FORCE YEARS 8 – 10

ON-FARM FOOD WASTE COMPOSTING DEMONSTRATION PROJECT

FINAL REPORT

FEBRUARY 2011

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YEAR 9 RESEARCH PROJECT: ON-FARM COMPOSTING DEMONSTRATION PROJECT FINAL REPORT

TABLE OF CONTENTS

Section **Page**

List of Tables

List of Figures

Appendices **Page**

SECTION 1.0
INTRODUCTION

Background and Purpose

The revised Chapter 62-709, F.A.C. defines when farm-based composting operations are exempt from having to obtain a solid waste permit because they fall within the definition of "normal farming" (62-709.305(2)). These revisions also expand the materials that may be processed under the normal farming exemption to include off-farm generated vegetative waste. Farm-based composting represents a significant opportunity to link Florida's agricultural and organics recycling communities, with businesses and institutions that generate significant amounts of vegetative waste, thereby closing the loop between food production, consumption, and recovery, economically benefiting farms, and helping improve farm soils. The purpose of this project is to demonstrate proper design and operational procedures for on-farm composting; evaluate operations, economics, environmental parameters, and compost quality; and share project results with the Florida composting community. The specific focus was to be (a) the use of off-farm vegetative waste to optimize composting of yard trash or manure generated on the farm or (b) use of off-farm yard trash as part of manure management operations regulated under Chapter 62-670, F.A.C.

Partners for the project were to be identified in collaboration with Florida Department of Environmental Protection (FDEP) (i.e., industrial wastewater program) and the Department of Agriculture and Consumer Services (DOACS).

This project was designed with both research and demonstration objectives. Materials handling and composting activities were to be closely monitored, and data regarding operational procedures, best practices, feedstock and compost quality, and economics were to be gathered. The information obtained and the operation itself was to demonstrate and help to promote efficient and environmentally sound on-farm composting. It was intended that the project would serve double duty as a demonstration site for the Compost Education and Training project.

Potential operational and research aspects of the project included:

- Separate compost piles for vegetative waste versus manure
- Two different mix ratios of food waste and yard trash
- Two different composting methods – turned windrow and modified static aerated pile
- Compost product analysis

- Labor and equipment utilization assessment
- Economic pro forma for full-scale operations

Task activities were to include the following:

- Research Protocol to include, but not be limited to:
  - Feedstocks
  - Test batches and mix recipes
- Operating Plan to include, but not be limited to:
  - Project partner selection
  - Material collection
  - Material receiving, mixing and pile construction
  - Active composting
  - Post-processing and curing
  - Distribution and use
- Monitoring, Sampling and Analysis Plan to include, but not be limited to:
  - Temperature monitoring procedures
  - Compost sampling procedure
  - Off-site lab analyses
  - Leachate
  - Odor

Task deliverables were to include the following:

- Coordinating and implementing a demonstration project
- Demonstration project report

Project Overview

The project entailed establishing an on-farm demonstration composting operation conforming to the regulatory exemption for "normal farming operations." Off-farm vegetative waste was used to optimize the composting of manure and animal bedding (AB) to produce compost for on-farm use.

Tampa General Hospital (TGH) was selected to provide source-separated pre-consumer vegetative food waste from its food services. TGH is the leading hospital in the Tampa Bay area regarding environmental initiatives. Sweetwater Organic Farm (Sweetwater), located at 6942 West Comanche Avenue in Tampa, was selected to be the composting site. Sweetwater is a diversified organic farm that produces compost that is utilized as the major component of the farm's soil improvement and fertility program. It currently composts AB generated by the Lowry Park Zoo.

Operating and research aspects of the project were planned to include:

- Two different mix ratios of food waste and AB
- Two different composting methods – turned windrow and modified static aerated pile
- Compost product analysis
- Labor and equipment utilization assessment
- Economic pro forma for full-scale operations

Acknowledgements

The Project was coordinated and conducted by Kessler Consulting, Inc. (KCI) on behalf of Sumter County and Florida Organics Center for Excellence (FORCE.) KCI wishes to expressly thank the following parties for their generous help on the Project.

