Food Recovery and Recycling Hierarchy

Innovative Recycling Grant IG1-14

Final Report - April 26, 2004

Submitted to
Florida Department of Environmental Protection

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Table of Contents

Index of Figures

Index of Tables

Index of Acronyms

CCSWDC	–	Central County Solid Waste Disposal Complex
CDC	–	Center for Disease Control
CHAC	–	Children's Haven and Adult Community Services
CI	–	Confidence Interval
EcoPOD	–	Ecologically Preferred Organic Digester
FAC	–	Florida Administrative Code
FDA	–	Food and Drug Administration
FDEP	–	Florida Department of Environmental Protection
FORA	–	Florida Organics Recyclers Association
IFAS	–	Institute for Food and Agricultural Sciences
MDL	–	Method Detection Limit
MRF	–	Materials Recovery Facility
MSW	–	Municipal Solid Waste
NELAP	–	National Environmental Laboratory Accreditation Program
NTU	–	Nephelometer Turbidity Unit
PDP	–	Pesticide Data Program
PFRP	–	Process to Further Reduce Pathogens
ppm	–	parts per million (= mg/kg)
PSRP	–	Process to Significantly Reduce Pathogens
RCRA	–	Resource Conservation and Recovery Act
RFT	–	Recycle Florida Today
RMG	–	Resource Management Group, Inc.
SCTL	–	Soil CleanupTarget Level
SPLP	–	Synthetic Precipitation Leaching Procedure
USDA	–	United States Department of Agriculture
VOC	–	Volatile Organic Compound

Executive Summary

Food wastes are a non-traditional recyclable material currently recycled at very low rates (<4%) both in Florida and nationally. Historically, the recycling community has not focused efforts to divert food waste, due to various real and perceived barriers to recycling this material. Many of the technologies involved in the collection, processing, and distribution of food waste products (i.e. feedstocks for compost) are still in fledgling stages of development.

This project set out to divert food waste materials through an integrated value hierarchy. The objective was to divert food to its highest and best use. This included diversion of food to food banks, farmers to feed animals and to composting facilities to make an agronomic soil amendment. Some sections of the project were implemented and remain in operation, other sections confronted significant challenges to implementation. Specifically, the project team did not develop a sustainable system to divert food to composting operations.

The project team believes many of the challenges are common among businesses and municipalities seeking to divert food waste through composting. The overriding barrier to food waste composting is the *cost* of construction and management of food waste composting facilities in compliance with FDEP's compost rule.

Leachate management is the greatest cost of compliance and impacts all aspects of facility design. The compost rule and facility design sections stipulate that essentially all stormwater and rainwater falling on a composting facility must be contained and managed. This requirement stems from the notion that where there is a possibility for the water to contact incoming feedstocks, composting materials, curing and final product, the water becomes leachate by definition.

The way the rule is written and the requirements for leachate management, imply that leachate from food waste composting facilities would have the same characteristics as leachate derived from general commingled municipal solid waste.

A technology not in common use in Florida, the in-vessel Ag-Bag EcoPOD® system, was utilized in an attempt to find more cost effective mitigation strategies.

The project team was concerned with defining the quality of leachate at various stages of the composting process. The team then interpreted the data first to determine what environmental impacts the leachate might have on the environment if released, and then to hypothesize alternate strategies for constructing food waste composting facilities that are protective of human health and the environment, yet are more cost effective. This information is being utilized to provide recommendations to FDEP.

Summary of findings regarding the quality of leachate

The project team found that food waste composting produces leachate that has qualities needing management. For example:

- When waste is first received, the leachate generated on the receiving pad exceeded the Class III surface water standards for both nutrients and metals.
- When equipment used to process food waste is washed down, the resulting leachate exceeded the Class III surface water standards for both nutrients and metals.
- Rainwater falling on a cleaned receiving pad has characteristics similar to rainwater.
- While not all bags produced leachate, when created during the composting process leachate within Ag-Bags exceeded the Class III surface water standards for nutrients and some metals. The project results indicate that more leachate is formed within the POD when additional nutrients are added, and that this leachate has greater potential to pose a potential to exceed Class III surface water standards for nutrients.
- Leachate created during the windrow composting process exceeded the surface water standards for nutrients and a few metals on the initial flush following a rain event, but dissipated.

Because the facility was located on an active landfill cell, the project team is concerned that some of the data may reflect cross-contamination of food waste composting operations with wind blown contaminates including landfill dirt/dust/particles and vector distributed debris. Furthermore, the temporary nature and construction of the facility also made sampling of leachate from curing compost and final compost products impossible.

Due to these operational and sampling condition limitations, further sampling and analysis under more typical composting conditions is necessary to fully ascertain the quality of leachate that could be expected from a food waste composting system. This investigation should focus primarily on nutrients and biological activity, as this project indicated that these were of greater concern than other parameters in stormwater runoff.

Compost made from food waste

The analysis of waste and compost indicated that when source separated collection methods are utilized, there is no concern in the way of volatile organic compounds, chlorinated and organophosphorus pesticides, or heavy metals in these materials. Further, compost made using food waste has the potential to produce a higher quality end product, from an agronomic standpoint.

Source separated collection programs pose little risk to human health and the environment when dealing with pre consumer wastes. In post-consumer situations there does exist a potential for contaminants to be present in incoming feedstocks. The use of prudent diversion and collection methods will reduce this risk. Spotters and operators at a facility can intercept and address problems as they occur. Further, post-composting screening is necessary to guarantee the removal of potentially dangerous or unpleasant inorganic materials.

The use of compost as a soil amendment in horticultural and agricultural projects will increase the benefits of the program and increase the cost effectiveness of a collections program by making up costs through sale of product. Development of markets cannot be fully undertaken until a long-term facility is constructed.

Summary of Findings Relative to Compost Facility Construction and Operation

Based on the analysis of data obtained during this project, the following conclusions and comments have been reached:

- Leachate from incoming food-derived feedstocks must be kept from directly running off of the receiving pad and into the environment. However, the project team would like FDEP to explore options other than a double walled continuous feed leachate storage system as defined by current rule. Alternate management strategies to consider, include: a simpler no discharge system or a single walled storage system to accommodate leachate from wastes and equipment washdown.
- Actively composting materials produce leachate that may be of concern, especially in terms of nutrients when urea has been added to the waste. However, two strategies need to be considered:
  1. FDEP should determine from this project's data that the Ag-Bag system is effective at containing wastes during the initial composting process. During residence in the Ag-Bag, the materials undergo a process to reduce pathogens and meet the EPA part 503 regulations. Additionally, any leachate generated is contained within the EcoPODs.
  2. FDEP could determine through additional testing and analysis that during the composting process, facilities that manage food waste produce leachate that can be managed through the use of low-tech settling ponds and vegetative filters prior to release as stormwater, as opposed to lined systems to contain, store, and treat leachate. This hypothesis needs further investigation.
- Compost derived from food waste was found to have no metals that exceeded the Code 1 levels defined in the Compost Rule (FAC 62-709).
- Compost derived from food waste was found to have no pesticide or volatile organic residuals at soil cleanup target levels (SCTLs).
- Compost derived from food waste mixed with yard waste has superior qualities when compared with composts derived from yard-waste only.

Conclusions and Recommendations

The project has answered many questions about the potential impacts of food waste composting on human health and the environment. As with many studies, the project has also led to the discovery of more questions that need further investigation.

The project composted a total of 40 tons food waste and 80 tons yard waste. This small quantity of material was sampled and analyzed extensively, and should leverage a much greater diversion in the future. However, greater diversion will occur, only if FDEP uses the information developed with this study, to make food composting more available to Florida communities. To do this, FDEP must make it more feasible to set up research projects without requiring a full solid waste permit to be sought, and without requiring the full range of protections as defined in the statute for creation of solid waste management facilities.

A line item exemption within 62-709.300(10) FAC from certain solid waste permitting requirements would be appropriate for food waste composting facilities of small size working under the auspices of scholastic, industry or grant funded research. This will allow municipalities and commercial entities to investigate community specific methodologies without making significant capital investment in permanent infrastructure.

A research and development exemption will foster more relevant research into innovative food waste composting operations. The results of these investigations will be more relevant and cost effective. When a community reaches conclusions based upon these findings, it can pursue more formal solid waste permitting or recommend/request rule modification and/or best management practices. Examples of similar exempting regulations can be found in several states throughout the country.

Sarasota County has designed a prototype research facility that could be located at the County's CCSWDC. The model facility utilizes the Ag-Bag for compost containment, a single walled collection tank for receiving pad leachate, and an unlined curing pad. Rainwater to the entire site flows to a surface water collection detainment area and then discharges to a stormwater swale.

Using Ag-Bag would be considered an interim measure to ultimately setting up a facility with open windrows. However, this would occur after data on impacts to stormwater were more clearly known. Surface and groundwater could be monitored through existing systems and more cost effective sampling and analysis plans could be developed and implemented. This could focus more sampling on areas of potential concern, such as nutrients, while avoiding costly sampling for analytes now known to be of less concern, such as pesticides and metals.

The model facility could be constructed for under $200,000 and receive up to eight tons per day. If located at the CCSWDC the facility would be able to take advantage of the existing storm water and ground water monitoring systems. Such a facility would be both transferable and scaleable.

Setting up a research facility that does not comply with the existing solid waste rule may be considered to be an unusual proposal. It is certainly not a strategy that is typically used by FDEP. However, it offers an opportunity to operate over a longer term, in conditions that do not expose the process to landfill cross-contamination, and with the goal of diverting waste that is currently not being diverted. Unless FDEP is willing to work with entities seeking the common goals of safe, cost-effective diversion, the County and its project team sees very little chance of improving the state of food waste composting in Florida.

Section 1 - Introduction

1.1 - Background of how this project came about

Sarasota County Government sought funding to develop Florida's first integrated food discard management program using an intrinsic value hierarchy. FDEP estimated 1.3 million tons of food waste was collected in Florida in 1998. In addition to food, the project targeted the following materials for recovery: food soiled paper, yard waste, unmarketable paper (e.g., paper materials recovery facility (MRF) residue), waxed cardboard, and other compostable components of the MSW stream.

Sarasota County estimated in 1998 that food discards comprise about 8% of the waste stream (exclusive of C&D debris). Other organic materials that could potentially be included in a program comprised another 60% of the waste stream. These included office paper, corrugated paper, other paper, and yard trash. Food waste and yard trash alone comprised 26% of the waste stream (exclusive of C&D debris) in 1998. Thus the County was motivated to seek new and innovative ways to divert food discards, and other organics, from its waste stream.

The County sought to develop a program that would serve the community's largest generators of food discards, including supermarkets, restaurants, and institutions (e.g., hospitals, schools, and prisons). Rather than focusing on only one management strategy, the County sought to develop local systems to distribute food discards within the community based on the food's highest and best value.

The County developed the concept of a food discards reuse hierarchy, consisting of three tiers: Food for People, Food for Animals, and Food for Plants.

- ***Food for People***: food that is of highest quality would be best utilized if collected by a local food bank.
- ***Food for Animals***: food that is of good quality, but not suitable for human consumption would be best utilized if diverted to local farmers.
- ***Food for Plants***: food that is not suitable as food would be best utilized if collected and processed through composting and vermicomposting into valuable soil amendments.

Each of these tiers were proposed as program components that function independently, yet complement one another, forming a food discards management pyramid. This powerful diversion strategy is unique in Florida. Overall the hierarchy captures the greatest value in food discards from an environmental, social, and cost-effective standpoint.

In preparation to move forward with the project, private sector and other partners were involved with the intention of utilizing private sector funding to help implement the program and assure its ongoing sustainability. Following is a summary of project partners

Sarasota County Government. The Resource Conservation Division would spearhead and manage the project, however other staff and departments within the County organization were contacted to make different divisions aware of the proposal in the event that divisions other than Resource Conservation might be effected by the grant.

All Faiths Food Bank (*the Food Bank****)***. The Food Bank is a local non-profit organization that distributes food to agencies serving Sarasota county residents. The Food Bank identified a need to increase collections of fresh food for distribution within its network. A refrigerated truck supplied to the Food Bank would support the food-for-people component of the project. The Food Bank would contribute in-kind support, for annual operational and maintenance costs on the truck, hiring a dedicated driver, and staff support time.

Childrens Haven and Adult Community Services (CHAC). CHAC serves children, teens and adults who have a variety of developmental, physical, mental health, sensory and/or multiple disabilities. Its primary purpose is to offer inventive programs/services, which improve the educational, self-sufficiency and independence levels of its clients. On a daily basis, 600+ persons are served from four Florida counties: Sarasota, Manatee, DeSoto and Charlotte. CHAC's main campus consists of 32+ acres with buildings, a plant nursery, and open space. CHAC planned to develop a commercial scale vermicomposting program on its main campus as an occupational transition training program and fundraising mechanism to sustain the organization.

Publix Supermarkets (Publix). Publix is a retail grocery chain with several stores located within Sarasota County and others located throughout Florida. Publix was interested in diverting food from disposal to save on landfill tip and waste hauling fees. In exchange for potential savings, Publix took a lead both on developing educational materials, and in developing the food-for-animals program, utilizing its network of supporters. Publix contributed in-kind support in the form of staff time and purchased specialized containers for the project.

Byron and Lou Crofut. The Crofuts are local business people with composting experience and long held ties to the community and agriculture and are owners of several plots of land located near the central population of Sarasota. The Crofuts took a lead in the food-for-plants program. Their contributions to the project include donating land for siting the operation, equipment for running the operation, and staff time.

Vermitechnology Unlimited. Vermitechnology Unlimited is a vendor of worm farming products and supplies. Vermitechnology Unlimted offered to donate staff time for program implementation, training, and marketing of worm castings.

Resource Management Group, Inc (RMG). RMG is a locally owned and operated consulting firm with long held ties to the community and expertise in composting and project management. RMG donated consulting staff time for program implementation, training, and marketing of end product and project results.

Ozores-Hampton Associates, Inc. A private consulting firm with expertise in composting horticulture, and agriculture. Ozores-Hampton Associates, Inc. provided guidance and resources to the project team for the food for plants segment of the project. They also performed field trials using the compost produced by the project.

1.2 - Objectives

At the onset of the project, the County and its implementation team agreed upon three primary objectives that would result in the development of an integrated county-wide food recovery hierarchy:

- Design and implement a food donation program for people, including the purchase of a refrigerated collection truck.
- Design and organize a food donation program for animals.
- Set up two commercial scale food composting facilities to provide food for plants. The first operation utilizing traditional composting methods and the second using vermicomposting methods.

In January 2003, the County renegotiated the third objective with FDEP, replacing it with the following:

- Develop and implement a sampling and analysis program to demonstrate the impacts food waste composting has on the environment, so that the current composting regulations can be evaluated and examined relative to the data collected.

The shift in strategy with regard to the third project objective is discussed in the implementation section.

In addition to materially setting up the three operational elements of the food recovery hierarchy, the team agreed to design systems that would be:

- Cost effective
- Sustainable
- Compliant with applicable regulations
- Replicable and transferable to other Florida communities
- Innovative
- Diverting targeted materials as defined in the FDEP grant guidelines

The team also sought to create a compost product that would not only be safe and meet Class A standards, but also of high agronomic value. Thus an additional objective of the program included demonstrating the value of adding food discards to composting of other organics, such as yard debris, that are commonly recycled in Florida.

1.3 - What made the project innovative

Food discards account for 5% to 10% of the overall municipal solid waste stream (exclusive of industrial discards) and offers a huge opportunity for recovery of value from materials otherwise destined for disposal as waste. This project offered strategies to handle discards that were not in common use in Florida, which demonstrated a novel application of an existing technology, and overcame obstacles to recycling.

Not in common use in Florida

- ***Integrated Hierarchy***. Not one Florida county had implemented a sustainable, integrated food discards management hierarchy.
- ***Source Separation***. At the time of the grant application, there were no permitted source-separated food discards composting programs utilizing post-consumer materials currently operating in Florida. Only Sumter County composts any appreciable quantity of food discards, and there the food is mixed with MSW. The product, municipal-solid-waste compost, has limited end-market applications.
- ***Innovative Carbon Sources***. The project developed procedures for incorporating innovative carbon sources (food-soiled paper, wax cardboard, unmarketable paper) into the composting process.

Novel application of an existing technology or process

- ***Hierarchy of Diversion***. Hierarchical use of food discards includes source reduction (food for people), food reuse (as animal feed); food recycling (including onsite in-vessel composting and vermicomposting). While each of these individual components have been used throughout the ages to manage food discards, the holistic, integrated approach utilized in this project is a novel one.
- ***Co-Collection Efficiency.*** Some near-expiration foods that are appropriate for animal feed can be co-collected with food for people, while maintaining compliance with FDA and supermarket guidelines for food safety. This novel approach could save farmers time and increase the supply of fresh food for animals.
- ***Permit***. The project sought a solid waste permit to accept and compost food discards and develop guidance for others seeking permits to compost source-separated organic MSW. The Project Team worked closely with FDEP to share information about successes and challenges in the permit process, and identify proposals for streamlining this process to stimulate investment in food discards composting, should FDEP choose to do so.

Overcoming obstacles to recycling

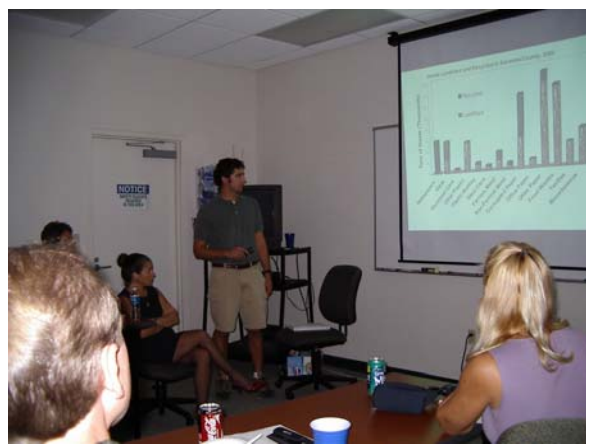
- ***Compost Markets (Value).*** Compost has been a historically low priced commodity in Florida. Because of this, many operators minimize investment in composting and sell inferior, typically un-finished materials. These poor products compound market disinterest in compost. The project overcame this obstacle by creating compost that is more beneficial to end-users' horticultural needs. This project utilizes food with yard waste, to create a finished product with more nutritional value than compost derived from yard trash alone.

- ***Overcoming Collection Challenges***. Two of the major obstacles to food discards management are the limitation on collection infrastructure and failure to integrate collection strategies.
- ***Odor Suppression***. Odor has been the primary cause of composting operation failure. The project investigated technologies with the potential to incorporate odor controls to facilitate reduction in this prevalent nuisance condition.

1.4 - The proposed audience and date for the final presentation at a national workshop or conference.

The project team has made several presentations to get the word out about the project results, including:

- Presentation at national United States Composting Council Conference, January 2004 (attached).
- Presentation at national workshop sponsored by the Carolina Composting Council at the University of North Carolina, Greensboro December 2003
- Presentation and facility tour for FORA committee and interested parties in October 2003.
- Presentation at workshop in April 2004 in Cooperation with Disney



Presenting Project Findings

Publications in which project results have been disseminated, include:

- Various newsletters, including the Recycle Florida Today newsletter (attached).

Future activities planned by the County to further disseminate information on the project results, include:

- Proposed publication in BioCycle Magazine and others
- Proposed presentation at RFT conference in June 2004

Section 2 – Implementation

The County utilized the services of consultants and community agencies to implement the project. During the first two years of the grant period, through May 31, 2003, CHAC was the primary contractor. During this period, the project team consisted of the County, CHAC, RMG, and other subcontractors and project partners as appropriate.

CHAC did not renew its contract with the County to complete the project implementation after a project extension was granted. The County contracted with RMG to complete project implementation from June 2003 through April 2004. During this period, the project team consisted of the County, RMG, and other subcontractors and project partners as appropriate.

Because the project consisted of four distinct, yet integrated programs, the project team worked on each of the program areas simultaneously. All activities were coordinated by Sarasota County Government to assure compliance with Innovative Grant guidelines.

This section is organized into sub-sections as follows:

- Food for People
- Food for Animals
- Food for Plants – Vermicomposting
- Food for Plants - Innovative Composting Program

Each of the above sub-sections includes a detailed accounting of how the program was implemented, including discussion of the following key elements:

1. Equipment and/or services purchased and how utilized
2. How the project demonstrated cooperative recycling effort with other counties
3. Description of project elements/components
4. Problems encountered and how they were resolved or addressed

The implementation phase of this project spanned a period of three years. During this time, many changes took place within many of the partner organizations involved with project implementation. Additionally, some barriers encountered during implementation led to lowered involvement by some of the original project partners. This document provides summary of activities and describes how the goals and objectives of the project were implemented.

2.1 - Food for People

The top of the food recovery hierarchy is eliminating the disposal of food that is edible for humans. To accomplish this goal, the County partnered with All Faiths Food Bank (the Food Bank), whose mission is to solicit, warehouse, process and distribute food to not-for-profit agency partners offering hunger relief. The Food Bank reduces food waste by reclaiming the food that might otherwise go into our landfills. It also provides community leadership and education to the community on issues related to food, nutrition and hunger.

The agency works as follows: the Food Bank partners with a church feeding and tutoring program that goes into low income neighborhoods to counsel at risk children. Another agency focuses on educating children who have been expelled, suspended or dropped out of school. If All Faiths Food Bank was not in operation, these agencies would have to spend more money on food and less on client focus.

Food Bank volunteers process and store food solicited from the community at the Food Bank's 20,000 square-foot warehouse on Cattlemen Road in Sarasota. Every can and box of food is sorted and checked by experienced volunteers. Using food bank trucks, the Food Bank then distributes supplies to not for profit agencies offering hunger relief in Sarasota and DeSoto counties.

The Food Bank identified perishable food as a critical and currently unattainable nutrient stream. From it's existing relationships with Publix, Kash & Karry, Albertsons, Winn Dixie, and other local grocers, the Food Bank realized that perishable food was available but currently being disposed rather than diverted into its warehouse due to lack of refrigerated transportation infrastructure. Therefore, placing a refrigerated truck into service would help increase food stream by up to 1 million pounds of food per year.

Food Bank - Dry Goods Awaiting Distribution to Agencies.

Additional information about Florida's commitment to food recovery can be found online at the Florida Department of Agriculture and Consumer Service's website: http://www.fl-ag.com/food/food.htm.

2.1.1 - Food for People Program Description

The Food for People program was implemented in several phases:

1. Procurement of refrigerated truck;
2. Establishing collection and delivery routes;
3. Employing driver;
4. Begin collection and distribution; and
5. Monitor and maintenance of program.

Refrigerated Truck

Procurement of Truck

The Food Bank, CHAC, and RMG prepared a grant proposal for securing additional funding from a local foundation to fund the purchase of a refrigerated truck. A proposal was submitted in April 2002, resulting in funding of a $76,745 grant by the Gulf Coast Community Foundation of Venice in June 2002. The Foundation was particularly impressed with the Food Bank's concept of implementing a "mobile warehouse" (i.e., the truck) to serve Sarasota's South county. This equipment was received and placed into use in September 2002.

