Final Report

Food Waste Reasonable Management Practices

Pierce County Public Works and Utilities
Solid Waste Division

October 2012

SAIC®

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Abbreviations

ARB	California Air Resources Board
AUF	airspace utilization factor
BMP	best management practice
C-Team	Coordination Team
CA	California
CAR	Climate Action Reserve
CH_4	methane
CO_2	carbon dioxide
County	Pierce County
CNG	compressed natural gas
CY	cubic yard
DGE	diesel gallon equivalent
EPA	Environmental Protection Agency
FSE	food service establishments

GCCS	LFG collection and control system
GHG	greenhouse gas
kwh	kilowatt hours
lbs	pounds
LEED	Leadership in Energy and Environmental Design
LFG	landfill gas
LRI	Waste Connections/Land Recovery, Inc.
MSW	municipal solid waste
MTCE	metric tonnes of carbon equivalent
mtCO2e	metric tonnes of carbon dioxide equivalent
MW	megawatt
PMT	Project Management Team
RGGI	Regional Greenhouse Gas Initiative
RMP	reasonable management practice
scfm	standard cubic feet per minute
SWMP	Solid Waste Management Plan
Tacoma	City of Tacoma
WARM	Waste Reduction Model

EXECUTIVE SUMMARY

The purpose of this study was to develop reasonable management practices (RMPs) for food waste. The Pierce County (County) 2010 waste audit identified food waste as a significant volume of waste currently being landfilled. The County viewed this food waste as a potential opportunity to reduce landfilled waste and preserve the available capacity of their landfill; capture a useful resource for the community; and continue to be an ecological and socio-economic leader in the region as food waste diversion has become a growing consideration in solid waste management.

By exploring the wide range of alternatives, the County will better be able to avoid the problems that have arisen in other jurisdictions from implementing a system that may not have been fully planned out and may not actually meet the needs of the users. The evaluation of each alternative considered cost of service (economic), effects to the environment, and its effect on the County solid waste management system carbon footprint.

This report summarizes the evaluations conducted for determining RMPs for food waste. Each alternative (e.g., processing technology and programmatic option) was evaluated for its reasonableness to be implemented as part of the County's solid waste management programs. A critical factor in determining reasonableness was a successful operating history of programs and processing technologies in the United States and North America.

As evaluations progressed into more detailed analysis, scenarios were developed from the various alternatives. The three scenarios evaluated included:

1. Food Waste Reduction. This scenario focuses on ways to reduce the need for food waste collection and off-site processing through substantially greater attention to reducing the generation of organics at the source and promoting on-site reuse.
2. Sector Based Programs. This scenario defines program elements for the single-family residential, multi-family residential, commercial, and self-haul sectors utilizing composting and anaerobic digestion technologies.
3. Landfill Disposal and Landfill Gas Beneficial Use. This scenario evaluates the current management practice of disposing food waste in the landfill from the landfill perspective and considers the effect of diversion on landfill gas generation and energy production.

Each scenario was further sub-divided into program elements of various intensities. For example, a low intensity would represent a program element that would yield a portion of the food waste, but implemented with little cost to the customer and may result in less impact to the environment and carbon footprint. A high intensity, on the other hand, may yield a greater volume of food waste, but at a higher cost to the customer with potentially greater environmental and carbon footprint effects.

Program elements may be implemented alone, or a program may be designed as a combination of multiple elements. Projected outcomes will vary based on the type and intensity of elements selected.

Reasonableness of each program element can ultimately be determined if the costs and environmental and carbon footprint effects do not outweigh the benefits a program element achieves.

Based on the results of the analysis and in consideration of the County's solid waste management system, SAIC determined the following scenarios could be (initial) RMPs for the County to consider at this time.

1. Consistent with the Environmental Protection Agency (EPA) solid waste management hierarchy, which ranks Source Reduction and Reuse as the preferred method:
    a. In the commercial sector, expand the County's current waste reduction program to include a more significant focus on food waste; and
    b. In the residential sector, re-double efforts to reduce the need for off-site processing of grass clippings, which affects the compost facility operation's capacity to effectively manage food waste, if diverted.
2. Implement a pre-consumer commercial sector food waste diversion program.
    a. Divert vegetative food waste only.
    b. Source separate, but use composting technology (without the availability of an operating anaerobic digestion facility, excluding consideration of the wastewater treatment plant).
    c. Program would be voluntary.
    d. Focus on the types of generators that have only vegetative food waste, such as wholesale produce, coffee shops, and juice bar establishments.
    e. During peak periods, if (the Compost Factory is) at capacity, divert material to the Silver Springs facility or the landfill.
3. Implement a single-family residential sector food waste diversion pilot program in two communities.
    a. Divert vegetative food waste only.
    b. Collect food waste with yard waste for composting.
    c. Program would be voluntary.
    d. Program would be limited to routes which transport material to the Compost Factory (food waste is not permitted at Purdy).
    e. During peak periods, if (the Compost Factory is) at capacity, divert material to the Silver Springs facility or the landfill.

4. While beginning efforts to divert food waste from the landfill, continue to landfill food waste, taking into account plans to develop a landfill gas (LFG) beneficial use project and utilize the additional landfill gas generated.

Section 1
INTRODUCTION

1.1 Project Purpose

Pierce County (County) Public Works and Utilities, Solid Waste Division, retained SAIC in July 2011 to develop reasonable management practices (RMPs) for residential and commercial food waste. The County, supported by SAIC, in its 2010 waste audit has identified food waste as a significant volume of waste currently being landfilled. The County viewed this food waste as a potential opportunity to reduce landfilled waste and preserve the available capacity of their landfill; capture a useful resource for the community; and continue to be an ecological and socio-economic leader in the region as food waste diversion has become a growing consideration in solid waste management.

Food waste refers to vegetative (e.g., lettuce, fruit peels and cores) and non-vegetative, animal-based (e.g., meat, dairy and fatty foods) food scraps. Compostable paper, containers and utensils are not included in this category and are not part of this analysis.

The analysis of food waste RMPs evolved from the County's commitment to comprehensive planning to inform their decision-making process. The County had already taken some initial steps by implementing the waste characterization, carbon assessment, and other studies. The development of RMPs was the next step in this process. By exploring the wide range of alternatives in consideration of the current environmental, economic, and community concerns, the County will better be able to avoid the problems that have arisen in other jurisdictions from implementing a system that may not have been fully planned out and may not actually meet the needs of the users.

The food waste RMPs analysis examined programmatic approaches to and methods for food waste management. These RMPs are waste management practices which have an opportunity for success and may be appropriate for the County's customers. The intent of the RMPs is to provide the Solid Waste Division and project stakeholders information to facilitate development of a more concise list of Best Management Practice (BMP) recommendations. The Solid Waste Division in conjunction with project stakeholders will recommend the final BMPs to elected officials for approval.

Project stakeholders were incorporated into the analysis process as a part of the County's commitment to comprehensive planning. The Solid Waste Division designed the project to follow a public process ensuring transparency and accountability. The Solid Waste Division administrated the project through an internal Coordinating Team (C-Team). In addition, an external Project Management Team (PMT) was developed to:

- Facilitate a comprehensive understanding of program needs and constraints;

- Elicit input and guidance from the stakeholders on important elements of the analysis;
- Vet the basis for narrowing food waste management options to RMPs; and
- Promote acceptance of the analysis results and future development of BMPs by the County.

The PMT consisted of representatives from the County's Solid Waste Advisory Committee, County's disposal contractor (Waste Connections/Land Recovery, Inc. (LRI)), County's franchise waste haulers, County's sewer utility division, City of Tacoma (Tacoma), Tacoma-Pierce County Health Department, C-Team Members, and Department of Ecology.

1.2 Project Approach

The food waste RMPs analysis began with data collection and initial assessments of the available organics within the County's solid waste management system and potential impacts of food waste diversion from the landfill. Initial assessments are available in Appendix A-1 (Organics Availability) and Appendix A-2 (Food Waste Diversion Impact on Landfill Gas Generation).

These initial assessments were followed by a broad screening analysis, which generated general information on various food waste management technologies and programmatic approaches. The resulting screening matrix and organics program system scenarios are contained in Appendix B.

In consultation with the C-Team and the PMT, the broad screening analysis was refined to specific County food waste management scenarios, with varying intensities, which underwent additional evaluation in a detailed analysis. The scenario descriptions and resulting detailed analysis is presented herein.

Throughout the analysis, the considerations have had the primary focus on impacts to economics, carbon footprint, and the environment.

1.3 Background

1.3.1 Current Practice

The 304th Street Landfill is owned and operated by Pierce County Composting, Recycling and Disposal, dba LRI. The landfill began operation in late 1999 and has disposed of approximately 9.4 million tons of waste. The landfill was expected to dispose of approximately 910,000 tons of municipal solid waste (MSW) and other waste types in 2011, including waste from both the County, Tacoma, and others. The County 2010 waste audit showed a contribution of 375,000 tons disposed. 2012 disposal quantities are expected to be approximately 347,000 tons. Based on current tonnages and waste reduction and diversion projects, LRI is projecting landfill capacity to be reached in 2048.

Of the waste disposed in the landfill, the County's 2010 waste audit identified food waste as 28.1 percent (by weight). Extrapolating out to the established analysis evaluation year of 2021 with a projected population growth rate of 0.9145 percent, this represents approximately 116,450 tons of food waste disposed by the County per year.

Note that unless specifically mentioned, the analysis is specific to impacts on the County's system and does not speculate at potential diversion programs initiated by Tacoma or others.

1.3.2 LRI Landfill Gas Beneficial Use Project

Another consideration regarding the utilization of food waste as a resource is that LRI will be implementing a landfill gas (LFG) beneficial use project at the landfill.

Methane, in the form of LFG, can be a valuable resource. The current practice is to flare combust the LFG to reduce greenhouse gas (GHG) emissions, which doesn't utilize the methane potential. LRI, partnered with BioFuels Energy, has completed a LFG use feasibility study. The study reviewed options for beneficial use of the LFG and the economic value each option may provide to LRI. The feasibility study indicated that two options are available for LFG use: electricity generation and conversion of LFG to compressed natural gas (CNG) for use as vehicle fuel. The feasibility study also evaluated the development of an LFG beneficial use project in phases that consider the available methane potential over the life of the landfill.

According to BioFuels Energy, the LFG beneficial use project should be developed in three phases. Each phase would be independent of the other, without the development and payback for a specific phase requiring the development and associated revenue of a subsequent phase. The development of Phase 1 is likely to occur in two sub-stages and is feasible based on the current in-place waste mass and LFG production at the landfill.

Project phasing was also emphasized due to potential impacts on the waste stream as a result of materials diversion. The second and third phases are expected to become feasible if the current disposal practices are maintained; however, each phase is expected to be re-evaluated with actual field testing at a later date, as the time of their potential incorporation approaches. Regardless of future County policy and waste diversion programs, if all applicable permits are received, Phase 1 is expected to occur. According to BioFuels Energy, the viability of Phase 2 and Phase 3 may be jeopardized as a result of food waste diversion from the landfill and the impact it has on LFG generation.

When fully implemented as planned, Phase 1 includes conversion of LFG to both electricity (Phase 1A) and CNG (Phase 1B). The study estimates that with Phase 1 approximately 900,000 diesel gallon equivalent (DGE) can be produced per year. This is enough to annually fuel 159 trucks, assuming each truck averages 25,000 annual miles at 4.5 miles per gallon. Additionally, the landfill could generate approximately 4.8 megawatts (MW) of electricity with the remaining LFG. This is equivalent to the electricity consumed by approximately 3,500 homes, annually. Each subsequent phase could be either electricity generation, CNG conversion, or some combination of the two.

The costs for development and operation of LRI's beneficial use projects and the revenues the projects generate are not expected to have a direct economic impact on the County.

1.4 Scenarios

The following three sections discuss the scenarios that were selected by the C-Team and PMT to be brought forward from the screening analysis into a more detailed evaluation. The scenarios are intended to provide high level information pertaining to potential economic, environmental, and carbon footprint impacts, if a scenario or variation thereof were to be implemented into the County's solid waste system. Scenarios are generally discussed with different levels of intensity to provide a range of possible impacts. Scenarios, and internal elements within each scenario, can be viewed independently or considered in conjunction with other options.

Section 2
SCENARIO 1 – FOOD WASTE REDUCTION

2.1 Introduction

This scenario focuses on ways to reduce the need for food waste collection and off-site processing through substantially greater attention to reducing the generation of organics at the source and promoting on-site reuse.

Methods

The primary methods explored are:

- Education and Outreach: Expanding current education and outreach efforts.
- Training: Offering technical training.
- Financing: Providing outright grants, matching grants, low-interest loans, and discounts for the on-site or on-farm processing of food waste.
- Partnerships: Establishing or strengthening programmatic support for the rescue of edible food for people in need.
- Economics: Establishing a rate structure that rewards on-site processing over off-site collection and processing of organics, including food waste and yard trimmings.
- Policy: Establishing requirements regarding the source separation of recyclables and organics from trash.

Sectors

This scenario covers all sectors, including single-family residential, multi-family residential, commercial and institutional sectors. Within the multi-family residential sector, targeted subsectors include residential housing associations and apartment buildings. Within the institutional sector, targeted subsectors include universities, jails, military installations, hospitals, senior living centers, schools, social service agencies that are involved with edible food rescue and distribution, community gardens, and local government facilities. The primary targeted subsector within the commercial sector is food service establishments (FSEs). For the purpose of simplicity, the discussion for commercial and institutional sectors are combined in this section, and termed "commercial sector."

It should be noted that this scenario can stand alone, or it can be implemented in conjunction with any other scenario. This scenario could result in a decreased need for off-site collection and processing, possibly by 1,000 to 10,000 tons per year.

2.2 Education and Outreach

Education and outreach efforts to reduce food waste should use a multi-pronged and sustained approach. Some of the information dissemination and promotional approaches for food waste reduction include, among others:

- Internet Based Media:
  - Website, with how-to information, frequently asked questions and answers, case studies, first-person vignettes, resources, and other useful links;
  - Blogs;
  - Twitter feeds;
  - YouTube how-to video, with first-person vignettes;
  - FaceBook multi-way communication and information-sharing;
  - Other localized electronic media.
  - Print Media:
  - Articles and informational ads in neighborhood, non-English, and major newspapers;
  - Information flyers, brochures, and poster boards available at area stores and garden centers;
  - Utility bill inserts; and
  - Press releases.
- Radio, TV, and Telephone:
  - Public Service Announcements;
  - Interviews and news stories; and
  - Telephone Hotline (for questions and answers).
- Community Action:
  - Educational seminars and workshops presenting best management practices and case studies;
  - Information booth at community events and fairs;
  - Volunteer training for outreach;
  - Demonstration sites and displays; and
  - Various links with school-sponsored programs and activities.

Link to Grasscycling

Though not specific to food waste reduction, but in the context of promoting organics waste reduction as a way to achieve higher environmental quality, it is particularly important to reduce the need for collection, off-site transfer and composting of grass clippings, since grass clippings can be one of the more common causes of odor events at compost facilities. Home composting, grasscycling, and changes in planting and watering are three ways to reduce reliance on government, and its permitted haulers and processors, for managing one's own landscape. The most basic of these approaches is grasscycling, a term that while well-known to recycling professionals has not yet entered common usage. Grasscycling is simple - leaving grass clippings on the lawn after mowing. Slightly adjusting mowing methods and frequency, and using mulching mowers, can aid in the effort.

2.2.1 Single-Family Residential

The approach would be to increase efforts to promote home composting, worm composting, grasscycling, and the wider use of mulching mowers.

A summary of the County's current program includes free two-hour workshops on yard waste composting (for yard trimmings, with possible addition of food waste) and on food waste composting with worm bins (for food waste only). The yard waste composting course covers do-it-yourself options for bin construction, but does not include an option to purchase a discount bin, whereas the food waste composting workshop includes an option for a worm bin and worms for $30. In 2011, 58 home composting classes were taught throughout the County with an overall audience of about 1,100 people, using grant funding provided by the Washington State Department of Ecology. (It was not determined the extent to which the program was internally funded and the extent to which it relies upon funding support from the State of Washington.) The goal for this year is to increase the number of locations in the County at which the workshops are offered.

Meanwhile, Tacoma periodically offers one-day home compost bin sales, at a discounted price of $35 (available to Tacoma residents only), and monthly home composting and worm composting workshops (open to all). Tacoma's website appears to refer to home composting as a technique for yard trimmings. This statement potentially could be expanded to include vegetative food waste.

Teaching 1,100 residents in one year about ways to manage their own landscape trimmings and food waste is an achievement. However, in a county of nearly 600,000 residents, there's considerable room for acceleration in the practice of residents taking greater personal responsibility for their own discards. Comprehensive programs in similar size communities elsewhere include: dedicated staff; workshops; creative advertising; use of social media; demonstration sites; distribution of discounted bins; portable displays; grasscycling promotion; and ties with resource-efficient landscaping and green gardening programs.

Benefits of these programs are many and substantial:

- Avoided collection, transfer and centralized processing;
- Reduced disposal burden;
- Lowered residential trash bills (where unit costing exists);
- Improved soil health and fertility;

- Job creation (home composting program coordination and promotion);
- Reduced air and water pollution;
- Hands-on methods of science education (especially worm composting);
- Reduced traffic congestion (less hauling of materials);
- Increased residential interest in and dedication to sustainability efforts;
- Exercise and relaxation;
- Reduced use of artificial fertilizers and pesticides;
- Greater sense of personal responsibility, and personal/community pride.

Detractors point out that the penetration rate of home composting programs can remain low, even after several years of effort; that home composting is less visible than placing distinctively colored organics bins on a regular basis at curbside for collection, and thus does not provide a strong social reinforcement; that home composting is not suitable for animal proteins, which large-scale organics processing operations more typically handle; and that home composting, when done improperly, can raise the incidence of vectors and nuisances.

A 1995 report (Sherman, 1995) cited information obtained from the City of Olympia, which estimated that participating households compost approximately 500 pounds per year (of yard trimmings mostly). This means that for every four participating households, one ton of yard trimmings is composted at home. Existing home composters are natural candidates for being taught how to effectively incorporate vegetative food waste into their home composting systems. In addition, apartment-dwellers and schools can be targeted for reduced off-site food waste disposal via worm composting, which can be done without nuisance in a small space indoors or outdoors. A small 2 foot by 2 foot bin can process at least 100 (and up to 200) pounds of food waste per year. At this rate, 10 to 20 participating households would divert one ton of food waste from the landfill and from the need to be collected and processed off-site.

The report concluded that the average total net benefit derived by local governments which have home composting programs is substantial: “Local governments reduce solid waste collection and disposal costs by an average of at least $43 per ton [for materials] that are composted [or otherwise source-reduced] at home.” Considering the current year and the County’s system, reduced costs can be expected in the range of $85 per ton. With this in mind, it may be worthwhile for the County to determine a baseline level of home composting, grasscycling and other related source reduction activities, and to establish a goal for the adoption of such practices by a certain percentage of the population by a certain date.

2.2.2 Multi-family Residential

Modest in-roads in reducing food waste by the multi-family residential sector can occur as a result of promoting vermicomposting (composting using worms), as mentioned above. Red worms (eisenia foetida) in small, indoor, low-cost bins can convert vegetative food waste (primarily fruits and vegetables) to worm castings, which can then be added as a soil conditioner or fertilizer for indoor or outdoor plants. With proper equipment and bin management, concerns about the potential for fruit flies, ants, odor, and leaks can be minimized. Not surprisingly, this approach is not likely to be adopted widely within the multi-family residential sector. No voluntary programs in Washington State have been able as yet to achieve substantial reduction of food waste from this sector.

2.2.3 Commercial

In outreach to the commercial sector, it is useful to tie the on-site composting of yard trimmings with adding in food waste where possible. The County could begin to hold or hold more resource-efficient landscaping workshops specifically geared to professional landscapers, and ideally taught by a certified landscaper. It might be possible to link the workshops with green landscaping certification, if such a designation exists in the region, or provide some other form of recognition. While professional landscapers are not typically high generators of food waste, there may be situations in which landscapers can incorporate the food waste collected on the premises, such as a corporate campus, into an on-site composting system. Generally, though, this type of outreach can be expected to have a larger effect on organics diversion as a whole. Moreover, given the minimal cost of off-site transport and disposal of yard trimmings in the county, it will be challenging for the County to motivate professional landscapers to incorporate resource-efficient landscaping practices into their services.

Meanwhile, in the institutional subsector, schools should be encouraged to incorporate on-site composting, worm composting, and grasscycling, and the use of organic soil amendments, into their regular practices. A potential challenge to its widespread implementation is available and trained staff. For the commercial sector as a whole, one additional area of growing interest is in achieving Leadership in Energy and Environmental Design (LEED) certification for buildings. Designing in the use of green gardening and opportunities for on-site food waste composting or vermicomposting can qualify for innovative credits within the LEED certification structure.