- Sweetwater generously provided numerous in-kind services that included the site, feedstocks, equipment, and personnel necessary to conduct the Project.
- TGH generously provided in-kind services that included feedstocks and personnel necessary to collect the feedstock.
- The City of Tampa generously provided the collection carts used to collect and deliver the feedstock from TGH to Sweetwater.
- FDEP staff in Tallahassee and the Southwest and Central District offices provided crucial help with approvals that made the Project possible.

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SECTION 2.0
METHODOLOGY AND RESULTS

Feedstocks and Regulatory Compliance

Feedstocks used in this demonstration project conformed to the definitions in the newly revised 62-709 F.A.C. Criteria for Organics Processing and Recycling Facilities.

Food waste collected from TGH was pre-consumer vegetative waste (PCVW), which means:

> source-separated vegetative solid waste from commercial, institutional, industrial or agricultural operations that is not considered yard trash, and has not come in contact with animal products or byproducts or with the end user. This term includes material generated by grocery stores, packing houses, and canning operations, as well as products that have been removed from their packaging, such as out-of-date juice, vegetables, condiments, and bread. This term also includes associated packaging that is vegetative in origin such as paper or corn-starch based products, but does not include packaging that has come in contact with other materials such as meat. Plate scrapings are specifically excluded from this definition. 62-709.200(17)

The animal bedding (AB) sourced from Lowry Park Zoo conforms to the regulatory definition of manure, which means "a solid waste composed of excreta of animals, and residual materials that have been used for bedding, sanitary or feeding purposes for such animals." 62-709.200(13)

The composting demonstration at Sweetwater did not require a registration or permit because it complied with the exemption for normal farming operations, which includes "composting or anaerobic digestion of yard trash, manure, or vegetative wastes generated from off the farm, for use on the farm, as part of agronomic, horticultural or silvicultural operations." 62-709.305(2)(c)

PCVW was collected from TGH's on-site food services, namely materials generated during preparation of food. It was separated at the point of generation and included small amounts of plastic film, paper, and packaging. It did <u>not</u> include post-consumer food waste such as plate scrapings. Based on literature, we anticipated PCVW with the following average characteristics:

- Density = 1,200 pounds per cubic yard (range 1,000 – 1,500)
- Moisture content = 80% by weight (range 70% - 90%)

- Carbon:Nitrogen ratio = 15:1 – 20:1

The AB from Lowry Park Zoo was expected to contain a high percentage of straw and has low moisture content. Based on literature, we anticipated it would have the following average characteristics:

- Density = 500 pounds per cubic yard (range 400 – 600)
- Moisture content = 30% by weight (range 25% - 40%)
- Carbon:Nitrogen ratio = 40:1 – 60:1

Test Batches (Windrows) and Mix Recipe

The initial Operating Plan called for the evaluation of two different methods for composting PCVW and AB using two mix recipes for each method:

- Mix 2:1 Turned Windrow (TW 2:1)
    - 2 parts AB and 1 part PCVW
    - Turned by bucket loader meeting FDEP process control for disinfection (15 days at 55ºC with 5 turnings)

- Mix 2:1 Modified Static Aerated Pile (MSP 2:1)
    - 2 parts AB and 1 part PCVW
    - Turned by bucket loader on Days 14 & 28

- Mix 3:1 Turned Windrow (TW 3:1)
    - 3 parts AB and 1 part PCVW
    - Turned by bucket loader meeting FDEP process control for disinfection (15 days at 55ºC with 5 turnings)

- Mix 3:1 Modified Static Aerated Pile (MSP 3:1)
    - 3 parts AB and 1 part PCVW
    - Turned by bucket loader on Days 14 & 28

During the planning stage of the Project, TGH estimated that it would generate approximately 8 to 10 cubic yards per week of PCVW. Based on this and the feedstock characteristics above, the initial Operating Plan identified two mix recipes to be used in order to meet proper parameters for composting with regard to C:N ratio and moisture content:

- Mix 2:1
    - 20 cy of AB + 10 cy of PCVW
    - C:N ratio = 34:1
    - Mixture of yard trash (YT) as necessary to achieve initial moisture content = 60%

- Mix 3:1
    - 24 cy of AB + 8 cy of PCVW
    - C:N ratio = 38:1
    - Mixture of YT as necessary to achieve initial moisture content = 60%

The recipes were designed to yield material sufficient to build one windrow measuring approximately 20 feet long by 12 feet wide by 6 feet tall per week over a four week period of time. The total approximate amount of feedstocks required for the project was to be:

- 98 cy of AB
- 36 cy of PCVW

Actual operations needed to deviate from the initial Operating Plan in several ways. First, the evaluation of the MSP method could not be conducted because Sweetwater, in order to maintain its certification as an organic farm, must follow the compost methodology required by the organic certification protocol, which is the Turned Windrow method. Secondly, the actual quantity of PCVW recovered by TGH was 2 to 3 cubic yards per week. In addition, the AB from Lowery Park Zoo had more manure and less bedding straw, meaning that it had a lower C:N ratio and higher moisture content than projected during the planning phase.