Establishing collection and delivery routes


Food Truck Loaded for Delivery

In June 2002, the Food Bank staff led the team in developing the collection/distribution system. In addition to the primary goal of setting up the system for the Food Bank, the team collected ideas on strategies to merge collections with the Food for Animals system.

The Food Bank established a collection route that included pick-ups at multiple south Sarasota county locations, including grocery stores, grocery distribution centers, and Goodwill Industries donation center.

Deliveries are made with the same truck, creating an efficient backhaul situation. By adding the new truck, the Food Bank was able to service 23 agencies in the south Sarasota county area. These agencies had been previously un-served or under served. Three other trucks serve the north Sarasota area and Desoto county.

The collection and delivery route requires the effort of one full time equivalent driver. Having a truck in the area allows the Food Bank to greatly increase service of the agencies and generators on an "as needed" basis.

Employing driver

The Food Bank hired a driver to be responsible for the new collections. The driver requires a Commercial Drivers license. The cost of the driver has been integrated into the Food Bank budget.

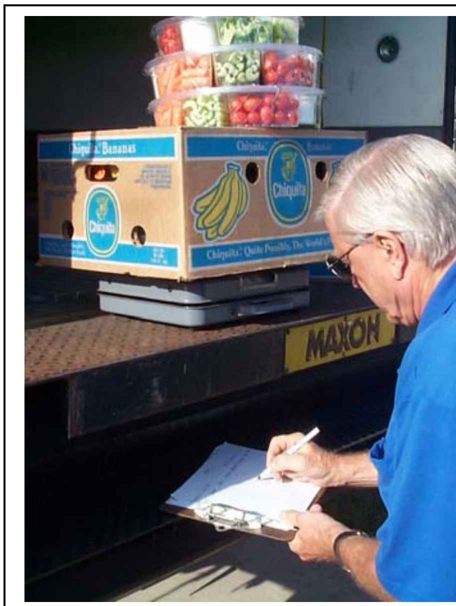
Begin collection and distribution

The truck was placed into service on September 2002.

The Food Bank makes collections and deliveries every day, Monday through Friday, and occasionally on weekends.

The system of collection varies by location. Generally, donors fall into one of two categories. The first type of donor has aggregated donations into a central area on the donor's dock, where the Food Bank personnel can remove the materials by pallet jack, or hand loading directly onto the collection truck. The second type of donor requires additional support, and the Food Bank driver will accommodate this situation by visiting each of the departments within the donor's facility to seek out donations and assist with transportation of the material from the department area to the loading dock.

A Box of Food



Food Bank Staff Weighing Incoming Food.

The Food Bank staff are equipped with log sheets and a mobile scale. At each location, the quantity of material accepted is recorded and this information is logged into the Food Bank's inventory system upon delivery to the Food Bank warehouse. At the warehouse, food is re-sorted into delivery packages based on agency or program needs.

On a weekly basis the Food Bank diverted approximately 4300 lbs using the refrigerated collection truck. This results in 11,500 meals per month distributed to needy families.

Monitor and maintenance of program

Prior to the implementation of the refrigerated collection program, the Food Bank distributed approximately 1.3 million pounds of food - the equivalent to approximately 60,000 meals per month. After implementation, the Food Bank increased distribution to 2.5 million pounds of food - the equivalent to approximately 166,000 meals per month. While not all of this increase is attributed to the new truck, it was a critical element in program expansion.

The Senior Friendship Center and YMCA Daycare are among the new agencies served by this truck. “It (the Truck) has opened up new avenues of distribution,” says Maynard Stringer, Food Bank, “for example, we now prepare food boxes which we give to working parents using subsidized daycare at the YMCA. So when a parent picks up “Johnny” from daycare, the YMCA can offer a food box to take home as well. Its a very dignified way to do distribution to people in need.”

2.1.2 - Demonstration of Cooperative Effort with other Counties

The Food Bank, being a multi-county agency, inherently transfers the benefits of this program to multiple Florida counties.

2.1.3 - Equipment/Services

In the budget submitted to FDEP, the County indicated that a refrigerated truck would be purchased for the Food Bank so the organization could increase diversion of perishable foods collected at local grocery stores.

The project partners identified and sought local funding to pay for the refrigerated truck, which was received from the Gulf Coast Community Foundation of Venice in Spring 2002. The Food Bank purchased the refrigerated truck with this external grant funding and placed the truck into service.

The cost of truck is reflected as an in-kind contribution by the Food Bank to the project. After the truck was placed into service, the County requested and FDEP granted reallocation of the grant funds to other aspects of the project.

The truck is anticipated to be in service for 8-10 years and the Food Bank anticipates replacing the truck at the end of its service life, due to the success of the programs developed.

2.1.4 - Problems encountered and how they were addressed

There was a delay in implementing the expanded Food for People program. This was related to the decision by the project team to seek external funding for the Food Bank’s truck, and from changes in the Food Bank's staffing. On the whole, the delay did not impact the overall functioning of this highly successful program.

2.2 - Food for Animals

The second tier of the Food Recovery Hierarchy is diverting food for animal feed. This project element evolved out of an understanding of how food is distributed, both by grocery stores, and the Food Bank. Food that may be fit for human consumption may not be able to sold or distributed to a Food Bank agency because of the time the food will be moved around, processed, and stored in the organizations' systems.

For example, a banana may be ripe today and fit for consumption. However, it must first travel from the warehouse to the store, then processed and re-packaged at the store, and finally placed out for sale – or in the case of the Food Bank, the items must travel from store to Food Bank, and then from Food Bank to agency, and then to the consumer. While this may only take a day or two, the customer may end up with food past it's prime. In order to keep high standards for their human customers, grocers and the Food Bank may opt to discard food under these circumstances.

Thus the project team set out to develop a system to target the fit but past prime foods for diversion to farmers.

2.2.1 - Farmer Education

The farmer must know and follow correct handling and shipping procedures. First and foremost, the farmer must be knowledgeable about their livestock health standards because, while fruit and vegetables used as animal feed are not directly regulated by the government, recovered food can be harmful to the livestock. Each participant was required to confirm that targeted food is approved for feeding their livestock.

Moldy Squash - Not Good for Animal Feed.

For example, generally speaking, fruits and vegetables may be fed to cattle. However, good animal husbandry allows for the following concerns about feeding fruit and vegetables.

- May cause choking if feed is not cut up properly;
- Some pesticide residues found on fruit and vegetables may be harmful to cattle and swine;
- Because they contain roughly 85% water, it takes large quantities to provide the energy required for livestock and may not provide adequate supply of total daily nutrients and protein;
- Coffee grounds and salty foods may be harmful to livestock;

Additionally, there are issues of supply that must be integrated to the farmer's food planning budget. For example, supplies from groceries may vary from week to week and season to season. The farmer must be able to accept fluctuating quantities of material, and have the facilities and storage to manage these variable inputs.

2.2.2 - Food For Animals Program Description

The implementation of the Food for Animals program consisted of the following elements:

1. Analyze regulations effecting the diversion of food for animals;
2. Evaluate the potential for diverting food for animals;
3. Establish program; and
4. Monitor and maintain program.

These elements are described below.

Analyze Regulations Effecting The Diversion Of Food For Animals

Regulations are in place that manage human food and other food discards which are used as animal feed. The US Environmental Protection Agency does not regulate vegetative food discards fed to animals, if the feed does not contain any meat or animal materials. However, Federal Swine Health Protection Act of 1980 (PL 96 468) regulates converting food discards into feed for livestock (swine, cattle, etc.) when the discards contain meat or animal materials, or in cases where food has come into contact with meat or animal products.

Under the regulation, discards targeted for feed programs should be separated from other waste materials and kept covered and refrigerated (or stored in a cool place) until picked up. The regulation also requires that farmers boil any food scraps containing meat before they can be used as feed for swine.

The Florida State provisions are outlined in the Swine Garbage Feeding section of the Florida Administrative Code, Rule 5c-11.017. In this regulation, food discards are defined as "garbage" and feed operations must adhere to the following procedures:

- All garbage, regardless of previous processing, shall, before being fed to animals, be thoroughly cooked for at least 30 minutes at 212 degrees F.
- All equipment utensils and vehicles used in the collection, transportation and distribution of garbage and all other facilities used in the treatment and feeding of the garbage shall be kept and maintained in a sanitary condition at all times. All containers of raw garbage shall be covered and retained within the enclosure surrounding the cooker, along with all empty containers used in the collection of garbage. The premises surrounding the

enclosure shall be kept free of remains of previously fed garbage, rubbish, and raw garbage spilled from containers while unloading or filling the cooker.

- Any person feeding garbage to animals shall keep records regarding the collection, transportation and distribution of garbage, and the operation of the equipment and procedure of treating garbage to be fed to animals. Such records must cover the previous twelve months of operation. In other words, documentation, such as where the food waste was picked up, who picked it up, where it was dropped off, the amount of food picked up, the date, etc. should be kept, filed, and stored. This will allow the Dept. to trace the spread of a virus, disease, or contaminated food, quickly to prevent further contamination.
- Swine which have been fed garbage which has not been treated to destroy disease germs, virus, or bacteria shall be placed under quarantine by the department and no such swine shall be moved onto or from the quarantined premises without written permission from an authorized representative of the department. No indemnity will be paid for swine confiscated or destroyed when such swine have been fed raw garbage.

During the implementation of this component of the project, the County and project partners have observed increasing scientific and popular interest in the connection between diet and livestock diseases. Thus, the concerns about feeding discarded food to livestock may be growing, which may result in further limitations or health-safety procedures in the diversion of Food for Animals.

From the Center for Disease Control's website (March 21, 2004): "Since 1996, evidence has been increasing for a causal relationship between ongoing outbreaks in Europe of a disease in cattle, called bovine spongiform encephalopathy (BSE, or "mad cow disease"), and a disease in humans, called variant Creutzfeldt-Jakob disease (vCJD). Both disorders are invariably fatal brain diseases with unusually long incubation periods measured in years, and are caused by an unconventional transmissible agent.

"On December 23, 2003, the U.S. Department of Agriculture (USDA) announced a presumptive diagnosis of bovine spongiform encephalopathy (BSE, or "mad cow" disease) in an adult Holstein cow from Washington State. The diagnosis was confirmed by an international reference laboratory in Weybridge, England, on December 25. Preliminary trace-back based on an ear-tag identification number suggests that the BSE-infected cow was imported into the United States from Canada in August 2001." Additional information about BSE is available through the CDC website: http://www.cdc.gov/ncidod/diseases/cjd/cjd.htm and the Food and Drug Administration's website: http://www.fda.gov/fdac/features/2001/201_cow.html.

Permitting Food For Animals Programs

Farmers who accept commercially generated food scraps must have a permit, under the federal Swine Health Protection Act of 1980. To obtain a permit, a written request for a permit to feed garbage, together with a non-refundable application fee of $50 (price increases with the number of stock possessed), must be submitted to the Division of Animal Industry, Florida Department of Agriculture.

An authorized representative of the department will inspect the facility to determine compliance. Non-compliance after issue of a permit will result in the retraction of the permit and livestock may be confiscated or destroyed – presumably if a food security risk is perceived.

Evaluate The Potential For Diverting Food For Animals

The County identified project partners with natural linkages to diverting food for animals: groceries and the Food Bank. The project team did not conduct an extensive study to determine the potential quantity of food for animals available in the County. However the program was targeting an estimated pilot program volume of 10 tons per day food waste for composting. Food for animals was estimated to be less than 10% of overall recovery.

Groceries and the Food Bank generate appreciable quantities of produce discards, which though potentially usable as food, might not be able to be used as food for people because of distribution issues. This material was targeted for food for animals. Restaurants were not considered for the pilot program due to concerns about contamination of the program with meat scraps.

The project team identified, up front, several potentially factors which might limit the implementation of a food for animals program. From the generator organization's perspective, labor was the main concern. From the receiver's perspective, contamination was the main concern, both by inorganic materials and food that the livestock would not or should not eat. Furthermore, issues of human health and safety were raised.

Early in the project, the County was contacted by NutraCycle, LLC, a company that provides management services for food-to-feed projects in Korea and other international markets. NutraCycle indicated interest in locating a plant in Florida, in a community that could supply 80 to 220 tons per day food residuals.

NutraCycle Plants use the patented Jet-Pro® textured drying process. (Jet-Pro is a registered trademark of NutraCycle LLC). Each NutraCycle plant consists of the following unit operations:

Pre-Processing

Pre-processing consists of metal detection and grinding. Wet waste is ground into a fine soup.
Plate wastes from resorts, theme parks and institutions have sortation lines and automated equipment to remove metals, bottle caps, waste paper, bones, and other non-edible residuals which are separated prior to grinding.

Mixing

Wet and dry wastes are combined and mixed into a slurry-type feedstock with a target moisture content. Dry ingredients are selected for specific formulations for dairy, beef, swine, or poultry feed applications.

Pelletizing

The mixture of wet and dry slurry is fed to a patented Jet-Pro pelletizer and extruded into pellets.

The purpose for forming pellets is to convert the material into a form that can be easily handled and subjected to further processing, such as drying.

Drying, Conditioning and Cooling

The pellets are fed to a patented Jet-Pro fluidized bed dryer. Drying removes much of the moisture, making the pellets less subject to degrading and spoilage. Conditioning is similar to the process of pasteurizing dairy products to assure the product is free of any pathogenic organisms. The product is heated to 230 deg-F and then maintained at this elevated temperature for 10-15 minutes. The end product is dry (10% moisture content) and can store up to a year for use as animal feed.

The County hopes to evaluate this as an option in the future, however during the project period, total volumes diverted and potential for diversion were lower than the minimum required by the feed conversion company.

Establish Program

Food Bank Food for Animals Program

The Food Bank has been working with a local farmer for five years to distribute Food for Animals to his farm to feed cattle. Food that is past its expiration date, and can no longer be consumed by people, is placed on pallets in the Food Bank warehouse refrigerators for periodic collection by the farmer, who collects food at least once per week in his pick-up truck.

Farmer Collecting Food for Livestock

The Food Bank offers both old produce and packaged food products to the farmer. The farmer does not collect any meat, eggs, dairy products, moldy food, broccoli or onions (cattle will also not eat broccoli or onions). Food Bank staff place loose food products, such as produce and bread, in boxes before loading these in to the pick-up truck. Packaged goods are placed directly by hand into the truck.

The farm is located approximately seven miles from the Food Bank. The farmer removes all packaging at his farm. De-packaging occurs in the field, where contents are spread for immediate consumption by the cattle.

Innovative Food for Animals Diversion

In addition to donating food for livestock, the Food Bank has established two programs that allows for the distribution of food to Manatees and Lions, Tigers, and Bears (oh my!).

Sarasota is home to Mote Marine, which houses a marine mammal hospital and rehabilitation program, as well as a permanent display of two manatees. The large vegetarian animals, also called the "sea cow" eat copious quantities of lettuce. Therefore, when the food bank has an extraordinary load of lettuce that cannot be distributed through regular means, Mote Marine receives a contribution to its marine mammal feeding program.

Sarasota is also home to Rosaires Big Cat Habitat, an organization dedicated to housing and feeding retired show animals, specifically bears and lions. This affords the Food Bank a rare opportunity to deliver meats for reuse, which typically cannot be fed to livestock and swine without special preparation.

Grocery Food for Animals Program

A local grocery was identified as a potential participant in the food for animals program. They had adequate space for the program and were perceived to have less risk of contamination of food with material of poor or improper quality.

The County and its implementation team created a guide to train store personnel in a food for animals diversion program. The food for animals program was presented as a component of a larger organics diversion program.

Store associates were provided with three types of containers:

1. a blue recycling container for the farm animal (edible) organics;
2. a yellow recycling container for the plant (compostable) materials; and
3. regular trash cans for the inorganic and other trash that cannot go into the two recycling containers.

Associates were also provided with posters describing the types of materials or products in each category.

Instructions for operation included use of liners in each container so the organics and trash could be removed without contaminating the recycling containers and trash cans. Compostable biodegradable liners were provided to each pilot store location.

Associates were instructed to use the following flow chart when discarding the produce or produce trimmings,

IS THIS SOMETHING THAT CAN BE FED TO FARM ANIMALS?			
if	yes	**then**	Put the produce in the Blue recycling container
if	no	**then**	Put the produce in the Yellow recycling container

Materials for the farm animal food program
These materials go into the BLUE RECYCLING CONTAINER – for donation to the farms. • Blemished or unsaleable produce that is not suitable for the food bank • Trimmings from produce; fruit • All vegetables except broccoli and onions (animals do not like them)

Monitor And Maintain Food for Animals Program

During Set up of the grocer program, the food for animals program was discontinued. The implementation team found that the additional separation required for distinguishing between food for people and food for animals was not feasible for the associates to implement.

Furthermore, no direct farmer pickup could be arranged, therefore a backhaul to the Food Bank would have been required. The Food Bank's primary mission is food for people, so space on the truck would have been limited or non-existent for use to backhaul animal feed. Additionally, this would have raised some cross-contamination issues from a food safety standpoint.

Results Food for Animals Program

The project team concluded that "Food-for-Animals" programs should be limited to situations where a local farm is able to make a direct pickup of feed materials on a regular basis. This offers a direct relationship between donor and recipient. This facilitates clear communication about the quality of the feed being provided and occurrences of contamination can be kept to a minimum. From the generator's perspective, frequency of pickup can be managed with the farmer.

In the case of the Food Bank, the availability of a local farmer and other organizations to collect and utilize meat, produce and bread discards proved to be sustainable and mutually beneficial. "We rescue food for a living," says Maynard Stringer, Food Bank, " the Food for Animals program helps us complete our mission." It also helps to increase staff morale, since the materials are not being wasted.

2.2.3 - Demonstration of cooperative effort with other Counties

Information gleaned from this project component was shared with other county representatives in presentations made by the project team. Both Publix and the Food Bank are able to disseminate information pertaining to this project within their multi-county organizations.

2.2.4 - Equipment/Services – how utilized

Collection containers were privately funded by the project partners as in-kind to the project and remained with the organizations for continued use.

2.2.5 - Problems encountered and how they were addressed

The lack of sufficient agricultural infrastructure in Sarasota County was a limiting factor, as was the changing regulations and fear concerns relating to Mad Cow disease and food safety. These inherent difficulties with a food for animals program were not completely overcome in the project.

The solution was to reduce the program to produce and bread products only, for livestock, and to cultivate a direct conveyance of materials from generator to farmer, without intermediary transportation. In the case of the Food Bank, sending meats to a unique local outlet, a Big Game preserve, proved to be helpful in diverting food that might otherwise been unable to redistribute.

2.3 - Food for Plants – Vermicomposting

The third tier of the food recovery hierarchy is diverting food discards to be used as plant food. One strategy that this project explored is Vermicomposting – composting using red-wiggler earthworms (Eisenia foetida).

Children's Haven and Adult Community Services (CHAC) became involved with this program to utilize their large campus to develop a commercial scale vermicomposting program. CHAC sought to implement this program as a strategy to assist with fulfilling its mission to employ and provide vocational training for its clients. CHAC also perceived vermicomposting as a revenue producing and sustainable program that would fit well with its operating plant nursery and planned farming operation.

CHAC's Tractor

Vermicomposting could function as a stand-alone operation for managing food wastes from offsite generators, or as a finishing process to convert partially decomposed food compost produced by other project partners into higher value worm castings.

2.3.1 - Vermicomposting Program Description

In August 2001, the project team began designing a vermicomposting system for implementation on the 32-acre CHAC campus in Sarasota County. Vermicomposting operates with worms doing the work of decomposition of the feedstock. Composting with worms is quite different than typical composting operations.

Most notably, the worms operate when composting is in the Mesophilic Stage - a stage in the composting process characterized by bacteria that are active in a moderate temperature range of 20° to 45°C (68° to 113°F). This typically it occurs later in the composting process, after the thermophilic stage and is associated with a moderate decomposition rate. In fact, hot composting – thermophilic stage, which is typically used to measure composting success, will destroy the worm population and must be avoided.

Vermicomposting is accomplished in holding areas called "worm beds" in which worms live, breed, and digest food. Worm beds contain worms, a bedding material, feed for the worms, and grit, such as sand, to aid in digestion of the feed. Worm beds require protection from environmental conditions that could either dry out, heat up, freeze, or overly moisten the beds. When conditions are not acceptable, worms will attempt to migrate to better environments.

Worms are small creatures, and require that their food is ground up to allow for minimal processing time. The program intended for CHAC would accept whole food discards, e.g., whole potatoes, broccoli stalks, and corn cobs, as well as paper and boxes in which the food was packaged. Thus finding appropriate size reduction technologies was important to the success of the project. Additional dietary concerns revolve around the ability of the worm processing system to accept meat and diary products which may be found in the food waste stream.

Worms require oxygen to survive, and typically operate (i.e., consume food) in the top 4" - 6" of any given environment. Thus, vermicomposting requires a large surface area relative to volumes processed, whereas traditional composting operates on a more volumetric – cube like – requirement.

A home-made trommel style worm castings extractor

Of course, vermicomposting is reliant on worms being present in the worm beds. Therefore, harvesting finished vermicompost, or worm castings, can be challenging. Worms and worm eggs must be separated from the finished product and returned to the bed, so subsequent organic material may be processed.

All of the above concerns became factors for evaluation as the project team began developing a vermicomposting program at CHAC. The implementation of the program was divided into two phases. Phase I involved implementing a small-scale system to manage food discards generated on-site by CHAC's other programs. Phase II involved permitting and operating a commercial scale facility.

Vermicomposting at CHAC, Phase I

The team began implementing Phase I in November 2001 by collecting data on food discards generated at CHAC. The findings of this initial survey determined that there are three major sources of food discards on the CHAC campus, accounting for as much as 60,000 lbs per year of food discards (using U.S. Environmental Protection Agency assumptions for food waste generated per meal for institutional generators).

1. Three Group Residential Homes, serving two meals per day (breakfast and dinner) on Monday through Friday and three meals per day on Saturday and Sunday. Based on the number of clients served, this results in an estimated total of 480 meals per week or 24,960 meals per year.

2. Occupational Training Building, serving one meal per day (lunch) on Monday through Friday. Based on the number of clients served, this results in an estimated total of 600 meals per week or 31,200 meals per year.

3. Selby Preschool, serving two meals per day (breakfast and lunch) on Monday through Friday. Based on the number of clients served, this results in an estimated total of 3,800 meals per year.

In addition, the CHAC garden center and weekend farmer's market on campus generated a large and variable quantity of food and vegetative discards.

The project team saw multiple benefits for establishing a small-scale system prior to implementation of a commercial scale facility. These benefits included:

- Training CHAC staff on the mechanics and animal husbandry aspects of vermicomposting
- Troubleshooting problems on a small scale
- Developing track record with small waste streams that were not dependent on collection and management by the institution
- Establishing experience and expertise in low-tech operations prior to purchase of more expensive and more technically complicated systems
- Using the smaller system to breed worms that could be put to work in larger systems as they were brought on-line

Based both on the food diversion and educational needs of CHAC, the team designed a program for managing on-site generated food discards. A low tech-system and training program was purchased from Vermitechnology Unlimited and several "Earth Machine" composters were obtained from the County for use as a pre-composting system and/or accept food waste overage when worm bins were full.