2.3 Training

While the terms “education and outreach” and “training” sometimes are used interchangeably, their distinguishing characteristics are worthy of note, in part because in waste reduction programs they sometimes appear as distinct line items. Education is a more all-encompassing term, for it involves the self-discovery, co-discovery, or communication of information and techniques in how to think, or act, or what to believe. Training, more narrowly defined, involves teaching, typically through hands-on practice, for the goal of building specific vocational or practical skills. In short, and in the context of this section, training is about teaching someone how to do a specific task or set of tasks. Using this delineation, it is possible to place home composting under Training rather than under Education and Outreach, but we have reserved training examples for a business or organizational context.

2.3.1 Commercial

The primary training opportunities for food waste reduction include food inventory, storage and handling practices, and institutional food service methods.

Reduction of food waste in the large food preparation environment usually begins with a food waste generation assessment. (Sometimes, this action is called a "waste audit", but experience elsewhere has shown that businesses tend to be more open to a third-party assessment rather than an audit.) In a typical assessment sponsored by a local government's waste reduction and recycling program, a government employee or specialized contractor will examine the sources, characteristics, volume, and pace of incoming materials (e.g., food purchases), locations within the organizations or businesses where discards are generated (e.g., food waste), and the causes of inefficiently-run operations (e.g., inefficient, imperfect, or lower-grade use of material inputs to production, as evidenced by what and how much material shows up in trash, recycling, and organics containers). The inefficient use of materials has three primary financial effects at a business: higher input costs; lower gross revenue; and higher refuse removal and processing costs. Among the myriad of ways to reduce food waste generation within a food service business, the following are leading standard examples of how to do so and where to look for opportunity for improvement:

- Purchasing and Inventory Control: Effective forecasting of production and purchase needs affects the generation of food waste. It is easier said than done, but tracking the generation of food waste can help managers analyze patterns and quantities, which potentially can help managers to calibrate better in the future.
- Reducing Overproduction: There are numerous examples of ways to reduce overproduction. One such way involves switching from buffet-style stations to made-to-order stations in institutions, which may result in less wastage of food.
- Serving and Portion Control: Understanding appropriate serving size and portion control results in less overproduction of food and less pre-consumer and post-consumer food waste.
- Menu Development: Maintaining a flexible menu with chef's specials, limited time offers, or other daily specials can help operations use up what they have on hand and prevent over-purchasing.
- Marking foods clearly for "use-by" dates, and storing them in a way that older products will be used first.
- Properly storing foods for maximum freshness and longevity.
- Avoiding excess trimming when preparing food.
- Establishing effective communication and feedback between day and night shifts.
- Having clear, consistent, and well-observed internal protocols for the donation of surplus food.

- Regularly observing the contents of trash and organics containers close to when their collection by haulers occurs, to identify additional opportunities for food waste reduction.
- Education and Training: A large part of prevention comes from training and empowering staff to understand and adopt the culture of waste prevention.

In a food service business such as a restaurant or supermarket, preventing the wastage of food in a food service operation frequently affects the bottom line more readily and positively than establishing organics collection service for the business. These approaches complement each other; however, and both are needed. Enhancing operational efficiencies to prevent waste is especially important in areas where organics processing facility capacity or availability may be significantly constrained.

In well-established commercial organics collection programs, owners and managers of restaurants in particular have noted that once they started to source-separate their organics and deposit them in organics containers either loose or in clear plastic bags, they could see much more readily opportunities for food waste reduction, such as described above. This is an important cost savings opportunity for businesses that extends any potential cost savings that a business might realize through participation in a commercial organics collection program.

2.4 Financing

Various means of financing can be deployed to help achieve and accelerate reduction in the generation and off-site processing of food waste.

2.4.1 Single-Family Residential

Single-family households that have regular collection service typically spend over $250 each year on trash, recycling, organics, and household hazardous waste collection and processing. Much of the material that is collected consists of organics that can be managed at home.

The County could establish deep(er) discounts for items that help residents to shift their materials management habits. These items could include, among others:

- Home composting bins (typical discounted price: $25-$40);
- Worm composting bins and worms (typical discounted price: $20-30, including one pound of worms);
- Worm composting how-to booklets; and
- Mulching mowers (discounts of 25 percent or more tend to catch people's attention). See, for example: http://www.abag.ca.gov/bayarea/grass/resources/grassresources2.html and http://www.ci.brentwood.ca.us/pdf/new/extra_limited/MowerRebatea.pdf

As indicated above, however, even with such discounts, the adoption rate among residents typically remains low, and these programs generally are more effective for yard trimmings reduction than for food waste reduction.

For residents who install resource-efficient landscaping, the County, in conjunction with local cities and water agencies, could explore how to provide incentives for such investments. Mechanisms might include rebates (e.g., drip irrigation systems, smart timers for watering based on ambient weather conditions, etc.) and tax incentives (e.g., reduced property transfer tax, etc.). Any such program could cross-promote home composting and worm composting of food waste.

Getting home composting bins into motivated residents' hands is a key step in reducing the generation of food waste by residents, as research in Alameda County (CA) and elsewhere has shown. Encouraging residents to build their own bins, and providing them with instructions and plans, as the County does, is a laudable first step. It provides a (presumably small) subset of those who want to compost at home with the means to do so. A number of enthusiastic early-adopters have built their own bins. Experience indicates, however, that few beginning composters will spend the time and money to obtain materials and construct bins. Offering residents a more immediate, and yet still low-cost, way to start to compost at home will result in more widespread adoption of this materials management practice. Numerous communities have made home composting bins available to community members at reduced prices, including Tacoma and the City of Seattle. While possibly adding some degree of administrative complexity, the costs for operating a bin distribution program often can be reduced when local governments work cooperatively to order bins, provide workshops and promote the program.

2.4.2 Multi-Family Residential and Commercial

In addition to offering identical or similar equipment and incentives, as described under the single-family residential sector, the County could provide grants (outright or cost-sharing) for institutional-scale, on-site processing equipment for food waste and landscape trimmings. This equipment could be organized in a few categories, such as smaller grants for on-site, in-vessel composting units that are favored by institutions, and larger grants and low-interest loans (and possibly technical and permitting assistance) for on-farm processors (composters, vermiculture, animal feed conversion, anaerobic digesters) that actively accept clean, source-separated organics (including food waste) that otherwise would remain in the County's solid waste stream. Administering such programs, however, requires staff time, financial oversight, and the ability to effectively judge the likelihood of success of proposed projects. In any given year, relatively few grants and/or loans are likely to be provided, and most of the project benefits would accrue to the grantees for it is not expected that their success would result in widespread voluntary, non-subsidized adoption of similar projects.

2.5 Partnerships

Establishing effective partnerships to help all sectors to reduce the generation of food waste (and landscape trimmings) that need off-site processing is an important area for further exploration. Partnerships take many forms. Here are some examples:

- County-City partnerships (such as with Tacoma, which often has proven to be a first mover in recycling and organics management programs);
- Regional partnerships;
- County-State Department of Ecology partnerships;
- County-Washington State University Cooperative Extension partnerships (for outreach to farmers, professional landscapers, and green gardeners);
- Groups of local cities and towns;
- Community-based groups that have non-formal links to the County Solid Waste Division, such as Master Gardeners, if such a program exists and is separate from Cooperative Extension;
- Local community gardening groups; and
- Professional-based groups that have non-formal links to the County Solid Waste Division, such as local professional landscaping associations or the local chapter of US Green Building Council, if any.

With a topic that cuts across so many segments, and with budget realities, expending effort to establish, broaden, or deepen partnerships with other organizations in or near Pierce County may be a prudent step for the County.

2.6 Economics

Economics, or more specifically the rate structure for refuse, recycling and organics collection and processing, can provide an incentive or act as an impediment to the reduction of food waste. Below are two ways in which the rate structure can be developed to provide an incentive.

- Use of a combination of a set base rate for a minimum level of refuse and organics collection service, plus volume- or weight-based variable collection charges for each type of service. In addition, charges are applied for increased frequency of collection. This approach yields an incentive for users to seek to use not more than the minimum level of service, which may mean that users put effort into reducing the generation of food waste.
- Setting of organics collection service rates in such a way that they are substantially lower, perhaps by as much as 50 percent lower, than the rate charged for an equivalent level of trash collection service. This approach is more common in the commercial sector than in the residential sector, for the collection of organics. It is quite effective, and several communities view it as an essential factor in their program's success. In order to offer a significant

discount for organics collection relative to refuse collection, rates for refuse collection typically are increased slightly (less than 10 percent) and spread across the entire commercial sector. By being charged directly for organics collection and a higher price per equivalent level of refuse collection service, customers have a clear economic incentive to (a) keep organic materials out of the trash and (b) to reduce the generation of organics (to reduce or avoid the variable charge for organics collection).

It is possible to set up a "Cash for Trash" or similar education and outreach effort that incorporates a non-rate structure economic incentive in the form of gift certificates or discount coupons given to randomly-selected residents whose refuse, upon examination at curbside, does not contain more than 10 percent of materials that are accepted in the community's recycling and organics collection programs. One example of this program is:

http://www.ecologycenter.org/recycling/cashfortrash2003/index.html.

This program may indirectly promote the home composting of food waste. While a positive and low-cost form of publicity and education, it is not likely in and of itself to result in significant changes in behavior (i.e., food waste reduction or source separation).

2.7 Policy

Policy initiatives primarily take the form of establishing requirements for the source separation of organic materials, including food waste, from refuse. On the West Coast, Seattle and San Francisco have led the way in setting comprehensive source-separation requirements for various sectors. For information on several programs' mandatory recycling approach, see: http://www.stopwaste.org/docs/Summary-Matrix-Mandatory-Programs-7%2024%202011-w-citations.pdf.

A second form of local policy initiative is the establishment of a ban on the disposal of certain materials. In Alameda County, California, for example, the ban is enforced at transfer stations and landfills, which are required by Alameda County and the Alameda County Waste Management Authority (aka StopWaste.Org) to assess a 50 percent surcharge above and beyond the normal refuse disposal rate for self-hauled loads that contain certain types of materials, such as yard trimmings, above de minimis levels. It is conceivable that this surcharge could be expanded to cover food waste that is excessively commingled with trash.

These policy approaches may raise greater awareness about food waste, and may indirectly contribute to the adoption of food waste reduction measures by generators. They tend to be controversial during the discussion and policy-making phases and during the first year of implementation, but then become far less so over time, as residents adjust and as businesses incorporate the changes into their standard operating procedures.

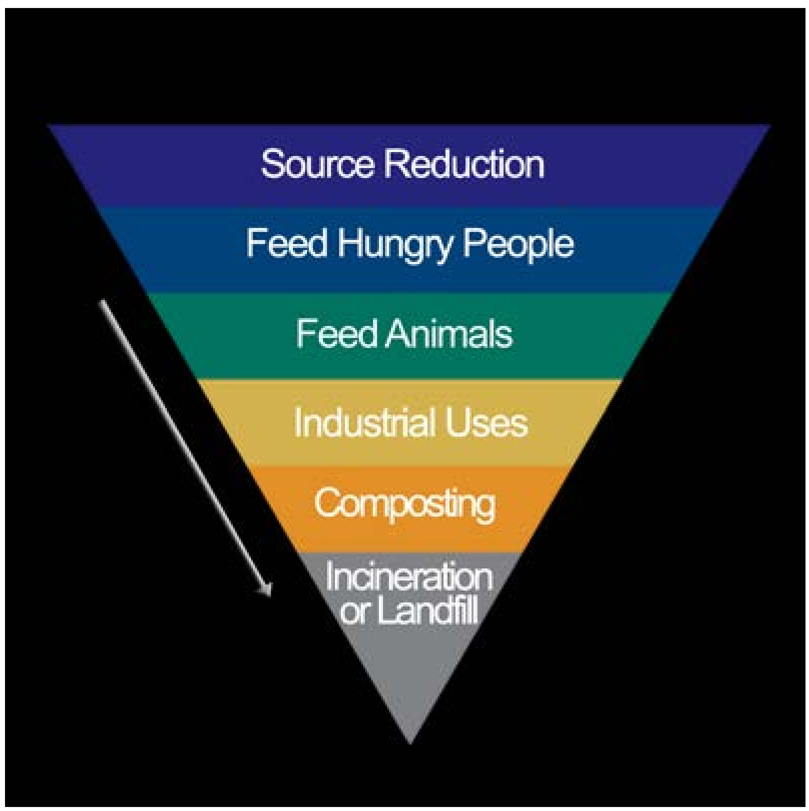
2.8 Economic, Carbon Footprint, and Environmental Benefits

Economic Benefits

Economic benefits have been described earlier in this section. Briefly, food waste reduction can reduce the overall system costs for collection and off-site disposal or materials processing. On an individual household or business basis, the potential exists for program participants to realize cost savings through avoided disposal.

Carbon Footprint Benefits

Food waste reduction results in the diversion of materials that, when disposed in landfills--whether those landfills contain gas capture systems or not--causes the generation and emission to the atmosphere of methane, a potent greenhouse gas. Landfilling and composting, respectively, are at the bottom of the United States' hierarchy of preferred options for managing food waste (see Food Recovery Hierarchy, www.epa.gov/foodscraps).



Food waste reduction also reduces the number of vehicle miles traveled, resulting from a reduction in the number of collection vehicle loads. This trip reduction reduces the amount of air emissions of greenhouse gases.

Environmental Benefits:

In addition to landfill diversion, environmental benefits can include:

- Avoided collection, transfer and centralized processing, with attendant equipment and land use impacts;
- Reduced disposal burden;
- Improved soil health and fertility;
- Reduced air and water pollution associated with disposal;
- Hands-on methods of science education;
- Reduced traffic congestion (less hauling of materials);
- Reduced use of artificial fertilizers and pesticides;

An important social benefit associated with food waste reduction may be a greater sense of personal responsibility for one's discards and business community pride in showing environmental leadership and stewardship.

Section 3
SCENARIO 2 – SECTOR BASED PROGRAMS

3.1 Introduction

The following program elements are defined for the single-family residential, multi-family residential, commercial, and self-haul sectors. Program elements may be implemented alone, or a program may be designed as a combination of multiple elements. Projected outcomes will vary based on the type and intensity of elements considered.

Program elements were evaluated considering various intensities of implementation. For example, a Low Intensity would represent a program element that would yield a portion of the food waste, but implemented with little cost to the customer and may result in less negative impact to the environment and less beneficial impact to carbon footprint reduction. A High Intensity, on the other hand, may yield a greater volume of food waste, but at a higher cost to the customer with potentially greater environmental and carbon footprint effects.

Reasonableness of each program element, or combination thereof, should consider the economic, environmental, and carbon footprint effects and if these result in a benefit to the County and customers.

3.1.1 Commercial

A commercial program could target business, institutional, industry, and government facilities and would require that generated amounts of vegetative and non-vegetative food waste be separated at the source in an individual bin, or container, for the organic material to be collected and transported by County franchise haulers.

A Low Intensity commercial program could primarily target only those business, institutional, industry, and government facilities that generate significant amounts of food waste that can be separated at the source in a volume that warrants an individual bin. This would have a higher yield for the level of effort than would otherwise be required if food waste separation were mandatory for all commercial entities. Depending on items such as outreach, education, financial incentives, and community desire, the level of participation will vary. Mandatory collection could be an option if the cost for the level of effort to capture additional amounts of food waste created significant benefit, such as being the difference between a desired type of beneficial reuse project verses a less desirable one.

Commercial collection at target facilities will have a much higher yield of food waste than a residence, and can better justify separate collection. The vegetative and non-vegetative food waste will not be mixed with or have a high concentration of yard waste, providing confidence for either composting or anaerobic digestion processing technology options regardless of the intensity of program implementation. Since composting was explored in greater detail as part of the single-family residential portion of this scenario, the commercial sector will consider anaerobic digestion.

Anaerobic digestion refers to a process where microorganisms break down organic materials, such as food waste, in mechanical digesters in the absence of oxygen. Anaerobic digestion produces biogas and a solid residual. Biogas, made primarily of methane and carbon dioxide, can be used to produce electricity or natural gas. The solid residual can be composted and used as a soil amendment.

This approach applies to all intensities.

Low Intensity

Focus on large food waste generators, such as grocery stores, high-volume restaurants, and certain institutions, in a voluntary program that provides rate incentives to encourage participation. Source-separated food waste collection would be weekly, or multiple days a week depending on need. Food waste capture is assumed to be 20 percent of that available.

Note that throughout this report, “capture” refers to the quantity of material collected from customers, and “yield” refers to the quantity of usable material, once marginal material and contaminants have been removed from the collected material.

Moderate Intensity

Low Intensity PLUS increase outreach to include smaller commercial generators. Food waste capture is assumed to be 40 percent of that available.

High Intensity

Moderate Intensity AND participation is mandatory for all commercial sector generators of food waste. Food waste capture is assumed to be 75 percent of that available.

3.1.2 Single-Family Residential

A single-family residential program could target only those customers that have, or are able to subscribe to, curbside yard waste collection. The geographical diversity of the County, and the fact that current programs do not mandate curbside yard waste service for all single-family residences, does not readily facilitate an initial mandatory participation type program.

The single-family residential portion of this scenario focused on food waste diversion to the yard waste program, rather than source separation of food waste into its own waste stream. This approach has less impact on the County’s existing system by utilizing an existing program, rather than developing an entirely new program. Source separation of food waste could be considered in the future, but due to the number of customers requiring collection and the very low yield per single-family residential customer, source separation of food waste was not evaluated.

Collection of food waste in the same container with yard waste and composting the materials was considered the preferred food waste reuse option for evaluation. Composting refers to a process where the organics are biologically decomposed under controlled conditions. Composting is an aerobic process in which organic materials are ground or shredded and then decomposed to humus in windrow piles or in mechanical digesters to produce a material that can be used as a soil conditioner or fertilizer.

This approach applies to all intensities of implementation. Each intensity could also consider the addition of other compostable materials, such as compostable, non-recyclable paper, though those volumes are not considered as part of this evaluation.

The anaerobic digestion of residential yard waste mixed with a relatively small amount of residential food waste was not evaluated. This is a new approach to managing this type of organics waste stream, and currently lacks the history of performance that was needed to advance the approach for this study. Anaerobic digestion of comingled yard waste and food waste may be something to consider in a future study.

Low Intensity

Participation is voluntary (i.e., food waste in trash container is not prohibited). No change in collection frequency (i.e., organics collection remains at every-other-week, on a year-round basis) or container offerings. Food waste capture is assumed to be 40 percent of that available.

Moderate Intensity

Low Intensity PLUS shift to weekly collection of organics, on a year-round basis. Food waste capture is assumed to be 50 percent of that available.

High Intensity

Low Intensity OR Moderate Intensity, AND participation is required for those customers with available curbside collection (i.e., food waste in the refuse container is prohibited). Food waste capture is assumed to be 70 percent of that available.

3.1.3 Multi-Family Residential

Given the relatively low quantity of food waste available for recovery in the multi-family waste stream compared to other sectors, a program designed to capture this waste would be relatively expensive compared to the potential benefit of diversion, and therefore was not considered to be a reasonable management practice at this time. Program expansion to this sector could be considered at a later date.

3.1.4 Self-Haul

Given the relatively low quantity of food waste in the self-haul waste stream, it was determined that collection of this material was not considered to be a reasonable management practice. Program expansion to this sector can be considered at a later date.

3.2 Economics

Economic impacts can vary greatly due to the large number of influencing factors that can impact any of these single-family residential and commercial intensities. This high level evaluation will focus on the following economic considerations.

- Costs for education and outreach: It is assumed that the County will incorporate an education and outreach program to inform and encourage the community to divert food waste from the landfilled waste stream.
- Impacts to collection: These are expected to primarily include impacts to collection due to quantity shifts between disposal programs and disposal destinations.
- Costs for facility modifications, development, and operation: Diversion will require facilities that can process food waste volumes. This may include modification to existing facilities and/or development of a new facility.
- Potential funding opportunities: Grants and carbon credits may be able to help fund food waste diversion projects/programs.
- End product revenue: There is expected financial gain from utilizing food waste from the County as a resource to produce energy or additional compost.
- Impacts to landfill revenue and airspace preservation: There are tipping revenue impacts as volumes of the waste streams change, and potential airspace is preserved by diverting the County's food waste from the landfill.
- Value to the community: The community may perceive value to their utilization of food waste as a resource, and may value one use higher than another.