In order to accommodate these conditions, actual compost pile construction deviated from the Operating Plan. Instead of building a separate composting pile for each of the four weeks, KCI oversaw construction of a separate pile for each <u>two</u> weeks' worth of food waste received by Sweetwater. This was necessary given the limited FORCE budget for this project that was based on four weeks of food waste delivery being part of the R&D project. By building one windrow for each two weeks, it was possible to provide piles large enough to better simulate full-scale composting conditions. In addition, the mix recipes were modified due to the higher moisture and lower C:N ratio in the AB. Food waste deliveries from weeks one and two formed one windrow labeled RM 1/2; deliveries from weeks three and four formed the second windrow labeled RM 3/4. The actual test batch windrows and mix recipes are summarized below.

- RM 1/2

- Mix 2:1 10 cy of AB + 4.4 cy of PCVW
- C:N ratio = 20:1
- Initial moisture content 54%

- RM 3/4
  - Mix 4:1 21 cy of AB + 5.3 cy of PCVW
  - C:N ratio = 22:1
  - Initial moisture content 50%

Materials Collection, Receiving and Mixing

TGH staff collected PCVW in separate containers at food preparation stations. The PCVW from each station was transferred to 64-gallon carts stored in a refrigerated area. Each cart was filled to half capacity to reduce weight for easier handling. The 64-gallon carts were borrowed from the City of Tampa for the duration of the pilot project. The carts were transported to Sweetwater by TGH staff and truck. After they were emptied, the carts were rinsed with water to remove lingering food residue prior to transport back to TGH. TGH cleaned and sanitized the carts prior to re-use.

TGH delivered carts of PCVW once or twice weekly over the four weeks of June 21 through July 16, 2010. Kessler Consulting, Inc. (KCI) was present on-site during this phase of the Project and monitored all deliveries. KCI staff recorded the number of carts, percent full for each cart, types of contaminants, and notes about the feedstock content. Delivery logs are shown in Appendix A

Some contaminants such as open salad dressing packages, butter cups, open juice boxes, and jello bowls were found in the first deliveries. TGH was informed about contamination issues, and additional staff education was implemented that reduced contamination significantly.

At the composting site, Sweetwater was responsible for all materials handling and operations. AB was stockpiled at the mixing and composting area. A sufficient volume of AB was available on-site prior to receiving PCVW. KCI provided guidance to Sweetwater to create four separate stockpiles of AB for use during mixing and windrow construction:

- AB to be used for mixing.
- AB that had been pre-wetted with water to be used for mixing and adjusting moisture content.

- Dry AB to be used as a base layer for modified static piles.
- Partially composted AB that had been stacked up and pre-heated for use as a capping layer.

Prior to receiving PCVW, a two-foot think layer of AB was spread out in the Mixing Area. PCVW was delivered to the Mixing Area, and discharged onto the two-foot layer of AB. The bed of AB helped absorb free liquid present in the PCVW. After all PCVW was deposited on the bed of AB, additional AB was added to achieve the designated volumetric ratio for the mix recipe. PCVW and AB were thoroughly mixed by bucket loader and placed into the windrow.

The actual initial measured size of the windrows is shown in Table 1 below:

Table 1: Initial Windrow Size

	Base Width	Top Width	Height	Length	Approx CY
RM 1/2	8’	2’	5.5’	12’	12
RM 3/4	10’	3’	6’	18’	26

Each week, immediately after windrow construction, KCI collected samples of the raw mixture of just delivered PCVW and AB before it started composting. The samples were shipped for analysis according to the Operating Plan. The lab results found that the raw mixtures had acceptable parameters for composting (see Table 2).