The Breeder Bin system with Raccoon Exclusion Top

The system as installed consists of an enclosure made of insulated aluminum panels and side to side reinforcements to reduce bowing. The bins are approximately 18" high by 20' long. A cover to exclude raccoons was added by CHAC, after this vector was found to be disturbing the worm bins.

The system is designed as a vertical layer system. A layer of bedding – consisting of partially decomposed horse manure and stable sweepings, is placed in the base of the bin. Moisture is added if the bedding is too dry. Worms are added to the bin. Food discards are placed in the bin forming a 1-3" layer. Bedding is placed to cover the food waste completely. Worms work their way up through the food waste. Each day additional area receives a layer of food discards, and the material progresses down the length of the bed.

CHAC Staff in Training

When the end of a bed is reached, the layering is continued in the next bed, or at the beginning of the bed. Occasional mixing may be necessary for aeration, however the worms do most of the processing. Too much agitation can disturb the worms.

When a bin is completely filled, the top layer of material is removed, containing the bulk of worms, which are feeding on the freshest food. This layer is placed in an inactive bed, or on a tarp for temporary holding. The remaining worm castings or finished compost is removed from the lower levels of the bed and is placed in storage for sale or onsite use. The bed is then ready for re-starting. A worm castings extractor (rotating screen) may be used for harvest. In CHAC's system, all harvesting activities are conducted manually – with the use of a shovel.

This system was installed in March 2002, and remains in use at the time of this report writing. CHAC received trainings on vermicompost system operation prior to system installation, during system installation, and after system installation.

Vermicomposting at CHAC, Phase II

At the same time that the project team was designing and implementing Phase I, the small scale vermicomposting system, the project team was designing a commercial scale vermicomposting system for processing food discards from off-site generators. Activities for Phase II included vermicomposting facility and operational plan design; meetings with appropriate regulators, coordination with industry experts, project partners, other interested parties, and the Florida Organics Recycling Center of Excellence (FORCE) project in Sumter county.

Feed Mixer Auger System. These machines can mix up feedstock and ready it for vermicomposting.

Commercial Vermicomposting must take into account all the basic issues of composting with worms as described in the Phase I system, with the additional factor of requiring mechanical bed filling and harvesting techniques, as well as mechanized size reduction, processes to reduce pathogens, and other factors relevant to commercial programs.

Thus the project team researched and analyzed several commercial scale vermicomposting systems, and considered several hybrid systems that combined systems being offered in the marketplace with existing and potential resources available to the project team.

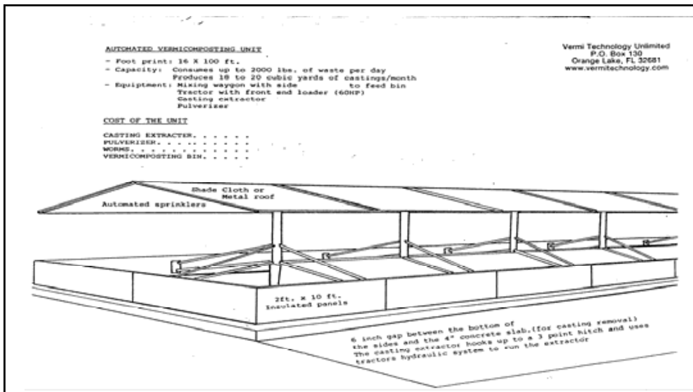
A successful commercial scale vermicomposting operation was found in California at the University of California, Berkeley. This program collects food discards from dorms and cafeterias, and processes these discards into vermicompost. The "Berkeley Worms" facility uses a livestock feed mixer mounted to a pickup truck for collection of food discards. As the truck moves from collection point to composting facility, the food discards and bulking agent are thoroughly mixed in the feed mixer.

Myakka City Worm Farm

The homogenized mix is discharged into cylindrical bins which each hold one truck batch of material. The food mix heats up, then dissipates and is finished off by the worm population resident in the bin base. A full account of the program can be found in the attachment ***Berkeley Worms Composting Collective***. In comparison, the attachment ***Myakka City Worm Farm***, describes a worm farming operation whose focus is growing/breeding worms as opposed to using worms as a strategy for processing food discards.

Vermitechnology Unlimited proposed the installation of its commercial scale LC-2000 vermi-compost facility to process food waste. This system utilizes a concrete floor worm bed, pole-barn structure for worm shelter, proprietary castings harvesting equipment, trommel screen for worm harvesting, food shredders, a tractor, and a converted feed-mixer for blending. This system was designed into the plan for a commercial scale program at CHAC.

The LC-2000 offered several technical innovations that fit with the objectives of the grant, including a proprietary castings extractor not in common use and innovative worm bed design. Additionally, the operation was designed to operate on a concrete pad with overhead roofing. These factors were considered to help expedite permitting.



The LC-2000

Upon selection of equipment, the project team prepared a construction/operating plan, which is presented as the attachment ***Construction/Operation Plan for A Food feedstock Vermicomposting Facility***. This plan is a critical component of a solid waste facility permit application, which is required of facilities that accept food discards generated from off-site. However, a permit application for a commercial scale vermicomposting facility was not submitted. This is discussed in the problems section below.

Vermicomposting Alternate Proposal

After CHAC determined it would not pursue a permit for a facility on its property, the County and its partners researched alternate programs to demonstrate commercial scale vermicomposting.

By August 2002, the project team had established letter agreements to begin on-site vermicomposting at three new locations. These locations were: New College of Florida (a public undergraduate campus of the State University System), Bay Haven School (a public elementary school), and All Faiths Food Bank. Additionally, the breeder bin system was to be maintained and the program expanded at CHAC.

Systems Considered

The project team considered several vermicomposting systems. While home-made systems have been proven effective on a commercial scale, the project team believed that aesthetically pleasing and "turn-key" systems would prove more transferable. Therefore, only off-the-shelf commercial systems were considered.

Three systems were chosen based on overall value to the project. All systems are comparatively priced. Table 1 - Summary of vermicomposting systems, provides a list of the systems considered, their projected installation location, and their price. Systems with no location indicated were not planned for implementation.

Table 1 - Summary of vermicomposting systems

Proposed Location	Quantity	System	Estimated Capacity Per Day	Estimated Cost (FOB Sarasota)
Bay Haven	5	BioStack	80-100 lbs	$ 9,420.16
Food Bank	1	Good Earth Solutions*	40-75 lbs	$ 5,315.00
New College	1	VermiScience System**	50-75 lbs	$ 10,480.00
	0	EPM, Inc.*	35-75 lbs	$ 5,733.00
	0	Eggen's Original	30-50 lbs	$ 14,200.00
	0	VermiCo	35-75 lbs	no-bid

*** this system requires installation of weather shelter, which costs $2,000 to $4,000**
**** this system includes set-up by manufacturer's representative which is an extra cost for other systems.**

The purpose of installing the vermicomposting systems was two-fold. First, the project team would document and compare each system's performance. None of the systems proposed were currently operating in Florida. This would establish data on the efficacy of the systems in the field and also serve to document diversion. Secondly, the cost-effectiveness of on-site food discards management versus central collection would be evaluated and compared with the food recovery pilot composting facility.

The County requested bids from vendors as per state law. Unfortunately, due to County vendor insurance requirements, insufficient bids were received. In October 2003, FDEP eliminated the vermicomposting component from the project scope.

2.3.2 - Demonstration of cooperative effort with other Counties

The vermicomposting component was not fully implemented and was not transferred to other counties.

2.3.3 - Equipment/Services – how utilized

As described above, the project utilized the planning, design, and consulting services of the project team to design and implement a Phase I – breeder bin vermicomposting system and prepare a construction/operating plan for a food discards vermicomposting facility. Worms were purchased to populate this system.

The breeder worm bin is in operation at CHAC and will continue to operate as a regular function of the plant nursery and on-site food management. This equipment and worms are estimated to be used by the not-for-profit organization for three to five years.

The County did not purchase any other equipment for this aspect of the project. Expenses related to Phase II and the Alternate proposal included primarily consulting services.

2.3.4 - Problems encountered and how they were addressed

The vermicomposting project had three components, Phase I – Breeder Bin set-up and operation; Phase II – Commercial Scale set-up; and Alternate proposal. Each component's problems are discussed below.

Vermicompost Phase I Breeder Bin

The breeder system experienced only minor problems, due to inexperience of the operator. The main issue, worms migrating from worm beds due to flooding, resolved by implementing best management practices and increasing education among CHAC staff and clients. After modifying the feeding strategy and repairing the roofing to eliminate leaks, the bins have functioned well. The minor problems encountered were anticipated, thus reinforcing the project team's strategy of implementing a small scale program prior to initiating a commercial scale program.

Vermicompost Phase II – Commercial Scale

The overriding problem with implementing the Commercial Scale program was incompatibility of CHAC location with permitting requirements. Issues included: zoning of the CHAC property, setback requirements from CHAC owned residences, buildings, and water bodies on the CHAC campus, set back requirements from adjacent properties, and political issues with neighbors that might oppose permitting of a vermicompost facility.

Ultimately, however, it was an issue of timing that caused the project not to proceed. Even with an extension to the project grant timeline, the project team anticipated such a lengthy permitting process that CHAC deemed it unfeasible to begin implementing this phase of the project. Given a longer period of time to secure permits for the operation, the project would have had a much better chance of proceeding.

Vermicompost Alternate Proposal

Offering an "alternate proposal" in itself was a response to the problem of lengthy and costly permitting encountered in the implementation of Phase II vermicomposting. The Alternate proposal offered to bypass the permitting regulations required for facilities that accept off-site waste. The Alternate proposal offered to establish on-site commercial scale composting, which would be exempt from solid waste permitting requirements.

However, the FDEP determined that this solution to problems encountered diverged from the original project proposal, and did not accept this modification to the project scope.

2.4 - Food for Plants - Innovative Composting Program

The third tier of the food recovery hierarchy is diverting food discards to be used as plant food. One strategy that this project explored is an innovative composting pilot program.

2.4.1 - A description of elements and components

The innovative composting pilot consisted of the following elements:

- **Permitting** – The County and its project team sought and received a solid waste permit for operating a food discards composting facility. This effort began in August 2001 and a permit was issued in May 2003;
- **Collection/Diversion Program** – In partnership with the City of Venice, the County operated a composting diversion/collection program, from June 2003 through September 2003;
- **Composting Facility Operation** – Using innovative technology such as the Ag-Bag in-vessel system, the Packer 750 industrial grinder, and solar power for electrical source, the County operated a compost facility from June 2003 through December 2003; and
- **Sampling Analysis Program –** The County and its project team conducted an extensive sampling and analysis regimen, which was initiated in June 2003 and concluded in March 2004.

These activities are described below.

Permitting

A permit is necessary for the operation of a compost facility that accepts food discards from off-site generators. The project team had in mind the concept of a “Farmer-Field-Friendly” composting operation that could be set up with minimal capital cost and allow for rapid transferability to agricultural entities throughout the region. Permitting proved to be challenging to this preliminary assumption.

Food waste is defined as “solid waste” by Florida statute (FAC 62-701, and FAC 62-709). As such, composting of food discards is subject to solid waste facility permitting requirements. One of the most costly elements required of a Solid Waste facility is leachate containment and management. Containment has come to mean creating an in-penetrable barrier between waste and ground and surface waters.

By rule, stormwater or rainwater that comes in contact with food waste, or compost derived from food waste is considered leachate. Thus a facility must manage all leachate generated on the feedstock receiving pad, the composting pad, and the curing pad. By rule stored leachate must be placed in double walled containment systems. It may be reintroduced to the composting process.

Concrete, asphalt, soil-cement, and geo-membrane underlayment may be acceptable barriers for pad construction based on specific site considerations. District offices of the FDEP are responsible for specific decisions regarding what constitutes containment and management.

Cost of leachate containment and management can be substantial. For example, the project team calculated that sending leachate to a wastewater treatment plant would cost an estimated $30,000 per year in leachate transportation and disposal costs for a two acre site located in Sarasota. In addition, leachate containment incurs additional facility construction costs, both for impermeable operating surfaces and for leachate collection, storage, and pumping equipment.

Four potential sites were considered for the operation, two private properties and two publicly owned locations.

Private Sites

Byron and Lou Crofut were original project partners identified in the Grant Application. Their properties were first considered for program implementation. Their sites, however, were not suitable for facility development.

The first location considered was a 20 acre parcel zoned open use rural district. The site was used as a cattle farm and storage facility for the Crofuts' excavation and composting operations. Within 1/4 mile of the proposed location of the compost facility on the Crofut property, existing land uses are agricultural, 'estate' properties with single-family dwellings on either 2 or 5 acres minimum or a recreational site. The property just to the west of the Crofut property contains a private heliport and helicopter maintenance facility.

The compost facility would be located 1,100 feet from East Road in the northwest corner of the property. The facility would be surrounded by open agricultural lands and could be easily screened from view of the road and adjacent properties. At the time there were no residences within 500 feet of the proposed facility. Access to the proposed facility from East Road was available via an existing gravel driveway along the southern property line. The property was approximately 1/2 mile south of Fruitville Road, allowing easy access by trucks hauling proposed feedstocks for the compost operation, including food waste, yard waste, cardboard waste and manure.

The site fell short of County land area requirements for compost facilities. The configuration of the property, limited the usable area when FDEP setback requirements were considered. Finally, an adjacent property had a permitted heliport and helicopter maintenance facility, which could limit the siting of composting facilities nearby.

The second location considered was a 40 acre parcel with an incompatible land use designation (zoning) that would require a public hearing and variance proceeding. The adjacent property was a recreational vehicle and mobile home park. This establishment had experienced odor problems with another neighbor who housed a chicken farm. The Crofuts and the project team considered a variance request to be unlikely to be granted, given the presumed challenges from the owners and residents of the adjacent facility.

Private Site – Alternate

After the Crofut's sites would not serve the project requirements, the project team sought additional private locations to site the facility. The team believed that permitting a facility on a privately owned site would be most likely to result in a program that would be sustained past the initial grant period.

Private entities with equipment and agricultural operations were also ideal from a materials management and product integration perspective. Compost produced could be applied to agricultural uses, reducing external handling and increasing vertical marketability of product. Furthermore, this strategy would be consistent with the Farmer-Field-Friendly concept for facility development.

Conversations were held with several land-owners. However, due to the booming real-estate market and the dwindling agricultural community, a suitable site was not identified within a critical path timeline.

Public Site - Bee Ridge Landfill

While seeking facility locations, the team also began discussing permitting requirements with the District Office of the FDEP. It was clear that leachate containment and collection would be required of the facility. Therefore, the project team then sought a location that would allow the facility to tap into an existing leachate management system.

Two County owned locations became logical "short list" locations, a recently closed landfill located at the eastern terminus of Bee Ridge Road (the Bee Ridge Landfill), and the newly developed Central County Solid Waste Disposal Complex (CCSWDC).

The Bee Ridge Landfill was in the process of being converted to long term recreational park use. An area of the facility had been used for model airplane flying. The asphalt topped "runway" strip for the flyers club offered an ideal operating pad for the compost facility. However, because of real or perceived conflict with the recreational project on the site and concerns over cost and permit ramifications of tapping into the closed landfill leachate collection system, the use of this site was not pursued.

Public Site – CCSWDC

In April 2002, the project team began exploring the possibility of creating a pilot compost facility at the Central County Solid Waste Disposal Complex (CCSWDC). In addition to a Class 1 landfill, accepting municipal and commercial solid waste, the CCSWDC has facilities to accept and process yard waste, appliances, tires and construction and demolition debris and certain special wastes. The CCSWDC includes several hundred acres designated for waste management and recycling activities, as well as hundreds of additional acres used as buffer zone between operations and the surrounding properties.

The project team considered four locations at the CCSWDC for locating the compost facility, including:

1. Areas adjacent to the CCSWDC's leachate storage tank:
2. Areas adjacent to the CCSWDC's yard waste composting operation;
3. The top of closed landfill cells 1 and 2; and
4. In a portion of the active landfill cell.

After evaluating each site and weighing costs and benefits, the project team opted for seeking a permit to operate within the active cell of the landfill. This option offered the lowest cost and quickest ramp-up time, due to the ability to tap into the existing leachate collection system without using any mechanical assistance – i.e., all runoff from the operation could be directed into the landfill.

Permitting at this location began in May 2002 and a permit was issued for construction and operation of the pilot facility in April 2003.

Diversion Program

The diversion and collections segment of the project targeted a variety of companies and institutions in the city of Venice, Florida. Venice is a small town of approximately 20,000 people. It is located in Sarasota County along the gulf coast. Primarily a retirement community with little industry, Venice has a large service sector. This includes hospitals, restaurants, managed care facilities, and others that have a high potential to produce food wastes.

Back area with space for an extra dumpster

The project team identified participants for the diversion program through evaluation based on the following criteria:

- Ease of collection and placement of designated food waste receptacles
- Type of business and waste stream
- Attitude of proprietor and managers
- Ease of training and integration of a food waste collection program

Because the composting facility size was small, and the project duration temporary, the project team designed the collection program around a few, but very different, waste generators. Types of operations could be assessed based upon the specific challenges faced by each institution, and more broad generalizations could be made about how such institutions could be integrated into a larger scale program.

The steps involved in the setup and implementation of the training program include:

1) The project team contacted business owners and managers to discuss the goals of the project and the possibility of utilizing the food wastes generated at the location.

2) The project team scheduled a site visit at each location that agreed to participate, assessing the waste stream, employees, facility layout, and general attitudes and potential of the establishment.

3) The project team distributed materials (training materials, compostable bags, and waste bins) to those facilities that possessed the right combination of characteristics and scheduled a training day.

4) The project team trained employees on the basics of composting, compostable materials, and separation/disposal methods.

5) Businesses began separating their wastes after the training day.

6) The project team supplied materials upon request and returned periodically to answer questions and address problems.

This format allowed the project team to get acquainted with the locations and adequately address the specific needs of each generator. Managers and supervisors also had open lines of communication with the project team to receive feedback and address problems.

The project team also took an informal survey after implementation to assess the positive and negative aspects of the diversion and collections programs. This survey was comprised of two parts: a quantitative and qualitative section. The project team distributed the survey as the diversion program ended and feedback about the program could be compiled and assessed. A copy of the survey and summary of results are displayed in Appendix A – Survey Responses.

Locations

Three general types of facilities were included in the program:

- Grocers
- Restaurants
- Produce Distributors

Different methods of collection were employed at each location as their production and disposal methods differed. Grocers, restaurants, and the hospital were supplied a separate dumpster in which to dispose of their compostable materials. Venice Public Works dedicated a collection truck scheduled after its normal route to collect materials bi-weekly. Training materials were provided when necessary and generator employees were given hands-on instruction by the project team coordinators. Signs, compostable bags, and waste bins were also supplied as necessary.

Table 2 - Generator Characteristics

Generator Type	Grocers	Restaurants and Hospital	Produce Distributors
Feedstock	Pre-consumer Fruits, Vegetables, Breads	Pre and Post-Consumer food scraps	Fruits and Vegetables
Packaging	Compostable bags	Compostable bags	Pallets, boxes, some plastic packaging
Challenges	Potential for plastics, metal, or glass. Illegal dumping.	Potential for plastics, metal, or glass. Illegal dumping and pathogens.	Separation of packaging materials prior to processing.

Table 2 - Generator Characteristics, above, outlines the waste characteristics of each generator and some of the challenges accepting these wastes in the program. Wastes varied between the generator locations both in nutrient composition and in potential for foreign materials. The project team attempted to minimize contamination risks by addressing foreign material and potentially problematic feedstocks such as meats during training.

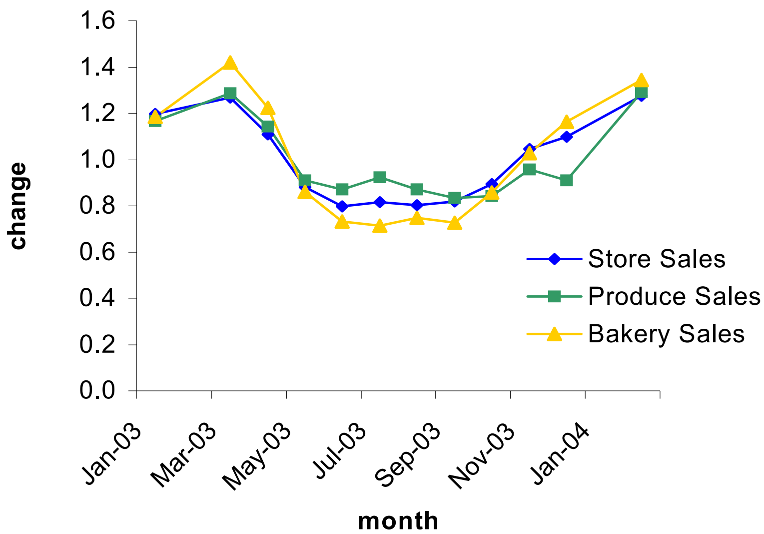
The food bank and produce distributor generated exclusively fruits and vegetables that arrived at the facility packaged with varying degrees of non-compostable material (e.g. plastic bags, liners, straps, etc.). The grocer's waste focused on only the produce and bakery departments within each store, which limited the materials to fruits, vegetables, and starchy materials, with low contamination of synthetic non-compostables. Restaurant and hospital wastes were also primarily fruits and vegetables; though generator employees frequently included some meat, bone, and other material. There was also higher risk of contamination in this material as most was post-consumer.

Illegal dumping into compost-designated dumpsters was a concern. This presented the problem of non-compostable or potentially hazardous materials contaminating feedstocks. This was addressed through clear labeling of dumpsters, and in one case, a special security dumpster with locking capability and warnings painted on it as a deterrent.

Grocery

Three grocery stores in the Venice area participated in the program. They were all medium-high volume stores. They share similar characteristics in patronage, sales volume, and area served. The busy season is October to March, peaking in February –March each year. The lowest volume period is June through September. Store sales volume can drop by a third compared with the peak months. The collections program was conducted during this low-volume period. Figure 1 shows the typical sales curve of a store.

Figure 1 - Sales Curve of Grocer. Baseline = 1.0



The project team initially approached store managers with the concept of a food materials recycling program. The project team met with these managers and discussed the project, presenting them with training materials and a proposed timeline. Training materials included a manual on food scrap separation and signs for delineating bins. The manual discussed each department individually, including the types of waste to be expected, and materials to include in bins containing compostable materials. Managers would then distribute this material to their associates and the project team delivered bins and compostable bags. The manual is included as the attachment **Disposal of Organic Wastes at Grocery Stores**.

Signage

Produce and bakery departments were chosen to participate in the program because of the low risk of contaminants and the relatively benign nature of these feedstocks from an odor and pathogen management perspective. The team started with a single produce department and then increased collections to three stores, with 2 departments each. This gave the project participation of six departments in three stores, with 3 each of produce and bakery departments.

The project team remained in contact with department managers and associates throughout the collection program. Materials were supplied (i.e. compostable bags) upon request and instruction or assistance was provided when needed. Some associates expressed dissatisfaction with parts of the program, while others seemed content. Those who were dissatisfied were given alternatives to their current methods and some associates were pleased with their results, others remained indignant despite modifications.