3.2.1 Commercial

General Data and Assumptions

1. The number of County commercial customers in 2007 was 13,000. With a 0.9145 percent projected growth to 2021, the commercial customer base would be 14,767.
2. Total available food waste in 2021 is projected to be 38,733 tons, annually. Applying the capture rates for the different intensities and a general 90 percent yield rate results in the following.
   - Low Intensity: 7,747 tons capture and 6,972 tons yield.
   - Moderate Intensity: 15,493 tons capture and 13,944 tons yield.
   - High Intensity: 29,050 tons capture and 26,145 tons yield.
3. Unlike single-family residential, food waste quantities will likely be disproportionate to the percentage of participating commercial customers. This is

particularly the case for lower intensity programs that target large quantity food waste generators. The assumed number of participating County customers for each intensity is as follows:

- Low Intensity: 100 to 200 customers.
- Moderate Intensity: 400 to 800 customers.
- High Intensity: Approximately 2,000 customers.

Education and Outreach

The County already has in place an education and outreach program. It is assumed that the County will incorporate additional education and outreach programs to inform and encourage the commercial sector to divert food waste from the landfilled waste stream. This is particularly significant in the Moderate and High Intensities. General program information would need to be developed and provided. It's expected that this would have an initial cost, but that in the long term cost could be reduced since education and outreach materials can be reused and that over time commercial customers will become accustomed to the new program. This could apply to any intensity with an additional annual cost expected to range from $100,000 to $400,000 depending on the program and the aggressiveness of the program.

Collection

Unlike the single-family residential program, the commercial program collection analysis assumed the commercial refuse collection would remain unchanged. Those entities participating in the food waste diversion program would still receive regular refuse collection, but would additionally receive source separated food waste collection. This approach does not take into account reduced refuse volumes at participating locations. The model estimated the primary costs of the personnel, vehicles, carts, processing and disposal costs, profit, income tax, and other costs.

The Low Intensity assumed 100 to 200 commercial customer participants which resulted in a $405,624 increase in the cost of collection. The impact on collection vehicles was two additional trucks. Results for all three intensities are shown in Table 3-1 below. Note that modeling was based on the 2008 Supplement to the Solid Waste Management Plan (SWMP) projections and that tonnages differ from the 2012 updated information. Differences were not considered significant with respect to the modeling.

Table 3-1:
Commercial Collection Impacts

Intensity	Food Waste Diversion Participation	Annual Organics Program Tonnage	Annual Increase to Collection Costs	Additional Collection Vehicles Required
Low	100 – 200	7,800	$405,624	2
Moderate	400 – 800	15,600	$901,949	4

High	~2,000	29,300	$2,454,201	11

Facility Modifications, Development, and Operation

The Low Intensity assumes to generate 6,972 tons of material (food waste) from the County to be processed evenly through the year. This will require the construction of a 19-ton per day anaerobic digestion facility.

Based on Rapport, et al., 2008, installation and annual operation and maintenance curves, a 19-ton per day facility will require approximately $4,000,000 to 5,000,000 for construction and $600,000 to $800,000 annually to operate. These costs are general and can be impacted by a large number of factors. An annualized cost assuming a 15-year payback period at 6 percent interest would be $463,332 per year or $66 per ton.

Applying a similar approach to both the Moderate and High Intensities results in the following Table 3-2.

Table 3-2:
Commercial Anaerobic Digestion Facility Costs

Intensity	Food Waste (Tons/Day)	New Facility Cost	Annualized Capital Cost	Annual Operating Cost
Low	19	$4M - $5M	$463,332	$0.6M - $0.8M
Moderate	38	$6M - $7M	$669,258	$0.8M - $1.1M
High	72	$9M - $10M	$978,146	$1.0M - $1.3M

Potential Funding Opportunities

Funding opportunities through grants and loan advantages for an anaerobic digestion facility are considered moderate. Specific amounts were not determined as part of this analysis.

Similar to the discussion in the single-family residential program, carbon offset potential can be a funding opportunity for an anaerobic digestion facility. One important note, however, is that Climate Action Reserve (CAR) and most other offset programs only issue credits for the emissions that are directly avoided within an organization's boundaries, but will not issue offsets for indirect emissions reductions such as those that result from producing energy. In other words, CAR will credit the destruction of methane, but not the emissions that are avoided by the increased availability of emissions-free energy; therefore, considering only the emissions reductions resulting from waste breakdown, transportation, and facility operation.

GHG emissions were analyzed as part of Section 3.3, below. Applying those results the three intensities resulted in the carbon offset potential ranges shown in Table 3-3.

Table 3-3:
Commercial Carbon Offset Potential

Intensity	Total Emission Reductions ($mtCO_2e$)	Revenue at $2/ton	Revenue at $10/ton	Revenue at $16/ton
Low	3,057	$6,114	$30,570	$48,912
Moderate	6,058	$12,115	$60,576	$96,921
High	11,094	$22,187	$110,936	$177,497

Assuming private ownership, revenues generated from carbon offsets would not be County revenues. It's expected that these revenues will help offset the additional expenses for diversion when disposal contracts are negotiated.

End Product Revenue

The end product will be additional energy and residual compost material. For this evaluation, energy production will consider power provided back to the grid in kilowatt hours (kwh) per year. The Low Intensity 6,972 food waste diversion tonnage from the County would generate 1,360,452 kwh per year based on an SAIC model. Using an assumed $0.03 per kwh power sales price, the facility could generate $40,814 per year. Additionally, applying a 70 percent liquid reduction and an 80 percent volatile solids reduction to the 6,972 tons would reduce the material to 418 tons of residual compost. At the current $10 - $12 price (assume $11) of whole-sale, or bulk, compost per cubic yard and a bulk density range of 800 to 1,000 pounds per cubic yard (assume density of 900 lbs/cy), the Low Intensity would yield $10,225 of additional annual revenue.

Results for the three intensities are shown in Table 3-4 below.

Table 3-4:
Commercial End Product Revenue

Intensity	Food Waste (tons)	Power per Year (kwh)	Power Revenue	Residual Compost (CY)	Compost Revenue	Total Annual Revenue
Low	6,972	1,360,452	$40,814	930	$10,225	$51,039
Moderate	13,944	2,720,904	$81,627	1,859	$20,451	$102,078
High	26,145	5,101,695	$153,051	3,486	$38,345	$191,396

Assuming private ownership, revenues generated would not be County revenues. It's expected that these revenues will help offset the additional expenses for diversion when disposal contracts are negotiated.

Landfill Revenue and Airspace Preservation

The 2012 tipping fee at the landfill is approximately $130.00 per ton. There is not a current charge for disposal of organics. Organic fees are subsidized by the refuse tipping fee. The Low Intensity diversion of 7,747 tons of the County's food waste will result in a $1,007,051 loss of revenue to LRI.

Long-term airspace preserved assumes that the Low Intensity capture of 7,747 tons is further reduced though screening of contaminants to a yield of 6,972 tons, with the remainder being directed to the landfill at the processor's expense. If the yield tonnage had not been diverted from the landfill, the food waste would have been reduced to gas, leachate, and residual. The residual would result from a 70 percent liquid reduction and an 80 percent volatile solids reduction to a remaining 418 tons. 418 tons of landfill capacity would be preserved. Revenue preserved for disposal of refuse would be $54,381. The net result would be an LRI revenue loss of $952,670.

Table 3-5, below, shows the results for all three intensities.

Table 3-5:
Commercial Landfill Impacts

Intensity	Food Waste Capture (tons)	Lost LRI Revenue through Diversion	Food Waste Yield (tons)	Residual (tons)	Revenue Generated by Preserved Disposal	Net Loss LRI Revenue
Low	7,747	$1,007,051	6,972	418	$54,381	$952,670
Moderate	15,493	$2,014,102	13,944	837	$108,762	$1,905,341
High	29,050	$3,776,442	26,145	1,569	$203,928	$3,572,514

Though revenue losses, above, are specific to LRI and not the County's system, it's expected that diversion costs will result in a possible refuse tipping fee increase, a new fee for organics disposal, or some other means to provide funding to counter the losses. The likely end result will be an increase to the refuse fee paid by customers with a goal of covering the additional cost of diversion. Establishing an organics fee rather than subsidizing the expense through the refuse fee could also reduce incoming out-of-county organics from self haul and commercial customers. This could recapture some existing facility capacity.

It's also worth noting that second and third phases of the LFG beneficial reuse project at the landfill may not occur if food waste is diverted. This is a potential 5,700,000 DGE per year of CNG. The economic feasibility of these phases is not part of this evaluation, but it is assumed that the result is positive. Also, any revenues from the LFG beneficial reuse project do not directly affect the County, as the project is a private project, but can benefit the community.

Value to the Community

There may be a non-quantitative value perceived by the community to have the option to divert food waste. Utilizing food waste in energy production may be viewed as a better use of a resource, rather than generating compost. The EPA lists energy generation as higher value utilization. The value to the community will likely be heavily dependent on general community opinion and marketing by the County or other entity.

3.2.2 Single-Family Residential

General Data and Assumptions

1. The 2012 number of County customers that receive curbside refuse collection is 145,752. With a 0.9145 percent projected growth to 2021, the single-family customer base would be 158,196.
2. The current number of County customers that receive curbside yard waste collection is 73,298. With a 0.9145 percent projected growth to 2021, the single-family customer base would be 79,556.
3. Curbside yard waste collected in Pierce County in 2011 was 53,680 tons, and is projected to be 58,796 tons per year by 2021.
4. Curbside food waste collected in Pierce County in 2010 was 53,305 tons, and is projected to be 58,919 tons per year by 2021. Applying the capture rates, above, for the different intensities and a general 85 percent yield rate results in the following.
   - Low Intensity: 23,568 tons capture and 20,033 tons yield.
   - Moderate Intensity: 29,460 tons capture and 25,041 tons yield.
   - High Intensity: 41,243 tons capture and 35,057 tons yield.
5. Recent quantities of organic waste received at the existing Purdy and Compost Factory compost facilities are as follows:
   - 2006 = 115,786 tons
   - 2007 = 140,841 tons
   - 2008 = 122,545 tons
   - 2009 = 145,937 tons
   - 2010 = 166,857 tons
   - 2011 = 140,935 tons

   Through discussions will LRI, it is assumed that the capacity of the existing compost facilities is the 140,935 received in 2011. Applying a 0.9145 growth rate, the 2021 quantity is projected to be 154,367 which doesn't include food waste diversion.

Education and Outreach

The County already has in place an education and outreach program. Since the addition of food waste to the yard waste program would be a new program, general program information would need to be developed and provided. It's expected that this would have an initial cost, but that in the long term cost could be reduced since education and outreach materials can be reused and that over time residential customers will become accustomed to the new program. This could apply to any intensity with an additional annual cost expected to range from $100,000 to $400,000 depending on the program and the aggressiveness of the program.

Collection

A baseline model was developed to estimate the cost impacts of changes to the County's current refuse and yard waste collection programs that may result from food waste diversion. The baseline model estimated the primary costs of the current program including personnel, vehicles, carts, profit, income tax, and other costs. These results were compared to three intensity models that have been developed to reflect food waste diversion from the refuse program to the yard waste program (organics program).

The current baseline system compared to the low intensity resulted in a $156,000 increase in system-wide cost-of-collection. The impact on system-wide collection vehicles was one additional truck. Results for all three intensities are shown in Table 3-6 below. Note that modeling was based on the 2008 Supplement to the SWMP projections and that tonnages differ from the 2012 updated information. Differences were not considered significant with respect to the modeling.

Table 3-6:
Single-Family Residential Collection Impacts

Intensity	Annual Refuse Program Tonnage	Annual Organics Program Tonnage	Annual Increase to Collection Costs	Additional Collection Vehicles Required
Baseline	155,000	60,000	NA	NA
Low	131,000	84,000	$156,000	1
Moderate	125,000	90,000	$1,394,000	8
High	113,500	101,500	$3,203,000	14

Facility Modifications, Development, and Operation

Currently, the two County utilized compost facilities (Purdy and Compost Factory) are considered at capacity at 140,935 tons per year. The facilities generally process organics from the County and Tacoma. Purdy processes approximately 30 percent of the yard waste, while the Compost Factory processes the remaining 70 percent. The current yard waste processing time is assumed to be 3 months. Processing time will increase with the addition of a food waste component, reducing the capacity of an existing facility. For the purposes of this analysis, it is assumed that the addition of a food waste component to the yard waste will increase the processing time by 50 percent. A more detailed approach to capacity impacts would require discussion of materials handling, mixtures, and curing techniques that could be implemented to manage the compost process most efficiently in a given space.

This reduced capacity is only applicable to the Compost Factory, as Purdy is not currently permitted to accept food waste. Due to the sensitive location of the Purdy facility, food waste is not anticipated for this site. It is assumed that the capacity at Purdy will remain approximately 42,281 tons of yard waste only material per year, which will require customer coordination to exclude any curbside organics collection. It is possible that logistically Purdy would need to be closed, requiring its existing capacity to be added to a new facility.

Note that Silver Springs compost facility in Thurston County is also operated by LRI, and may have some available capacity under certain circumstances. Silver Springs is not considered an option as a long-term organics disposal site for the County.

Applying a direct, linear relationship between processing time and capacity at the Compost Factory, capacity is reduced from 98,655 tons per year to 73,991 tons per year due to the addition of food waste. Combined, the existing facilities are assumed to be able to process approximately 116,271 tons per year. The projected yard waste tonnage is 154,367 tons. Adding the 20,033 tons and 5,516 tons of Low Intensity food waste from the County and Tacoma, respectively, results in a total organics annual tonnage of 179,915 tons. The new Low Intensity compost facility would be required to process the remaining 63,644 tons of organics. Note that the facility capacity evaluation does include consideration of food waste from Tacoma.

The new compost facility is assumed to utilize aerated static piles, and would require a processing building, offices, utilities, and equipment. The processing building would be required to fully enclose the operation to comply with the County's SWMP. At a general cost of $200 per ton of the annual facility capacity, the estimated capital cost for the Low Intensity facility would be $12,728,796. Note that costs are dependent on many factors (i.e., technology, site location, financing) and can vary significantly. This cost is considered reasonable based on the 1998 Compost Factory construction cost of $11,000,000. An annualized cost assuming a 15-year payback period at 6 percent interest would be $1,310,592 per year or $21 per ton.

For the level of this evaluation, it is assumed that long term operational costs at the existing facilities do not change. Assuming an approximate $22.00 per ton cost of operation, based on a 2009 report by Columbia University, the new facility for the Low Intensity would have an annual operating cost of $1,400,168. Note that the per ton cost is only for processing of material at the facility.

Applying a similar approach to both the Moderate and High Intensities results in the following Table 3-7.

Table 3-7:
Single-Family Residential Compost Facility Costs

Intensity	New Facility Processing (tons/year)	New Facility Cost	Annualized Capital Cost	Annual Operating Cost
Low	63,644	$12,728,796	$1,310,592	$1,400,168
Moderate	70,031	$14,006,211	$1,442,118	$1,540,683
High	82,805	$16,561,042	$1,705,171	$1,821,715

It should be noted that the above facility sizing is based on accommodating the annual tonnage, rather than considering peak monthly tonnage. The monthly peak quantity currently received at Purdy and the Compost Factory is assumed to be 20,000 tons, based on the 2011 peak month. It is assumed that Purdy and the Compost Factory can currently process a maximum 6,000 tons and 14,000 tons of yard waste per month, respectively. Applying a direct, linear relationship between processing time and capacity at the Compost Factory, results in a reduced monthly capacity of approximately 10,500 tons per month. The two existing facilities would be able to process a combined maximum 16,500 tons per month.

The Low, Moderate, and High Intensities are estimated to contribute 2,129, 2,661, and 3,726 tons of food waste to the organics program monthly, respectively. Based on 2011 tonnages at the existing facilities, the 16,500 tons per month capacity would only be exceeded twice for the Low Intensity and four times for the Moderate and High Intensities. Alternative to constructing a new facility to accommodate food waste quantities and modified processing time, organics could be diverted to the landfill, or potentially Silver Springs, when existing facility capacity is exceeded. An acceptable level of potential diversion from the two compost facilities would need to be considered, including the cost of disposal.

Potential Funding Opportunities

Funding opportunities through grants and loan advantages for a compost facility are considered low, and for this evaluation is assumed to be none.

Carbon offset potential, or carbon credits, can be a funding opportunity. A carbon offset represents one metric ton of GHG emissions reductions. Offsets can be a tradable mechanism that allows a polluter to reduce their carbon footprint by purchasing the rights to GHG emission reductions that occur at another location for a lower cost than would be incurred by reducing their own emissions directly. Offsets are intended to spur GHG reduction projects that would not be viable without the addition of the carbon offset revenue. There are both regulatory and voluntary markets for carbon offsets. The regulatory markets in the U.S. are associated with GHG cap and trade programs, the Regional Greenhouse Gas Initiative (RGGI) in the Northeast, which placed a cap on the electricity sector, and the up and coming California cap and trade program which will be economy wide. Under these programs parties subject to the cap are able to meet a certain percentage of their compliance obligation through the purchase of offsets. The voluntary market is available to both commercial and residential customers and in 2010 was worth an estimated $424 million.

GHG emissions were analyzed as part of Section 3.3, below. Applying those results, the three intensities resulted in the carbon offset potential ranges shown in Table 3-8.

Table 3-8:
Single-Family Residential Carbon Offset Potential

Intensity	Total Emission Reductions ($mtCO_2e$)	Revenue at $2/ton	Revenue at $10/ton	Revenue at $16/ton
Low	17,611	$35,222	$176,112	$281,779
Moderate	21,673	$43,346	$216,728	$346,765
High	30,169	$60,338	$301,689	$482,703

The mid-range estimate of revenue potential shown in Table 3-8 is based on the assumption that the CAR Organic Waste Composting Protocol and/or CAR Organic Waste Digestion Protocol will be officially accepted by the California Air Resources Board (ARB). If ARB adopts the Protocol, then composting offsets verified through CAR would be eligible for the compliance market associated with the California GHG Cap and Trade program and the price for offsets from Protocol would be expected to be in the $10 per metric ton range. In a phone interview conducted with CAR in August 2011, CAR staff cautioned that there is no certainty that the ARB will adopt the Protocol and therefore prices as high as $9 per ton should not be used for planning purposes. CAR staff noted that the voluntary market shows strong activity at $2 to $3 per ton, and it may be more likely that a composting project would appeal to voluntary market customers. In follow-up interviews in July 2012, CAR staff indicated that offsets under the pre-compliance protocols are trading as high as $14-16 per ton, and this was used to set the high-end estimate. However, it should be noted that these higher prices require guarantees of offset conversion into the compliance market, secondary verification, protection against invalidation and other non-standard services.

As of today, the only real option to participate in the GHG market is voluntary offsets through the CAR. The protocols are available on their website at:

http://www.climateactionreserve.org/how/protocols/.

The County would need to ensure that the project meets the eligibility, monitoring, and reporting requirements spelled out in the composting protocol. Information on submitting and registering the project with the CAR is available at:

http://www.climateactionreserve.org/how/projects/register/.

There are also monthly webinars about the program.

It's possible that ARB will adopt the composting protocols that the CAR has developed for compliance purposes as ARB has with four previous CAR protocols (forestry, urban forestry, manure management, ozone depleting substances). If that occurs, then the precedent has been that there would be an avenue by which voluntary projects could be migrated to compliance projects at which point they would fetch higher market prices.

In addition to potential revenue from the sale of offsets, there are costs associated with registering and verifying carbon offsets including:

- A $0.20 per ton issuance fee;
- Verification costs which typically can be $10,000 - $15,000 in the first year and less for subsequent years over the 10-year crediting period; and
- The cost of staff time required to complete the reporting and monitoring activities required by the Protocol.

Assuming private ownership, revenues generated from carbon offsets would not be County revenues. It's expected that these revenues will help offset the additional expenses for diversion when disposal contracts are negotiated.

End Product Revenue

The end product will be additional compost material generated from the County. The yard waste component of the compost operation is projected to contribute an annual 154,367 tons by 2021. With a 50 percent degradation reduction factor, this produces 77,184 tons of compost. The addition of 20,033 tons of food waste annually, under the Low Intensity, will produce an additional 10,016 tons of compost.

There are varying perceptions on whether or not the nutrients provided by the addition of food waste will increase the value of the compost material. There are also concerns that the food waste can increase the salt content and contents of other unwanted chemicals in the compost. Adding food waste also increases the opportunity for material contamination which can make the compost less desirable. Due to the uncertainty surrounding this issue, it is assumed that the unit revenue from compost will not change. Only the volume of compost will change corresponding to the volume of food waste processed.

The current price for compost in whole sale, or bulk, is $10 - $12 per yard, depending on volume purchased (assume $11). With a bulk density range of 800 to 1,000 pounds per cubic yard (assume density of 900 lbs/cy), the low intensity would yield $244,842 of additional revenue. Results for the three intensities are shown in Table 3-9 below.