Table 2: Summary of Lab Analyses – Raw Mixture

Parameter	Unit	Raw Mix 1	Raw Mix 2	Raw Mix 3	Raw Mix 4	Average
Density	Lb/cy	691	1,079	1,306	910	997
Moisture	%	52	56	54	46	52
pH	pH Unit	6.10	4.80	5.80	5.00	5.43
Carbon:Nitrogen	x:1	17	23	17	27	21
Fecal Coliform	mpn/g	9.4×10^6	2.3×10^5	3.2×10^5	5.5×10^6	3.9×10^6

The lower than expected C:N ratio of the AB meant that the C:N ratio of the raw mixture was also lower than projected (20:1 to 22:1 versus 34:1 to 38:1). While lower than expected, this C:N ratio is within the range of acceptable parameters for windrow composting. The levels of *Fecal coliform* were in the range of expectations for feedstocks containing animal manures.

After construction, the windrows were covered with a one-foot thick "capping layer" of AB. The purpose of the capping layer was to visually hide the presence, and mask the odor, of PCVW in the pile to reduce the likelihood of attracting scavengers such as birds and rodents.

Active Composting

KCI worked collaboratively with Sweetwater during the active composting phase of the Project. KCI provided compost monitoring forms and visited the composting site twice weekly to assess composting progress, review monitoring logs, equipment and labor utilization, and provide diagnostic assistance to ensure proper composting. Sweetwater was responsible for materials handling and operations, and assisted with temperature monitoring.

Windrows were managed to meet time, temperature and turning standards for disinfection: 15 consecutive days at 55ºC (131ºF) with 5 turnings. The turning schedule for RM1/2 and RM3/4 was determined by KCI based on temperature data. Sweetwater was responsible for windrow turning using its one-yard bucket loader.

KCI monitored each of the two demonstration compost windrows twice weekly throughout the active composting phase, which lasted for 58 and 56 days for windrow RM 1/2 and RM 3/4, respectively. Temperature was monitored at three points in each windrow. At each point, temperature was recorded at two depths – one foot and three feet. Additionally, Sweetwater staff monitored temperatures once weekly and periodically measured pH. Both windrows sustained thermophilic temperatures above 131 degrees for well over two weeks and easily met the time-temperature-turning regime (see Figures 1 and 2 below). The detailed monitoring logs can be found in Appendix C.