The process established at the produce department was separation of spoiled produce and trimmings from fruits and vegetables preparations. This differed very little from traditional disposal methods in that a compost-designated bin was used instead of the traditional garbage can. The food and other compostable material was then dumped into the compost dumpster instead of the trash compactor. At the bakery however, employees had to first remove packaging (primarily plastic, foil, and polystyrene (Styrofoam®), which contributed to increased labor over traditional disposal.


Bakery wastes

Bakery departments had to separate packaging from waste before it could be deposited into food waste containers. This was time consuming due to the removal of heavy packaging.

Total diversion from grocery stores alone is estimated to be 15.6 tons of material. Each grocery store has a trash chute in the back area that leads to a 30-yard compactor attached through the wall. All wastes diverted during the project were diverted from these compactors to the designated compost dumpsters. Table 3 - Cost savings per grocery store, below shows cost savings of diversion from these compactors between 2002 (no diversion program) and 2003 (diversion program implemented).

Table 3 - Cost savings per grocery store

	2002 (May – Sept)		2003 (May – Sept)		Savings	
Store	Tons/Pull	Disposal cost	Tons/Pull	Disposal cost	Calculated	Actual*
1	6.3	$10,935.35	6.06	$10,613.95	$321.40	$441.90
2	7.14	$12,634.55	6.96	$12,382.02	$252.53	$213.00
3	5.73	$10,172.02	4.74	$8,846.25	$1,325.78	$1,399.36
Total	25.73	$45,025.46	23.80	$42,429.39	$2,343.55	$2,744.93

All stores showed some reduction in tonnage during the May to September period of the program.

- Store 1 showed an average reduction of about 0.5 tons per week. After the completion of the project, garbage increased by 0.1 ton (200 lbs and then dropped 0.2 tons (400 lbs).

* Differences in actual costs include variations in number of pulls, rounding, etc.

- Store 2 showed an average reduction of 1.3 tons per week in May, 0.6 tons in June, and 0.8 tons in July. August 2003 showed a decrease of 0.3 tons, and September 2003 showed an increase of 0.4 tons per week.

- Store 3 showed the largest decreases in the amount of garbage disposed. May showed a decrease of 0.8 tons; June had a decrease of 1.2 tons per week; July was 0.4 tons per week, and August and September had an average reduction of 1 ton per week. Review of the periods before and after the diversion project indicate that this store showed an average decrease of 0.3 tons per week. Therefore the net impact to the garbage reduction due to the organics diversion would be about 0.4 tons per week less than the reductions noted.

All services for collection and disposal were paid for through grant funds over the course of the diversion program. Though the overall cost savings were over $2,700, the real cost of collection must be factored in to estimate how a program would operate outside the auspices of a state and local innovative pilot project.

The cost of contracting with the City of Venice for once a week pick-up of the organics would have been $45.45 per month. If service were increased to twice a week pick-up, the cost per store would be $82.50 per month. Three times per week service would cost $119.73 per month.

The total additional costs incurred for dumpster service to the three stores are calculated to be $1,127 for the duration of the pilot. Net savings from diversion of organics would be $1,618 or about $539 per store if the cost of the dumpster service were included. Store #1 would have saved $66 or $13 per month; Store # 2 saved $106 per month, and store #3 saved $205 per month.

Surveys were taken with each individual department under the supervision of the project team. The project team interviewed individual employees and filled out the survey form throughout the interview. This allowed direct and accurate feedback, while also allowing the project team to clarify certain comments, ideas, or problems. The survey results (see Appendix A) for the grocers indicated that feelings were mixed about the methods used during the program. The most common comments were:

- Recycling is important and food should not be thrown away
- Signs and training materials worked well
- Bags worked well as liners but did not hold weight
- Bins worked well for disposal but were often too big to dump easily
- Boxes and rolling carts worked well as an alternate method
- Separation of plastics in bakery departments was time consuming
- Disposing of materials outside was more work than using the trash chute
- If some of the methods were altered, continued participation would be more likely

Enthusiasm and flexibility of employees was directly correlated with diversion volumes. For example, Store 3 showed the most success in diverting food from the compactor. They also gave the most positive feedback about the program. When faced with the challenge of dumping heavy bins, they modified their collection to incorporate wheeled carts and waxed cardboard boxes. Other locations lost interest and did not innovate other methods. Even when the project team worked directly alongside employees, some were still not willing to try new methods.

Restaurants

Initially a traditional buffet restaurant and seafood restaurant were incorporated into the program. These were selected as representative of the types of restaurants in the Venice area while at the same time providing a good space in which to supply bins and dumpsters without significant modification to the current configuration. The buffet restaurant had a capacity of approximately 400 and the seafood restaurant over 200. Business varies seasonally and weekly at both locations with higher patronage observed over the winter season and on weekends. During the course of the project, the buffet restaurant was disposing of waste in an 8-yard dumpster that was emptied 4 times a week while the seafood restaurant was using a 6-yard dumpster emptied once a week.

Spanish Signage

Both locations were supplied with bins, bags, and a 2-yard dumpster for disposal. They were supplied signage as well for placement on bins, dumpsters and walls. Spanish speaking employees are common in Florida and many are not fluent in English. Therefore the project team supplied bilingual illustrated signs for placement at some workstations as well.

Restaurants differed from grocers in three important ways:

- Post consumer food waste recycled
- Smaller staff/Less turnover
- Quick pace

In both restaurants bins were supplied and used at two types of locations: food preparation and scrap disposal. The food preparation areas changed little between traditional methods and the composting program. This is because bins in this area were already designated preparation waste, which is primarily compostable organic matter, with little other types of waste being disposed. Scrap disposal areas however, added the compost bin for food scraps and retained the other bin for traditional refuse. This required more space at the disposal area and required extra effort from the bussing and wait staff. The same is true of dumpster areas, as employees had to make two runs to dispose of waste in the dumpsters and the space at the dumpster area had to accommodate the extra 2-yard dumpster.

Food waste bin and regular trash at bus station

Unfortunately, the buffet restaurant closed shortly after initiating the program and so limited amounts of waste and data were collected from that location. However, the project team worked closely with their staff during the training and setup phases and they provided useful feedback for the program.

Restaurant waste is estimated at 3.47 tons diverted over the course of the program. This led to a savings of approximately $220 in hauling costs. This cost was avoided because the grant funded the collections. The costs without this compensation would have been comparable to normal waste collection.

The restaurant surveys differed in some ways from the grocer's, reflecting the differences in operation noted above. They sometimes had difficulty separating table wastes during busy hours. Though the separation of wastes took only a second or two, this had the potential to slow traffic in some areas. Higher rates of disposal also led to some contamination of plastics, particularly small items such as straws and creamer cups. Restaurant employees also noted that compostable bags were too thin, though most said they would continue participating in the program without modification.

Hospital

The hospital is a 342-bed full service health care facility with a cafeteria. The project collected both preparatory wastes and table scraps from the cafeteria. Wastes from the rooms were not collected due to constraints in separation and concerns over pathogens. However, the cafeteria kitchen does prepare the meals for the rooms and so the pre-consumer waste was diverted into the program.

The disposal configuration was slightly different from other locations, as the kitchen was larger and the disposal method was more straightforward than other restaurants. The hospital provided its own bin, which was a simple 50-gallon garbage can on a wheeled base. The project team provided compostable bags and signs. Prep and disposal stations around the kitchen filled smaller waste containers (~30gal) and these were brought to the centralized container. The compostable bags were used in both the large centralized container and the smaller peripheral bins. Signs were placed at prep stations and disposal areas.

The hospital was equipped with a dock on the east end of the building. Dumpsters were located there and the employees charged with emptying the compost bins took materials out to this location. When full, the bin was wheeled out to the dumping area and simply tipped into the opened dumpster. This activity differed significantly from other locations, where employees had to lift materials into the dumpsters.

This difference was reflected in the survey results. The primary concerns of personnel were pickup frequency and pathogen/vector concerns. They would like a program with tri-weekly pick up to reduce vector and odor concerns. Their concerns about bags were similar to restaurants, though this is likely due to improper sizes and overfilling of containers. They experienced some contamination issues with others in the kitchen using the food container as a trash can.

Total waste estimated from the hospital over the course of the diversion program is 5.2 tons, a savings of $330.

Produce Distributors

The produce distributors required the least amount of preparation in order to develop a successful program. Separation and disposal methods were not required at the generator locations as the material was delivered in bulk, either directly to the facility by the generator itself, or picked up and delivered by the project team.

Produce loads arrived on pallets

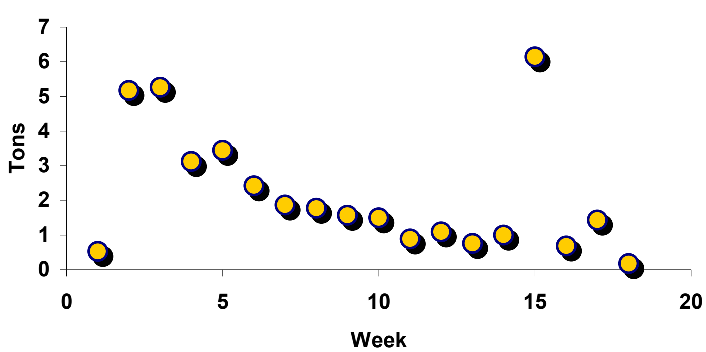
When delivered by the generator, the material arrived in a refrigerated box truck. Wastes were still packaged for shipping in boxes on pallets, which were offloaded to the facility using a pallet jack and hydraulic tailgate. When collected by the project team, the materials arrived in a dumping bed truck or open trailer. In both cases material was off-loaded by hand.

A total of 14.6 tons were collected from produce distributors. This equals a savings of $930. There is no difference in cost for distributors between bringing materials to a landfill or composting facility.

Diversion Program Findings

Collections of materials began in May 2003, after the diversion program, training and support materials were put into place. This continued through the first half of September, 2003. Figure 2 outlines the tonnages collected overall throughout the program.

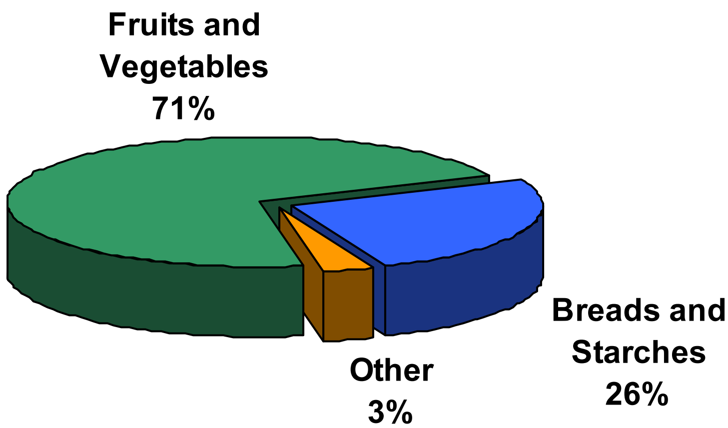
Figure 2 - Collections summary



Collections began slowly then increased in volume rapidly as more generators were added to the program. Volumes then declined steadily as the project moved forward. A number of factors contributed to this including generator attitudes and seasonal slowdown. The large spike at week 15 is due to a large load of spoiled fruits and vegetables from one of the produce generators. This was the largest of these loads received at the facility over the operating period.

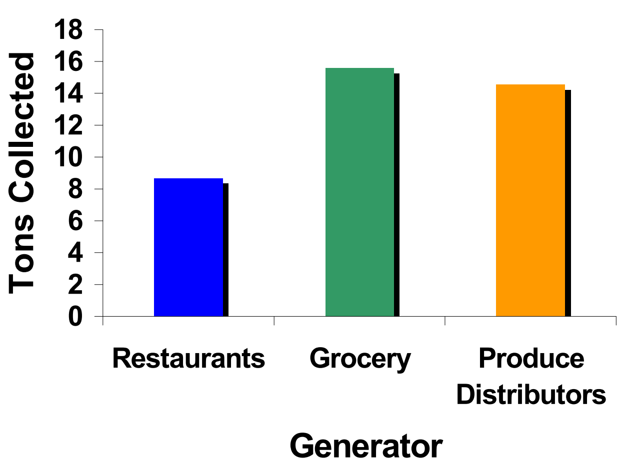
Figure 3 shows the relationship between the types of materials collected over the course of the program. Vegetative materials composed the vast majority of the materials collected.

Figure 3 - Feedstock Composition



This relationship is explained by the volumes of materials provided by each type of generator, outlined in Figure 4 - Generator diversion. Grocers and produce generators contributed the most material to the pilot facility. Produce distributors were 100% fruits and vegetables, while the grocers were about 60% fruits and vegetables by weight.

Figure 4 - Generator diversion



The restaurants and hospital contributed the only meats collected during the program. They were instructed not to include this material but meats were frequently deposited in the compost bins regardless of recommendations and signage.

Pilot Facility

The pilot facility was operated between May 2003 and December 2003. This facility was small to allow for the temporary nature of its construction. It measured 275' x 65' and was constructed of intermediate fill and mulch materials. Berms were constructed on all sides and graded to allow for efficient runoff. See attached Appendix B – aerial map for diagrams of the facility location and layout. Please see Appendix C – Yard Plan for the design and dimensions of the facility.

Description of Facility/Location Layout

The pilot facility was located at the Sarasota Central County Solid Waste Disposal Complex (CCSWDC), 4000 Knights Trail Road, Nokomis, Florida, 34275. The project team identified a portion of cell 3 to locate the site to contain runoff from the facility within the leachate collection system of the CCSWDC. Cell 3 was the current active cell of the landfill and remains the active cell at the time of this writing.

Site Improvements

The compost facility itself underwent construction and installation in May of 2003. This included fill material, equipment operation, and drainage according to the approved plans submitted with the permit application. A concrete slab was installed with drainage collection for the receipt and processing of incoming waste and leachate sample collection.

Pilot Facility

The following equipment was leased and delivered to the facility in May, 2003:

- Packer 750 industrial grinder
- Kubota Tractor Loader
- Ag-Bag CT-5
- Power Washer
- Solar Array with batteries and associated equipment
- Plumbing, tanks and associated materials
- Tools and supplies for site and equipment maintenance

Various site improvements were completed in order to prepare the facility to receive waste. These improvements were made during April and May 2003. These included the following:

- Transportation of fill material

- Grading of the operating surface
- Construction of earth berms
- Transportation and spreading of surface material (mulch)
- Installation of 50' x 35' concrete operating pad
- Construction and installation of the leachate collection and sampling systems
- Set up of concrete bin blocks to assist in the processing of incoming waste

See Appendix D for the final equipment configuration used during processing.

Operations

Receipt of Food Waste

Materials arrived at the facility for processing in four delivery methods:

- Front loading garbage truck
- Rear loading box truck
- Dumping bed truck
- Open top trailer

The receipt and operation differed slightly for each method.

Food waste dumped

The garbage truck was the most common method used and included all material from the city of Venice generators. These included restaurants, grocery stores, and the local hospital. The project team would prepare the receiving pad by spreading a small (1-3yd) bed of yard waste where the materials were to be dumped. This would prevent excessive moisture runoff and aid in processing. This material would then be processed into the grinder using the Kubota tractor-loader.

The box truck backed onto the pad and material was offloaded using a hydraulic tailgate and pallet jack. All waste was packed for commercial delivery in boxes on pallets of approximately 1000lbs each. These were sometimes wrapped in plastic and secured with straps. The pallets would be maneuvered near the grinder and then each pallet could be unloaded individually into the grinder by hand.

Produce generator delivering food

Material delivered using the open trailer and dump truck would be backed onto the operating pad to the grinder where it could be loaded directly from the vehicle into the grinder bay. This material was on pallets similar to the box truck but was not offloaded before being placed through the grinder.

Yard waste collection

Sarasota County yard waste before processing by the County

Sarasota County supplied yard waste for the operation. This material was collected and ground at the County's yard waste facility located at the CCSWDC. Sarasota County subcontracts the grinding operations at the CCSWDC. Waste was mixed lawn and leaf materials, combined with tree cuttings and some land clearing debris.

Mixing and processing

The grinding equipment used during the project was a Packer 750 industrial grinder. It is a ram-fed horizontal grinder with a rotating drum and retractable conveyor belt. Materials are loaded into a 6'x 2' hopper chamber. A 2 ¼-inch screen was used initially but was soon changed to a 3-inch screen size to reduce jamming and smooth operations.

The grinding operation varied slightly depending on the method and type of waste delivered. Open waste delivered via garbage truck was ground both by itself and combined with other materials. This waste contained the following:

- Fruits and vegetables in compostable bags and corrugated cardboard boxes
- Breads, cakes, and pastries in compostable bags and corrugated cardboard boxes
- Meats, shellfish and dairy products in compostable bags and corrugated cardboard boxes
- Sparse contamination with plastic and polystyrene items, occasional glass and metal

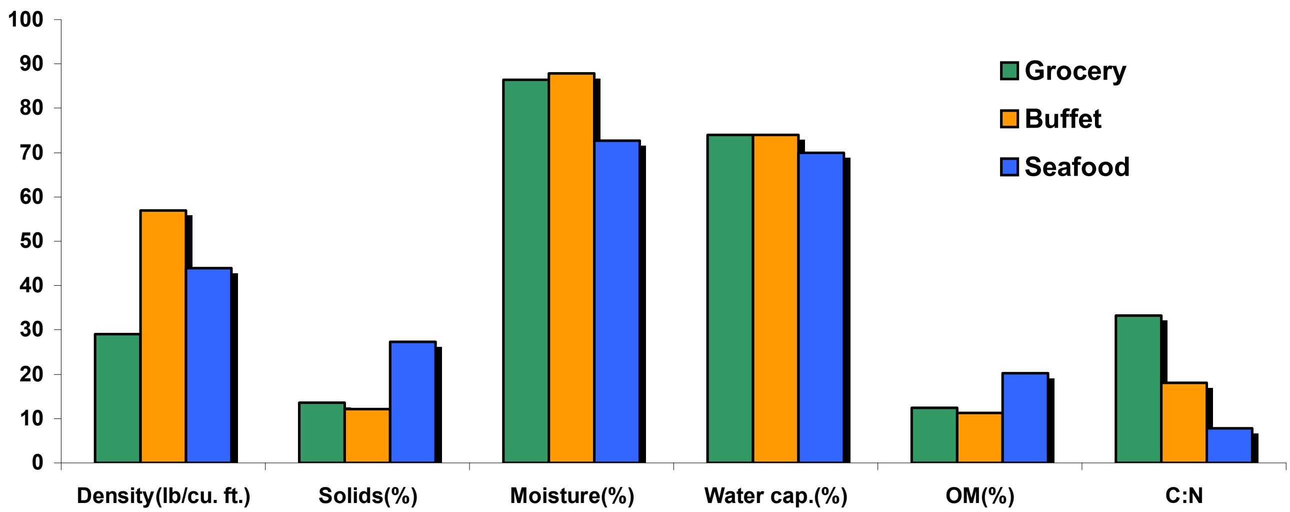
Project team members on site could readily deal with major contaminants. Most contamination occurred outside of the bagged material, which made it easy to remove. This material is estimated to be either material placed in the wrong dumpster by those not associated with the project, or material left in the garbage truck from other waste hauls. Items were removed and disposed of in the landfill. Some contaminants, primarily plastics, remained in the waste and the project team processed this with the food.

Detail of Yard Waste

Yard waste was added to the mix through either grinding with the food material, or added to the material upon exiting the grinder. The yard waste was ground 3-inch minus by Sarasota County, though it could vary (3 – 5 in.) depending on the equipment of subcontractors.

Food waste characteristics are generally varied, which make their management different from other types of waste. This Heterogeneity is illustrated in Figure 5 - Food waste characteristics.

Figure 5 - Food waste characteristics



Food waste has high amounts of moisture and a variable C:N ratio. Yard waste was added to the mixed wastes at an overall ratio of 1-2:1 by weight. Yard waste was added at higher ratios on some occasions to appropriately control for moisture content of the feedstocks. This often translated to 2-5 units of yard waste by volume to each unit of food waste.

The Kubota tractor-loader was used for all grinding operations of wastes from City of Venice generators. Bucket capacity was ½-yard, working well with the size of the grinder. The loader was also small enough to maneuver on the limited space of the operating pad.

Granular Urea (46-0-0) was added by hand to the food/yard waste mix. This was deemed appropriate to achieve both high temperatures sustained during composting and to supply a high nutrient content to the final product.

Before loading materials into the Ag-Bag EcoPODs, the materials that had exited the grinder and all materials that were added after grinding were mixed using the tractor-loader bucket. Homogenization is important in the distribution of nutrients and to avoid pockets of high moisture or nitrogen that could lead to odors. The approximate final mix that the project team attempted to achieve is outlined in Table 4 - Final compost recipe.

Table 4 - Final compost recipe

C:N	Moisture	~ Yard Waste (yds)	Food Waste (yds)	Urea
25:1	60%	2.5-3.5	1	20 lbs/ton

Ag-Bag loading and operation

The project team used Ag-Bag CT-5 equipment for composting feedstocks received at the facility. This in-vessel system was chosen for its ability to protect the composting material from the environment inexpensively while maintaining an internal environment favorable to composting. It also provides odor mitigation opportunities, though these were not specifically investigated by this project. Equipment specifications can be accessed at the Ag-Bag website (www.ag-bag,com/ct5.html).


Ag-Bag CT-5

The Ag-Bag CT-5 uses a hopper mechanism with a 48" horizontal ram to load long plactic tubes, the EcoPODs. A 13-hp gas motor powers the ram. Each tube is attached to an opening at the end of the machine. Perforated aeration tubing is fed under the machine from a roller attached near the rear. Normal operation uses up to 200-foot sections of bag for each EcoPOD.

The first two PODs were loaded under the supervision and direction of Ag-Bag personnel. The project team then loaded subsequent PODs using these methods and feedstock recipe recommendations of Ag-Bag.

The project team used the Kubota tractor-loader for the majority of the CT-5 loading operations. On one occasion County equipment was used to load the machine. Mixed feedstocks that were piled at the output of the grinder were carried across the operating pad in the loader bucket to the location of the CT-5.


Ag-Bag EcoPOD being filled

The ram was extended and the bag loaded each time the hopper chamber was filled. This continued until all wastes received that day were processed in the EcoPOD. The ram was then fully extended and the tube cut and hermetically sealed by hand. This caused each POD's length to vary with the volume of material received on a given day.

The aeration tube was run through the end of the bag and sealed. The project team would then attach the aeration tubing for the next POD to this end, thus creating sealed units for each load's feedstocks. Each chain of PODs formed a continuous aeration pipeline.

A total of 12 PODs of various lengths were filled over the course of the project. The final configuration of PODs and aeration is displayed in Appendices E and F.

Monitoring and aeration systems

Aeration was supplied by blower fans attached at the base of each chain of PODs. These fans were 110VAC powered by the on site power system. The tube from the base POD would be connected directly into the blower fan and the project team made efforts to reduce and eliminate leakage at joints and seals.

