ (780,717)**	**$ (759,828)**	**$ (738,515)**	**$ (716,772)**	**$ (694,589)**	**$ (671,958)**	**$ (648,868)**	**$ (625,312)**	**$ (601,280)**	**$ (576,761)**	**$ (551,747)**	**$ (526,227)**	**$ (500,191)**	**$ (473,628)**	**$ (446,528)**
Per Ton	*$ (37)*	*$ (36)*	*$ (35)*	*$ (33)*	*$ (32)*	*$ (31)*	*$ (29)*	*$ (28)*	*$ (27)*	*$ (26)*	*$ (24)*	*$ (23)*	*$ (22)*	*$ (20)*	*$ (19)*	*$ (18)*

(Option 2) - Commingled Residental and Non-C&D Commercial and Multifamily	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
			100%													
Material Recovery																
Tons Recycled	38,201	38,583	38,969	39,358	39,752	40,150	40,551	40,957	41,366	41,780	42,198	42,620	43,046	43,476	43,911	44,350
Tons Composted	19,310	19,504	19,699	19,896	20,095	20,295	20,498	20,703	20,910	21,120	21,331	21,544	21,759	21,977	22,197	22,419
Tons Landfilled	34,809	35,157	35,509	35,864	36,223	36,585	36,951	37,320	37,693	38,070	38,451	38,836	39,224	39,616	40,012	40,412
Total Tons Processed	**92,320**	**93,244**	**94,176**	**95,118**	**96,069**	**97,030**	**98,000**	**98,980**	**99,970**	**100,970**	**101,979**	**102,999**	**104,029**	**105,069**	**106,120**	**107,181**
Diversion Rate	*62%*	*62%*	*62%*	*62%*	*62%*	*62%*	*62%*	*62%*	*62%*	*62%*	*62%*	*62%*	*62%*	*62%*	*62%*	*62%*
Revenue Requirements																
MRF Operations	$ 5,212,583	$ 5,301,668	$ 5,392,535	$ 5,485,219	$ 5,579,757	$ 5,676,185	$ 5,774,542	$ 5,874,866	$ 5,977,197	$ 6,081,574	$ 6,188,039	$ 6,296,633	$ 6,407,399	$ 6,520,381	$ 6,635,622	$ 6,753,167
Debt Services	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757
Total Expenses	**$ 8,551,340**	**$ 8,640,425**	**$ 8,731,292**	**$ 8,823,976**	**$ 8,918,514**	**$ 9,014,942**	**$ 9,113,299**	**$ 9,213,623**	**$ 9,315,954**	**$ 9,420,331**	**$ 9,526,796**	**$ 9,635,390**	**$ 9,746,156**	**$ 9,859,138**	**$ 9,974,379**	**$ 10,091,924**
Expenses per Ton	*$ 93*	*$ 93*	*$ 93*	*$ 93*	*$ 93*	*$ 93*	*$ 93*	*$ 93*	*$ 93*	*$ 93*	*$ 93*	*$ 94*	*$ 94*	*$ 94*	*$ 94*	*$ 94*
Revenue																
Tip Fee Revenue	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Material Sales	$ 4,039,511	$ 4,126,493	$ 4,215,281	$ 4,305,912	$ 4,398,423	$ 4,492,854	$ 4,589,243	$ 4,687,630	$ 4,788,056	$ 4,890,563	$ 4,995,193	$ 5,101,990	$ 5,210,996	$ 5,322,259	$ 5,435,823	$ 5,551,736
Average Net Sale Price	*$ 106*	*$ 107*	*$ 108*	*$ 109*	*$ 111*	*$ 112*	*$ 113*	*$ 114*	*$ 116*	*$ 117*	*$ 118*	*$ 120*	*$ 121*	*$ 122*	*$ 124*	*$ 125*
Organics to Compost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenue	**$ 4,039,511**	**$ 4,126,493**	**$ 4,215,281**	**$ 4,305,912**	**$ 4,398,423**	**$ 4,492,854**	**$ 4,589,243**	**$ 4,687,630**	**$ 4,788,056**	**$ 4,890,563**	**$ 4,995,193**	**$ 5,101,990**	**$ 5,210,996**	**$ 5,322,259**	**$ 5,435,823**	**$ 5,551,736**
Revenue per Ton Processed	*$ 44*	*$ 44*	*$ 45*	*$ 45*	*$ 46*	*$ 46*	*$ 47*	*$ 47*	*$ 48*	*$ 48*	*$ 49*	*$ 50*	*$ 50*	*$ 51*	*$ 51*	*$ 52*
Net Revenue	**$ (4,511,829)**	**$ (4,513,932)**	**$ (4,516,011)**	**$ (4,518,065)**	**$ (4,520,091)**	**$ (4,522,088)**	**$ (4,524,056)**	**$ (4,525,993)**	**$ (4,527,898)**	**$ (4,529,768)**	**$ (4,531,603)**	**$ (4,533,401)**	**$ (4,535,160)**	**$ (4,536,879)**	**$ (4,538,556)**	**$ (4,540,189)**