Figure 1: Active Composting Monitoring Results – On-farm Windrow RM1/ 2

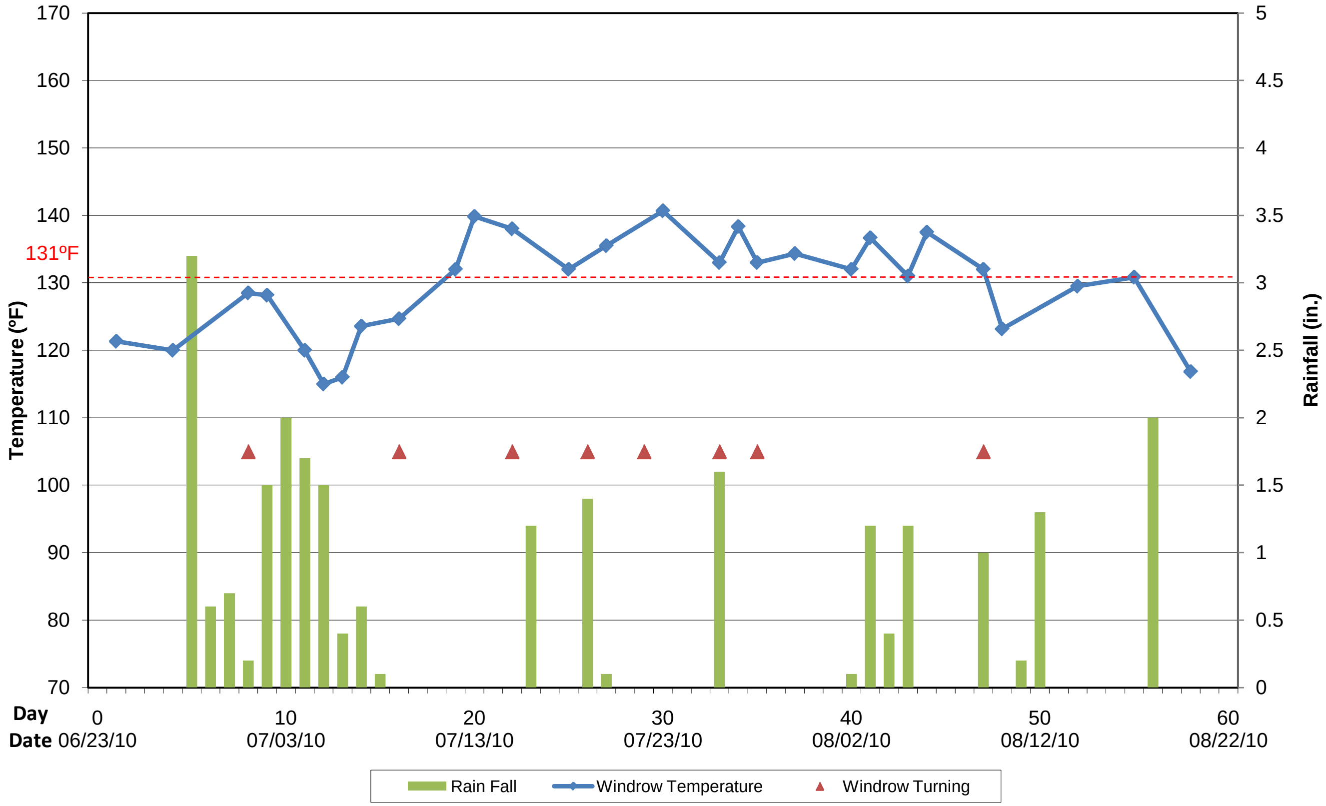
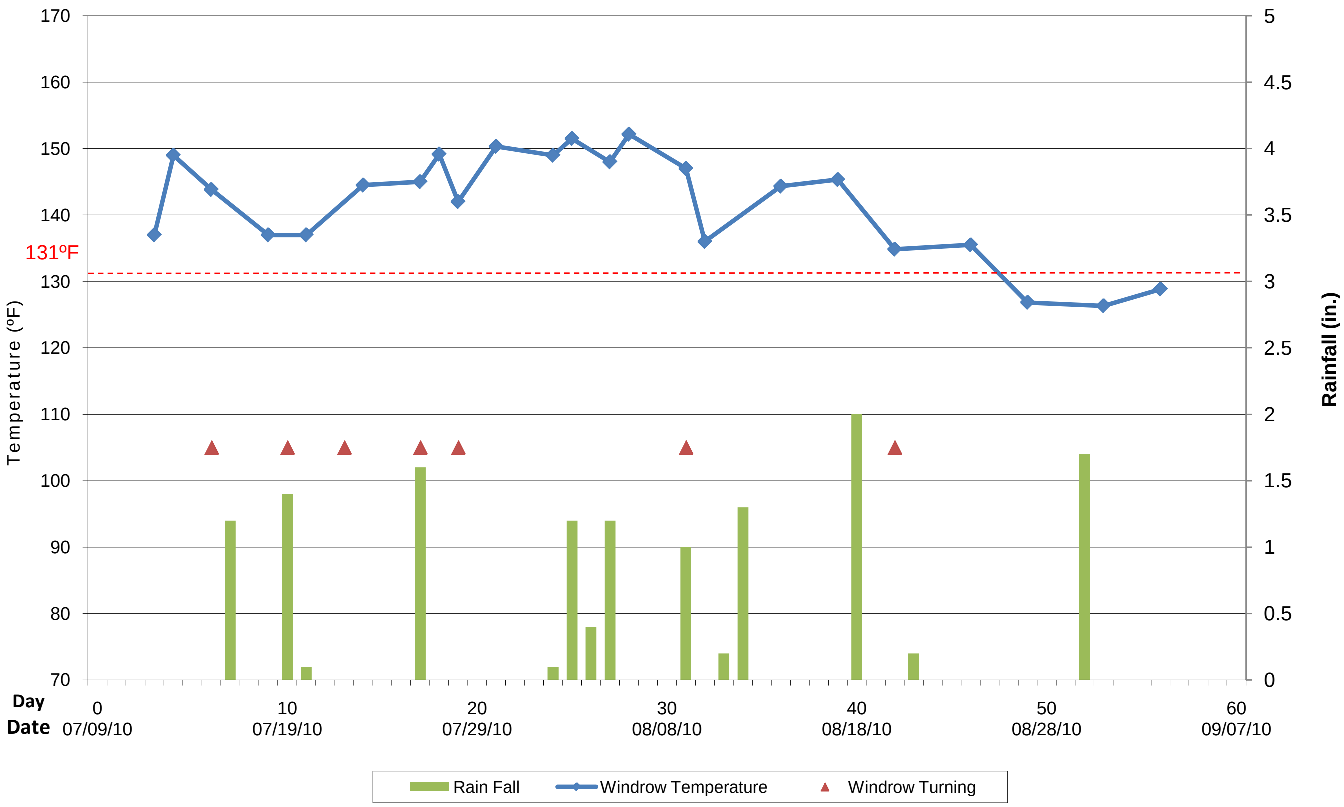