Monitoring stations were inserted into the plastic skin of the bag at regular intervals down its length. These were simple plastic vents with adjustable openings. They served two primary functions:

- Provide access for process monitoring
- Allow for ventilation

These were labeled along the POD and the project team used these labeling schemes to conduct process evaluations. The results of this monitoring are discussed further in the Sampling Program – Monitoring Process section.

Power system and management

Utility electrical power was not available at the site location so the project team designed and installed temporary power at the facility.

Ag-Bag provided 1/3 horsepower blowers for aeration of the EcoPODs. Ag-Bag personnel recommended these operate at 2/10-minute on/off intervals for aeration, requiring 115 volt a/c power in an on-off mode 24 hours a day, 7 days a week.

Power was supplied via a bank of ten 12 volt deep cycle marine batteries driving a 5000 Watt 115 volt a/c inverter. The batteries were charged by a combination of a charge-controlled 4-panel 340-Watt solar array and a battery charger powered by a 5000-Watt gasoline generator.

Commonly available power supply components were selected and sized to provide required project power at reasonable capital cost. A higher output tracking solar array could provide total solar power for an unattended operation but generator assist was chosen for this project because it was frequently attended.

When the project team was on site, the generator was utilized to operate the Ag-Bag blowers directly and to supplement the solar charge by means of an automotive battery charger. This procedure was utilized to maximize battery storage capacity when the site was unattended.

Loader harvesting EcoPOD

Appendix G contains a power schematic for the system described above.

Harvest of Ag-Bags

The first six Ag-Bag Eco PODs were harvested on October 17th, 2003. This took place under the supervision of Ag-Bag, Inc. personnel. Sarasota County contributed a large loader (3yd bucket) and operator for the operation to speed processing.

PODs were sliced open lengthwise and the plastic was folded away from the compost within. The loader scooped material from the open bag parallel to the POD's orientation. Using this method the weight of the material itself was used as a push wall and this aided in recovery of materials.

At the end of each POD, the tractor-loader was used to provide a push wall for the final mass of material.

The loader deposited compost from the harvest onto the operating pad. Here the material from the six bags was combined into two windrows for curing.

Experimental windrow

An experimental windrow was constructed on September 24th, 2003, after the receipt of the final load of material. Food feedstocks were mixed with yard waste material at a ratio of 4:1 yard waste to food waste. This was ground and mixed as described in the previous sections. A 6-inch layer of yard waste was placed on the operating pad and the mixed feedstock was placed on to of this. More yard waste was added on top of this material to a depth of 4-6 inches. A perforated aeration tube was run along the bottom of the pile to facilitate passive aeration. The final dimensions of the experimental windrow were 23' long by 10' wide by 5' tall. This approximated the dimensions of materials in the Ag-Bag EcoPODs.

The goals of the experimental windrow were to examine the differences in management, performance, and

- Investigate differences between management of the open windrow and the in-vessel Ag-Bag system
- Analyze runoff from the windrow during rain events to gauge mitigatory effect of Ag-Bag system.
- Observe differences in compost performance between the two systems.

The windrow was constructed and maintained on the operating pad until it was harvested. This meant the windrow shared the composting pad area with the harvested material windrows after October 17th. A seal was placed between the windrow areas and the curing areas to prevent mixing of runoff from the two areas. Runoff was sampled as described in the Sample Program section (p59).

Operations Data and Findings

The project team filled a total of 12 EcoPODs over the course of the project. These combined for a total of 400 ft of POD, 80 tons of yard waste, and 39 tons of food waste.

Removal of contaminants or packaging will reduce the efficiency of processing. Table 5 - Processing characteristics, outlines each of these processes.

Table 5 - Processing characteristics

Waste Type	Method	Challenges	Hrs/Ton
Packaged Wastes	Remove plastics and load grinder by hand	Individually wrapped and packaged items	4
Boxed Wastes	Load grinder by hand	Lower degree of homogeneity achieved	3
Open Wastes	Load grinder with loader, one spotter	Manually remove large contaminants	1.5-3

Packaged waste

The project team sorted plastic packaging from waste received from a produce generator on June 30, 2003. This load included 3 pallets (Packaged Wastes) weighing a total of 1160 lbs. Items were individually packed vegetables such as mushrooms and salads, as well as individually packaged cakes and pastries. These took 35 - 45 minutes per pallet to remove packaging and size-reduce with two-man teams. Each pallet weighed approximately 380 lbs. This simplifies to approximately 6 man-hours per ton of individually packaged waste.

Other produce wastes packaged with less plastic materials (boxed wastes) were processed much more quickly. One ton of fruits and vegetables in cardboard boxes could be size-reduced in 1.5 hours with a two-man team. This translates to 3 man-hours per ton of unpackaged wastes.

Open wastes from garbage could be processed quickly using the tractor-loader and a spotter. These were generally processed quickly through the grinding equipment at a rate of approximately 45 minutes to 1.5 hours per ton, depending on the contaminant level of the feedstocks, moisture levels, and amount of grinder-jamming material (i.e. cakes and pastries).

Grinder down-time caused by jamming, mechanical, or other problems, greatly increased processing time and was generally avoided. Though problems did occur that slowed processing, these were generally minimal, and are not factored into Table 5.

Time measurements for filling of the EcoPODs were between 2-4 hours, depending on the proximity of the CT-5 to the grinder at the time it was being filled. This simplifies to approximately 30 minutes per ten-foot section of POD. The loading took only 10-15 minutes per section with the large loader provided by the County.

Vector intrusions were documented when they were observed. Table 6 shows vector intrusions documented by the project team. An intrusion was defined as a hole made completely through the plastic with greater than ½" diameter.

Table 6 - Vector Intrusion

POD	Vector Intrusions by Week			
	1	2	3	4
1	11			
2	19			
3	3			
4				
5		1	1	
6				2
7	33	1		
8	6	2		
9	2			
10	6		1	
11		2		
12		2	2	

Intrusion was highest in POD 7, without added nitrogen. Intrusions were also higher in PODs that contained more animal residue such as bones and shells. Intrusions were highest within the first week of loading each POD, then declined as time went on. No intrusions were observed in POD 4. Further, after four weeks of composting, no further vector intrusions were observed.

Leachate collected in most of the composting bags to varying degrees. POD 6 contained approximately 32 gallons of leachate at harvest. This translates to about 1.5 gallons per foot. Many PODs did not have enough leachate to measure at the time of harvest. This is due to lack of initial formation, or, in the case of PODs 7, 8, and 9, leachate was generated in small amounts and was either reabsorbed into the composting material or evaporated. POD 11 generated the most leachate, about 103 gallons, or about 1.3 gallons per foot. So a 200-foot CT-5 bag fully loaded would likely generate about 250 gallons of leachate.

The operation of the pilot-scale facility varies in the equipment used and methods employed from a full-scale operation. Some of these differences include:

- Full-sized equipment (e.g. CT-10, loader and grinder)
- Reduce proximity to landfill active face
- Experienced workers using the equipment
- Reduced incremental costs
- Higher quality operating surface.

This must be taken into account in that the quantifiable observations will only be loosely translated to a large-scale operation. Much of the data can be used however, in the development of best management practices and during the planning phase of a larger, self sustaining facility.

Sample Program

The sampling plan was developed as a response to regulatory constraints that prevented the development of an economically viable and self-sustaining composting operation. These issues are discussed in section 2.4.1 - Permitting. The areas that influenced the decision-making process on the part of permitting authorities were water quality concerns and contamination issues.

The goals of the sampling program were to demonstrate what, if any, chemical, physical or biological constituents are cause for concern. These include:

Solid Waste: Determination of the characteristics of the incoming solid waste. This includes information gathered to assess processing such as nutrient and moisture data, as well as to assess the potential risks these feedstocks pose to human health and the environment.
Compost: Determine if compost made from food waste is suitable for general distribution and use. Assess areas of potential concern and evaluate the product as an agronomic amendment.
Leachate: Determine the potential impacts and analytes of concern in runoff from a food waste composting facility. Investigate how the specifics of the composting methods used in this project affect the quality and/or quantity of runoff.

Please refer to the project's **Sampling and Analysis Plan** and amendment, included an attachment to this document. This document covers the parameters of interest in detail, the methods of their collection and analysis, and the parties involved in implementing the sampling regimen. It also delineates that sampling that was required by permit and that sampling that was done as a part of the analytical process.

Laboratories

Services of three laboratories were utilized over the course of the project: Elab, Inc., Wood's End Research Laboratory, and Thorton Laboratories. Elab and Thornton are certified through the National Environmental Laboratory Accreditation Program (NELAP) for the analysis used during the program. Elab was used for analysis of feedstocks, leachate, and compost with regard to chemical compounds of interest, such as organics and metals. Wood's End was used for analysis of feedstocks and compost for nutrients and physical properties. Thornton was used only for the analysis of the final compost product for foreign matter, as part of solid waste permit compliance. Thornton was NELAP certified for this analysis, while ELAB and Wood's End were not.

Sampling Solid Waste Feedstock

The project team used a variety of methods to collect waste at the facility as discussed in the sections Diversion Program and Pilot Facility (pages 40 and 50) . In all cases however, facility operators passed material through a grinder, combined it with yard waste, and added it to the CT-5 with a front-end loader. Some solid waste was ground simultaneously with yard waste to ease processing and reduce occurrences of grinder jamming.

The project team took a total of 12 samples of feedstocks over the course of the 5-month collections period, May through October 2003. Three of these were synthetic precipitation leaching procedures (SPLP SW method 1312). The rest were analyzed as solids.

Solid waste was sampled as it exited the grinder. At least five grab samples were taken over the course of a grinding operation. Each was approximately ½ gallon in size and these were combined in a 5-gallon bucket and composited. A sub sample was then taken from this material and sent to Elab. Of these samples, four were comprised of only food wastes from one or more of the generators. The other five were comprised of food waste combined with yard waste.

The project team analyzed wastes for a variety of parameters, including metals, volatile organic compounds, chlorinated and organophosphorus pesticides, and various physical and biological parameters. These parameters are outlined specifically in the Sampling and Analysis Plan and in the tables that follow. The arithmetic mean and standard deviation were used to calculate a 90% confidence interval (one-tailed) for parameters in the wastes. Though not specifically regulated, these intervals were compared to Soil cleanup target levels (SCTLs) for residential and commercial direct exposure. This is for comparative purposes and to assess potential areas of concern. Concentrations of materials are likely to increase in compost so information regarding sources could be useful in investigating areas of concern.

Table 7 - Metals in shows concentrations of heavy metals found in the feedstocks used in the project. Displayed in the table are three different regulatory guidelines: Soil Cleanup Target Levels (SCTLs), EPA part 503 biosolids requirements, and chapter 62-709 or the Florida Administrative Code (FAC), which regulates compost classification. These standards are presented side by side for comparative purposes and because various parameters analyzed throughout the project are compared with different regulatory levels.

Table 7 - Metals in Solid Waste

PARAMETER All values in (mg/kg)	SCTL		§503.13 Table 3	FAC 62-709 CODE 1	90% CI
	Residential	*Commercial*			
Antimony (Sb)	26	240	NC	NC	1.0
Arsenic (As)	0.8	3.7	41	NC	2.4
Barium (Ba)	110	87000	NC	NC	10.4
Beryllium (Be)	120	800	NC	NC	0.1
Cadmium (Cd)	75	1300	39	15	0.2
Chromium (Cr)	210	420	NC	NC	5
Cobalt (Co)	4700	110000	NC	NC	7
Copper (Cu)	110	76000	1500	450	11
Iron (Fe)	23000	480000	NC	NC	880
Lead (Pb)	400	920	300	500	2.4
Nickel (Ni)	110	28000	420	50	1.6
Selenium (Se)	390	10000	100	NC	1.4
Silver (Ag)	390	9100	NC	NC	0.3
Thallium (Th)	NC	NC	NC	NC	0.8
Vanadium (V)	15	7400	NC	NC	3.9
Zinc (Zn)	23000	560000	2800	900	40
Mercury (Hg)	3.4	26	17	NC	0.1

NC - No Criteria Established

- Exceeds part 503 — - Exceeds 62-709 FAC — - Exceeds SCTL Commercial — - Exceeds SCTL Residential

The compost rule provides a basis upon which to classify the compost, and when no parameter existed within the compost rule the project team referred to either 503 biosolids regulations or Florida SCTLs. As Table 7 illustrates, arsenic (As) is not regulated under the current compost rule and the confidence interval for arsenic in the feedstock (2.4 mg/kg) fell above the residential direct exposure level for that metal (0.8 mg/kg). It fell short of the commercial direct exposure level and far below the biosolids requirements. All other metals were well below all regulatory thresholds.

In an attempt to describe the source of arsenic the project team compared feedstocks containing only food wastes and those that had yard waste added. Figure 6 - Arsenic in Feedstocks shows a comparison of means of arsenic in Feedstocks. Those feedstocks with yard waste added had a higher mean concentration than those that were composed of only food materials. Though observations were low ($n=4$, $n=5$) and a t-test showed significance approaching the 80% level ($p = .23$), the information does give insight into the nature of arsenic in the waste stream. It should be noted however, that food materials and yard waste were processed through the same grinding equipment and the machinery was not cleaned in between. This may have resulted in cross contamination.

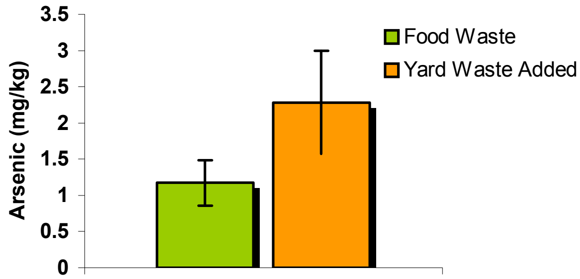


Figure 6 - Arsenic in Feedstocks

Organic compounds in the feedstocks fell into three categories: chlorinated pesticides, organophosphorus pesticides, and volatile organic compounds (VOCs). These are outlined in tables 7, 8, and 9. Because no criteria exist for these parameters in either the part 503 biosolids rule or the Florida compost rule, only the SCTLs were used as guidelines.

Table 8 - Chlorinated Pesticides in solid waste

PARAMETER All values in (mg/kg)	**SCTL**		**90% CI**
	Residential	***Commercial***	
Aldrin	**0.07**	**0.3**	**< 0.01**
α-BHC	**0.2**	**0.5**	**< 0.01**
β-BHC	**0.6**	**2.1**	**< 0.01**
δ-BHC	**22**	**420**	**< 0.01**
γ-BHC	**0.7**	**2.2**	**< 0.01**
α-Chlordane	**NC**	**NC**	**< 0.01**
γ-Chlordane	**NC**	**NC**	**< 0.01**
Chlordane	**3.1**	**12**	**< 0.01**
4,4´-DDD	**4.6**	**18**	**< 0.01**
4,4´-DDE	**3.3**	**13**	**< 0.01**
4,4´-DDT	**3.3**	**13**	**0.02**
Dieldrin	**0.07**	**0.3**	**< 0.01**
Endosulfan I	**410**	**6700**	**< 0.01**
Endosulfan II	**410**	**6700**	**< 0.01**
Endosulfan sulfate	**410**	**6700**	**< 0.01**

Endrin	21	340	≤ 0.01
Endrin aldehyde	NC	NC	≤ 0.01
Endrin ketone	NC	NC	≤ 0.01
Heptachlor	0.2	0.9	≤ 0.01
Heptachlor epoxide	0.1	0.4	≤ 0.01
Hexachlorobenzene	0.5	1.1	≤ 0.01
Methoxychlor	370	7500	≤ 0.01
Toxaphene	1	3.7	0.08

NC - No Criteria Established

- Exceeds 62-709 FAC   - Exceeds SCTL Commercial   - Exceeds SCTL Residential   - Analyte Observed

Six chlorinated pesticides were observed in the feedstock materials:

- α-chlordane
- γ-chlordane
- 4,4'-DDT
- Dieldren
- Endosulfan II
- Endosulfan sulfate

None of these pesticides occurred chronically and all occurred at very low levels, often near the method detection limit (MDL). All chlorinated pesticides fell below the SCTL level for residential direct exposure.

Organophosphorus pesticides in feedstocks were only detected once, and never in a sample containing food waste. Chlopyrofos was detected in one yard waste sample near the detection limit. Confidence intervals based on detection limits are found in Table 9 - Organophosphorus pesticides in solid waste.

Table 9 - Organophosphorus pesticides in solid waste

PARAMETER All values in (mg/kg)	**SCTL**		**CI (90%)**
	Residential	***Commercial***	
Atrazine	NC	NC	0.02
Azinphos ethyl	NC	NC	0.14
Azinphos methyl	NC	NC	0.14
Bolstar	NC	NC	0.14
Carbophenothion	9.8	180	0.14
Chlorfenvinphos	NC	NC	0.14

Chlorpyrifos	220	4200	0.14
Coumaphos	18	300	0.14
Demeton-O	NC	NC	0.14
Demeton-S	NC	NC	0.14
Diazinon	55	760	0.14
Dichlorvos	0.2	0.3	0.14
Dimethoate	8.4	86	0.14
Dioxathion	NC	NC	0.14
Disulfoton	2.9	56	0.14
EPN	0.7	15	0.14
Ethion	38	780	0.14
Ethoprop	5.5	69	0.14
Famphur	NC	NC	0.14
Fensulfothion	14	180	0.14
Fenthion	NC	NC	0.14
Leptophos	NC	NC	0.14
Malathion	1300	20000	0.14
Merphos	2.2	41	0.14
Mevinphos	16	240	0.14
Monocrotophos	NC	NC	0.14
Naled	130	2100	0.14
Parathion, Ethyl	450	9100	0.14
Parathion, Methyl	450	9100	0.14
Phorate	14	280	0.14
Phosmet	1400	21000	0.14
Phosphamidon	NC	NC	0.14
Ronnel	3600	59000	0.14
Stirophos	NC	NC	0.14
Sulfotepp	NC	NC	0.14
TEPP	NC	NC	0.14
Terbufos	1.4	17	0.14
Tokuthion	NC	NC	0.14
Trichloronate	NC	NC	0.14

Several volatile organic compounds were observed in feedstocks. Table 10 - Volatile organic compounds in solid waste outlines the applicable confidence intervals and regulatory thresholds.

Table 10 - Volatile organic compounds in solid waste

Parameter All values in (mg/kg)	SCTL		CI (90%)
	Residential	*Commercial*	
Acetone	780	5500	16
Acrylonitrile	0.3	0.5	0.08
Benzene	1.1	1.6	≤ 0.01
Bromochloromethane	57	390	≤ 0.01
Bromodichloromethane	1.4	2	≤ 0.01
Bromoform	48	84	≤ 0.01
Bromomethane	2.2	15	1.4
2-Butanone	3100	21000	0.6
Carbon disulfide	200	1400	0.5
Carbon tetrachloride	0.4	0.6	≤ 0.01
Chlorobenzene	30	200	≤ 0.01
Chloroethane	2.9	4	≤ 0.01
Chloroform	0.4	0.5	≤ 0.01
Chloromethane	1.7	2.3	0.5
1,2-Dibromo-3-chloropropane (DBCP)	0.8	2.7	≤ 0.01
Dibromochloromethane	1.4	2.1	≤ 0.01
1,2-Dibromoethane (EDB)	0.01	.04	≤ 0.01
Dibromomethane	58	400	≤ 0.01
trans-1,4-Dichloro-2-butene	NC	NC	≤ 0.01
1,2-Dichlorobenzene	650	4600	≤ 0.01
1,4-Dichlorobenzene	6	9	≤ 0.01
1,1-Dichloroethane	290	2000	≤ 0.01
1,2-Dichloroethane	0.5	0.7	≤ 0.01
1,1-Dichloroethene	0.09	0.1	≤ 0.01
Cis-1,2-Dichloroethene	19	130	≤ 0.01
trans-1,2-Dichloroethene	31	210	≤ 0.01
1,2-Dichloropropane	0.6	0.8	≤ 0.01
Cis-1,3-Dichloropropene	0.2	0.2	≤ 0.01
trans-1,3-Dichloropropene	0.2	0.2	≤ 0.01

Ethylbenzene	1100	8400	0.04
2-Hexanone	5.1	34	≤ 0.01
Iodomethane	NC	NC	≤ 0.01
4-Methyl-2-pentanone	NC	NC	0.05
Methylene chloride	16	23	0.2
Styrene	2700	21000	0.2
1,1,1,2-Tetrachloroethane	4	5.7	≤ 0.01
1,1,2,2-Tetrachloroethane	0.7	1.1	≤ 0.01
Tetrachloroethene	8.9	17	≤ 0.01
Toluene	380	2600	0.2
1,1,1-Trichloroethane	400	3300	≤ 0.01
1,1,2-Trichloroethane	1.3	1.8	≤ 0.01
Trichloroethene	6	8.5	≤ 0.01
Trichlorofluoromethane	200	1300	≤ 0.01
1,2,3-Trichloropropane	0.01	0.02	≤ 0.01
Vinyl acetate	230	1600	≤ 0.01
Vinyl chloride	0.03	0.04	≤ 0.01
Xylenes, Total	5900	40000	0.02

NC – No Criteria

- Exceeds 62-709 FAC **- Exceeds SCTL Commercial** **- Exceeds SCTL Residential** **- Analyte Observed**

A total of thirteen volatile organic compounds were observed in the solid waste feedstock, the majority of which occurred at low levels near detection limits. The analytes observed were as follows (observations appear in parenthesis):

- Acetone (2)
- Benzene (2)
- Bromomethane (2)
- 2-Butanone (3)
- Carbon disulfide (2)
- Chloromethane (2)
- cis-1,2-Dichloroethene (1)
- Ethyl benzene (3)
- 4-Methyl-2-pentanone (1)
- Methylene chloride (1)
- Styrene (1)
- Tetrachloroethene (1)
- Toluene (3)

No volatile organics were present in levels above regulatory thresholds.

Acetone, 2-butanone, carbon disulfide, ethyl benzene and bromomethane were all observed in more than one sample. Bromomethane occurred in high concentration in one sample (2.4 mg/kg), which exceeded the SCTL of 2.2 mg/kg for residential direct exposure, and at moderate concentration (2.0 mg/kg) in one other. Bromomethane was not detected in any other samples. Bromomethane (a.k.a. methyl bromide) is a common pesticide in use in Florida. Confidence intervals for all organic compounds observed fell far below their applicable regulatory thresholds and no further compounds were present in feedstocks at dangerous levels.

Pesticide Data Program

The pesticide data program (PDP) was designed to sample fruits, vegetables, meats, drinking water and other resources for pesticide residues. This nationwide program provides data on possible contamination issues in the food supply. Examination into the types and concentration of pesticides observed in the PDP will give insight concerning the potential for compost, which uses food as a feedstock, to contain these compounds.

The pesticide data program is a project managed by the United States Department of Agriculture in cooperation with the Environmental Protection Agency and the Food and Drug Administration. State agencies and laboratories collect samples of domestic and imported produce commodities. Further description of the project, as well as reports, can be found on the web at: www.ams.usda.gov/science/pdp/

The Florida Department of Agriculture and Consumer Services is one of the participating state agencies that samples and analyzes produce, both domestically grown and imported, for the program.

In 2002, approximately 78 percent of all samples were domestic and 20 percent were imported. Approximately 1 percent of the samples were of mixed origin and less than 1 percent was of unknown origin.