Per Ton	*$ (49)*	*$ (48)*	*$ (48)*	*$ (47)*	*$ (47)*	*$ (47)*	*$ (46)*	*$ (46)*	*$ (45)*	*$ (45)*	*$ (44)*	*$ (44)*	*$ (44)*	*$ (43)*	*$ (43)*	*$ (42)*

(Option 3) - Commingled Residential and Select High-Grade Non-C&D Commercial Waste			100%													
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Material Recovery																
Tons Recycled	32,680	33,007	33,337	33,671	34,007	34,347	34,691	35,038	35,388	35,742	36,099	36,460	36,825	37,193	37,565	37,941
Tons Composted	8,296	8,379	8,463	8,547	8,633	8,719	8,806	8,894	8,983	9,073	9,164	9,256	9,348	9,442	9,536	9,631
Tons Landfilled	14,558	14,704	14,851	14,999	15,149	15,301	15,454	15,608	15,764	15,922	16,081	16,242	16,405	16,569	16,734	16,902
Total Tons Processed	**55,534**	**56,090**	**56,651**	**57,217**	**57,789**	**58,367**	**58,951**	**59,540**	**60,136**	**60,737**	**61,345**	**61,958**	**62,578**	**63,203**	**63,835**	**64,474**
Diversion Rate	*74%*	*74%*	*74%*	*74%*	*74%*	*74%*	*74%*	*74%*	*74%*	*74%*	*74%*	*74%*	*74%*	*74%*	*74%*	*74%*
Revenue Requirements																
MRF Operations	$ 3,704,583	$ 3,763,508	$ 3,823,612	$ 3,884,917	$ 3,947,449	$ 4,011,231	$ 4,076,289	$ 4,142,648	$ 4,210,335	$ 4,279,375	$ 4,349,796	$ 4,421,625	$ 4,494,891	$ 4,569,622	$ 4,645,848	$ 4,723,598
Debt Services	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757
Total Expenses	**$ 7,043,340**	**$ 7,102,265**	**$ 7,162,369**	**$ 7,223,674**	**$ 7,286,206**	**$ 7,349,988**	**$ 7,415,046**	**$ 7,481,405**	**$ 7,549,092**	**$ 7,618,132**	**$ 7,688,553**	**$ 7,760,382**	**$ 7,833,648**	**$ 7,908,379**	**$ 7,984,605**	**$ 8,062,355**
Expenses per Ton	*$ 127*	*$ 127*	*$ 126*	*$ 126*	*$ 126*	*$ 126*	*$ 126*	*$ 126*	*$ 126*	*$ 125*	*$ 125*	*$ 125*	*$ 125*	*$ 125*	*$ 125*	*$ 125*
Revenue																
Tip Fee Revenue	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Material Sales	$ 3,363,328	$ 3,430,931	$ 3,499,893	$ 3,570,240	$ 3,642,002	$ 3,715,207	$ 3,789,882	$ 3,866,059	$ 3,943,767	$ 4,023,036	$ 4,103,899	$ 4,186,388	$ 4,270,534	$ 4,356,372	$ 4,443,935	$ 4,533,258
Average Net Sale Price	*$ 103*	*$ 104*	*$ 105*	*$ 106*	*$ 107*	*$ 108*	*$ 109*	*$ 110*	*$ 111*	*$ 113*	*$ 114*	*$ 115*	*$ 116*	*$ 117*	*$ 118*	*$ 119*
Organics to Compost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenue	**$ 3,363,328**	**$ 3,430,931**	**$ 3,499,893**	**$ 3,570,240**	**$ 3,642,002**	**$ 3,715,207**	**$ 3,789,882**	**$ 3,866,059**	**$ 3,943,767**	**$ 4,023,036**	**$ 4,103,899**	**$ 4,186,388**	**$ 4,270,534**	**$ 4,356,372**	**$ 4,443,935**	**$ 4,533,258**
Revenue per Ton Processed	*$ 61*	*$ 61*	*$ 62*	*$ 62*	*$ 63*	*$ 64*	*$ 64*	*$ 65*	*$ 66*	*$ 66*	*$ 67*	*$ 68*	*$ 68*	*$ 69*	*$ 70*	*$ 70*
Net Revenue	**$ (3,680,012)**	**$ (3,671,334)**	**$ (3,662,476)**	**$ (3,653,434)**	**$ (3,644,204)**	**$ (3,634,782)**	**$ (3,625,164)**	**$ (3,615,347)**	**$ (3,605,325)**	**$ (3,595,096)**	**$ (3,584,653)**	**$ (3,573,994)**	**$ (3,563,114)**	**$ (3,552,007)**	**$ (3,540,670)**	**$ (3,529,097)**