Table 3-9:
Single-Family Residential End Product Revenue

Intensity	Additional Organics (tons)	Additional Compost (Tons)	Additional Compost (CY)	Additional Revenue
Low	20,033	10,016	22,258	$244,842
Moderate	25,041	12,520	27,823	$306,053
High	35,057	17,528	38,952	$428,474

Assuming private ownership, revenues generated would not be County revenues. It's expected that these revenues will help offset the additional expenses for diversion when disposal contracts are negotiated.

Landfill Revenue and Airspace Preservation

The 2012 tipping fee at the landfill is approximately $130.00 per ton. There is not a current charge for disposal of organics. Organic fees are subsidized by the refuse tipping fee. The Low Intensity diversion of 23,568 tons of the County's food waste will result in a $3,063,801 loss of revenue to LRI.

Long-term airspace preserved assumes that the low intensity capture of 23,568 tons is further reduced though screening of contaminants to a yield of 20,033 tons, with the remainder being directed to the landfill at processor's expense. If the yield tonnage had not been diverted from the landfill, the food waste would have been reduced to gas, leachate, and residual. The residual would result from a 70 percent liquid reduction and an 80 percent volatile solids reduction to a remaining 1,202 tons. 1,202 tons of landfill capacity would be preserved. Revenue preserved for disposal of refuse would be $156,254. The net result would be an LRI revenue loss of $2,907547. Table 3-10, below, shows the results for all three intensities.

Table 3-10:
Single-Family Residential Landfill Impacts

Intensity	Food Waste Capture (tons)	Lost LRI Revenue through Diversion	Food Waste Yield (tons)	Residual (tons)	Revenue Generated by Preserved Disposal	Net Loss LRI Revenue
Low	23,568	$3,063,801	20,033	1,202	$156,254	$2,907,547
Moderate	29,460	$3,829,752	25,041	1,502	$195,317	$3,634,434
High	41,243	$5,361,652	35,057	2,103	$273,444	$5,088,208

Though revenue losses, above, are specific to LRI and not the County's system, it's expected that diversion costs will result in a possible refuse tipping fee increase, a new fee for organics disposal, or some other means to provide funding to counter the losses. The likely end result will be an increase to the refuse fee paid by customers with a goal of covering the additional cost of diversion. Establishing an organics fee rather than subsidizing the expense through the refuse fee could also reduce incoming out-of-county organics from self haul and commercial customers. This could recapture some existing facility capacity.

It's also worth noting that second and third phases of the LFG beneficial reuse project at the landfill may not occur if food waste is diverted. This is a potential 5,700,000 DGE per year of CNG. The economic feasibility of these phases is not part of this evaluation, but it is assumed that the result is positive. Also, any revenues from the LFG beneficial reuse project do not directly affect the County, as the project is a private project, but can benefit the community.

Value to the Community

There may be a non-quantitative value perceived by the community to have the option to divert food waste. Utilizing food waste in composting may be viewed as a good use of a resource; however, there may be more value recognized in producing energy, rather than generating compost. The EPA lists energy generation as a higher value utilization. The value to the community will likely be heavily dependent on general community opinion and marketing by the County or other entity.

3.2.3 Economic Summary

Table 3-11, below, compares the six program elements on a basis of annual impact to revenues, both County and LRI.

Table 3-11:
Annual Economic Impact to the System

Program/ Intensity	Collection (Additional Cost)	Capital (Additional Cost)	Processing (Additional Cost)	Refuse Fee (Lost LRI Revenue)	Carbon Offset (Additional Income)	Product Revenue (Additional Income)	Annual Impact to System Funds
Commercial: Low	($405,624)	($463,332)	($700,000)	($952,670)	$44,091	$51,039	($2,426,497)
Commercial: Moderate	($901,949)	($669,258)	($950,000)	($1,905,341)	$87,619	$102,078	($4,236,851)
Commercial: High	($2,454,201)	($978,146)	($1,150,000)	($3,572,514)	$159,416	$191,396	($7,804,049)
Single-Family: Low	($156,465)	($1,310,592)	($1,400,168)	($2,907,547)	$224,336	$244,842	($5,305,594)
Single-Family: Moderate	($1,393,654)	($1,442,118)	($1,540,683)	($3,634,434)	$278,111	$306,053	($7,426,726)
Single-Family: High	($3,203,381)	($1,705,171)	($1,821,715)	($5,088,208)	$384,973	$428,474	($11,005,028)

Table 3-12 provides a unit comparison of the annual revenue impact on the County's customers.

Table 3-12:
Annual Impact to Revenues Unit Comparison

Program/Intensity	Tonnage Diverted	Additional Cost per Ton Diverted	Additional Annual Cost per Refuse Account (Single-Family and Commercial)
Commercial: Low	6,972	$348	$14
Commercial: Moderate	13,944	$304	$24
Commercial: High	26,145	$298	$45
Single-Family: Low	20,033	$265	$31
Single-Family: Moderate	25,041	$297	$43
Single-Family: High	35,057	$314	$64

3.3 Carbon Footprint

3.3.1 Approach

The relationship between GHG emissions and organic waste is fairly complex and dependent on disposal methods, control technologies, and composition of the organic matter. At its most basic, as organic matter decays in anaerobic (oxygen deprived) conditions such as at a landfill or anaerobic digester, methane (CH_4), an extremely potent GHG, is produced. As organic matter decays in aerobic (oxygen rich) conditions such as at a well-managed compost facility, carbon dioxide (CO_2), a much less potent GHG is produced. In addition, some organic matter may not decay and ends up actually sequestering carbon. Based on the interplay between these variables, a waste treatment system could be either a net GHG emitter or a net GHG sink.

To quantify the climate benefit of the waste management scenarios analyzed in this report, the GHG emissions were calculated from each scenario using a combination of data sources, as appropriate for each disposal system. The primary tool for landfill and composting emissions was the EPA's Waste Reduction Model (WARM). Emissions from anaerobic digestion were calculated using the Climate Action Reserve's (CAR) Organic Waste Digestion Project Protocol, Version 2.0.

WARM was first released in 1998 and has emerged as the industry standard methodology to estimate GHG impacts from solid waste/resource recovery decisions. WARM allows solid waste managers to calculate and compare GHG emissions from different waste management practices (i.e., landfilling, source reduction, recycling, combustion, composting). The model provides lifecycle analysis of the GHG implications of different waste management or resource recovery processes for over 40 different material types, including food waste. WARM is capable of modeling emissions from a variety of sources across the lifecycle including waste transport, equipment operation, waste breakdown and carbon sequestration, and benefits of energy production. WARM was used to quantify emissions from landfill waste breakdown and compost operations in this analysis.

The CAR Organic Waste Digestion Protocol was developed through a multi-stakeholder process in order to quantify emission reductions, and potential carbon offsets, from projects that divert eligible waste streams from landfills to anaerobic digestion. The CAR methodology was used in this analysis to quantify the emissions that would be expected to result from the digestion of food waste, including leaks from the digester gas collection system, un-combusted methane, and emissions from effluent treatment.

Note that because WARM does not provide modeling support for anaerobic digesters, it was not utilized for transportation emissions to provide methodological parity across the treatment options to the extent possible. Waste transportation was modeled using information provided by waste haulers based on the defined scenarios, and corresponding GHG emission factors.

3.3.2 Analysis

A baseline and the six waste disposal alternatives targeted for the management of food waste, as described above, were analyzed. While additional waste is being disposed of, the goal of this analysis was to identify the net change in emissions attributable to only the food waste diversion portion of the waste stream. The baseline scenario assumes that the landfill has equipment in place that is recovering 75 percent of the landfill gas emissions coming from the landfill. The baseline and six alternatives are described in Table 3-13, below.

Table 3-13:
Disposal Scenarios for Food Waste

Program/Intensity	Food Waste Landfilled (tons)	Food Waste Diverted to Composting (tons)	Food Waste Diverted to Anaerobic Digestion (tons)	Total Food Waste Disposed (tons)
Baseline	116,450	NA	NA	116,450
Commercial: Low	109,478	NA	6,972	116,450
Commercial: Moderate	102,506	NA	13,944	116,450
Commercial: High	90,306	NA	26,145	116,450
Single-Family: Low	96,418	20,033	NA	116,450
Single-Family: Moderate	91,410	25,041	NA	116,450
Single-Family: High	81,393	35,057	NA	116,450

Four distinct emissions sources were considered for this analysis to estimate GHG emissions from each of the six alternatives. Emissions from each source, except transportation, were calculated on a per ton of food waste basis, as shown in Table 3-14. For example, a ton of waste disposed of in a landfill in Washington will emit 0.71 metric tonnes of carbon dioxide equivalent (mtCO_2e) through waste decay, and, through a LFG beneficial use project, reduce emissions generated from a fossil fuel based energy source by 0.064 mtCO_2e. Similarly, a ton of food waste disposed of at an anaerobic digestion facility can be expected to produce emissions of 0.264 mtCO_2e, and generate enough energy to reduce emissions from grid-delivered electricity by 0.073 mtCO_2e. By summing across all four emission sources, Table 3-14 shows the net benefit of diverting a ton of food waste from the landfill to other disposal options. The benefit of diverting a ton to compost is 0.819 mtCO_2e, calculated as the difference between emissions from landfilling that ton (0.647 mtCO_2e), and composting it (-0.172 mtCO_2e). Similarly, the benefit of anaerobically digesting one ton of food waste relative to landfilling is 0.456 mtCO_2e.

Table 3-14:
Comparison of GHG Emissions for 3 Different Food Waste Disposal Options

Emission Source	Landfill ($mtCO_2e$/ton of food waste)	Composting ($mtCO_2e$/ton of food waste)	Anaerobic Digestion ($mtCO_2e$/ton of food waste)
Waste Breakdown	0.710[a]	(0.200)[b]	0.264[c]
Facility Operation	NA	0.029[d]	NA
Energy Generation (Avoided Emissions)	(0.064)[e]	NA	(0.0729)[f]
Total	0.647	(0.172)	0.191

a Source: WARM, food scraps landfilled with typical LFG recovery in WA, under wet conditions.
b Source: WARM, food scraps composted with centralized windrow pile facility, including sequestration benefit of applying compost to soil.
c Source: CAR, Organic Waste Digestion Project Protocol Version 2.0.
d Source: WARM, food scraps composted with centralized windrow pile facility.
e Source: WARM, marginal energy benefit calculated as difference between food scraps landfilled under specified conditions with and without energy recovery.
f Source: Kwh savings calculated by I. Sutton, applying eGRID 2010 emission factor for NWPP.

Transportation emissions were based on an SAIC model developed utilizing information received from waste haulers. The model results indicated collection impacts on the number of vehicles required to service the system. The increase in required vehicles is indicated in Table 3-15. Table 3-16 provides a calculation of emissions for each truck type, based on assumed fuel efficiency, expected annual miles traveled, and diesel emission factors.

Table 3-15:
Additional Trucks Required

Program/Intensity	Additional Automated Trucks Required	Additional Pickup Trucks Required
Commercial: Low	2	-
Commercial: Moderate	4	-
Commercial: High	10	1
Single-Family: Low	1	-
Single-Family: Moderate	7	1
Single-Family: High	13	1

Table 3-16:
Annual Emissions for One Additional Required Truck

Truck Type	Miles Travelled Annually	Miles Per Gallon	Emission Factor	Annual Emissions ($mtCO_2e$)
Automated	25,000	4.5	0.01015	56.39
Pickup	25,000	15.0	0.01015	16.92

Based on the values in Tables 3-13 through 3-16, the net GHG benefit from each diversion scenario was calculated using emissions from each waste disposal scenario relative to the baseline across all four sources. The results in Table 3-17 separately report emissions reductions from waste breakdown, operations, transportation, and energy production. Positive values represent a reduction in GHG, and negative values represent additional GHG generation.

Table 3-17:
Net GHG Reductions from Each Diversion Scenario
(negative values represent net increases)

Program/Intensity	Waste Breakdown ($mtCO_2e$)	Operations ($mtCO_2e$)	Transportation ($mtCO_2e$)	Energy Production ($mtCO_2e$)	Total Emission Reductions ($mtCO_2e$)[a]
Commercial: Low	3,113		(113)	64	3,064
Commercial: Moderate	6,227		(226)	129	6,130
Commercial: High	11,674		(581)	241	11,335
Single-Family: Low	18,248	(580)	(56)	(1,275)	16,336
Single-Family: Moderate	22,810	(725)	(412)	(1,594)	20,079
Single-Family: High	31,934	(1,015)	(750)	(2,232)	27,937

[a] Totals may not sum due to internal rounding.

For the compost scenarios, the waste breakdown process significantly reduced CO_2e emissions, but this reduction was somewhat offset by increases in emissions due to compost operations equipment and loss of renewable energy production. For the anaerobic digestion scenarios, the reductions from waste breakdown were more modest, but these scenarios had the added benefit of generating additional reductions from the production of renewable energy. Overall, even at low diversion levels, composting has a higher climate mitigation potential than anaerobic digestion.

It should be noted that the County's solid waste management system already operates as a net sink for GHG emissions. An overall assessment of GHG emissions from the County's solid waste management system was evaluated in a 2011 technical memorandum by HDR Engineering, Inc. The assessment showed that if the County followed the SWMP, by year 2020 the County's solid waste management system would have a total estimated annual GHG emissions of 289,800 metric tonnes of carbon equivalent (MTCE) compared to a system that landfilled all generated waste. This net sink is equal to -1,062,697 mtCO_2e.

3.4 Environmental

Potential environmental impacts were considered and are discussed qualitatively, below, as it relates to each disposal facility.

3.4.1 Landfill

The landfill is currently required to meet regulatory environmental standards which are in place to minimize environmental liabilities resulting from the disposal of solid waste. The landfill's permit requires the landfill to include measures to minimize environmental liabilities including control of air pollution, surface water, leachate, noise, odors, and vectors. Reducing the quantity of food waste disposed of at the landfill will not have any change in the practice of environmental controls, and the landfill will be considered no more, nor no less, an environmental concern.

The primary impact food waste diversion is expected to have on the landfill is a reduction in LFG and odor generation and draw to vectors. Considering the quantity of diverted food waste compared to the amount that will continue to be disposed of in the landfill, along with all the other solid waste, diversion of food waste is not expected to have significant environmental impacts at the landfill.

3.4.2 Compost Facilities

The existing Purdy and Compost Factory facilities are currently required to meet regulatory environmental standards which are in place to minimize environmental liabilities resulting from the disposal and processing of yard waste. The facilities' permits require them to include measures to minimize environmental liabilities including control of air pollution, surface water, leachate, noise, odors, and vectors. A newly developed compost facility will be required to meet the same established standards.

The addition of food waste to the compost process would not change any of the mandated environmental standards. Facilities would have to adjust facility engineering and operations to effectively process the modified feedstock material while maintaining environmental compliance. The primary concerns are odor and vectors, which can be managed. There would; however, be additional carbon dioxide generated at the facilities as a result of aerobic food waste decomposition. These emissions would be uncontrolled, but are considered less harmful than methane which could otherwise be generated anaerobically, if the food waste was disposed of at the landfill. Additional collection vehicle noise and exhaust is also expected to facilitate collection of the diverted material.

The significant impact to the environment would be the development of a new facility. The result would be a new source for all of the above mentioned environmental liabilities. There would be new environmental impacts resulting from a new facility, even if the facility is operated within regulatory environmental compliance.

Food waste diversion is not permitted at the existing Purdy facility; and therefore, no new environmental impacts will occur. There is a possibility that Purdy will no longer be viable, if food waste is diverted to curbside yard waste collection.

3.4.3 Anaerobic Digestion Facility

If an anaerobic digestion facility were developed, it would be required to meet regulatory environmental standards which are in place to minimize environmental liabilities resulting from the disposal and processing of food waste. The facility's permit would require measures to minimize environmental liabilities including control of air pollution, surface water, leachate, noise, odors, and vectors.

The facility would have to be engineered and operated to effectively process the feedstock material while maintaining environmental compliance. The primary concerns are noise, odor, and vectors, which can be managed. There would be new environmental impacts resulting from a new facility, even if the facility is operated within regulatory environmental compliance.

Additional impacts include methane generated at the facility as a result of anaerobic digestion of food waste. These emissions would primarily be controlled, and are expected to be much more efficiently captured than if food waste was disposed of at the landfill. Additional collection vehicle noise and exhaust is also expected to facilitate collection of the diverted material.

Section 4
SCENARIO 3 – LANDFILL DISPOSAL AND LANDFILL GAS BENEFICIAL USE

4.1 Introduction

The landfill disposal and LFG beneficial use scenario focuses on potential impacts to the landfill as a result of food waste diversion. This scenario builds on the initial assessment of Food Waste Diversion Impact on Landfill Gas Generation which is available in Appendix A-2. As such, the basis of this scenario utilizes the 2008 Supplement to the SWMP values (e.g., 1.02 percent growth projection, disposal rates, and landfill life projections), rather than the 2012 update information from the County. The scenario also includes diversion of food waste from Tacoma.

As discussed in Section 1, the County's 2010 waste audit identified food waste as 28.1 percent (by weight) of the waste being disposed in the landfill by the County. In conjunction with Tacoma's 2009 waste audit data, food waste accounts for approximately 26.0 percent (by weight) of the material that is disposed of in the landfill. Extrapolating out to 2021, this represents approximately 154,000 tons of food waste disposed per year.

Scenario 3 evaluates the landfill based on the current management practice of food waste disposal in the landfill and the potential impacts that may occur if food waste is diverted. The analysis considers three food waste disposal quantities, two of which include a component of diversion. These represent the three different intensities for this scenario. Note that diversion quantities are general, and not associated with any specific scenario, or combination thereof, from the Scenario 2 elements or intensities. The three intensities for this scenario are defined as follows:

Low Intensity

Low Intensity maintains the operation of food waste disposal in the Landfill. No diversion.

Moderate Intensity

Moderate Intensity assumes that food waste diversion has been instituted for the commercial sector to a level that results in 50 percent diversion of commercial food waste (approximately 27,000 tons of food waste per year). This volume is an estimate and does not take into direct account the influences of participation capture and yield. Capture and yield are discussed in more detail in Scenario 2.

High Intensity

High Intensity assumes that food waste diversion has been instituted for all sectors to a level that results in 75 percent diversion of food waste (approximately 115,000 tons of food waste per year). This volume is an estimate and does not take into direct account the influences of participation capture and yield.

4.2 Economics

From the landfill perspective, economic impacts focus primarily on the preservation of airspace and the generation of LFG. Diversion of food waste can conserve airspace and extend the landfill life expectancy to some relative degree, but at the cost of eliminating a high LFG generating material which can affect the viability of potential LFG beneficial use projects.

4.2.1 Airspace Considerations

The landfill is owned and operated by LRI. The landfill began operation in late 1999 and has disposed of approximately 9.4 million tons of waste, including food waste. The landfill disposed of approximately 910,000 tons of MSW and other waste types in 2011. At the time LFG modeling was performed for this study, LRI was projecting landfill capacity to be reached in 2028 (note that the County update projects landfill capacity to extent to 2048) at previous filling rates and growth projections.

Various factors are used when projecting the life expectancy of a landfill including an estimated projection of future tons per year, degradation and settlement expectations, compaction rates, and other variables. In considering the three intensities of this scenario, food waste was evaluated in relation to these factors.

The projected tons of food waste landfilled in the year 2021 under the low, moderate, and high intensities are 154,000, 127,000 and 39,000, respectively. Food waste has very high water content and degrades rapidly, generating leachate and LFG. It’s expected that significant gain in airspace from food waste degradation is likely realized within the first year of disposal. For the purposes of this analysis, food waste will be considered to have 70 percent moisture content and be 80 percent volatile solids. From a high level, simplified approach applying the percentages directly to the initial tonnages, this translates to decomposed food waste residual airspace consumption (in tons per year) of 9,000, 8,000, and 2,000 tons for the low, moderate, and high intensities, respectively. This is a significant difference in actual long-term airspace consumption by food waste.

It’s important to emphasize that landfill life expectancy projections do take into account degradation and settlement of the waste, including the food waste which decomposes more rapidly than most other waste types. Generally, airspace consumption is calculated using annual survey data and waste receipts. This determines the compaction rate of the waste mass. The compaction rate of the waste mass as a whole is sometimes referred to as airspace utilization factor (AUF). The presence of food waste in the disposal waste stream does have an impact on the compaction rate of the waste mass (e.g., from 1,700 pounds/cubic yard to 1,650 pounds/cubic yard). Generally, food waste is denser than other waste types. It also compacts better and provides some additional moisture to the waste. Life expectancy is calculated using compaction rates and projected tonnages.