Table 11 - Fresh samples taken in Florida

Commodity	Samples
Apples	63
Asparagus	84
Bananas	82
Broccoli	83
Celery	84
Carrots	63
Cucumbers	20
Mushrooms	84
Onions	84
Peaches	67
Pineapples	41
Potatoes	42
Sweet Bell Peppers	21
Spinach	42
Total	860

A tolerance is the maximum amount of a pesticide residue allowable on a raw agricultural commodity. Established tolerances are listed in the Code of Federal Regulations (CFR), Title 40, Part 180. In 2002, PDP testing found residues exceeding an established tolerance in 0.3 percent of the 12,200 samples (excluding drinking water). Residues with no established tolerance were found in 2.7 percent of all samples (excluding drinking water). These residues were detected at very low concentrations, well below established SCTLs in Florida.

Table 11 - Fresh samples taken in Florida, outlines the fresh commodities sampled in Florida and the number of samples taken for each. A total of 2,272 imported samples were collected nationally in 2002 from 27 countries. Asparagus, bananas, cucumbers, peaches, and pineapples accounted for most of the imported commodities. Samples were taken over all seasons during the year.

The pesticides observed most often by the project team in analyzing the feedstocks were Chlordane and Dieldren. These were observed consistently, though all well below regulatory levels. Observations of note concerning the Pesticide Data Program:

- Chlopyrifos was observed in some cucumber and peach samples above EPA regulatory levels for food residuals. Concentrations varied between 0.002 and 0.079 ppm. The Florida SCTL for Chlopyrifos is 220ppm.
- Chlordane was observed above regulatory limits in Sweet Bell Peppers ranging in concentration from 0.001 to 0.003ppm. The Florida SCTL for Chlordane is 3.1 ppm.
- Carbaryl was observed in asparagus samples at concentrations between 0.02 and 15 ppm, exceeding the regulatory tolerance limit in some cases. The Florida SCTL for carbaryl is 6800ppm.
- DDT was observed in some samples. Mushrooms contained the highest concentrations, ranging from 0.002 to 0.006 ppm. The Florida SCTL for DDT is 3.3 ppm.
- Dieldrin was observed in a variety of samples, with potatoes containing the highest concentration at 0.01 ppm. The Florida SCTL for Dieldrin 0.07 ppm.
- More pesticide observations were made for some imported commodities than in domestic supplies, notably peaches and asparagus. However, even these commodities showed significantly lower concentrations than would pose a threat to human health or the environment in compost.

This indicates that pesticides, though present at low levels in the food supply, are not present at levels that would be of concern to those composting it or using compost derived from it. The project team hypothesizes that many of the pesticides observed throughout the project were present in yard waste rather than food waste. Please refer to the above website for further information pertaining to the PDP.

Compost

The sampling of composts took place during the winter of 2003/04. Samples were taken when materials were harvested from bags, after screening, and prior to distribution. In all cases the compost samples were minimum 5-part composites taken at various depths as outlined in the sampling plan. Boring equipment was not necessary, as material was sampled while it was being moved, so as to facilitate collection from internal zones.

Metals were 2.6 times more concentrated in compost than in feedstocks on average. This is expected due to the mass reduction resulting from decomposition through loss of carbon dioxide during the composting process. These levels are illustrated in Table 12 - Metals in Compost.

Table 12 - Metals in Compost

PARAMETER All values in (mg/kg)	SCTL		§503.13 Table 3	FAC 62-709 CODE 1	90% CI
	Residential	*Commercial*			
Antimony (Sb)	26	240	NC	NC	3.1
Arsenic (As)	0.8	3.7	41	NC	4.5
Barium (Ba)	110	87000	NC	NC	15
Beryllium (Be)	120	800	NC	NC	0.3
Cadmium (Cd)	75	1300	39	15	0.6
Chromium (Cr)	210	420	NC	NC	32
Cobalt (Co)	4700	110000	NC	NC	4.1
Copper (Cu)	110	76000	1500	450	61
Iron (Fe)	23000	480000	NC	NC	1130
Lead (Pb)	400	920	300	500	4.9
Nickel (Ni)	110	28000	420	50	2.1
Selenium (Se)	390	10000	100	NC	4.3
Silver (Ag)	390	9100	NC	NC	1.1
Thallium (Th)	NC	NC	NC	NC	4.1
Vanadium (V)	15	7400	NC	NC	5.8
Zinc (Zn)	23000	560000	2800	900	62.8
Mercury (Hg)	3.4	26	17	NC	0.05

NC - No Criteria Established

- Exceeds part 503 - Exceeds 62-709 FAC - Exceeds SCTL Commercial - Exceeds SCTL Residential

Arsenic levels were more concentrated in compost (4.5 mg/kg), this time exceeding the regulatory threshold for commercial direct exposure of 3.7 mg/kg. They still fell far below the threshold for biosolids land application concentrations (41 mg/kg).

Further investigation of this relationship showed no significant (p=0.65) difference between arsenic levels in compost made with food waste mixed with yard waste (n=50) and compost made with yard waste only (n=50).

Organics in the compost differed slightly from those found in feedstocks.

Chlorinated pesticides occurred in similar amounts in compost, though some compounds were observed at different frequencies. Their confidence intervals are presented in Table 13 - Chlorinated pesticides in compost. Three analytes were detected on a regular basis:

- α-chlordane
- γ-chlordane
- Dieldren

Table 13 - Chlorinated pesticides in compost

PARAMETER All values in (mg/kg)	SCTL		90% CI
	Residential	*Commercial*	
Aldrin	0.07	0.3	0.004
α-BHC	0.2	0.5	0.004
β-BHC	0.6	2.1	0.004
δ-BHC	22	420	0.004
γ-BHC	0.7	2.2	0.004
α-Chlordane	NC	NC	0.015
γ-Chlordane	NC	NC	0.018
Chlordane	3.1	12	0.015
4,4´-DDD	4.6	18	0.004
4,4´-DDE	3.3	13	0.015
4,4´-DDT	3.3	13	0.016
Dieldrin	0.07	0.3	0.004
Endosulfan I	410	6700	0.004
Endosulfan II	410	6700	0.004
Endosulfan sulfate	410	6700	0.004
Endrin	21	340	0.004
Endrin aldehyde	NC	NC	0.004

Endrin ketone	NC	NC	0.004
Heptachlor	0.2	0.9	0.004
Heptachlor epoxide	0.1	0.4	0.004
Hexachlorobenzene	0.5	1.1	0.004
Methoxychlor	370	7500	0.039
Toxaphene	1	3.7	0.004

NC - No Criteria Established

- Exceeds 62-709 FAC
- Exceeds SCTL Commercial
- Exceeds SCTL Residential
- Analyte detected

These pesticides did not occur in dangerous levels at any time and were not found to be above any regulatory threshold despite their recurrence during the sampling program. Only one other pesticide was observed in compost samples, 4,4’-DDT, though it was only observed once near the detection limit, far below regulatory thresholds.

Organophosphorus pesticide compounds were never detected in compost. Confidence intervals calculated based on method detection limits are presented in Table 14 - Organophosphorus pesticides in compost.

Table 14 - Organophosphorus pesticides in compost

PARAMETER All values in (mg/kg)	SCTL		CI (90%)
	Residential	*Commercial*	
Atrazine	NC	NC	0.017
Azinphos ethyl	NC	NC	0.170
Azinphos methyl	NC	NC	0.170
Bolstar	NC	NC	0.170
Carbophenothion	9.8	180	0.170
Chlorfenvinphos	NC	NC	0.170
Chlorpyrifos	220	4200	0.170
Coumaphos	18	300	0.170
Demeton-O	NC	NC	0.170
Demeton-S	NC	NC	0.170
Diazinon	55	760	0.170
Dichlorvos	0.2	0.3	0.170
Dimethoate	8.4	86	0.170
Dioxathion	NC	NC	0.111
Disulfoton	2.9	56	0.170
EPN	0.7	15	0.170

Ethion		38		780		0.170	
Ethoprop		5.5		69		0.170	
Famphur		NC		NC		0.170	
Fensulfothion		14		180		0.170	
Fenthion		NC		NC		0.170	
Leptophos		NC		NC		0.170	
Malathion		1300		20000		0.170	
Merphos		2.2		41		0.170	
Mevinphos		16		240		0.170	
Monocrotophos		NC		NC		0.691	
Naled		130		2100		0.691	
Parathion, Ethyl		450		9100		0.170	
Parathion, Methyl		450		9100		0.170	
Phorate		14		280		0.170	
Phosmet		1400		21000		0.170	
Phosphamidon		NC		NC		0.170	
Ronnel		3600		59000		0.170	
Stirophos		NC		NC		0.170	
Sulfotepp		NC		NC		0.170	
TEPP		NC		NC		0.612	
Terbufos		1.4		17		0.170	
Tokuthion		NC		NC		0.170	
Trichloronate		NC		NC		0.170	
NC – No Criteria Established							
	- Exceeds 62-709 FAC		- Exceeds SCTL Commercial		- Exceeds SCTL Residential		- Analyte Observed

Volatile Organic Compounds (VOCs) observed in compost were similar to those observed in feedstocks, though often at lower frequency and concentration. No volatile organic compounds were found above regulatory thresholds in compost. Table 15 - Volatile organic compounds in compost shows the calculated concentrations (arithmetic mean) of volatile organics in feedstock as compared with compost. Compounds in bold were observed in both feedstock and compost.

Table 15 - Volatile organic compounds in compost

Parameter All values in (mg/kg)	Concentration	
	Feedstock	*Compost*
Acetone	6.6	.06

Benzene	<.01	<.01
Bromomethane	0.7	ND
2-Butanone	0.3	ND
Carbon disulfide	0.2	ND
Chloromethane	0.2	ND
cis-1,2-Dichloroethene	< .01	ND
Ethyl benzene	.02	<.01
4-Methyl-2-pentanone	.02	ND
Methylene chloride	.06	<.01
Styrene	.06	ND
Tetrachloroethene	.04	ND
Toluene	.06	<.01

Concentrations of volatile organic compounds in compost were lower than in feedstocks. This observation is expected due to the volatility of these compounds and their decomposition during the composting process.

The project team conducted a series of experiments in order to assess the agronomic and horticultural value of the compost produced by the project. These experiments were conducted in Spring of 2004 at the University of Florida Institute for Food and Agricultural Sciences (IFAS) in Immokalee, Florida. **Food Waste Compost in Ornamental Plant Growth**, attached, discusses this field trials in detail. Some data is included here as well for convenience.

The experiments were conducted on a series of horticultural plants in 4-inch pots. The plants included in the trials were:

- Basil
- Merigold
- Impatient
- Croton
- Aglomera


Ornamental plant trials

The trials were conducted using food/yard waste compost from the project as a replacement for peat moss at different mix ratios. Table 16 - Horticultural treatments outlines the various mixes used in the growth trials.

Table 16 - Horticultural treatments

Treatment	Compost	Peat	Vermiculite	Perlite
1	100%	0%	0%	0%

Treatment	Compost	Peat	Vermiculite	Perlite
2	60%	0%	25%	15%
3	30%	30%	25%	15%
4 (control)	0%	60%	25%	15%

The effects on growth and germination of basil plants are displayed in Table 17 - Effect of compost in total percent germination. The treatment number refers to the mix shown in Table 16 - Horticultural treatments.

Table 17 - Effect of compost in total percent germination

Treatment	Germination (%)
1	80a
2	80a
3	67ab
4 (control)	47b

Means in columns (a, b) followed by the same letter do not differ at P≤ 0.05.

Basil treatments 1– 4, left to right

Basil was dried and weighed after 45 days of growth. These results are displayed below in Table 18 - Effect of compost on total basil biomass.

Table 18 - Effect of compost on total basil biomass

Treatment	Total dry weight (g)
1	1.5b
2	2.5a
3	1.9ab
4 (control)	1.2b

Means in columns (a, b) followed by the same letter do not differ at P≤ 0.05.

This experiment showed that the project's food waste compost was a viable substitute for peat when included in potting mixes at 30% and 60% by volume. Economic implications of this are discussed in section 3.3 - How this project led to greater quantities of recovered materials, created a product more recyclable/marketable.

Leachate

The majority of leachate was collected from the leachate collection bucket as is drained from the pad. This leachate was concentrated by varying degrees depending upon its source. Some samples of leachate were also collected from within the Ag-Bag EcoPODs, though leachate did not always occur in sufficient quantities for sampling in these locations.

Leachate draining from the pad came from three primary sources: the waste itself, equipment washdown, and storm water discharge. These ranged in concentration from extremely concentrated fluids with viscous consistency, to very dilute fluids with little discernable difference from rainwater.

Concentrated leachate and washdown leachate was collected directly from the collection bucket. The liquid was drained through a 2mm stainless steel strainer directly into sample bottles.

Concentrated leachate from the operating pad exceeded surface water quality standards for class III fresh water in both metals and nutrients (see Table 19 - Metals in Leachate from waste received). The total volume of fluids was low, ranging from 1-4 gallons per ton.

Table 19 - Metals in Leachate from waste received

PARAMETER All values in (µg/L)	Surface Water Crieteria (62-302.530 FAC)		90% CI
	Class I	*Class III Fresh*	
Antimony (Sb)	14	4300	62
Arsenic (As)	50	50	320
Barium (Ba)	1000	1000	630
Beryllium (Be)	0.01	0.13	1.1
Cadmium (Cd)	3.37	3.37	38
Chromium (Cr)	268	268	857
Cobalt (Co)	420.00	420.00	720
Copper (Cu)	30.50	30.50	700
Iron (Fe)	300.00	1000.00	380000
Lead (Pb)	18.58	18.58	115
Nickel (Ni)	168.54	168.54	790
Selenium (Se)	5.00	5.00	165
Silver (Ag)	0.07	0.07	6.5
Thallium (Th)	1.70	6.30	24
Vanadium (V)	49.00*	49.00*	219.6
Zinc (Zn)	387.83	387.83	18600
Mercury (Hg)	0.01	0.01	1.3

NC - No Criteria Established

- Exceeds Class III Surface Water (orange) - Exceeds Class I Surface Water (yellow)

* Groundwater criteria

Washdown leachate showed similar characteristics to leachate generated by waste received. The volume of this water was higher as well, depending on the amount of washing, it could range from 10 to 100 gallons.

Rainwater from the operating pad tested as surface water, except for low levels of copper and mercury, which are hypothesized to be a result of machinery operating on and near the facility. All other metals met surface water quality standards.

Volatile organic compounds, chlorinated pesticides and organophosphorus pesticides all fell within surface water quality standards. In fact, Organophosphorus pesticides were never observed at all in leachate samples. Volatile compounds observed were the same as those observed in solid waste samples.

The water from within the EcoPODs varied in its properties. The PODs that contained additional nitrogen showed more microbial activity and nitrogen metabolites (NO_3, NO_2). The PODs without additional nitrogen did not generate enough leachate to adequately sample for all parameters, but the small volumes that were retrieved indicate this water meets class I surface water quality standards.

In addition to these parameters, nutrients were analyzed over the course of rain events in the Fall, 2003. Though rain events were fewer, and volume of water reduced, samples were taken of storm water runoff using the autosampler. Based upon other sampling results, nutrients were judged to be of possible concern.

The project team posed the question of nutrient runoff from an exposed windrow. This will aid in the assessment of the Ag-Bag system's ability to mitigate for environmental impacts. The experimental windrow was constructed to assess the management concerns associated with an open system. It was constructed as discussed in the Pilot Facility section (p50).

Storm water samples were taken with an Isco 6712 autosampler, with 24 polyethlyene bottles for nutrient samples, or one glass bottle for composite sampling of organics. Teflon coated tubing was used for organics samples. Appendix H - water schematic depicts the sampling area design. A low-flow strainer was inserted into the outflow of the 2¼" PVC leachate pipe (section B of the water schematic).

The first rain event on the experimental windrow occurred September 25, 2003. Figure 7 and Figure 8 outline the rain levels over the period of the event and concentrations of various parameters in the water. The event lasted approximately 80 minutes and deposited 1.1 inches of water.

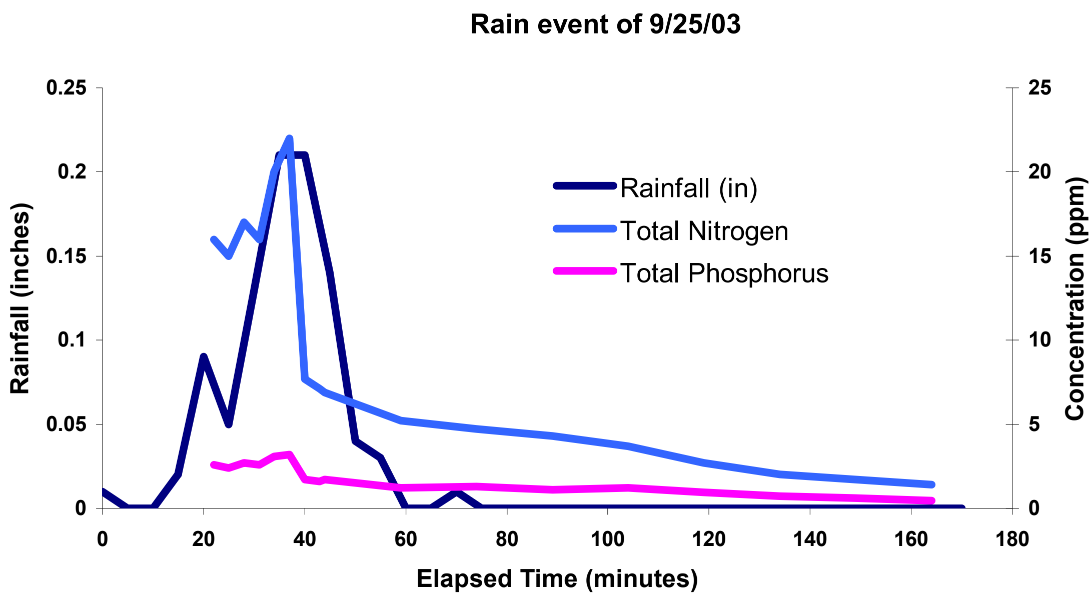


Figure 7 – Rainfall runoff nutrients

The storm water runoff (Figure 7) showed expected properties of dilution over the course of the rain event. Nitrogen peaked at just over 20 ppm in the initial flush and then dropped off sharply to 7 ppm, becoming more dilute as time went on. Nitrogen ended sampling at near 1.5 ppm. Phosphorus concentration mirrored that of nitrogen, peaking at 3.2 ppm, dropping sharply to 1.7ppm, and finishing at 0.4ppm.

Biochemical oxygen demand was highly variable, and did not correlate specifically with rainfall or nutrients. It ranged from 380ppm to 930ppm. Nitrate and Nitrate were undetected at the 0.01ppm level. Five of the 20 samples showed nitrate-nitrite, correlating with the peak in total nitrogen. Nitrate-Nitrite peaked at 0.015ppm.

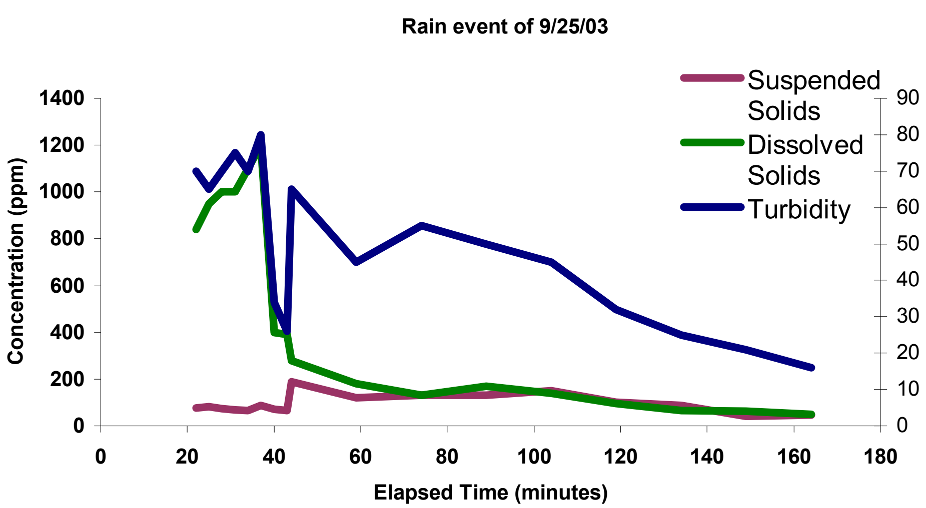
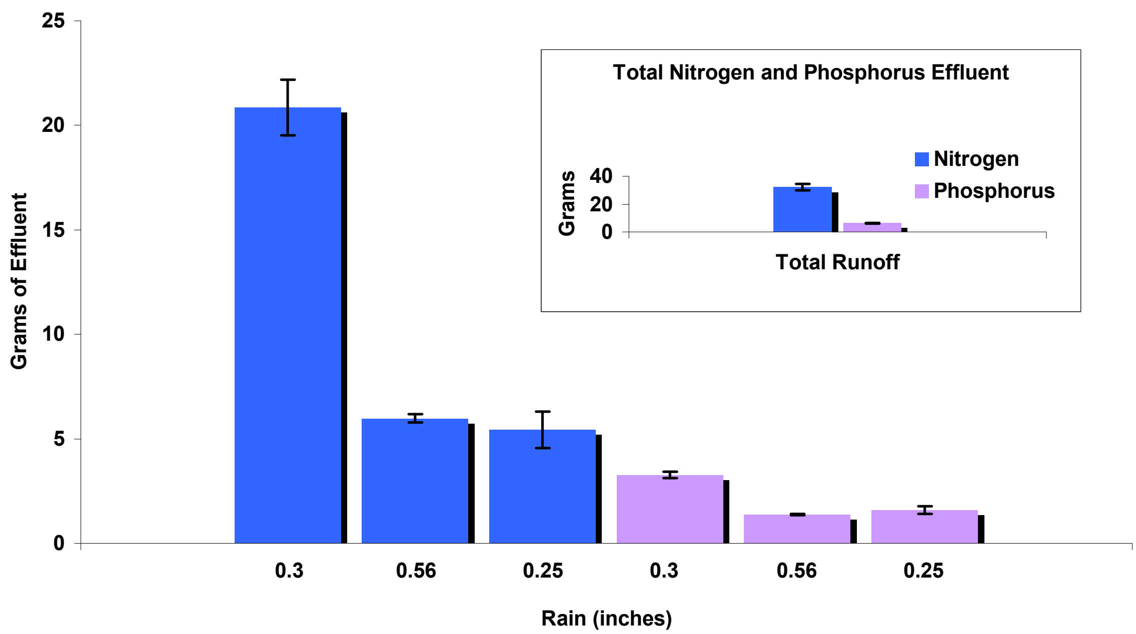


Figure 8 - Rainfall runoff physical properties

The physical properties of this rainfall event (Figure 8), show the initial flush was high in dissolved solids, peaking at near 1200ppm, then dropped off to 50ppm at the end of the rain event. Turbidity peaked with an increase in suspended solids.