Figure 2: Active Composting Monitoring Results – On-farm Windrow RM3/4



Moisture content was maintained at approximately 40 – 60% during active composting. Proper moisture content was assessed weekly using the "squeeze" test employed commonly in the composting industry. As can be seen in Figures 1 and 2, significant amounts of rain fell on the piles during active composting. So much so that moisture content of Windrow RM1/2 became too high and suppressed aerobic biological activity and thus temperature during the first two weeks. Subsequent windrow turnings and drier weather corrected the moisture conditions in that windrow and temperatures rose into "pathogen-kill" levels.

A few days after the average temperature met 55ºC, the windrow was turned and temperature monitored the following day to ensure it was at least 55ºC. The windrow was turned on subsequent days to meet FDEP standard.

Each time it visited the site, KCI staff qualitatively assessed the windrows' odor. Slight offensive odors were noted during initial windrow turnings, but not observed at other times. After two to three weeks of active composting, the offensive odors were no longer detected.

Compost Curing

KCI worked collaboratively with Sweetwater during the compost curing phase of the Project. KCI visited the composting site weekly to assess progress, review monitoring logs, equipment and labor utilization, and provide diagnostic assistance. Sweetwater was responsible for materials handling and operations, and assisted with temperature monitoring.

At the end of active composting, each windrow was thoroughly mixed; formed into a separate pile; and allowed to cure and mature for an additional period of time. It was crucial that the two test windrows remained segregated and separate throughout the curing phase. Curing pile temperatures were monitored at three points in each pile. At each point, temperature was recorded at one and three feet deep.

Windrow RM 1/2 cured for 70 days and was turned by bucket loader on days 39 and 70; it produced approximately five (5) cubic yards of finished compost. Windrow RM 3/4 cured for 63 days and was turned on day 28 and 63; it produced approximately seven (7) cubic yards of finished compost. Please see Figures 3 and 4 below for charts that reflect temperature and turning during the curing phase.