The significant impact to airspace by having food waste remain in the disposal waste stream is expected to be the final year or two of landfill operation, depending on cell configuration and filling operations. With the rate of food waste degradation, additional revenue can be generated by disposal of food waste over other more inert materials. The overall economic value of extending the landfill life involves a large spectrum of considerations and is beyond what can be captured here.

4.2.2 Landfill Gas Beneficial Use

Methane in the form of LFG is a valuable resource. Simple LFG disposal through flare combustion may not be the preferred method for managing LFG, depending on the available quantity and quality of the LFG and the economic viability of a beneficial use project. As mentioned in Section 1, LRI has completed a LFG beneficial use feasibility study. The study investigated LFG beneficial use options and the potential economic value of each option. The feasibility study indicated that two options are preferred for LFG use; electricity generation and conversion of LFG to compressed natural gas (CNG) for use as vehicle fuel. The feasibility study also evaluated development of the LFG beneficial use project in phases to account for possible impacts from potential County waste diversion programs.

LRI, partnered with Biofuels Energy, is currently planning to develop a LFG beneficial use project in three phases. According to Biofuels Energy, each phase would be independent of the other, meaning the development and payback for Phase 1 does not require the development (and subsequent revenue) of Phase 2, and so forth. The development of Phase 1 is planned to occur in the near future and is feasible based on the current in-place waste mass and generation of LFG at the landfill. Phase 1 is expected to be unaffected by any future County policy concerning potential food waste diversion. If the disposal of food waste continues in accordance with the Low Intensity approach to food waste management, Phase 2 and Phase 3 likely become feasible, but each will need to be re-evaluated as they near the date for potential implementation.

Food waste is a highly degradable waste material with potential to generate a significant portion of the LFG generated at a landfill. Food waste is a potential carbon source for methane, but due to its rapid degradation, its real value for generating LFG may be the water it contributes to the waste mass as food waste breaks down. This food waste generated leachate promotes the degradation of other, drier organic materials. Note that the impact that food waste moisture can have on the waste mass is highly facility and regionally dependant. For instance, if a facility uses leachate recirculation, food waste moisture will have less of an impact on LFG generation. If a facility is in an arid climate, food waste may be the primary contributor to moisture in the waste mass.

Diversion of food waste may make the landfill unable to economically sustain Phase 2 and/or Phase 3 of the LFG beneficial use project. If food waste is diverted from the landfill, LFG generation is impacted. The resulting composition of the disposed waste impacts the variables that are used for LFG generation modeling. It is not necessarily a direct relationship. In order to get a better understanding of the impact, SAIC used its proprietary LFG generation model to evaluate this impact. The results are in Appendix A-2 (Food Waste Diversion Impact on Landfill Gas Generation). Under Moderate Intensity diversion, LFG generation is reduced by approximately 10 percent within 10 years. Under High Intensity diversion, LFG generation is reduced by nearly 30 percent within 8 years. Ultimately, if Phase 1 is constructed, actual field and system operation would determine the feasibility of Phase 2 and Phase 3 at the time which they would be implemented.

Under the Low Intensity, Biofuels Energy anticipates the Phase 2 and Phase 3 developments will be able to generate an additional 4.8 MW and 6.4 MW of electricity, respectively. Note that the methane could instead be utilized as CNG.

It should be noted that the costs for development and operation of the landfill's LFG beneficial use project will not be borne by the County, and it is likely, and for the purposes of this study, that the County will receive zero economic benefit (i.e., revenue) from the operation of this project. For discussion and consideration, facility costs are estimated below.

The EPA has developed a guide for economic analysis of LFG beneficial use projects. The capital costs for construction of an electric power plant are approximately $1,700 per kilowatt. This includes initial infrastructure required for the system and a system interconnect to the existing power grid. For the Phase 1 system that provides 4.8 MW, an approximate capital cost would be $8,200,000 with an average annual operation and maintenance cost of approximately $860,000. For the compression and treatment part of the system that converts LFG to CNG, the EPA estimates capital costs at $960 per standard cubic feet per minute (scfm). This cost does not include the cost to convert existing vehicles from diesel to CNG, purchase new vehicles, install the storage and filling systems, or other systems needed to convert, store, and fuel vehicles. The approximate capital cost for the compression and treatment system of Phase 1 (at 570 scfm) is $600,000 and the annual operation and maintenance costs for the system are approximately $60,000. Once Phase 1 has been designed and installed, many of infrastructure costs for Phase 2 and 3 expansions can be avoided, and the cost per unit for Phase 2 and 3 is likely to be lower.

Biofuels Energy projects that the project payback for each phase will be 10 years. The revenue generated through the sales of electricity and CNG would likely be used to pay the project back and it is assumed that no tipping fee increase would result.

Also note that there is potential for the residents of the surrounding community to benefit from this project. Power rates in the Pacific Northwest are generally lower than the rest of the United States. However, electricity generation from LFG can stabilize costs and are comparable to current power rates.

4.3 Carbon Footprint

Operation of a MSW landfill has a significant carbon footprint. Collection vehicles, landfill equipment, and the decomposition of the waste all create GHG emissions. The largest contributor to GHG emissions related to landfill operations is that of LFG. The decomposition of waste in landfills is generally anaerobic which creates LFG, approximately 50 percent methane and 50 percent carbon dioxide, with the remaining being a variety of other constituents. In terms of GHG potency, LFG is approximately 21 times more potent than carbon dioxide.

Landfills are able to reduce their carbon emissions through the collection and destruction of the generated LFG. LRI does have an LFG collection and control system (GCCS) currently operating at the landfill. The GCCS collects LFG from the decomposing waste mass and routes it to a flare combustion system. This system applies a vacuum on the landfill to extract the LFG and through combustion converts the landfill methane to carbon dioxide, reducing the landfill's carbon emissions by a factor of 21.

Due to GCCS inefficiencies and potential lack of collection coverage in some waste areas, all of the LFG generated cannot be captured and converted. Generally, during the operating life of a landfill, collection efficiencies can range from 75 to 90 percent based on design of the collection system and operational considerations. Upon closure, collection efficiencies can be as high as 98 percent.

Using the SAIC developed LFG generation model, the landfill is estimated to generate a total of approximately 500,340 mtCO_2e of methane during 2013, assuming an average LFG flow rate of 4,798 scfm (Low Intensity). The year 2013 is used for the example because it represents the first year a food waste diversion program could be implemented under Scenario 3.

Methane reduction is assumed to occur through naturally-occurring bacteria in the cover soils. Some of the emitted methane is converted to carbon dioxide. According to the Intergovernmental Panel on Climate Change Guidelines (2006), naturally occurring methanotrophic bacteria in landfill soil covers oxidizes a small portion of landfill methane. This value is accepted as 10 percent. Therefore, if the landfill did not have a GCCS, the total natural emissions of methane would be approximately 450,300 mtCO_2e.

Assuming the existing GCCS has a collection efficiency of 75 percent of the generated LFG, 75 percent of the 500,340 mtCO_2e (375,255 mtCO_2e) of methane will be converted into carbon dioxide. Of the remaining 25 percent of methane generated, approximately 10 percent will be oxidized through natural soil bacteria resulting in 112,577 mtCO_2e methane emissions from the landfill. Adding 400 mtCO_2e for operation of the GCCS, total reduced methane emissions from the baseline 450,300 mtCO_2e will be 337,322 mtCO_2e or a 74.9 percent reduction. Table 4-1, below, provides the estimates for the three intensities evaluated in Scenario 3 for 2013. Note that all intensities are compared to the 450,300-mtCO2e baseline.

Table 4-1:
Carbon Footprint Calculations for the Three Intensities Based on 2013 Values

	Low Intensity Diversion	Moderate Intensity	High Intensity
Average LFG Flow (SCFM)	4,798	4,758	4,674
GHG Reductions (metric tons of CO_2e per year)	337,332	338,270	340,241
GHG reduction (%)	74.9%	75.1%	75.6%
Passenger car equivalents removed from roadways	65,000	65,200	65,600

As the 2013 LFG generation volumes are primarily driven by waste already in the landfill, it's expected that over time the GHG reduction resulting from food waste diversion for the Moderate and High Intensities will become more pronounced as compared to the Low Intensity. For example, in 2021, GHG emission reductions are expected to be 74.9 percent, 77.2 percent, and 83.9 percent for the Low, Moderate, and High Intensities, respectively.

4.4 Environmental Considerations

Current landfilling practices are performed to minimize environmental liabilities resulting from the disposal of solid waste. Landfills are designed and constructed with engineered measures to mitigate and minimize impacts to the environment. The landfill's permit requires the landfill to include measures to minimize environmental liabilities including control of air pollution, surface water, leachate, noise, odors, and vectors. Under the current landfill operations, which reflect the Low Intensity diversion, approved measures are in place to manage the potential environmental liabilities.

Food waste diversion would not be expected to have an effect on the landfill's management of environmental liabilities. Reducing the amount of food waste disposed will likely result in less LFG generation and a decrease in the draw of vectors, but since these liabilities are already accepted as properly managed, no significant environmental impacts are noted.

Section 5
SUMMARY

5.1 Summary

The above scenarios, with related intensities, provide a high level consideration of possible impacts to the County's solid waste management system, if these or similar approaches towards food waste management were made. The results of any implemented program are expected to differ from those outlined above; however, this analysis is intended to provide a reasonable range of what affects the County may expect in regards to economics, carbon footprint, and the environment depending on the selected programmatic approach to food waste management.

The expected next steps will be for the C-Team and PMT to consider this information when developing the BMPs to be proposed to elected officials by the Solid Waste Division.

5.1.1 Considerations for Decision Making

There are many issues to consider when developing the final recommendation for BMPs. Some of these issues are discussed below.

Policy can be a primary practice driver

The County has established a landfill disposal rate target of 1.09 lbs/capita/day. This target will need to be weighed against the costs of achieving the target. Generally this can come down to a consideration of opposing goals, for example, sustainability goals versus an economic responsibility to customers.

Impact to landfill capacity

There is motivation to preserve landfill capacity. In considering the waste audits, food waste is recognized as one of the larger initial disposal quantities within the landfill; however, with the rapid degradation rate of food waste, long-term consumption of landfill capacity may not be significant compared to other, more inert wastes being disposed, even though those inert wastes have a smaller initial disposal quantity.

Food waste is a resource

In a progressively more energy conscious society, food waste is more regularly being considered an available resource that should be utilized rather than discarded. With regard to energy production, the cost for separate collection and processing of food waste may outweigh the benefits that can be derived from its use as a resource. Another consideration is that even though landfill disposal can be viewed as a lost resource, this is not necessarily the case if food waste in the landfill is utilized in LFG beneficial use projects.

Food waste utilized in compost has the same collection and processing considerations for cost versus benefit; however, there is additional concern that though the contribution of food waste may increase nutrients in compost, it may also increase salt, chemicals, and contamination which in total can result in a lower quality product. Contamination levels can be influenced by larger customer participation that can contribute smaller individual quantities, and also whether materials are derived pre- or post-consumer.

BMPs are still evolving

Technologies for the collection and processing of food waste are still evolving. Food waste composting and anaerobic digestion facilities in North America are still in the learning stages. There are several projects (in North America) in planning or development stages, but this provides only a limited-to-no track record for certain technologies. If food waste management alternatives with a successful track record in North America are considered reasonable management practices for the County, then it may be better to continue to monitor the food waste management landscape for changes in policy, regulation or technology. The final BMPs need to be reasonable given the value of, and confidence in realizing, the benefits.

Factors are community dependent

RMPs and BMPs are very community and solid waste system dependent. It's important to consider how others are approaching diversion of food waste, but it's as important to understand the reasons for the decisions they have made or are making.

There is some uncertainty to GHG Impacts

Methane generated from landfills is a potent GHG. Established LFG models recognize food waste as having high methane potential, but this is only realized when degradation occurs in an anaerobic environment. Considering the rapid degradation of food waste, it can be argued that much of its decomposition is in the active area of a landfill, under aerobic conditions. Moisture that food waste contributes to the waste mass also has an impact on LFG generation, but in a wet Western Washington climate significant moisture may be available without food waste.

GHG emissions related to food waste diversion also needs to be considered in comparison to the County's overall carbon footprint. Under the single-family residential, High Intensity scenario, modeling shows a 27,937 mtCO_2e reduction. In comparison to the County solid waste management system's projected 2020 net sink of 1,062,697 mtCO_2e, this is only a 2.6 percent additional annual reduction. This increase in sustainability needs to be considered with the economic cost of implementation.

Environmental impacts are expected to be negative

Aside from potentially reducing GHG emissions, environmental impacts are expected to be negative if food waste is diverted. Rather than having a consolidated point source for food waste related issues, issues would also have potential impact at diversion facilities. Any new facility would be accompanied by new environmental considerations.

Successful compost facility and process designs are specific to the feed stock

Composting is complex and requires facilities and processes designed to handle specific feed stocks in specific climates. A change in feed stock can require a change in the composting system. The current Purdy and Compost Factory facilities are successfully processing yard waste. Introducing food waste into those systems is possible without significant impacts, provided that the food waste is compatible with those existing systems. Careful consideration should be used when determining what types of food waste should be diverted to preserve the functionality of a successful yard waste composting facility.

5.1.2 Example RMPs for Consideration

Based on the results of the analysis of various technologies and management practices for food waste, and in consideration of the County's solid waste management system and its customers, the following scenarios could be (initial) reasonable management practices for the County to consider at this time.

1. Consistent with the EPA's solid waste management hierarchy, which ranks Source Reduction and Reuse as the preferred method:
    a. In the commercial sector, expand the County's current waste reduction program to include a more significant focus on food waste; and
    b. In the residential sector, re-double efforts to reduce the need for off-site processing of grass clippings, which affects the compost facility operations' capacity to effectively manage food waste, if diverted.
2. Implement a pre-consumer commercial sector food waste diversion program.
    a. Divert vegetative food waste only.
    b. Source separate, but use composting technology (without the availability of an operating anaerobic digestion facility, excluding consideration of the wastewater treatment plant).
    c. Program would be voluntary.
    d. Focus on the types of generators that have only vegetative food waste, such as wholesale produce, coffee shops, and juice bar establishments.
    e. During peak periods, if (the Compost Factory is) at capacity, divert material to the Silver Springs facility or the landfill.
3. Implement a single-family residential sector food waste diversion pilot program in two communities.
    a. Divert vegetative food waste only.
    b. Collect food waste with yard waste for composting.

c. Program would be voluntary.

d. Program would be limited to routes which transport material to the Compost Factory (food waste is not permitted at Purdy).

e. During peak periods, if (the Compost Factory is) at capacity, divert material to the Silver Springs facility or the landfill.

4. While beginning efforts to divert food waste from the landfill, continue to landfill food waste, taking into account LRI's plans to develop a LFG beneficial use project.

5.1.3 Case Studies

Five case studies are included in Appendix C, which illustrate how other agencies are handling food waste, the success each program has achieved, where improvements are being considered, and elements (of their program or facilities) that should have been evaluated in greater detail during the initial planning and feasibility phases. These case studies may not have a direct similarity with the County, but are provided as examples of the current climate with respect to managing and processing food waste, beyond landfill disposal, throughout the solid waste industry in North America.

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Appendix A
INITIAL ASSESSMENTS

Memorandum

To: Rick Johnston, Pierce County Public Works and Utilities

From: Steven Sherman

Subject: Food Waste Reasonable Management Practices – Organics Availability

Date: December 13, 2011

Purpose

This memorandum provides an initial estimate of the amount and type of potentially divertible organics that are normally disposed in landfills in Pierce County (County). Potentially divertible organics focuses on food waste, yard waste, compostable paper, and diapers. Landfilled organics such as textiles, clothing, animal litter, and other miscellaneous organics are not being considered as divertible in this analysis.

Data Sources

The following sources of data were used in the analysis contained herein:

2010 Pierce County: Multi-Seasonal Waste Characterization Analysis *(ex-City of Tacoma)*

2009 City of Tacoma: Municipal Waste Stream Composition Study

2008 Tacoma-Pierce County Solid Waste Management Plan Supplement

Additional organics that are generated in the County, such as wastewater biosolids, food processing by-products that are not normally landfilled, agricultural residues, and other organics that are not captured in the County's landfill disposal system, were not included in the analysis. These materials are assumed to be recycled or reused already or else processed in ways other than landfilling, and are further assumed to be not available to the County. Organic materials generated from outside the County and disposed or diverted outside the county were not evaluated; it was assumed that the County does not wish to further attract organics that are generated outside the county.

Definitions

The following definitions may be helpful to readers of this memorandum:

Compostable paper: Generally, low-grade, non-recyclable, coated paper, and contaminated paper. Includes facial and toilet tissue paper, napkins, paper towels, paper plates, and other paper with significant moisture or food contamination. Would also include newspaper used for pet litter (to line bird cages), and waxed cardboard produce boxes. Does not include paper covered with paint or oil.

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Diapers (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.

Food waste: Food capable of being decomposed by microorganisms with sufficient rapidity as to cause nuisance from odors and gases. Kitchen wastes and food from containers are examples. Containerized liquids intended for human consumption are also included in this category.

Food Waste, Vegetative: Fruit and vegetable scraps.

Other Food Waste: Non-vegetative food waste, such as meats and dairy.

Other organic waste: Organic materials not otherwise categorized. Includes natural fibers, cork, hemp rope, wicker products, jute carpet backing, sawdust, hair and lint. Soap, bathroom products such as: bubble bath, body waste, shampoo, and conditioner.

Sector Types: Division of the waste stream into waste generator type.

Commercial: Waste generated by business, industry, and government that is collected and transported by County contracted haulers.

Residential Multi-Family: Waste generated by multi-family buildings with three or more units that is collected and transported by County contracted haulers.

Residential Single Family: Waste generated by single family and duplex type residences that is collected and transported by County contracted haulers.

Self-Haul: Waste generated by residential or commercial entities that is collected and transported by that entity.

Yard Waste: Lawn clippings, weeds and leaves that are not attached to branches. Small pieces of wood or chips that have been processed/shredded to less than 2-inch on any axis. Stumps, branches, prunings, and trimmings from trees, bushes, shrubs, and other plants.

Outline of Tables 1 through 5

Tables 1, 2, and 3 detail the most current organics data for the County, City of Tacoma (City), and these two entities combined. Data in the tables are presented by sector type: residential single-family, residential multi-family, commercial, and self-haul.

Table 4 presents estimates of the potentially divertible organics within the County's system in 2021, with the inclusion of material from the City. Table 4 projects the data in Table 3 to reflect the year

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2021, using an estimated population growth rate of 1.02% (with per capita waste disposal held constant).

In Table 5, a range of capture rates are applied to the food waste data found in Table 4, to yield first-approximation estimates of the likely range of capture of food waste by sector. These estimates are discussed in more detail in the next section and may be further refined over the course of this project.

Tables 1 through 5 Results

Tables 1 through 5 are attached at the end of this memorandum. Discussion points pertaining to each table are as follows.

- Table 1:
  - As shown in Table 1 (at the end of this memorandum), over 100,000 tons per year of food waste are landfilled by non-City of Tacoma generators within the County. Comparatively, this amount greatly overshadows the other divertible organics still landfilled by these generators, such as the remaining amount of yard trimmings (approximately 15,000 tons per year).
  - On a percentage basis, approximately one-third of the residential single-family disposed waste is estimated to consist of food waste. The next highest is the commercial sector with the figure estimated to be approximately one-quarter.
- Table 2:
  - As shown in Table 2 (end of this memorandum), approximately 33,000 tons per year of food waste are landfilled by City generators. In the aggregate, the commercial and residential single-family sectors generate about equal amounts of food waste, approximately 15,000 tons per year each.
  - The City (33,000 tons per year) generates approximately one-third of the amount of food waste that the County (105,000 tons per year) generates.
- Table 3:
  - As shown in Table 3 (end of this memorandum), nearly 140,000 tons per year of food waste are landfilled in the County from County and City generators. For compostable paper and yard trimmings, the annual disposal figures are approximately 38,000 tons and 18,000 tons, respectively. In addition, an estimated 19,000 tons per year of diapers are landfilled in the County.
  - On a percentage basis, over one-third of the residential single-family disposed waste is estimated to consist of food waste; for the residential multi-family and commercial sectors, the figures are estimated to be between one-quarter and one-third each. Self-haul food waste consists of less than 10% of total disposed waste.
- Table 4:
  - The projections shown in Table 4 (end of this memorandum) retain the same relative proportions, by material type and sector. The quantities generated have been

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increased on par with anticipated population growth over the next decade. The changes are modest, relative to 2010 estimates: materials generation rises approximately 1% annually.