Figure 9 - Total effluent shows the estimated total effluent for nitrogen and phosphorus over the course of the rain event. Due to the location of the pilot facility, the plumbing of the sampling area could not be outfitted with flow instrumentation. Therefore, the project team used rain data to estimate total flow volumes with a lag time added.

Figure 9 - Total effluent



Using the estimates of total effluent from the windrow. The Ag-Bag system mitigated for 270 grams of nitrogen into surface waters, and 50 grams of phosphorus. The mitigatory effects of the Ag-Bag system can be extrapolated using this information. A facility with a given volume of material on site using the CT-5 would reduce the nutrient runoff to surface water during a 1-inch rain event by the amount in Table 20 - Nutrient mitigation.

Table 20 - Nutrient mitigation

Facility Size (yds^3)	Nutrient Mitigation (kg)	
	Nitrogen	Phosphorus
20000	15.15	2.93
15000	11.36	2.20
10000	7.58	1.46
7500	5.68	1.10
5000	3.79	0.73

This does not take into account the amount of supplemental nitrogen added to the compost within the EcoPODs. Presumably the mitigatory affect of the Ag-Bag system would be greater under these conditions. Further, analysis of variation in nutrient loss over many rain events was not feasible for the project due to the temporary nature of the facility and location of the sampling area.

SPLP analysis

Table 21 - SPLP metals in final compost product

Metal	90% CI	Limit *
As	0.0099	5
Ba	0.0219	100
Cd	0.0002	1
Cr	0.0007	5
Pb	0.0011	5
Se	0.0021	1
Ag	0.0006	5
Hg	0.0003	0.2

The synthetic precipitation leaching procedure (SPLP), solid waste method 1312, was conducted on the solid waste feedstocks and compost to determine their potential to release environmental pollutants during rainfall. These showed the food waste compost contained no contaminants of concern at levels above those required by the Resource Conservation and Recovery Act (RCRA). These results are displayed in Table 21. Table 22 through Table 24 display results for organics and metals analyzed in feedstocks using the SPLP procedure.

Table 22 - SPLP metals in feedstock

Metal	90% CI	Limit*
As	0.147	5
Ba	3.864	100
Cd	0.001	1
Cr	0.043	5
Pb	0.007	5
Se	0.042	1
Ag	0.006	5
Hg	0.001	0.2

Table 23 - SPLP pesticides in feedstock

Pesticide	90% CI	Limit*
Chlordane	0.010	0.03
Endrin	0.002	0.02
gamma-BHC (Lindane)	0.001	0.4
Heptachlor	0.004	0.006
Heptachlor epoxide	0.001	0.006
Methoxychlor	0.002	10
Toxaphene	0.009	0.5

* RCRA toxicity criteria

Table 24 - SPLP volatile organic compounds in feedstock

Organic Compound	90% CI	Limit *
1,1-Dichloroethene	≤ 0.01	0.7
1,2-Dichloroethane	≤ 0.01	0.5
1,4-Dichlorobenzene	≤ 0.01	7.5
2-Butanone	0.05	200
Benzene	≤ 0.01	0.5
Carbon tetrachloride	≤ 0.01	0.5
Chlorobenzene	≤ 0.01	100
Chloroform	≤ 0.01	6
Tetrachloroethene	≤ 0.01	0.7
Trichloroethene	≤ 0.01	0.5
Vinyl chloride	≤ 0.01	0.2

The observations made by the project team would vary if a different system were used, such as the larger CT-10. Though the PODs can potentially rupture, this effect is minimized through the use of best management practices and an experienced operations team.

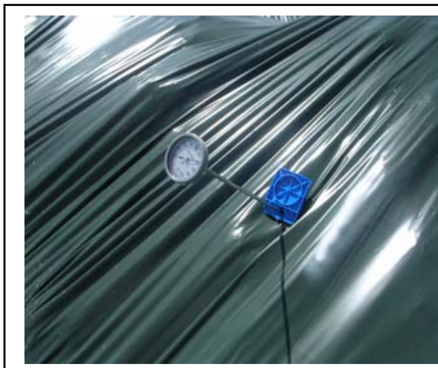
The differences between a large-scale commercial facility and the pilot facility would also affect various aspects of the sampling program such as:

- Exposure to contaminants, including both physical and chemical, would be limited by locating a facility farther from an active landfill face.
- Sampling could be much more standardized and cost would be significantly lower than costs for the pilot project sampling plan.

Future sampling programs designed around facilities with surface water collection and retention systems would provide an environment to better assess the nutrient risks associated with a food waste compost facility. More statistically reliable data sampled over longer periods under various conditions could be provided. Further, a sampling program specifically targeting a few parameters could be implemented in a much more cost effective way.

Monitoring Process

The monitoring of the composting process was conducted for three primary purposes:



Temperature probe

1) To assess the efficiency and effect of the aeration systems as a part of the Ag-Bag CT-5 in-vessel system.

2) To ensure compliance with US Environmental Protection Agency part 503 biosolids rules. Specifically process to significantly reduce pathogens (PSRP) and process to further reduce pathogens (PFRP) requirements.

3) To determine appropriate schedules for material harvest.

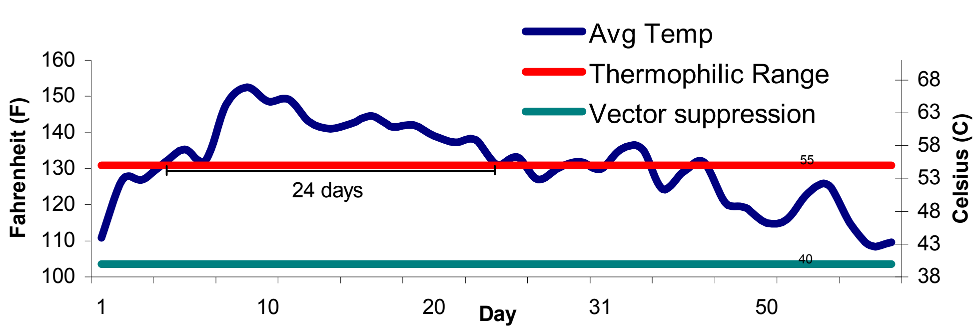
Monitoring data was collected over a six-month period beginning in June 2003 and ending in December 2003. The local climate during this period was hot and humid in June - September, as is characteristic of Florida during the summer season, then cooled to more moderate temperatures over the fall and winter months. The thermophilic composting phase took place in June through September, in which ambient temperatures ranged from 28 to 37 degrees Celsius (80 – 100 F), with most days averaging 33C.

Three types of data were collected at various frequencies for monitoring purposes: temperature, oxygen, and moisture. Temperature was collected most regularly and provided the vast majority of the monitoring data for the project. Temperature is an excellent indicator of the composting process and only when temperatures behaved in unexpected ways did the project team use other monitoring techniques to troubleshoot processing problems.

Temperatures were collected daily for two weeks upon initial loading of each EcoPOD and then at least weekly thereafter. A ReoTemp® stainless steel bi-metal compost thermometer (48") was utilized to take temperature readings. Appendix I contains temperature curves for all the PODs in the project. Certain graphs are included in this section as well for convenience.

All PODs used in the project allowed the material to reach thermophilic temperatures for sustained periods. Requirements of part 503 are 15 days and 3 days above 55 Celsius for windrows and in-vessel or aerated static pile methods respectively. The average number of days in which materials maintained temperatures above the thermophilic range was 30 days. The shortest duration was 15 days, the longest 64.

The material began composting immediately and heated quickly to the thermophilic range, usually peaking between 65 and 75 degrees Celsius within the first three days. The composting material maintained these temperatures for 2-4 weeks and then slowly cooled, sometimes reheating to thermophilic temperatures for short periods. The mesophilic stage then continued for another 6-10 weeks. Vector suppression temperatures were maintained throughout the composting process, including materials that were semi mature to mature. Figure 10 depicts the temperatures for POD 1, which is characteristic of the process.

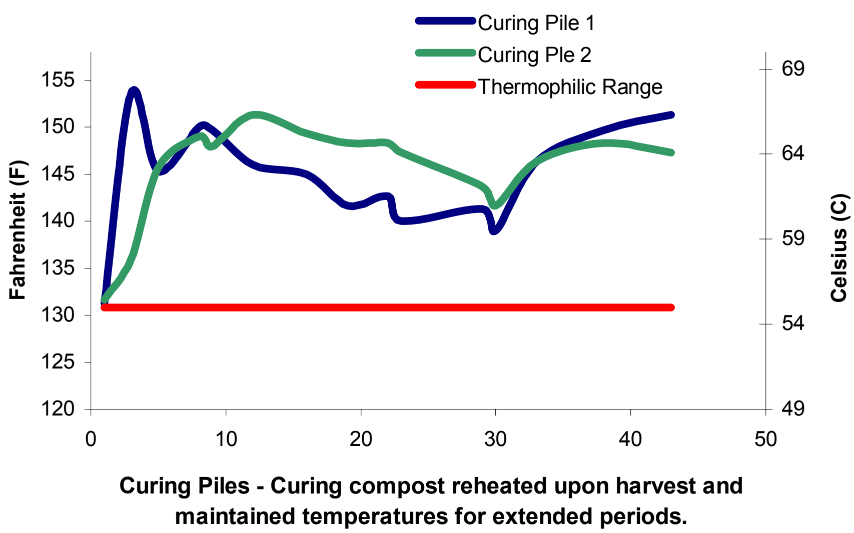


POD 1 - Average temperatures per day over a three month period. Composting product meets with part 503 recommendations for pathogen and vector control. Material composted above 55C from July 12th through August 4th, a total of 24 days.

Figure 10 – Temperature curve for EcoPOD 1

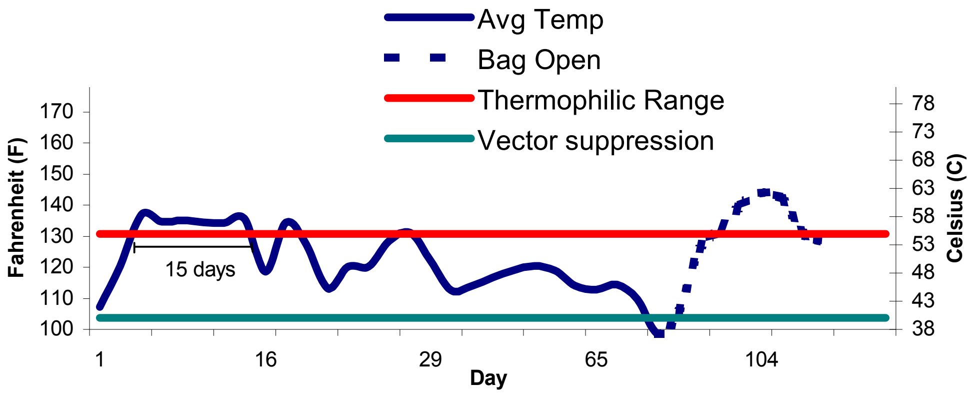
When a POD had composted for the recommended 8-12 weeks and significant cooling was observed, material was harvested. Details of this process are discussed in section Pilot Facility. PODs 1-6 were combined and cured on the receiving pad while other PODs were cured individually. Monitoring continued for materials when practicable and this period is represented in Figure 11 - Curing piles. Reheating was observed after harvest and material returned to thermophilic temperatures for up to many weeks. Only those PODs that were not recombined after harvest could be measured individually for reheating characteristics.

Figure 11 - Curing piles



Some PODs received additional organic nitrogen (i.e. urea) at the beginning of the process as discussed in section Pilot Facility. Figure 12 - POD 7 temperature curve, illustrates the difference in composting characteristics of those materials that did not receive additional nitrogen. These PODs did not reach peak temperatures as high as those that received nitrogen, nor did they maintain temperatures for as long. In fact, peak temperatures observed after harvest were often higher than those observed when material was first added to the POD. Further, PODs lacking additional nitrogen dried more quickly than did others, most likely a combination of their proximity to blower fans and their reduced rate of respiration.

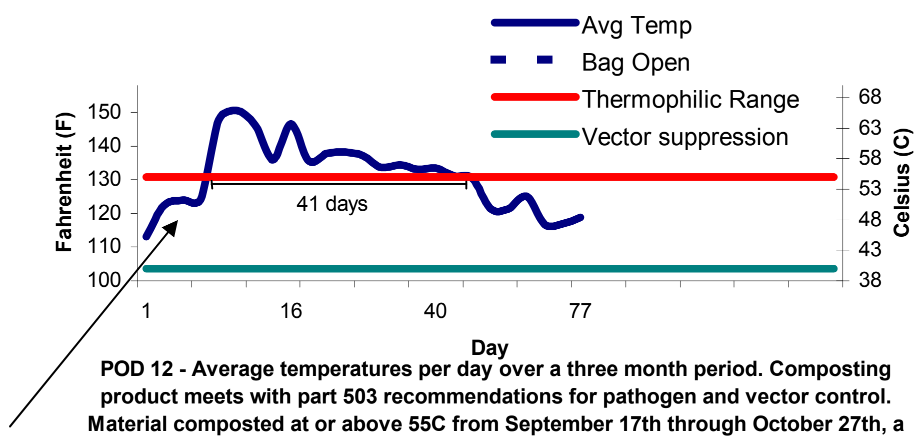
Figure 12 - POD 7 temperature curve



POD 7 - Average temperatures per day over a three month period. Composting product meets with part 503 recommendations for pathogen and vector control. Material composted at or above 55C from August 7th through August 21st, a total of 15 days.

As mentioned previously aeration data was also collected. This was calculated as percent oxygen of the air within the pile (20.9% O_2 is saturated air), was collected when deemed necessary to assess problems in process management. Appendices E and F show two aeration configurations used during the project. Configuration 1 was used initially and then modified for configuration 2. As the appendices indicate, POD 12 was located far from an aeration source under configuration 1, and closer under configuration 2. Observe Figure 13, the temperature curve for POD 12. Note the initial heating characteristics, particularly the spike at day 6:

Figure 13 - POD 12 temperature curve



POD 12 - Average temperatures per day over a three month period. Composting product meets with part 503 recommendations for pathogen and vector control. Material composted at or above 55C from September 17th through October 27th, a total of 41 days.

Upon loading, the material heated to about 50C (120F) and then leveled off. Oxygen readings during this period were averaged at 2% O_2 in POD 12, and 4% in POD 11. After modifying the location of the blower to its position in configuration 2, oxygen levels increased 100% and 300% in PODs 11 and 12 respectively. This correlated with a spike in temperature that brought both PODs into the thermophilic range. POD 12 saw the most increase and maintained its temperatures longer.

Aeration proved to be an ongoing challenge. Power sources were not as reliable as projected and leachate contributed to air blockage in POD 11. The temporal non-uniformity of aeration most likely contributed to the volatility observed in many of the temperature curves. Natural breakdown, matrix decomposition, and compaction are likely factors influencing these observations as well, especially in PODs containing additional nitrogen, in which pockets of nutrient-rich matrix may become available as the composting process progresses.

Upon harvest of the nitrogen-rich PODs 1 through 6, material was combined into two windrows on the operating pad for curing. These materials were monitored for temperature and showed strong reheating characteristics. Piles heated to 68C(~154F) and remained thermophilic for many weeks. The temperature curves are included in Appendix I. The materials showed strong reheating after turning as well. The compost was removed from the operating surface due to operation constraints at the disposal complex and was screened, then recombined with other materials to form the finished product.

2.4.2 - Demonstration of cooperative effort with other Counties in region

The project team worked with the Recycle Florida Today organics committee to communicate lessons learned over the course of the project. Information was shared with solid waste officials, managers, business people and interested parties from a number of Florida counties, including:

- Osceola County solid waste
- Hillsborough County solid waste
- City of St. Pertersburg sanitation services
- City of Lakeland
- City of Tallahassee
- Georgia Department of Natural Resources

This included sharing information about:

- Diversion and collection strategies
- Technology not in common use in Florida (eg Ag-Bag CT-5)
- Composting recipes for food and yard waste
- Permitting and regulatory issues

If the state, or any locality, wishes to implement a sustainable food waste recycling program, the information provided through this segment of the project will be critical during the planning, setup, and operation phases of a new program.

Further, the project team assessed the composting process and its effect on human health and the environment. This was done in an effort to recommend rule change or exemption status for facilities within the state of certain size and type. All counties within the state will benefit from any modifications or adaptations the department makes.

2.4.3 - Equipment/Services list of those leased in individual project areas

The project objectives were modified to include the operation of a temporary pilot facility to study the composting process. This meant the project was primarily a consulting project with no large equipment purchases made. However, a variety of equipment was leased to the project for the food for plants segment. This included:

- Ag-Bag CT-5 and associated equipment
- Packer 750 grinder
- Solar array and associated power equipment
- Kubota tractor loader
- Isco 6712 autosampler

Further the following services were purchased by the project:

- Analytical laboratory services
- Site improvements and modification
- Third party professional consulting services
- Construction and demolition of facility site
- Compost screening services
- Material hauling services
- Trash collection services

In addition to purchases, a variety of equipment was donated to the project:

- Compostable trash bags
- Source separation training manuals
- 64-gallon wheeled waste containers
- Yard waste materials

Solar array

At the conclusion of the project the solar array system was donated to the Gulf Coast Wonder and Imagination Zone (GWIZ) a Sarasota not-for profit science center and childrens' museum.

2.4.4 - Problems encountered and how they were addressed

The challenges faced by the project team in operating the facility were varied and allowed for frequent opportunities to investigate the composting and collections processes to find solutions.

Challenge 1 – Location

The location of the facility on an active cell of the Sarasota County Landfill complicated operations in a number of ways:

- Odor management at a composting operation is of primary importance in maintaining public relations and preventing the creation of nuisance conditions. The odors produced at the pilot facility were difficult to distinguish from those produced by the operation of the landfill. Therefore, the project team was not able to make an unbiased assessment of the odor risks associated with a food waste composting facility in Southwest Florida.

- The roads to the facility were difficult to maneuver in wet conditions. This was compounded by the fact that the project operated the facility during the wet season. The facility was not operated during rain events, but delivery trucks were stuck several times in persistent muddy conditions, complicating collections and processing.

- The proximity to the active face attracted vectors to the facility. This included birds, raccoons and possums. The high population density of these animals near the facility caused more frequent visits and intrusions that were difficult to prevent.

- Proximity to the active face allowed for cross contamination of waste and leachate. Vectors (i.e. birds) and wind deposited waste onto compost while curing. The project team monitored the material and removed solid waste manually. Trucks and machinery operating near the facility provided a source for chemical contamination. Diesel exhaust is known to contain metals such as mercury and volatile organics such as ethyl benzene and methyl ethyl ketone (2-butanone or MEK).

- The operating surface was 6” of mulch over 18” of intermediate cover. This surface was not ideal for operating equipment, both during harvest and while filling the Ag-Bag. Harvested material was not recovered at ideal rates for fear of mixing with material from the operating surface. The project team minimized these impacts when feasible.

- The east end of the facility became waterlogged during and after heavy rain, sometimes remaining so for weeks. This reduced the total operating area of the facility. The project team did not operate equipment in this area, which extended for about 30 feet from the east end of the facility. As the rainy season ended and Sarasota County was able to correct the problem, the water drained away.

- Power had to be produced on site. This increased cost and made uniform aeration a challenge. These problems are addressed in the power system and management section.

Challenge 2 – Ag- Bag operations

- The EcoPOD tore on two occasions as it was being loaded. Bags were reloaded or repaired as needed. Spilled materials were loaded back into bags. The operations team conducted more careful spotting while loading bags to address problems before they become breaks.
- Leachate appears to be generated and contained within the AgBag Pods. This situation was monitored, and additional yard waste was added in an attempt to balance moisture content of the feedstock. Though water is generated as a product of the composting process, one function of the Ag-Bag system is to contain this leachate.
- Additional aeration demand due to increased EcoPOD numbers put stress on the system and caused aeration inefficiency. New equipment was installed to compensate for the increased demand. The composting process was not significantly impacted, though some observations of temperature reduction are likely.
- Intrusion into the bags by raccoons and birds presented a challenge. Damage was repaired as it occurred and the impact on composting was minimal. The situation was monitored to assess the risk it causes for operations and environment. Though damage does pose the risk of causing leaks, this never occurred and is unlikely to occur.
- Materials were semi-mature and clumpy when harvested due to lack of agitation within the EcoPOD. This meant after agitation during the harvest operations, the material reheated to thermophilic temperatures and continued composting for many weeks during curing.

Challenge 3 – Equipment operation

- The grinder jammed frequently when the smaller 2 ¼ " screen was used. Using the 3" screen helped this problem, though certain feedstocks continued to be problematic (i.e. cakes and pastries).
- The material exiting the grinder was often clumped together, making homogenization and addition of yard waste using the tractor-loader more important and added to processing time.
- Grinder downtime slowed processing. Caused were screen jamming, fuel shortages, and mechanical problems. The project team lowered occurrence rates with equipment experience.

Challenge 4 – Waste Separation

- Contamination issues delayed processing and occasionally caused loads to be disposed of in the landfill. By working closely with generators, the project team was able to minimize these issues.
- The project team did do some manual separation of wastes that arrived in packaging. This was extremely time-consuming to separate manually and was only conducted on one occasion at the facility.

Section 3 - Results

3.1 - Objectives met or not met? how?

The project consisted of many segments, working separately to achieve common goals. The objectives and successes of each segment are presented below.

3.1.2 - Food for People

The food for people segment set out to maximize the diversion potential of organic wastes by donating to people when possible, putting it towards its best end use. This goal was accomplished through the procurement of a refrigerated truck to increase the flexibility of the Food Bank in both collection and distribution.

Prior to the implementation of the refrigerated collection program, the Food Bank distributed approximately 1.3 million pounds of food - the equivalent to approximately 60,000 meals per month. After implementation, the Food Bank increased distribution to 2.5 million pounds of food - the equivalent to approximately 166,000 meals per month. While not all of this increase is attributed to the new truck, it was a critical element in program expansion.

The capacity of the truck to refrigerate foods allowed for both more flexible and loner-range distribution while simultaneously allowing the Food Bank to collect goods from generators otherwise incapable of donation with a non-refrigerated truck.

3.1.2 - Food for Animals

The project team set out to design and organize a food diversion program for animals. A comprehensive, countywide program was not implemented over the course of the project, though many avenues of recovery were investigated and materials produced, including:

- Logistics of source separated collection including regulatory parameters
- Training materials for separation of food for plants and food for animals
- Innovative technologies were investigated for cost effectiveness

The Food Bank has found alliances with local farming and non-profit institutions are a nice compliment to its program. Any business in Florida can utilize this model for direct relationships with farmers to divert organics.

3.1.3 - Food for Plants

The objective of designing, constructing, organizing and operating a sustainable food composting operation was not implemented. Due to reasons discussed elsewhere, the project team deemed this goal unfeasible.

The objectives of the project were redeveloped in cooperation with county and state personnel. These new objectives, as specified in the introduction, were intended to create a pilot program to study the process of food composting and develop recommendations for the county and the state based on the findings.

This new objective was accomplished in a number of ways:

- Sampling and analysis – The project team designed and implemented a sampling scheme that would conclude what risks food waste composting posed to human health and the environment. This was executed and the results included as part of this report.
- Operation – The project team developed practices and strategies around an innovative composting technology not currently used in the state (Ag-Bag CT-5).
- Collection – The project team collected data on logistics, challenges, and costs involved in a source separated organics collection system.