Figure 3: Curing Monitoring Results On-farm Windrow RM1/2

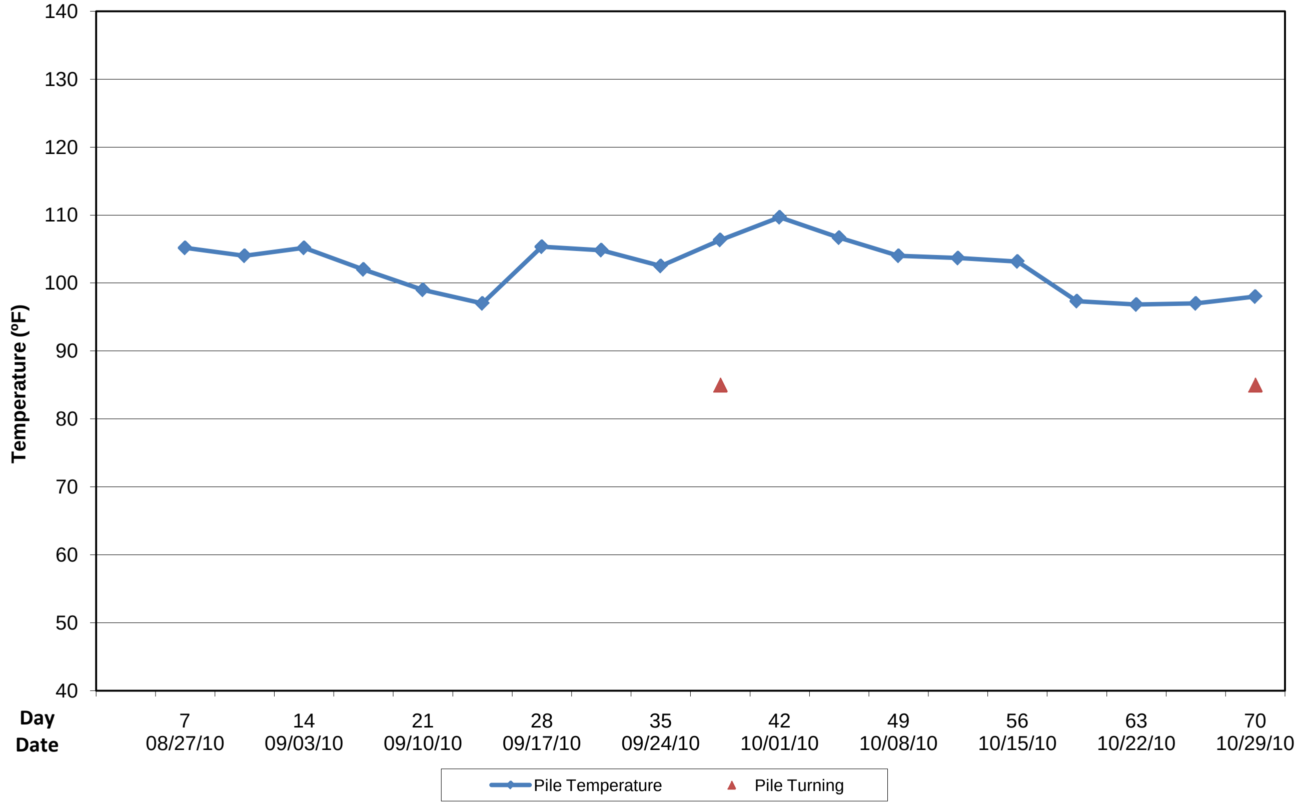
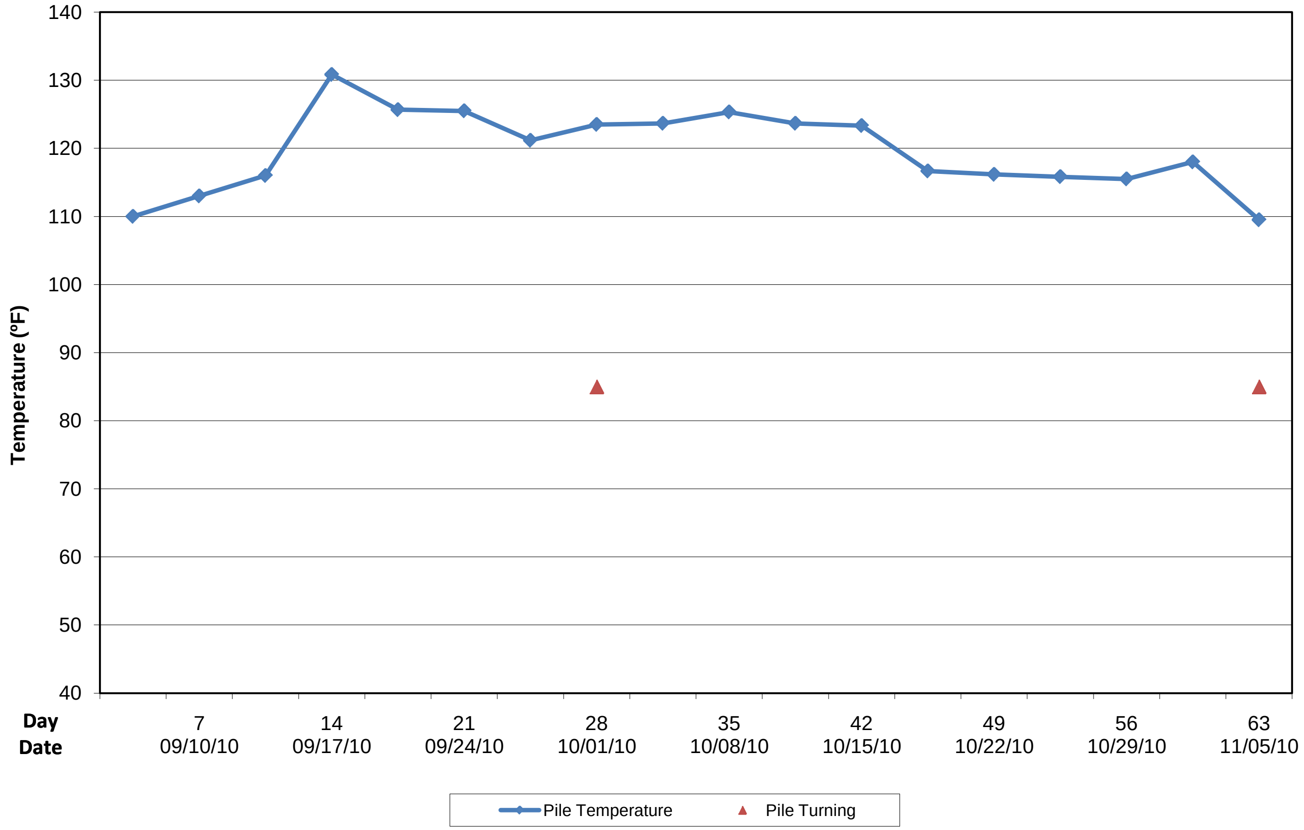