- Table 5:
  - Percent Captured refers to the estimated portion of generated food waste that could be collected from generators.
  - Percent Yield accounts for the generation of residual, marginally usable by-products or contaminants, often disposed as trash, by a materials processor.
  - The range of estimated capture rates ten years from now is based on projections obtained from programs that are the most mature in the U.S., along with planning-level documents from communities in the Western U.S. and British Columbia. The range of percent yield is based on field results from some leading West Coast processors of organic materials. These reflect a variety of possible outcomes for the beneficial use of food waste kept out of the County landfill based on the policy, program, infrastructure, outreach, and pricing choices made and put in place.
  - As shown in Table 5, for the County and the City combined, the estimated rate of capture of food waste in 2021 could range from as low as approximately 30,000 tons per year to approximately 94,000 tons per year. As discussed above, these figures will be reduced somewhat when disposal processing residue is factored. The residential single-family and commercial sectors are projected to yield substantially similar amounts, at the upper and lower ends of their ranges.
  - These ranges assume that moderate to aggressive efforts (using a 2021 projected context) are made over the ensuing decade to keep food waste out of local landfills.

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Table 1: Pierce County 2010 Organics

	Residential Single Family (tons)	Residential Multi Family (tons)	Commercial (tons)	Self Haul (tons)	Total Disposed (tons)	Residential Single Family (%)[1]	Residential Multi Family (%)[1]	Commercial (%)[1]	Self Haul (%)[1]	Total Disposed (%)[2]
Yard Waste	5,198	674	4,043	5,101	15,016	3.7%	2.2%	3.6%	5.5%	4.0%
Food Waste	53,305	8,903	35,042	8,104	105,354	38.4%	29.2%	31.0%	8.8%	28.1%
Diapers	8,245	2,868	4,421	48	15,582	5.9%	9.4%	3.9%	0.1%	4.2%
Compostable Paper	14,885	2,748	12,709	114	30,456	10.7%	9.0%	11.3%	0.1%	8.1%
Total Divertible Organics[3]	81,686	15,193	56,315	13,213	66,407	58.8%	49.8%	49.9%	14.3%	44.4%
Total Disposed Waste	138,933	30,498	112,954	92,146	374,734	37.1%	8.1%	30.1%	24.6%	100.0%

[1] Percent of total disposed waste per sector type.

[2] Percent of total disposed waste inclusive of all sector types.

[3] Sum of potentially divertible organics listed. Actual total organics in the waste stream includes additional waste types.

Table 2: Tacoma 2009 Organics

	Residential Single Family (tons)	Residential Multi Family (tons)	Commercial (tons)	Self Haul (tons)	Total Disposed (tons)	Residential Single Family (%)[1]	Residential Multi Family (%)[1]	Commercial (%)[1]	Self Haul (%)[1]	Total Disposed (%)[2]
Yard Waste	541	388	727	1,626	3,282	1.3%	3.3%	1.3%	4.5%	2.1%
Food Waste	14,544	3,038	14,519	1,392	33,493	33.7%	25.9%	25.6%	3.9%	21.0%
Diapers	2,182	803	575	31	3,591	5.1%	6.8%	1.0%	0.1%	2.3%
Compostable Paper	2,771	525	4,204	251	7,751	6.4%	4.5%	7.4%	0.7%	4.9%
Total Divertible Organics[3]	20,038	4,754	20,025	3,300	48,117	46.5%	40.5%	35.4%	9.1%	30.2%
Total Disposed Waste	43,118	11,729	56,618	36,095	159,391	27.1%	7.4%	35.5%	22.6%	100.0%

[1] Percent of total disposed waste per sector type
[2] Percent of total disposed waste inclusive of all sector types
[3] Sum of potentially divertible organics listed. Actual total organics in the waste stream includes additional waste types.

Table 3: Combined Pierce County and Tacoma Organics

	Residential Single Family (tons)	Residential Multi Family (tons)	Commercial (tons)	Self Haul (tons)	Total Disposed (tons)	Residential Single Family (%)[1]	Residential Multi Family (%)[1]	Commercial (%)[1]	Self Haul (%)[1]	Total Disposed (%)[2]
Yard Waste	5,739	1,062	4,770	6,727	18,298	3.2%	2.5%	2.8%	5.2%	3.4%
Food Waste	67,849	11,941	49,561	9,496	138,847	37.3%	28.3%	29.2%	7.4%	26.0%
Diapers	10,427	3,671	4,996	79	19,173	5.7%	8.7%	2.9%	0.1%	3.6%
Compostable Paper	17,656	3,273	16,913	365	38,207	9.7%	7.8%	10.0%	0.3%	7.2%
Total Divertible Organics[3]	101,724	19,947	76,340	16,513	214,524	55.9%	47.2%	45.0%	12.9%	40.2%
Total Disposed Waste	182,051	42,227	169,572	128,241	534,125	34.1%	7.9%	31.7%	24.0%	100.0%

[1] Percent of total disposed waste per sector type

[2] Percent of total disposed waste inclusive of all sector types

[3] Sum of potentially divertible organics listed. Actual total organics in the waste stream includes additional waste types.

Table 4: 2021 Combined Pierce County and Tacoma Organics

	Residential Single Family (tons)	Residential Multi Family (tons)	Commercial (tons)	Self Haul (tons)	Total Disposed (tons)	Residential Single Family (%)[1]	Residential Multi Family (%)[1]	Commercial (%)[1]	Self Haul (%)[1]	Total Disposed (%)[2]
Yard Waste	6,352	1,175	5,279	7,446	20,252	3.2%	2.5%	2.8%	5.2%	3.4%
Food Waste	75,096	13,216	54,855	10,510	153,677	37.3%	28.3%	29.2%	7.4%	26.0%
Diapers	11,541	4,063	5,530	87	21,221	5.7%	8.7%	2.9%	0.1%	3.6%
Compostable Paper	19,542	3,623	18,720	404	42,288	9.7%	7.8%	10.0%	0.3%	7.2%
Total Divertible Organics[3]	112,589	22,078	84,494	18,277	237,438	55.9%	47.2%	45.0%	12.9%	40.2%
Total Disposed Waste	201,496	46,737	187,684	141,939	591,176	34.1%	7.9%	31.7%	24.0%	100.0%

[1] Percent of total disposed waste per sector type
[2] Percent of total disposed waste inclusive of all sector types
[3] Sum of potentially divertible organics listed. Actual total organics in the waste stream includes additional waste types.

Table 5: 2021 Combined County and Tacoma Food Waste with Participation Factor

	Total Food Waste	Participation				Total Divertible Organics	Total Disposed Waste
		Percent Captured	Tons Captured	Percent Yield	Tons Yield		
Residential Single Family (tons)	75,096					112,589	201,496
Upper		60%	45,058	90%	40,552		
Lower		20%	15,019	80%	12,015		
Residential Multi Family (tons)	13,216					22,078	46,737
Upper		30%	3,965	80%	3,172		
Lower		10%	1,322	60%	793		
Commercial (tons)	54,855					84,494	187,684
Upper		80%	43,884	95%	41,690		
Lower		25%	13,714	80%	10,971		
Self Haul (tons)	10,510					18,277	141.939
Upper		10%	1,051	95%	998		
Lower		5%	526	80%	420		
Total Disposed (tons)	153,677					237,438	591,176
Upper			93,957	90%	84,562		
Lower			30,580	77%	23,547		

Memorandum

To: Rick Johnston, Pierce County Public Works and Utilities

From: Michael Cook

Subject: Food Waste Diversion and LFG Generation and Collection

Date: December 13, 2011

Introduction and Background

As part of the assessment for reasonable management practice of food waste, generation and collection estimates of landfill gas (LFG) were completed for the LRI 304th St. Landfill. The purpose of the modeling effort is to provide the County with an estimate of the current LFG generation and the impact that future food waste diversion programs may have on planned LFG generation and potential reuse projects.

Data was generated through correspondence with LRI, from the Tacoma-Pierce County Solid Waste Management Plan (Appendix F of the 2008 Supplement Report), the 2009 City of Tacoma Waste Characterization Study, and the 2010 Pierce County Waste Characterization Study. Tonnage information for the development of the LFG modeling was provided by LRI. The information provided by LRI also included future tonnage projections. This information was used as the major input for LFG generation modeling.

Also reviewed was the resulting increase of life expectancy due to increased airspace as a byproduct of diverting food waste from the landfill. Although food waste is only small portion of the total disposed waste (including all waste types disposed), the removal from the waste stream can potentially extend the life of the landfill.

Landfill Gas Generation Modeling

The tonnage information provided by LRI presented the disposed waste in two separate categories. The first category was classified as degradable waste. In this case, it is synonymous with municipal solid waste (MSW). The second category was classified as non-degradable, consisting of mostly inert waste types such as auto-fluff, construction and demolition wastes (C&D) and contaminated soils. Generally, LFG modeling includes all disposed waste as one lump sum. Since the two waste categories were provided separately, the LFG model will generate results by using only the tonnage listed as degradable. This allows for a more representative curve of LFG generation. The inert waste is excluded from the modeling because it would affect the generation values due to additional assumptions that would be required. The model would likely result in an over estimate of LFG generation.

If site specific information is unavailable for LFG model generation, generic values of the organic (actual decomposable waste) portion of the MSW are used. For the purpose of this model, the data

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collected from the two waste studies were used to further specify the approximate percentage of this organic waste within the MSW portion of the waste stream. Since a majority of the methane generation comes from the decomposition of organic waste, knowing this decomposable fraction of the MSW allows for the LFG generation model to easily be modified according to different organics diversion programs. The decomposable fractions of waste identified within the waste studies fall under three broad categories: organics, paper, and yard/wood. The approximate averages of each category for the two studies are represented in Table 1.

Table 1

Waste Type	Percent of total disposed MSW
Organics	37%
Paper	18%
Yard/Wood	5%

Note that not all of the decomposable waste is considered readily decomposable. Some of the waste types may rapidly degrade (food and yard waste) and some of the waste types may degrade over a longer period of time (textiles). Overall, there is approximately 55 to 60 percent of decomposable waste in the MSW stream, of which nearly 25 percent is food waste.

The major inputs into LFG modeling are the waste tonnage, percent organic (decomposable) waste (i.e., the methane potential of the waste), and the moisture of the waste. Two modeling equations were used: the USEPA's LandGEM and a model developed by SAIC. The results from the SAIC model are presented in Figure 1. LandGEM was used to provide a check of the SAIC model, however, the results from the LandGEM model are not presented because the model is generally more conservative in that it may over estimate LFG generation. In general, the LandGEM model is more conservative due to limitations of site specific data.

An initial baseline LFG generation curve was developed using the modeling equation. The methane potential value used for this model is higher than average methane potential values because of the available site specific data from the waste studies and disposed tonnage information. Generally, assumptions regarding the composition of the disposed waste are made which result in the use of methane potential values that may not accurately reflect the actual disposed organics. Using current LFG flow readings provided by LRI, the initial baseline models were calibrated to provide a more likely scenario of LFG generation. It was assumed based on information provided by LRI that the collection efficiency is nearly 80 to 85 percent. This memo includes results for the curves generated from the SAIC equation and the excepted LFG collected.

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From the baseline model, two additional scenarios were reviewed. The scenarios were selected to represent two possible food waste diversion cases. Scenario 1 evaluated the impact of removing 75-percent of the food waste from the entire waste stream and Scenario 2 evaluated the impact of removing 50-percent of the commercial source food waste.

> Scenario 1: Removing 75-percent of the total food waste results in an overall reduction in tons of approximately 19-percent and a reduction in the amount of organics landfilled by approximately 40-percent.
>
> Scenario 2: Removing 50-percent of the commercial food waste results in an overall reduction in tons of approximately 4.5-percent and a reduction in the amount of organics landfilled by approximately 15-percent.

The graph in Figure 1 below shows the baseline LFG generation model and models for Scenarios 1 and 2. It should be noted that the curves shown represent an approximate mid-point of a range of approximately +/- 10 percent and are shown in Table 2.

Table 2

	Baseline: Range of LFG Generation (SCFM)		Scenario 1: Range of LFG Generation (SCFM)		Baseline: Range of LFG Generation (SCFM)	
Year	Lower	Upper	Lower	Upper	Lower	Upper
1999	1	1	1	1	1	1
2000	140	171	140	171	140	171
2001	407	497	407	497	407	497
2002	714	873	714	873	714	873
2003	1,050	1,284	1,050	1,284	1,050	1,284
2004	1,408	1,721	1,408	1,721	1,408	1,721
2005	1,762	2,153	1,762	2,153	1,762	2,153
2006	2,142	2,618	2,142	2,618	2,142	2,618
2007	2,505	3,062	2,505	3,062	2,505	3,062
2008	2,808	3,432	2,808	3,432	2,808	3,432
2009	3,053	3,731	3,053	3,731	3,053	3,731
2010	3,237	3,956	3,237	3,956	3,237	3,956
2011	3,412	4,170	3,412	4,170	3,412	4,170
2012	3,646	4,456	3,646	4,456	3,646	4,456
2013	3,926	4,798	3,824	4,674	3,893	4,758
2014	4,209	5,144	3,873	4,734	4,111	5,024

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2015	4,476	5,471	3,849	4,704	4,304	5,261
2016	4,717	5,765	3,801	4,646	4,475	5,470
2017	4,936	6,033	3,750	4,583	4,629	5,657
2018	5,134	6,275	3,710	4,535	4,771	5,831
2019	5,308	6,488	3,674	4,490	4,894	5,982
2020	5,468	6,683	3,648	4,459	5,010	6,123
2021	5,619	6,868	3,633	4,441	5,122	6,260
2022	5,763	7,043	3,626	4,431	5,229	6,391
2023	5,899	7,210	3,627	4,434	5,333	6,518
2024	6,027	7,367	3,632	4,439	5,431	6,638
2025	6,144	7,509	3,637	4,446	5,521	6,748
2026	6,253	7,642	3,647	4,458	5,607	6,853
2027	6,348	7,758	3,657	4,469	5,681	6,944
2028	6,429	7,858	3,663	4,477	5,745	7,022
2029	6,171	7,542	3,495	4,272	5,509	6,734
2030	5,584	6,825	3,154	3,855	4,983	6,091
2031	4,912	6,004	2,770	3,385	4,382	5,356
2032	4,276	5,227	2,406	2,941	3,814	4,661
2033	3,692	4,512	2,072	2,533	3,291	4,023
2034	3,193	3,903	1,786	2,183	2,845	3,477

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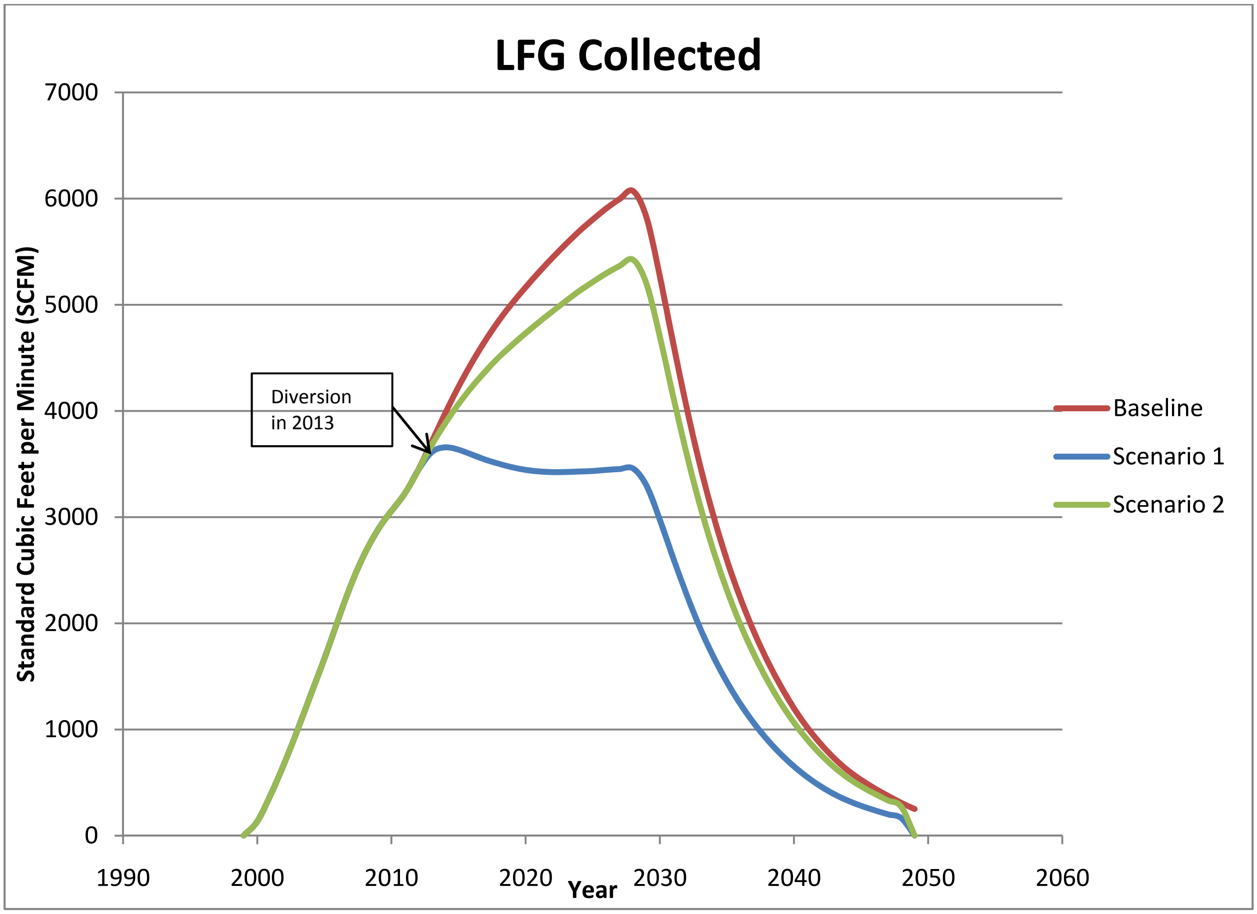

Figure 1: SAIC LFG Generation Model for LRI 304th St Landfill

The results demonstrate that food waste diversion would have a potentially significant impact on LFG generation. If a food waste diversion program is implemented, it is likely that its impact on collected LFG will not be realized immediately, but within two to three years after implementation as it generally takes a year to collect LFG from disposed waste. Also, it would be expected that a food waste diversion program will not result in a large diversion immediately because a diversion program may take some time to become fully implemented. In other words it would begin in a limited fashion before a higher percentage of diversion is seen.

Planned Landfill Gas Reuse Project

Further correspondence with LRI provided information regarding their potential LFG reuse project currently under consideration at the landfill. The reuse project is planned to be developed in three phases. Each phase is essentially independent of the development of the subsequent phase(s). In other words, if the first phase (Phase 1) is developed, but the second phase (Phase 2) is not, then Phase 1 would still be a viable reuse project on its own. The reuse project consists of a combination

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of electricity generation and conversion of LFG to compressed natural gas (CNG). Phase 1 consists of both reuse options, whereas the reuse options for Phase 2 and the third phase (Phase 3) may depend on future market conditions.

The implementation of a phased approach for LFG reuse was partly based upon possible future waste diversion programs instituted by Pierce County. LRI indicates that Phase 1 was developed with this in mind and was determined to be feasible regardless of any future diversion programs because it will use the already existing waste in place. Phase 1 is planned to consist of approximately 75% of collected LFG for electricity generation and the remaining 25% collected for CNG conversion. LRI notes that the CNG conversion is estimated for use of approximately 150 trucks operating at 30,000 miles per truck per year. LRI anticipates that a portion of the CNG would be sold to Joint Base Lewis McCord.

LRI indicates that the project developer reviewed LFG generation models that included potential organic waste diversion programs. Phase 2 and Phase 3 likely resulted from these models, but it is not clear what level of diversion was considered to make each future phase feasible. As demonstrated by the modeling shown above, any food waste (or other organics) diversion program would likely negatively impact LFG generation. Therefore, if a diversion program is implemented, the development of Phase 2 and Phase 3 could potentially be impacted. LRI indicates that a diversion program would likely eliminate the development of Phase 3, but may only modify the scope of Phase 2.

LFG reuse projects that focus on electricity generation in this area (Pacific Northwest) are difficult to pursue because electric rates are relatively cheaper compared to hydro-electric generation. However, a state mandate is requiring utilities make 15% of its energy portfolio from renewable sources by 2020, of which LFG electricity generation is an option.

Food Waste Diversion and Landfill Life Expectancy

Any diversion of waste from the landfill will likely have an impact on the expected life of the landfill. Although food waste will have some impact on the expected life expectancy, the actual impact is somewhat difficult to predict. If the two scenarios above are considered, the potential increase, strictly on a ton per cubic yard basis would result in an increase of approximately 1 to 3 years for Scenario 2 and 1, respectively. However, due to the nature of food waste and its rapid degradability, it is likely that the airspace would have been gained throughout the life of the landfill through natural biological decomposition, while producing LFG. The economic impact on LFG production as compared to that of the increased airspace would need to be further reviewed in detail.