The data provided through the implementation of this new objective will be used to supply the state and other counties with valuable information with regards the design, setup and implementation of food waste composting operations.

3.2 - Demonstration of processes not in common use

The intrinsic value hierarchy of food waste diversion is a novel method of waste management that is currently not employed in the state of Florida. Only 16 of the 67 counties in Florida recycle food waste of any kind, many of these at low levels. Food waste is currently recycled at a 4% rate, making food waste diversion and reuse an important innovation for meeting statewide diversion goals.

Through the food for people segment of the project, the project team was able to divert large quantities of food to its most valuable end use – feeding people. Some of the food diverted to the Food Bank couldn't be distributed in time for people and was not suitable for people. The project team then collected this waste and recycled it into food for plants. This demonstrates an innovative approach to waste management that captures the most valuable parts of the waste stream. When initiated in a commercial scale for on-going operations, this represents a significant shift from traditional food waste management strategies.

The Ag-Bag CT-5 system is also not in common use in Florida. The project team sought to find a means of diverting food wastes without incurring the cost of constructing a full-scale leachate collection system as required by solid waste permit. It was chosen as the technology of choice for three reasons:

- Low capital investment
- Did not expose material to the environment
- Low ongoing maintenance costs
- Farmer field friendly

3.3 - How this project led to greater quantities of recovered materials, created a product more recyclable/marketable

Currently the national average for food waste recycling is approximately 3%. This means that there is an incredible opportunity for diversion within this waste stream. This project has furthered the goal of increasing this number in Florida through the use of innovative methods and technologies.

The pilot program implemented during this project was used to evaluate techniques for diversion, impacts of composting, and market potential. This information will provide an important resource for other municipalities when they attempt to implement a food waste recycling program. By expanding the body of knowledge available to potential operators and regulators concerning food composting and source separation methods, a greater quantity of food wastes will be recovered and reused when full-scale operations are commenced.

Nutrient value of compost was increased through the introduction of food waste into the yard waste composting process. This increases the product's marketability and end uses in agricultural and horticultural applications. High quality, nutrient-rich compost has broad end use applications. Some of these include:

- Agriculture – Composts add organic matter and slow-release nutrients to soil, increasing long-term productivity and disease suppression.
- Landscaping – Compost can be blended into soils for slow-release nutrient availability for grass, trees, shrubs, and flowers.
- Horticulture – Fine, mature composts can be used as potting amendments for ornamental and food plants.
- Erosion control – Composts can be incorporated into soil, used in terra-seeding operations, or constructed into filter berms for slope stabilization, runoff mitigation, and reseeding projects.

These uses are better applied with compost higher in nutrients. Carbon-Nitrogen (C:N) ratio is a frequently used indicator of the nutrient content of compost. The average C:N ratio in yard waste compost is approximately 20. The average C:N ratio in the compost produced during the project was 16. This increase in nutrient value creates a product with more value-added characteristics, thereby increasing marketability.

Composting of MSW is a common mass reduction strategy for waste management entities. The marketability of this material is often limited by contamination issues. Often this prevents distribution by creating a product below class A qualification under Florida rule. By employing source separation methods to eliminate contamination, the project has increased marketability of compost products, and furthered the reputation of the industry as a whole. Table 25 - Food Waste Compost Properties outlines the final properties of the compost produced by the project team.

Table 25 - Food Waste Compost Properties

Parameter	Unit	Value
Moisture	% by weight (gals/ton)	34.43 (85)
Total Nitrogen	mg/kg – dry (lbs/ton)	5500 (10)
Nitrate-Nitrite	mg/kg – dry (lbs/ton)	190 (0.34)
Total Phosphorus	mg/kg – dry (lbs/ton)	1000 (1.8)
Total Potassium	mg/kg – dry (lbs/ton)	4500 (8.1)
Organic Matter (Total Volatile Solids)	% by weight	33
Reduction in Organic Matter	% by weight calc.	76
PH	Standard units	7.94
Foreign Matter	% by weight – dry	0.37
Cadmium	mg/kg – dry (lbs/ton)	0.08 (0.0005)
Copper	mg/kg – dry (lbs/ton)	10 (1.8)
Lead	mg/kg – dry (lbs/ton)	3.7 (0.007)
Nickel	mg/kg – dry (lbs/ton)	3.2 (0.006)
Zinc	mg/kg – dry (lbs/ton)	40 (7.3)
Fecal Coliform	cfu/g	Undetected at 117

In addition to the regulatory parameters outlined above, the material also has the agronomic characteristics outlined in Table 26 - Compost agronomic characteristics.

Table 26 - Compost agronomic characteristics

Attribute	Unit	Value
C:N	w:w	16.3
NH_3 rate[1]	tabular	5 (absent)
CO_2 rate[2]	tabular	7 (low)
Maturity Index[3]	tabular	7 (mature)
Bulk Density	lbs/yd^3	1112
Solids	% (lbs/ton)	64.6 (1292)

[1] Ammonia respiration based on the Solvita® maturity test. This is a scale of 1 – 5 with one being high respiration and five being low or absent.
[2] Carbon dioxide respiration as measured by the Solvita® maturity test. This is a scale of 1 - 8 with one being high respiration rate and eight being lowest.
[3] The Solvita® maturity index is a composite index of carbon dioxide and ammonia respiration. It is a scale of 1-8 with one being immature and eight being very mature. The compost produced by the project was a 7, "Well matured, aged compost, cured; few limitations for usage."

Water Holding Capacity	**gals/ton**	**118**
Conductivity	**mmhos/cm**	**3.6**
Sodium	**lbs/ton**	**2.1**
Calcium	**lbs/ton**	**131**
Magnesium	**lbs/ton**	**3.6**

Growth tests using cress grass (*Lepedium sativum*) yielded 100 percent germination and high (83%) weight as well.

The project team estimated market value through trials and the observations of professionals in the landscaping and horticultural fields. These included:

- Selby Botanical Gardens
- Various local landscapers
- Florida House (local non-profit demonstration project)
- Education using growth trials at a local school
- Germination and biomass experiments (see sampling section)

Education and outreach

The compost would likely sell at $9-$10 per yard on the open market if distributed in bulk, more if sold in individual bags. This would represent a greater overall program cost efficiency, profitability and sustainability with available end markets.

The nursery industry represents a strong potential market for these materials. Nurseries in Florida rely entirely on "peat" as a major component in potting soil media mixes. Peat is a non-renewable resource harvested in Florida and Canada. Escalating peat costs are a major concern for this industry. Nursery crops, in general, have high profit margins and the majority of the crops are growing in pots, so when a production cycle is completed, and the crop is sold, the growing potting soil media is sold with it. So, nursery growers must acquire new potting soil media at each new planting cycle. Table 27 - Compost use savings, shows the savings that can be expected by a nursery using compost as a replacement for peat moss in potting mixes. This assumes volume of 2,500 gallons of potting mixes used.

Table 27 - Compost use savings

	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Peat Treatment	0%	30%	0%	60%
Compost Treatment	100%	30%	60%	0%
Price of Peat (cu yard)	$20.00	$20.00	$20.00	$20.00

	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Price of Compost (cu yard)	$9.00	$9.00	$9.00	$9.00
Cost in Peat	$0.00	$345.60	$0.00	$691.20
Cost in Compost	$518.40	$155.52	$311.04	$0.00
Total Cost	$518.40	$501.12	$311.04	$691.20
Savings	$633.60	$190.08	$380.16	$0.00

Savings were calculated by subtracting total cost from the cost of using peat at the application rates of compost plus peat in the treatment. For example, Treatment 1 is 100% compost, the savings then are the difference between using 100% peat and 100% compost, while treatment 2 is 30% compost and 30% peat, so the savings are the difference between using 30% peat and 60% peat.

The remainder of the volume of the potting mix is additional potting material, such as vermiculite and perlite. These materials are not factored into total cost or savings. These materials would likely be used in conjunction with compost.

The horticultural trials (page 73) indicated that treatments 2 and 3 were effective replacement schemes for peat moss. As Table 27 shows, the potential savings for a nursery grower are significant. The environmental horticulture industry, which includes gardening and landscaping, is a $9.9 billion Florida industry, representing a large potential end market.

Future avenues of research can now be investigated. This project has answered many questions concerning the state of food recycling in the Florida, and many more have arisen. Through future programs and research, a much greater degree of materials will be recovered, and more valuable products created, expanding the potential for the diversion of this important segment of the waste stream.

3.4 - Transferability/applicability of technology/processes and applicability to other communities.

The collections systems, training materials, and data produced by this project are made available to the department and to other communities in the state for the purposes of furthering the goal of increasing local and state diversion rates.

The Ag-Bag CT-5 technology is transferable to other counties in the state and constitutes an opportunity to increase statewide diversion if the Department provides proper incentives for its utilization.

If FDEP adopts any rule change, as outlined below in part 3.5 section (e), these will be applicable to other counties in the state and all municipalities will benefit from any modifications that occur.

3.5 - Analysis of how this program resulted in cost efficiency as measured against statewide average costs.

a) FDEP funding for components of the program

Table 28 – FDEP Project Funding summarizes the project elements and the funding expended in each category, exclusive of in-kind contributions, which are presented in Section 3.5 (a).

Table 28 – FDEP Project Funding

FDEP PROJECT FUNDING	
Project Elements	**FDEP Funding**
1. Food for People	
1a. Refrigerated Collection Truck	$ 364
1b. Outreach	955
1c. Driver	-
2. Food for Animals	
2a. Refrigerated Collection Truck	-
2b. Outreach to Farms	1,709
2c. Outreach to Stores	68
3. Food for Plants (composting)	
3a. Facility design and Permitting	73,558
3b. Composting Pad (fill material)	1,136
3c. Composting Pad (transport fill)	23
3d. Composting Pad (site prep.)	1,555
3e. Composting Site Misc. Improve.	23
3f. Composting Equipment (lease)	52,070
3g. Operator Training	375
3h. Design collection route	4,162
3i. Collection and Tip Fees	2,846
3j. Collection container rental	-
3k. Education/training of generators	480
3l. Operator Compensation	85,133
3m. In-Vessel System	13,205
3n. Ground Urban Plant Debris	-
3o. Sampling and analysis	127,791
3p. Marketing Product	250
3q. Screening	-
3r. Lease Land	-
4. Food for Plants (Vermi-compost)	
4a. Design, and Permitting	22,109
4b. Operator Training	$ 45
4c. Vermi-Composting Equipment	5,526
4d. Operator Compensation	619
4e. Horse Manure	-
4f. Marketing Product	-
4g. Worms	455
5. General Tasks	
5a. Reporting, Dissemination of Information, Administration	40,883
5b. Insurance	-
5c. CHAC Administration	974
Total (total may differ due to rounding)	**$ 434,992**

b) Project expenditures – public and private

Table 29 - Public and Private In-Kind Contributions, summarizes project expenditures.

Table 29 - Public and Private In-Kind Contributions

Public and Private In-Kind Contributions	**TOTAL IN KIND**	**REPORTING PERIOD**											
Task		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1. Food for People													
1a. Refrigerated Collection Truck													
All Faith Food Bank	**$ 76,785.00**					x							
1b. Outreach													
1c. Driver													
All Faith Food Bank	**$ 34,557.00**					x							
2. Food for Animals													
2a. Refrigerated Collection Truck													
2b. Outreach to Farms													
2c. Outreach to Stores													
3. Food for Plants (composting)													
3a. Facility design and Permitting													
Resource Management Group	**$ 11,485.00**			x	x	x	x						
Gary Bennett	**$ 1,854.00**				x	x							
Sandra Washington	**$ 69.00**					x							
PBS & J	**$ 2,449.00**					x							
Tom Keith	**$ 120.00**					x							
Paul Wingler	**$ 2,094.75**				x	x	x						
Jodi John	**$ 450.00**				x								
Jean Nutter	**$ 579.09**				x	x							
3b. Composting Pad (fill material)													
3c. Composting Pad (transport fill)													
3d. Composting Pad (site prep.)													
3e. Composting Site Misc. Improve.													
3f. Composting Equipment (lease)													
Resource Management Group	**$ 1,650.00**									x			
3g. Operator Training													
Resource Management Group	**$ 2,500.00**								x	x			
3h. Design collection route													
Sarasota County-Stephen Brown GIS Supervisor	**$ 188.00**				x								
3i. Collection and Tip Fees													
City of Venice Solid Waste Tipping Fee $5 x 35.00 x 2	**$ 350.00**										x		
3j. Collection container rental													
Publix purchase price of inside containers & bags	**$4,084.48**						x	x		x			
3k. Education/training of generators													
Publix Management hourly contribution	**$ 8,400.00**				x	x	x	x	x	x	x	x	
3l. Operator Compensation													
Resource Management Group	**$ 11,499.00**												
3m. In-Vessel System													

Public and Private In-Kind Contributions	**TOTAL IN KIND**	**REPORTING PERIOD**											
Task		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
3n. Ground Urban Plant Debris													
Mulch/Onyx	**$ 2,568.67**										x		
3o. Sampling and analysis													
Frank Desteno/Sarasota County-May-July 2003	**$ 392.59**								x	x			
Resource Management Group	**$ 1,003.00**												
3p. Marketing Product													
3q. Screening													
3r. Lease Land													
4. Food for Plants (Vermi-compost)													
4a. Design, and Permitting													
Resource Management Group	**$ 7,036.00**			x	x	x	x	x	x	x	x		
4b. Operator Training													
4c. Vermi-Composting Equipment (lease or purchase)													
Earth Machine compost bins $25.00 x 6	**$ 150.00**			x									
4d. Operator Compensation													
4e. Horse Manure													
4f. Marketing Product													
4g. Worms													
5. General Tasks													
5a. Reporting, Dissemination of Information, Administration													
Sarasota County-Jean/VUS Composting /Vegas	**$ 1258.28**												
CHAC	**$ 133,365.00**						x						
Resource Management Group	**$ 1,187.00**												
Publix luncheon for workshop $145.00	**$ 145.00**										x		
Total	**$ 306,219.86**												

c) Tipping fees avoided

The project established sustainable commercial scale programs for diversion in the Food for People and the Food for Animals levels of the hierarchy. A facility wide diversion program was established for the Food for Plants – Vermicomposting component. Finally, a pilot scale facility operated for four months demonstrating the Food for Plants – Innovative Composting Pilot program. Table 30 - Tipping Fees Avoided, summarizes the avoided tip fees for each program element. Diversion for these programs are described below.

Table 30 - Tipping Fees Avoided

Program	***Tons Diverted***	***Tip Fee Avoided***
Food For People	181	$ 11,765
Food For Animals	40	2600
Food For Plants – Vermicomposting	12	780
Food For Plants – Innovative Composting Pilot	120	0
TOTAL	353	$ 15,145

Food For People

The Food Bank is diverting approximately 17,277 lbs per month collecting food discards from seven groceries on its regular route. Since the new truck was placed into service, approximately 181 tons of waste has been diverted. In addition, the truck has been used to make special collections, which is not tracked specifically by the truck used for the collection, but adds to the food bank's overall diversion numbers. Additionally, by creating a distribution network in south Sarasota county, the Food Bank has been able to accept more donations overall, since it has more outlets to send supplies. Overall, the Food Bank has increased the amount of food it is distributing to agencies by over 1 million lbs per year, during the grant period.

Food For Animals

The Food Bank diverts approximately 3300 lbs per month to three farmers and two non-profit organizations. During the grant period, approximately 40 tons of food has been diverted in this manner.

Food For Plants – Vermicomposting

CHAC has been diverting food waste from its residences and on-campus programs for use in its vermicomposting operation. Approximately 10 to 150 lbs per day is being diverted, depending on programs being held on campus, the number of clients being served, and the types of discards being generated. The project team estimates that average diversion is 200 lbs per week since the vermicomposting bins were installed. During the grant period, approximately 10 – 12 tons of waste has been diverted.

Food For Plants – Innovative Composting Pilot

The County and RMG operated a pilot facility that diverted a total of 120 tons of waste, however there was not avoided tip fees due to the operation being conducted at the County landfill. If a permanent program were to be established, the County would likely establish a new tip fee for source separated food waste, which would be lower than the tip fee for municipal solid waste.

d) Cost/benefit analysis – include assumptions

Food For People

The capital cost of a refrigerated truck is approximately $75,000. With the cost of the truck amortized over six years, $5,000 per year for fuel, maintenance and insurance, and $25,000 per year for the cost of the driver, the cost of operation is estimated to be approximately $45,000 per year. This allows the Food Bank to divert usable food to people in need for under $0.22 per lb.

Food For Animals
Because the farmers and non-profits in the program pick up the food, there is no cost to the organization, except for handling of this waste stream separately from disposable wastes. The Food Bank saves both landfill fees and hauling charges. This aspect of the program is the most cost effective of all aspects of the Food Recovery hierarch, as long as a farmer is willing to conduct the collection and the generator is willing to hold materials for pickup. This component can be accomplished with no new equipment purchases.

Food For Plants – Vermicomposting
Vermicomposting is ideal for on-site composting, which can be accomplished without seeking a solid waste management permit. Vermicomposting equipment purchased for the project, exclusive of training, cost approximately $2,000 including worms, and is anticipated to last approximately five years, or more. At the current rate of use, 10-12 tons per year, the cost of the system for five years of use is $33 to $40 per ton, which is half to one-third less than the cost of disposal in local landfills. The system capacity is greater than its current use, therefore increased diversion could result in even lower cost per ton for diversion.

Food For Plants – Innovative Composting Pilot
This project was conducted on a pilot scale with the intent of investigating the impacts of food waste composting on the environment. The facility’s size, equipment, and operating costs are not comparable to that of a commercial scale operation. Therefore the cost/benefit analysis of the project does not provide an accurate assessment of the actual cost/benefit of a full-scale operation utilizing appropriate methodologies.

Further investigation into appropriate management strategies, infrastructure development, and collections methods is necessary in order to assess the costs and benefits of composting in Southwest Florida. Initial findings indicate that diversion programs can be initiated in cost efficient ways provided the cost of collection is comparable to, or lower than, current collection fees (see section Diversion Program).

e) How did the project recycle non-traditional materials and aid in marketability/availability of products

According to FDEP solid waste and recycling reports, food waste comprises approximately 11% of the organic municipal solid waste fraction, yet makes up 1% of the overall recycling stream (see Figure 14 - Components of Florida's recycling stream). This makes it a non-traditional material that will require further innovation and management to divert on a statewide scale.

Figure 14 - Components of Florida's recycling stream

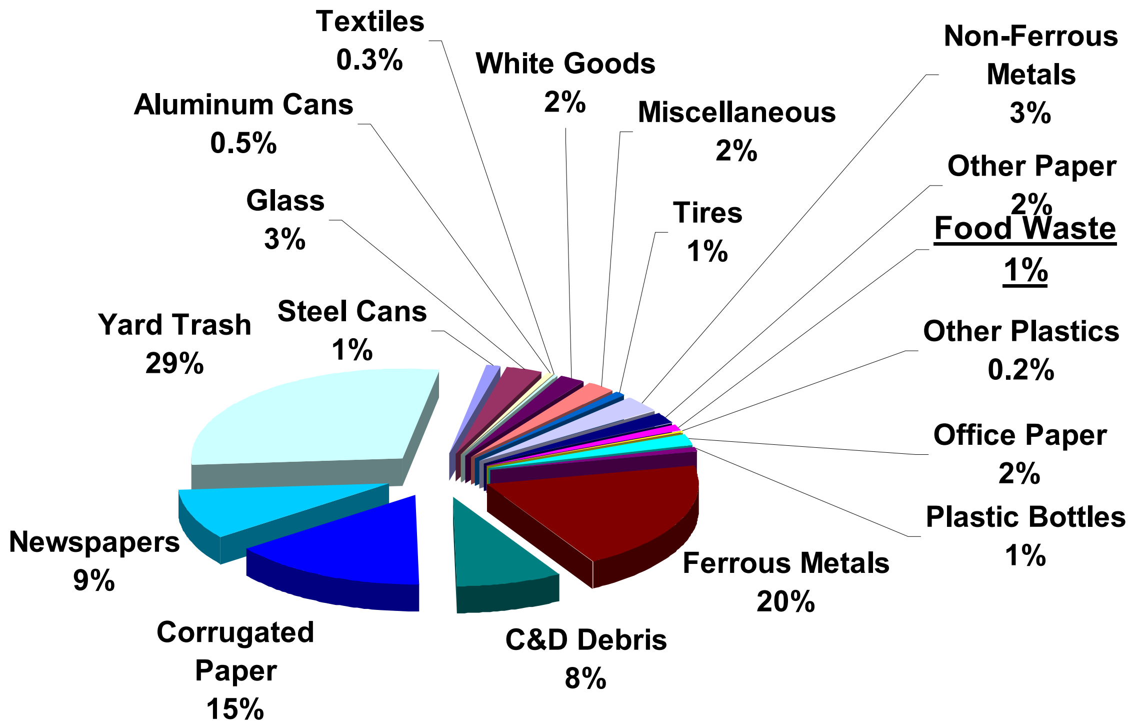


Table 31 outlines composting facilities processing material other than yard trash reported in the FDEP *Waste Reduction and Recycling Report*, year 2001-2002. These facilities composted MSW, manure, clean wood, seafood and food wastes. The food waste facility in the table is the facility operated under this project.

Table 31 - Solid waste composting facilities in Florida (2001-2002)

County	Facility Name	Type	Contact	Telephone	Capacity
Duval	Jacksonville Zoological Gardens	MAN	Marlo Doherty	904-757-4463 x159	45 tpd
Franklin	Franklin County Compost Facility	*	Van Johnson	850-670-8197	2600 Yd^3/yr
Hillsborough	Busch Gardens Composting Facility	**	Tom Burke	813-987-5354	4000 Yd^3 on site
Marion	Muckraker's Inc.	MAN	Becky Thomas Montgomery	352-237-4011	800 Yd^3/yr
Sarasota	County Innovative Grant Project	***	Gary Bennett	941-486-2600	90 tpm
Sumter	Sumter Co. Vol. Reduct & Landfl	MSW	Gary Breeden	352-793-0240	160 tpd

* Seafood, septage, and yard trash
** YT, Clean wood and manure
*** YT, Food waste
Tpd/m = tons per day/month

MAN = Manure
MSW = Municipal Solid Waste
YT = Yard Trash

This data shows a low number of communities throughout Florida are diverting food waste to composting programs, and recycling programs in general. This is indicative of a low-incentive environment in which municipalities don't have, and are not provided with, cost effective ways to divert this segment of the waste stream.

This project, through its analysis of the composting process, has attempted to provide information about avenues in which communities across the state can investigate. By innovating ways to divert this waste stream, the project team hopes that incentives will be more ubiquitous within the recycling framework in the future.

This would stimulate future avenues of research and innovation, leading to a developed industry within the state. Products would become standardized and management practices investigated and adopted.

This project has demonstrated a useful and marketable product in the way of a horticultural potting amendment, and more uses currently exist than this project was able to investigate. Only through incentives to develop larger, cost effective facilities, will there be an environment that will foster investigation into these potential avenues of market development.