Per Ton	*$ (66)*	*$ (65)*	*$ (65)*	*$ (64)*	*$ (63)*	*$ (62)*	*$ (61)*	*$ (61)*	*$ (60)*	*$ (59)*	*$ (58)*	*$ (58)*	*$ (57)*	*$ (56)*	*$ (55)*	*$ (55)*

(Option 4) - Commingled Residential Recyclables, High-Grade Non-C&D Commercial Waste, and High-Grade Non-C&D Self-Haul Waste			100%													
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Material Recovery																
Tons Recycled	39,462	39,856	40,255	40,658	41,064	41,475	41,889	42,308	42,731	43,159	43,590	44,026	44,467	44,911	45,360	45,814
Tons Composted	9,047	9,138	9,229	9,321	9,414	9,509	9,604	9,700	9,797	9,895	9,994	10,094	10,195	10,296	10,399	10,503
Tons Landfilled	31,477	31,791	32,109	32,430	32,755	33,082	33,413	33,747	34,085	34,425	34,770	35,117	35,469	35,823	36,182	36,543
Total Tons Processed	**79,985**	**80,785**	**81,593**	**82,409**	**83,233**	**84,066**	**84,906**	**85,755**	**86,613**	**87,479**	**88,354**	**89,237**	**90,130**	**91,031**	**91,941**	**92,861**
Diversion Rate	*61%*	*61%*	*61%*	*61%*	*61%*	*61%*	*61%*	*61%*	*61%*	*61%*	*61%*	*61%*	*61%*	*61%*	*61%*	*61%*
Revenue Requirements																
MRF Operations	$ 4,206,083	$ 4,275,038	$ 4,345,372	$ 4,417,113	$ 4,490,289	$ 4,564,928	$ 4,641,060	$ 4,718,714	$ 4,797,922	$ 4,878,714	$ 4,961,121	$ 5,045,177	$ 5,130,914	$ 5,218,366	$ 5,307,566	$ 5,398,551
Debt Services	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757	$ 3,338,757
Total Expenses	**$ 7,544,840**	**$ 7,613,795**	**$ 7,684,129**	**$ 7,755,870**	**$ 7,829,046**	**$ 7,903,685**	**$ 7,979,817**	**$ 8,057,471**	**$ 8,136,679**	**$ 8,217,471**	**$ 8,299,878**	**$ 8,383,934**	**$ 8,469,671**	**$ 8,557,123**	**$ 8,646,323**	**$ 8,737,308**
Expenses per Ton	*$ 94*	*$ 94*	*$ 94*	*$ 94*	*$ 94*	*$ 94*	*$ 94*	*$ 94*	*$ 94*	*$ 94*	*$ 94*	*$ 94*	*$ 94*	*$ 94*	*$ 94*	*$ 94*
Revenue																
Tip Fee Revenue	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Material Sales	$ 3,438,492	$ 3,507,605	$ 3,578,108	$ 3,650,028	$ 3,723,394	$ 3,798,234	$ 3,874,578	$ 3,952,457	$ 4,031,902	$ 4,112,943	$ 4,195,613	$ 4,279,945	$ 4,365,972	$ 4,453,728	$ 4,543,248	$ 4,634,567
Average Net Sale Price	*$ 87*	*$ 88*	*$ 89*	*$ 90*	*$ 91*	*$ 92*	*$ 92*	*$ 93*	*$ 94*	*$ 95*	*$ 96*	*$ 97*	*$ 98*	*$ 99*	*$ 100*	*$ 101*
Organics to Compost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenue	**$ 3,438,492**	**$ 3,507,605**	**$ 3,578,108**	**$ 3,650,028**	**$ 3,723,394**	**$ 3,798,234**	**$ 3,874,578**	**$ 3,952,457**	**$ 4,031,902**	**$ 4,112,943**	**$ 4,195,613**	**$ 4,279,945**	**$ 4,365,972**	**$ 4,453,728**	**$ 4,543,248**	**$ 4,634,567**
Revenue per Ton Processed	*$ 43*	*$ 43*	*$ 44*	*$ 44*	*$ 45*	*$ 45*	*$ 46*	*$ 46*	*$ 47*	*$ 47*	*$ 47*	*$ 48*	*$ 48*	*$ 49*	*$ 49*	*$ 50*
Net Revenue	**$ (4,106,349)**	**$ (4,106,190)**	**$ (4,106,021)**	**$ (4,105,842)**	**$ (4,105,652)**	**$ (4,105,451)**	**$ (4,105,239)**	**$ (4,105,014)**	**$ (4,104,777)**	**$ (4,104,528)**	**$ (4,104,265)**	**$ (4,103,989)**	**$ (4,103,699)**	**$ (4,103,395)**	**$ (4,103,075)**	**$ (4,102,741)**
Per Ton	*$ (51)*	*$ (51)*	*$ (50)*	*$ (50)*	*$ (49)*	*$ (49)*	*$ (48)*	*$ (48)*	*$ (47)*	*$ (47)*	*$ (46)*	*$ (46)*	*$ (46)*	*$ (45)*	*$ (45)*	*$ (44)*