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Conclusion

The diversion of food waste will ultimately impact the LFG generation volume over the life of the landfill. It appears that the project developer has considered the potential for waste diversion programs within their economic evaluation and has determined that at least the first phase is feasible under any diversion program. However, consideration should be given to the economics of extending the life of the landfill versus the additional LFG generation volume.

MJC

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Appendix B
SCREENING MATRIX AND ORGANICS PROGRAM SYSTEM SCENARIOS

Pierce County Public Works and Utilities
Food Waste Management - Developing Reasonable Management Practices
Screening Evaluation Matrix

						ECONOMIC					ENVIRONMENTAL IMPACT						OPERATION						TECHNICAL			
		Technology Description	Feedstock	Facility Scale	End Products	Capital Cost	O&M Costs	Funding Opportunities	Economic Viability	Revenue Potential	Air Quality	Water Quality	Noise	Vector Control	Diversion Potential	CARBON FOOTPRINT	Feedstock Composition	Feedstock Quality	Feedstock Processing	Ability for Maintenance without Shutdown and Diversion to the Landfill	Labor Resources	Ease of Operations	Positive Performance History	Space Required	Permit Approvals	End Product Quality
Composting	Aerated Static Pile	The aerated static pile method employs an aeration system in which air is blown through or drawn down through piles of organic materials that are built upon the fixed-air system. Typically, the piles are watered when necessary and monitored for temperature (often using sensors) and moisture content but are not turned. In wet climates, they can be covered.	Yard trimmings, food scraps, compostable paper.	Sizes can vary from small (e.g., roll-off container size) and simple, to large and complex, spanning several acres.	Compost.	Medium.	Medium.	Low.	High.	Moderate.	Potential for localized odor events. Equipment operation.	Low to moderate.	Low.	Low to moderate.	High.	Net benefit due to the creation of a product rather than landfilling without reuse.	Appropriate mix of nitrogen-rich food scraps with carbon-rich bulking agents, such as yard trimmings.	Moderate; moderate tolerance for contaminants.	Pre-processing to remove contaminants; controlled processing (aeration, possible cover); post-processing to further remove contaminants; curing.	Moderate.	Low to moderate.	Moderate.	Moderate to high.	Moderate.	Standard permitting requirements.	Low to high, depending on quality of inputs and amount of pre- and post-screening.
	Covered Windrow	Traditionally, this method uses elongated piles of several hundred feet that typically are 12 to 20 feet wide and 5 to 8 feet tall ("windrows"). This category can be broadened with some processing modifications to include other pile shapes, such as trapezoids. The windrow method relies on the use of mechanical means to turn the windrows periodically to maintain adequate aerobic conditions within the composting mass. Covers are used in wet climates to maintain an appropriate level of moisture and to reduce run-off that comes in contact with the composting mass.	Yard trimmings, food scraps, compostable paper.	Wide range, with municipal-scale systems typically from 5 acres to 40 acres, with some smaller and larger than this typical range.	Compost.	Low.	Low.	Low.	High.	Moderate.	Potential for localized odor events. Equipment operation. Dust when turning.	Moderate.	Low to moderate.	Low to moderate.	High.	Net benefit due to the creation of a product rather than landfilling without reuse.	Appropriate mix of nitrogen-rich food scraps with carbon-rich bulking agents, such as yard trimmings.	Low to moderate; moderate to high tolerance for contaminants.	Pre-processing to remove contaminants; controlled processing (use of windrow turner for aeration, size reduction, and to break anaerobic clumps; use of cover); post-processing to further remove contaminants; curing.	Moderate.	Low to moderate.	Simple to moderate.	Moderate to high.	High.	Standard permitting requirements.	Low to high, depending on quality of inputs and amount of pre- and post-screening.
	In-Vessel Systems	The in-vessel approach employs sealed containers or vessels in which organic materials are loaded and actively composted for an initial composting period. The in-vessel process begins the compost process and reduces odor by controlling the environment of the vessel. After an initial composting period, the composting mass is moved typically into windrows or other pile configurations for further processing. Some of the terms used include vessel, drum, silo, and concrete trench. A hallmark of the systems is strict control of the composting environment and use of mechanical devices to monitor key operating parameters.	Yard trimmings, food scraps, compostable paper.	Higher throughput per acre than other composting methods. Can range from being housed within a moderate-sized building to operating on a large outdoor facility.	Intermediate materials that meet standards for pathogen reduction and have lower potential for causing odor events, and suitable for further processing into stabilized compost.	High.	High.	Low.	Moderate.	Moderate.	Equipment operation.	Low.	Low.	Low.	High.	Net benefit due to the creation of a product rather than landfilling without reuse.	Appropriate mix of nitrogen-rich food scraps with carbon-rich bulking agents, such as yard trimmings.	Low to moderate; moderate to high tolerance for contaminants.	Pre-processing to remove contaminants; controlled processing (aeration, temperature, moisture, other parameters); post-processing to further remove contaminants; curing.	Low to moderate.	Low.	Complex.	Low to high.	Low for in-vessel phase; moderate for post-in-vessel phase of processing.	Standard permitting requirements.	Low to high, depending on quality of inputs and amount of pre- and post-screening.
	Vermicomposting	This method uses worms, typically Eisenia Foetida, to break down organics into nutrient-rich castings for use as a fertilizer.	Mostly food scraps, with bedding (such as leaves or shredded paper).	Single household bin to large facility (Yelm, WA). Some facilities can be 5 acres or more.	Worm castings for use as a fertilizer. Worm tea for use as liquid fertilizer. Worms for bait and vermicomposting	Low.	Low.	Low.	Moderate.	Moderate.	Low.	Low to moderate.	Low.	Attractant potential if meat/dairy products are used and if not properly mixed.	Low to moderate.	Net benefit due to the creation of a product rather than landfilling without reuse.	Food scraps with carbon-rich bedding.	High; low tolerance for contaminants.	Pre- and post-processing to remove contaminants; post-processing to separate worms from end product.	Low.	Low.	Simple to moderate.	Low to high.	High.	Small scale facilities (<1000 CY) are exempt from permitting.	High.
Anaerobic Digestion	Wet System	A process where microorganisms break down organic materials, such as food scraps, manure, and sewage sludge, in the absence of oxygen. It produces biogas and a solid residual. Biogas, made primarily of methane and carbon dioxide, can be used as a source of energy similar to natural gas. The solid residual can be land applied or composted and used as a soil amendment. The benefits of anaerobic digestion include renewable energy generation, greenhouse gas emissions reduction, and waste diversion. A wet system operates with higher moisture (approximately 20%) than a dry system and can operate with high solids/low solids.	Pumpable substrate, typically biosolids and possibly certain food processing by-products. Generally total suspended solids are less than 20%.	More land footprint than dry system to manage increased liquids	Biogas, depends on type of feed system. Digestate for composting, landspreading, or alternative daily cover.	High.	High.	Moderate.	Moderate.	High, based on imputed value of energy production.	Potential for localized odor events. Equipment operation.	Moderate.	Low.	Low to moderate.	Moderate.	Net benefit due to the creation of a product rather than landfilling without reuse.	Food scraps.	High; low tolerance for contaminants.	Pre- and post-processing to remove contaminants; mixing of feedstock; digestion; post-digestion further treatment or land application of digestate.	Low to moderate.	Low.	Complex.	Low to high.	Low for active phase; potentially moderate for further treatment of digestate.	Information pending Detailed Analysis.	Low to high, depending on degree of contaminant presence in end product.
	Dry System	Similar system as the wet system, except operation is under lower moisture contents and can be continuous or batch, and can operate with vertical or batch tunnel system. The vertical system utilizes grinders to increase vertical movement. Batch tunnel avoid grinding to maintain fluff.	Biosolids, food scraps, food processing by-products. Generally stackable with 25-40% total suspended solids.	Vertical system has smaller footprint.	Biogas, depends on type of feed system. Digestate for composting, landspreading, or alternative daily cover.	High.	High.	Moderate.	Moderate.	High, based on imputed value of energy production.	Potential for localized odor events. Equipment operation.	Moderate.	Low.	Low to moderate.	Moderate to high.	Net benefit due to the creation of a product rather than landfilling without reuse.	Food scraps mixed with other organics and possibly other materials.	Low to moderate; potential for considerable tolerance for contaminants.	Pre- and post-processing to remove contaminants; mixing of feedstock; digestion; post-digestion further treatment or land application of digestate.	Low to moderate.	Low.	Complex.	Low to high.	Low for active phase; potentially moderate for further treatment of digestate.	Information requires Detailed Analysis.	Low to high, depending on degree of contaminant presence in end product.
	Batch Feed	The system operates such that biomass is added to the reactor vessel, composted, and removed before the next series.	Biosolids, food scraps, food processing by-products.	Generally less equipment and simpler operation.	Biogas produced per curve. It will increase, peak, then decrease with each batch cycle.	High.	High.	Moderate.	Moderate.	High, based on imputed value of energy production.	Potential for localized odor events. Equipment operation.	Moderate.	Low.	Low to moderate.	Moderate.	Net benefit due to the creation of a product rather than landfilling without reuse.	Information would require Detailed Analysis.	Information would require Detailed Analysis.	Pre- and post-processing to remove contaminants; mixing of feedstock; digestion; post-digestion further treatment or land application of digestate.	Low to moderate.	Low.	Complex.	Low to high.	Low for active phase; potentially moderate for further treatment of digestate.	Information requires Detailed Analysis.	Low to high, depending on degree of contaminant presence in end product.
	Continuous Feed	The system operates such that biomass is constantly added, mixed, and removed from system.	Biosolids, food scraps, food processing by-products.	Multiple vessels may be used, requiring larger footprint.	Biogas produced on a constant and relatively consistent basis. Digestate for composting, landspreading, or alternative daily cover.	High.	High.	Moderate.	Moderate.	High, based on imputed value of energy production.	Potential for localized odor events. Equipment operation.	Moderate.	Low.	Low to moderate.	Moderate to high.	Net benefit due to the creation of a product rather than landfilling without reuse.	Information would require Detailed Analysis.	Information would require Detailed Analysis.	Pre- and post-processing to remove contaminants; mixing of feedstock; digestion; post-digestion further treatment or land application of digestate.	Low to moderate.	Low.	Complex.	Low to high.	Low for active phase; potentially moderate for further treatment of digestate.	Information requires Detailed Analysis.	Low to high, depending on degree of contaminant presence in end product.
	Co-digestion	This system combines multiple feedstocks, such as food and sewage sludge.	Biosolids mixed with municipal food scraps.	Publicly-owned treatment works of varying sizes.	Biogas (methane). Digestate for composting, landspreading, or alternative daily cover.	Very low, if use existing excess capacity at wastewater treatment facility; otherwise, high.	High.	High (WA Dept of Ecology; US EPA; others).	High.	High, based on imputed value of energy production.	Potential for localized odor events. Equipment operation.	Moderate.	Low.	Low to moderate.	Moderate to high.	Net benefit due to the creation of a product rather than landfilling without reuse.	Food scraps mixed with wastewater biosolids.	High; low tolerance for contaminants.	Pre- and post-processing to remove contaminants; mixing of feedstock; digestion; post-digestion further treatment or land application of digestate.	Low to moderate.	Low.	Complex.	Low to high.	Low for active phase; potentially moderate for further treatment of digestate.	Information requires Detailed Analysis.	Low to high, depending on degree of contaminant presence in end product.
On-Site Facilities	Large	Typically this would be composting, but anaerobic digestion could be an option in a farm or food processor setting.	Yard trimmings, food scraps, animal manure, agricultural residues.	Institutions, farms, food processing facilities, and others.	Soil amendments, and potentially energy.	Moderate.	Moderate.	Moderate (WA Dept of Ecology).	High.	Low.	Potential for localized odor events. Equipment operation.	Low to moderate.	Low to moderate.	Low to moderate.	Low.	Net benefit due to the creation of a product rather than landfilling without reuse.	Appropriate mix of nitrogen-rich food scraps with carbon-rich bulking agents, such as yard trimmings. Possibly could include farm animal wastes.	Moderate to high; low to moderate tolerance for contaminants.	Depends on processing method; varies considerably; not determined.	Low.	Low.	Simple to moderate.	Moderate to high.	Moderate.	Small scale facilities (<1000 CY) are exempt from permitting.	Moderate.
	Medium	Typically this would be composting, but anaerobic digestion could be an option in a farm or food processor setting.	Yard trimmings, food scraps, animal manure, agricultural residues.	Institutions, such as schools, universities, zoos, and prisons, parks, homeowners' associations, corporate parks.	Soil amendments, and potentially energy.	Low.	Low.	Moderate (WA Dept of Ecology).	High.	Low.	Low.	Low.	Low.	Low to moderate.	Low.	Net benefit due to the creation of a product rather than landfilling without reuse.	Appropriate mix of nitrogen-rich food scraps with carbon-rich bulking agents, such as yard trimmings. Possibly could include farm animal wastes.	Moderate to high; low to moderate tolerance for contaminants.	Depends on composting method employed; not determined.	Low.	Low.	Moderate.	Moderate to high.	Low.	Small scale facilities (<1000 CY) are exempt from permitting.	Moderate.
	Small	Vermicomposting or compost bins.	Yard trimmings, food scraps.	Homes, apartments, moderate-sized businesses.	Compost, vermicompost (fertilizer), worm tea (liquid fertilizer), worms (bait, vermicomposting).	Very low.	Very low.	Moderate (WA Dept of Ecology).	very high	None.	None.	Very low.	None.	Low.	Very low.	Net benefit due to the creation of a product rather than landfilling without reuse.	Appropriate mix of nitrogen-rich food scraps with carbon-rich bulking agents, such as yard trimmings.	High; low tolerance for contaminants.	Periodic turning and watering.	Low.	Very low.	Simple.	High.	Very low.	None.	Low to moderate.
Limited Action	Out-of-County	Unknown.	Unknown.	Unknown.	Unknown.	If no facility upgrades, very low cost to Pierce County.	Unknown.	Low.	Moderate.	Presumably none would flow directly to Pierce County.	None in Pierce County.	None in Pierce County.	None in Pierce County.	None in Pierce County.	None in Pierce County.	Net benefit due to the creation of a product rather than landfilling without reuse.	Unknown.	Unknown.	Unknown.	Unknown.	None in Pierce County.	Unknown.	Unknown.	None in Pierce County.	None in Pierce County.	Unknown.
	Animal Feed	Typically involves separation of acceptable food items from non-food items, cooking to achieve pathogen destruction, mixing according to various formula, and pelletizing or other final step.	Dry manufacturing (oil meals, pastas, bakery products), wet manufacturing (dairy, spent brewery grains, distillation products), food processing by-products (canning of fruits and vegetables), packaging culls (fruits and vegetables), pre-consumer vegetative trimmings.	Information would require Detailed Analysis.	Animal feed, industrial by-products.	Moderate.	Moderate.	Low.	Moderate.	High.	Low.	Low to moderate.	Low to moderate.	Low to high.	Moderate to high.	Net benefit due to the creation of a product rather than landfilling without reuse.	Depending on end use specific requirements. Considerable concern about adding food scraps of animal origin.	High; low tolerance for contaminants.	Sorting, blending, mixing, heating.	Low to moderate.	Low.	Moderate.	Low to high.	Low.	Information requires Detailed Analysis.	Generally high.
No Action	LFG Generation/Reuse	Organics disposed in a landfill decompose to generate landfill gas (LFG). LFG is collected through a collection network via a blower extraction system. Depending on reuse project, LFG is burned for electricity, heat, and/or converted to natural gas (NG).	Municipal solid waste (MSW) as currently collected.	generally, the reuse facility(ies) is(are) half an acre footprint or smaller, unless conditioning equipment is needed to convert to NG.	Depending on reuse project, LFG is burned for electricity, heat, and/or converted to NG.	Information Pending.	Information Pending.	DOE and other federal grants. Third party project developer.	With large enough LFG flow, payback generally occurs within 10 years.	Information Pending.	Emissions dependent on reuse project.	Contributes to landfill leachate generation.	Low to moderate.	High.	None.	Net benefit due to the creation of a product rather than landfilling without reuse.	MSW as currently collected.	Low; high tolerance for contaminants.	Landfill and LFG collection.	Low to moderate.	Moderate.	Complex.	Moderate.	Low to moderate.	Standard permitting requirements.	Moderate to high.

Memorandum

SAIC

To: Rick Johnston, Pierce County Public Works and Utilities

From: Steven Sherman

Subject: Food Waste Reasonable Management Practices
Organics Program System Scenarios

Date: December 13, 2011

The purpose of this memorandum is to present several concepts of reasonable management practices for food waste. These concepts have been developed to demonstrate a variety of options available and are presented to encourage thought and discussion, but do not necessarily represent the only options available to Pierce County.

This memorandum contains three sections that illustrate the step-wise decision-making approach that is being employed in arriving at a set of reasonable management practices:

1. List (see end of document) and categorization of key programmatic options;
2. Ten system-wide program scenarios for food scraps diversion from the landfill; and
3. Preliminary short-list of scenarios for further consideration (detailed analysis).

While each section presents a wide variety of optional elements in an overall food scraps diversion program, the options become progressively fewer while the program features come into clearer focus.

Key Programmatic Options

For the four sectors—residential single-family; residential multi-family; commercial; and self-haul—several programmatic options exist. The options were categorized in the following topics:

1. Participants;
2. Geography;
3. Collection frequency;
4. Collection method;
5. Collection pricing;
6. Collection materials;
7. Collection policy;
8. Processing location;

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9. Processing technology;
10. Processing ownership and operation;
11. Disposal policy.

Within each of these categories, several options are shown.

County Demographics

Pierce County, the second most populous county in Washington, has approximately 800,000 residents, according to the 2010 Census.

Approximately one-quarter of the county's population, or about 200,000 people, live in the City of Tacoma. This city is the third largest in the state.

Meanwhile, approximately 230,000 people live in several other incorporated cities and towns (herein shorted to "incorporated cities") in Pierce County. The four largest of these other incorporated cities, according to the Washington State Office of Financial Management (2010), include: Lakewood (approx. 59,000); Puyallup (approx. 39,000); University Place (approx. 32,000) and Bonney Lake (approx. 17,000). Combined, these four cities total 147,000 residents.

Additionally, approximately, 380,000 people live in unincorporated sections of the county, according to the Washington State Office of Financial Management. In the following pages, these unincorporated areas are referred to collectively as "unincorporated county."

System-wide Program Scenarios

Several scenarios for food scraps diversion are outlined briefly in the following pages. These scenarios draw upon the variables shown in the table presented at the end of this memorandum, which identifies key programmatic options. The time frame for these scenarios is over the next five years.

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Scenario A

Incorporated Cities

Residential Single Family - Voluntary

1. Year-round, weekly curbside collection in a 32-gallon, 64-gallon, or 96-gallon cart for yard trimmings, vegetative and non-vegetative food scraps, and compostable paper;
2. Source-separation of these materials from trash;
3. Costs are rolled into trash service level, and bundled (i.e., no line-item charge for organics collection and processing);
4. Weekly trash collection service;
5. Targeted, sustained outreach campaign; and
6. Processing in existing, in-county, privately-operated composting facilities.

Commercial - Voluntary

1. Year-round collection of vegetative and non-vegetative foods scraps and compostable paper in carts and bins of various sizes, and organics compactors available;
2. Service offered at a 25-50% lower price than trash service;
3. Sustained outreach and training; and
4. Processing in existing, in-county, privately-operated composting facilities.

Residential Multi-Family - Voluntary

1. Generally the same as Residential Single Family;
2. Carts only (no larger bins); and
3. Modest outreach.

Self-haul

None.

Unincorporated County

No residential service for food scraps; commercial service on an ad hoc basis.

City of Tacoma

Similar to incorporated cities, but with implementation 3 to 5 years earlier than incorporated cities.

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Scenario B

Incorporated Cities (for at least three incorporated cities; other incorporated cities implement program 3 years later).

Residential Single Family - Voluntary

1. Year-round, weekly curbside collection in carts of various size for yard trimmings, vegetative and non-vegetative food scraps, and compostable paper;
2. Source-separation of these materials from trash;
3. Costs are rolled into trash service level and bundled (i.e., no line-item charge for organics collection and processing);
4. Targeted, sustained outreach campaign; and
5. Processing in existing, in-county, privately-operated composting facilities, or other composting facility.

Commercial - Voluntary

1. Year-round collection of vegetative and non-vegetative foods scraps (no compostable paper, no bones or shells) in 64-gallon carts and bins of various sizes;
2. Service offered at a 25-75% lower price than trash service;
3. Sustained outreach and training; and
4. Processing at anaerobic digestion facility (location to be determined).

Multi-family - Voluntary

1. Generally the same as Residential Single Family;
2. Carts only, no larger bins;
3. Modest outreach.

Self-haul

None.

Unincorporated County

No residential service for food scraps; commercial service on an ad hoc basis.

City of Tacoma

Similar to incorporated cities, with earlier implementation.

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Scenario C

Incorporated Cities (for at least three incorporated cities; other incorporated cities implement program 3 years later).

Residential Single Family - Voluntary

1. Year-round, weekly curbside collection in a 32-gallon, 64-gallon, or 96-gallon cart for yard trimmings, vegetative and non-vegetative food scraps, and compostable paper;
2. Source-separation of these materials from trash;
3. Costs are rolled into trash service level and bundled (i.e., no line-item charge for organics collection and processing);
4. Targeted, sustained outreach campaign; and
5. Processing in existing out-of-county composting facility, or new in-county composting facility.

Commercial - Voluntary

1. Year-round collection of vegetative and non-vegetative foods scraps in carts (or bins of various sizes), and organics compactors available;
2. Service offered at a 25-50% lower price than trash service;
3. Sustained outreach and training; and
4. Processing in existing out-of-county composting facility, or new in-county composting facility.

Multi-family - Voluntary

1. Generally the same as Residential Single Family;
2. Carts only, no larger bins;
3. Modest outreach.

Self-haul

None.

Unincorporated County

No residential service for food scraps; commercial service on an ad hoc basis.

City of Tacoma

Similar to incorporated cities, with earlier implementation.

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Scenario D

Incorporated Cities (for up to three cities)

Residential Single Family - Voluntary

1. Pilot program in years 1-2, then evaluate (pilot program to test one or more collection methods);
2. Vegetative food scraps only;
3. No change in pricing; and
4. Processing: to be determined, but assumed to be at an existing facility.

Commercial - Voluntary

1. Pilot program in years 1-2 for collection of vegetative foods scraps only;
2. Carts only;
3. Service offered at a 25-50% lower price than trash service; and
4. Processing: to be determined, but assumed to be at an existing facility.

Multi-family

Not included in pilot program.

Self-haul

None.

Unincorporated County

Not included in pilot program.

City of Tacoma

Similar to incorporated cities that implement pilot programs in years 1-2.

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Scenario E

Incorporated Cities

Residential Single Family - Voluntary

1. Year-round, weekly curbside collection in a 32-gallon, 64-gallon, or 96-gallon cart for yard trimmings, vegetative and non-vegetative food scraps, and compostable paper;
2. Source-separation of these materials from trash;
3. Costs are not rolled into trash service level, and are charged separately (base rate, plus variable rate, depending on service level);
4. Pilot program for every-other-week collection of trash;
5. Targeted, sustained outreach campaign; and
6. Processing at new in-county composting facility.

Commercial - Voluntary

1. Year-round collection of vegetative and non-vegetative foods scraps and compostable paper in carts (or bins of various sizes) and organics compactors available;
2. Service offered at a 25-50% lower price than trash service;
3. Sustained outreach and training; and
4. Processing at new in-county composting facility.

Multi-family - Voluntary

- Generally the same as Residential Single Family;
- Carts and bins of various sizes; and
- Moderate outreach.

Self-haul

None.

Unincorporated County

No residential service for food scraps; commercial service similar to incorporated cities.

City of Tacoma

Similar to incorporated cities

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Scenario F

Incorporated Cities

Residential Single Family - Voluntary

1. Year-round, weekly curbside collection in a 32-gallon, 64-gallon, or 96-gallon cart for yard trimmings, vegetative and non-vegetative food scraps, and compostable paper;
2. Source-separation of these materials from trash;
3. Costs are not rolled into trash service level, and are charged separately (base rate, plus variable rate, depending on service level);
4. Pilot program for every-other-week collection of trash;
5. Targeted, sustained outreach campaign; and
6. Processing at new in-county composting facility.

Commercial - Mandatory

1. Year-round collection of vegetative and non-vegetative foods scraps and compostable paper in carts, bins of various sizes, and organics compactors available;
2. Source-separation of these materials from trash, for customers with 4 cy/wk or more trash service initially, and moving to a 2 cy/wk trash service threshold after 2 years;
3. Service offered at a 25-50% lower price than trash service;
4. Sustained outreach and training; and
5. Processing at new in-county composting facility.

Multi-family - Voluntary

- Generally the same as Residential Single Family;
- Carts and bins of various sizes; and
- Moderate outreach.

Self-haul

None.

Unincorporated County

No residential service for food scraps; commercial service similar to incorporated cities.

City of Tacoma

Similar to incorporated cities.

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Scenario G

Incorporated Cities

Residential Single Family - Mandatory

1. Year-round, weekly curbside collection in a 32-gallon, 64-gallon, or 96-gallon cart for yard trimmings, vegetative and non-vegetative food scraps, and compostable paper;
2. Source-separation of these materials from trash, after 2 years of full program implementation;
3. Costs are not rolled into trash service level, and are charged separately (base rate, plus variable rate, depending on service level);
4. Targeted, sustained outreach campaign; and
5. Processing at new in-county composting facility.

Commercial - Mandatory

1. Year-round collection of vegetative and non-vegetative foods scraps and compostable paper in carts, bins of various sizes, and organics compactors available;
2. Source-separation of these materials from trash, for customers with 4 cy/wk or more trash service initially, and moving to a 2 cy/wk threshold the following year, and then moving to no threshold;
3. Service offered at a 25-50% lower price than trash service;
4. Sustained outreach and training; and
5. Processing at new in-county composting facility.

Multi-family - Mandatory

Generally the same as Commercial.

Self-haul - Mandatory

Source-separation of acceptable organics from trash, with 50% surcharge above trash rate for mixed trash loads that contain acceptable organics above certain levels (levels can decrease over time, to allow for adjustment period).

Unincorporated County

Similar to incorporated cities.

City of Tacoma

Similar to incorporated cities.

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Scenario H

Any of the above scenarios, with far greater emphasis than at present on residential, institutional-scale, and on-farm processing of organics.

For example, this scenario could include:

1. Substantially increased education and outreach about residential and institutional-scale composting;
2. Deep(er) discounts for home composting bins;
3. Cost-sharing partial grant program for institutional-scale organics processing equipment;
4. Technical, financial, and permitting assistance for on-farm organics processing of clean, source-separated organics;
5. Imposition of base rate and variable charges for organics collection service, for all sectors;
6. Required source-separation of yard trimmings and vegetative food scraps from trash; and
7. For self-haul, required source-separation of acceptable organics from trash, with 50% surcharge above trash rate for mixed trash loads that contain acceptable organics above the minimum levels.

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Scenario I

Formal County program to increase use of residential and commercial food grinders, such that more food waste is disposed via the sewer system and processed via anaerobic digestion at wastewater treatment facilities. This scenario could include:

1. Education and outreach about food grinders and about wastewater biosolids processing;
2. Discounts for home-scale food grinders;
3. Cost-sharing partial grant program for institutional-scale food grinders;
4. Imposition of base rate and variable charges for organics collection service, for all sectors;
5. Required source-separation of yard trimmings and vegetative food scraps from trash;
6. Efforts to reduce rates for certain subsectors or certain types of food-based materials that are disposed via the sewer system;
7. Targeted technical assistance to food-generating businesses, such that they seek have their acceptable food waste trucked directly to wastewater treatment facilities for anaerobic digestion; and
8. For self-haul, required source-separation of acceptable organics from trash, with 50% surcharge above trash rate for mixed trash loads that contain acceptable organics above the minimum levels.

Scenario J

Largely status quo or laissez faire position by County unless and until substantial additional privately-owned and privately-operated organics processing capacity becomes available in the county.

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Preliminary Short List of Scenarios

The above scenarios will be winnowed to a handful for further study based on consultation with the C-Team and PMT. These scenarios include:

Scenario	Description
1	
2	
3	
4	
5	

It is anticipated that as the more detailed analysis unfolds, some of the programmatic elements will be modified, as additional clarifying information is gathered or becomes available.

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Food Waste/Organics Program System Options

Program elements are developed by selecting one item from each column moving from left to right on Page 1, and then again from left to right on Page 2

Option	Sector	Participation	Geography	Collection Frequency	Collection Method	Collection Pricing	Collection Materials
#	Residential Single-family	Mandatory	All	Weekly, year-round	Rear or side loaders, automated	Single charge, unlimited set-out	Yard trimmings
	Residential Multi-family	Voluntary	County only	Every other week (yard trimmings) + weekly (food, etc.)	Rear or side loaders, semi-automated	Transparent rates: base rate + variable charges based on organics collection weight or weekly organics service level	Yard trimmings and vegetative food with no compostable paper
	Commercial		Incorporated cities	Every other week, year-round	Front-end loaders, with flexibility to collect carts and bins	Transparent rates: Base rate + variable charges based on diversion service (recycling and organics collection) as percentage of overall service (trash, recycling and organics collection)	Yard trimmings and vegetative food with compostable paper
	Self-haul		City of Tacoma only		Front-end loaders, bins only	Embedded rates: charges tied to trash service level	Yard trimmings and all food with compostable paper
							Yard trimmings and all food with compostable paper and plastics

Collection Policy	Processing Location	Processing Technology	In-county Processing Ownership/Operation	Disposal Policy
Voluntary	Existing in-county compost facility	Composting: turned windrows	Pierce County owns; private operation	Unlimited disposal of organics
Required organics base charge for all trash customers; voluntary participation for organics collection	Existing in-county wastewater treatment facility	Composting: aerated static pile	Private ownership and operation	County restrictions at landfills and transfer stations on disposal of yard trimmings (self haulers and large generators)
Required participation, with separate charge for collection of organics as trash	Existing in-county animal feed production operation	Composting: in-vessel	Publicly-owned treatment works (wastewater treatment facility), public operation	County restrictions at landfills and transfer stations on disposal of yard trimmings (self haulers and large generators) + 50% surcharge on mixed trash loads containing yard trimmings above *de minimus*
Required participation, with possibility of non-collection of improper set-outs	Various on-site institutional processing sites	Anaerobic digestion: dedicated digester	Out-of-county	Lobbying for state-wide or regional policies
Required participation, with administrative penalty structure	New in-county composting facility	Anaerobic digestion: co-digestion with biosolids		
	Existing or new out-of-county processing facility	Animal feed production		
		On-site processsing, large-scale		
		On-site processsing, mid-scale		
		On-site processing, small-scale		
		Waste reduction		

Appendix C
CASE STUDIES

Case Study 1:
Cedar Grove Composting

Cedar Grove Composting includes two facilities located near Seattle, WA. The facility located in Maple Valley was constructed in 1989 and the facility located in Everett began operation in 2004. Both sites utilize Gore covered, in-vessel aerated piles. In total, both sites taken in 400,000 tons of organic waste (e.g., yard waste, grass trimmings, and food waste) annually. The food waste comes from residential and commercial sources (e.g., restaurants, grocery stores, and institutions). The facilities also accept meat, bone, dairy, and compostable bags and compostable plastic bags. Maple Valley began accepting pre-consumer food waste in 1994 and Everett began accepting food waste upon initial operation in 2004.

The Maple Valley site is 28 acres and the Everett facility sits on 26 acres. The facilities operate under the local Health District's solid waste permit, the State's air permit, the Department of Ecology's storm water permit, and one of the facilities dumps directly to sanitary discharge and requires an industrial discharge permit. Cedar Grove indicates that there has been only minor air NOV's in the past, but currently nothing outstanding.

The facilities accept waste on a tipping floor within a covered structure where heavy equipment premixes the yard and food wastes. The material is pushed through a grinder that homogenizes the waste. The facilities work to provide a compost recipe that has a carbon/nitrogen ratio of 30:1 by combining the carbon material within the food waste and the yard waste (e.g., container boxes). Once the material is mixed and at the correct ratio, moisture is added to the material and the material passes a magnet to remove any residual metals. It then is placed into heaps for composting.

To control odors, the facilities concentrate on the material recipe (C:N ratio), complete mixing and processing indoors under negative pressure, and compost using an in-vessel system. Cedar Grove reports that the facilities are successful due to the high volume of feedstock. However, the inclusion of food waste has led to contamination issues, specifically with waste types (other MSW) that are not supposed to be with the food wastes.

Starting over from scratch, Cedar Grove indicated that they would emphasize a higher focus on the food component. Allow only food waste to be discarded for composting. Do not allow the disposal of containers with the food waste as it is often times confusing to residents as to which items can or cannot be discarded with food waste. These items end up contaminating the incoming feedstock. Although some of the discarded containers provide necessary carbon for the composting, it leads to contamination. Having the higher organics of the food waste would be better. The carbon requirement can be supplemented with wood wastes. It is suggested that the food waste would be better incorporated after processing through an anaerobic digestion facility.

It takes approximately 60 days from waste arrival to the facility to become usable compost. The facility charges $54 per ton for yard waste and food waste would be about $60 per ton. However, self-haul of food waste is not allowed, so there is no listed tipping fee for this material. The facility sells the compost for $18 to 21 per cubic yard or $3 per bag. The facility does not receive any government subsidies.

Case Study 2:
East Bay Municipal Utility District

The East Bay Municipal Utility District ("EBMUD") in Oakland, CA has accepted pre- and post-consumer food waste at its wastewater treatment plant ("WWTP") since 2004. By 2014, EBMUD plans to process 120 tons per day of food waste through a food waste only anaerobic digester ("AD"). The gas generated from the seven digesters at the WWTP operate a 4.5 combined heat and power electric generator unit. The current WWTP uses seven AD facilities to handle and process 40 tons per day of commercial post-consumer food waste from the East Bay area. In addition the facilities accept 240,000 gallons per day of food processing waste which is mixed with municipal sludge (700,000 gallons per day). An additional goal of the food waste only digester is to improve the fertilizer product.

Excess capacity was available at the WWTP because of the significant investment in the mid to late 1900s made to build treatment facilities for the cannery and food industry. These industries left in the 1970s leaving additional capacity. This allowed for EBMUD to include fats, oils and greases and then expand to other food waste types. A lot of the feedstock comes from areas over 100 miles away that are unable to dispose of their food wastes because it would overwhelm the local WWTP or would not be accepted at a landfill. The EBMUD accepts this material in an effort to provide an alternative for these distant industries to protect the water quality of the Central Valley.

Feedstock is delivered to the WWTP via tanker trucks and dumped directly into the AD equipment, which helps in odor control. There are pre-processing machines that reduce the volume and minimize contaminants (e.g., bags and others). A majority of the material that goes through the AD is wastewater biosolids, liquids from food processing (e.g., canning, beverage makers) and waste from restaurants.

There is currently debate as to which regulatory authority the food waste AD process will be regulated. EBMUD is working proactively with state, regional, and local authorities to determine what rules should be applied to this process as it does not fully fall under either wastewater or solid waste.

The facility has been able to generate all its own power demands from the biogas generated from the AD process as well as sell excess to the grid. However, limits in AD capacity will likely decrease the amount of power generation at the facility until the dedicated food waste AD is operational. In general, EBMUD reports that the WWTP has been able to successfully co-digest food waste with biosolid waste and is one of the first to accomplish this. However, there are still issues with contaminants in the food waste feedstock that could be improved with better equipment. Additionally, if the facility plans to accept an increased variety of food wastes, additional pre-processing equipment would be needed. Also, as a way to provide an additional source of revenue to assist other communities in implementing similar processes, the ability to access carbon credit or renewable energy credit revenue should be made available[1].

[1] http://www.biocycle.net/2011/11/utility-district-ramps-up-food-waste-to-energy-program/

Case Study 3: Inland Empire Utilities Agency

The Inland Empire Utilities Agency (Agency) in Chino, California is a municipal water district that operates a Regional Plant No. 5 Solids Handling Facility (RP-5 SHF) which can process food waste. RP-5 SHF has been in operation since 2001. RP-5 SHF is an anaerobic digester facility designed to process dairy farm manure and food waste from food processing facilities. Methane gas that is generated is intended to be used as a fuel source to operate engine generators that produce electricity which can be used to operate equipment in the RP-5, RP-2 and Chino Desalter I facilities.

The Agency is not implementing any food augmentation to the digestion process at this time. The RP-5 SHF used to process cow manure which the Agency reports was a huge challenge due to the manure poor quality and presence of grit, rocks, twine, etc. in the stream. Food waste was added briefly (5% to 10%) just before the Agency decided to suspend operations for economic reasons.

The facility is now leased to Environ Strategy Consultants, Inc. At the RP-1 facility, the Agency hosted a pilot project where 20% food waste was added to the digester but never pursued the full scale implementation after that. In theory, food waste augmentation could increase digester gas production by 20 to 30 percent but the quality of the gas may decrease. The Agency was not able to confirm and demonstrate this fact during the short period of time where food waste was implemented as discussed above.

Based on information found in BioCycle Magazine (December 2010[1]), Environ is planning to rebuild and expand the RP-5 SHF through a 10-year lease with the Agency using a CalRecycle loan. Much of the required processing areas already exist at the facility, including a receiving building and anaerobic digestion equipment. The ability to generate electricity is currently available because of the facility's existing two 1.5 MW biogas powered ICE. Initially (as of the publication of this article), the facility would process 150 tons per day of food waste with planned increase of capacity to 300 tons per day. Initial operation was planned to begin in the first quarter of 2012[2].

[1] http://www.biocycle.net/2010/12/regional-roundup-85/
[2] http://www.cce.csus.edu/conferences/CalRecycle/lea_tts11/docs/Presentations/31_13A_AnaerobicMcNamara.pdf

Case Study 4:
City of San Jose, CA Dry Fermentation

The city of San Jose, CA is in the process of constructing and commencing operation of an organic waste-to-energy facility. At the time of the Pierce County Food Waste Reasonable Management Practices study, the facility is under construction (first phase). However, plans for the facility include processing up to 150,000 tons of food waste annually. The feedstock would come from a material recovery facility (operated by the same entity that will operate the anaerobic digestion facility) and from source-separated organics. The material will be processed through a dry fermentation technology. The process was chosen as an alternative to typical anaerobic digestion processes that generally handle wastewater that range from 8 to 15% solids, versus the incoming food waste at 50% solids. Initially, the plans include processing 50,000 tons per year and ramped up to a maximum of 150,000 tons per year[1].

[1] http://biomassmagazine.com/articles/2912/san-jose-advances-waste-to-biogas-facility-plans/

Case Study 5: Toronto, Ontario

The City of Toronto uses an anaerobic digestion (“AD”) processing technology (BTA) from Germany to process its residential green bin organic waste materials. This is a "wet" pre-processing system. The City's Leaf and Yard Waste (“L&YW”) materials are processed under contract to the private sector. These private contractors predominately use open windrows for the processing of L&YW materials. The AD facility is located on approximately 2.4 acres of land and began operating and collecting food wastes in 2002. The facility is allowed to operate under a Certificate of Approval through the Provincial Ministry of the Environment. This certificate dictates how much material the facility is permitted to receive, store, and process, and how it is to operate.

Approximately 130,000 metric tonnes of Green Bin organics and approximately 100,000 metric tonnes of L&YW materials are collected for processing. The Green Bin program, which sources most of its tonnage from residential households, accepts a large variety of food wastes. The program allows plastic bags to be used for lining the container. Typically, grocery bags are used. Compostable plastics are accepted, but not promoted. The bags are removed at the initial screening in the pre-processing stage. The bags are removed because it takes too long for the bags to compost. They do not require the use of bags because the City does not see a benefit in asking residents to pay extra for something that will be screened.

The facility has a pre-processing system that is designed to screen heavy materials (e.g., glass, shells, and bones) and bags and homogenize the incoming waste. Incoming material is tipped on the floor and directed to a conveyor system that takes the material to a hydro-pulper. The hydro-pulper mixes and homogenizes the waste materials allowing lighter materials (e.g., plastics) to surface and heavier materials to sink. The residual pulp is then processed to remove sand and grit and then is passed on to the digester.

Biogas is created during the AD process and is currently flared. However, work is being done to evaluate a beneficial use of the gas. The solids are dewatered and shipped for conversion to a compost product by a contracted third-party. During the processing, odors are controlled by utilizing a biofilter system, negative building pressure and having a competent operator. The AD process takes approximately 21 days and composting using open windrows can take between 3 to 6 months to convert the residual solids.

The facility notes that the use of AD has proven very successful at managing the source-separated organics (“SSO”) produced by the residents. They have not had any permit violations other than a few minor odor complaints in the last few years.

The City notes that beneficial use of the biogas should have been considered at the onset of the project, possibly to incorporate the gas into the system operation in order to offset energy costs.

Costs associated with facility improvements, maintenance, and operations are all included in the City's operating budget. The City does not receive revenue from the compost product, as the contracted third-party is responsible for creating the compost. The contracted party receives any revenue but also makes a portion of the compost available to the City for no charge.