Figure 4: Curing Monitoring Results On-farm Windrow RM3/4



At the conclusion of the curing phase, KCI collected samples from each pile and shipped them for off-site lab analysis. The samples were tested for organic solids, heavy metals, and other analytes. For a highlight report of the lab results, see Table 3 below. Complete lab analysis reports are included in Appendix B.

Table 3: Lab Analysis – End of Active Composting

Analysis Parameter	Units	RM1/2	RM3/4
Moisture	*%*	29.9	27.5
Carbon:Nitrogen	*n/a*	10:1	8:1
Total Nitrogen	*% dw*	0.6	0.66
Phosphorus	*% dw*	.49	.47
Potassium	*% dw*	.31	.48
Conductivity	*mS/cm*	1.7	1.9
pH	*pH units*	7.5	7
Stability Rating	*n/a*	Very Stable	Very Stable
FDEP Regulatory Metals (Cd, CU, Pb, Ni, Zn)	*ppm*	Code 1	Code 1
Fecal Coliform	*mpn/g*	5	Not detected
5-day Germination	*%*	100	100

Distribution and Use

At the conclusion of the project, the compost was utilized by Sweetwater Farm for its normal farming operations.

Photos

The photos on the following pages depict feedstock collection and delivery, mixing, windrow construction, and curing.

Sweetwater Farm in January 2010

Animal Bedding Being Delivered

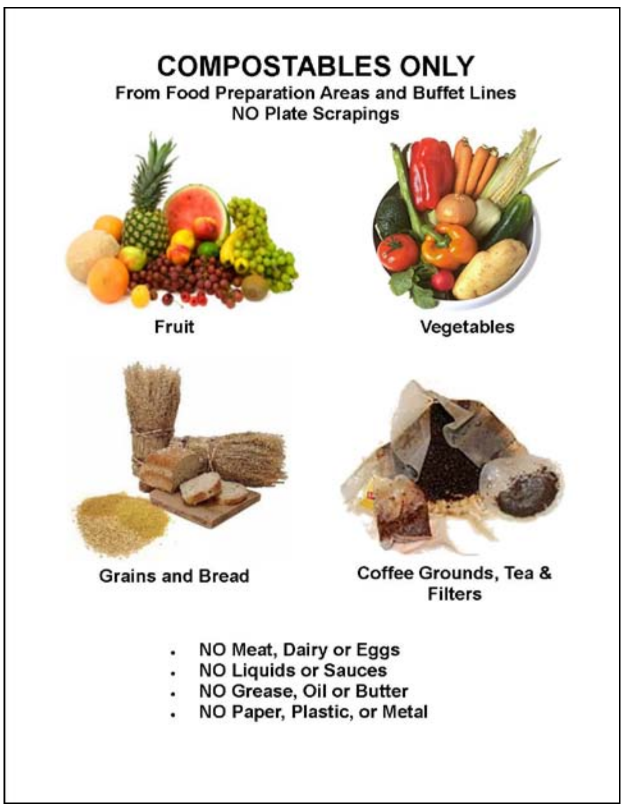
Receiving Area

Animal Bedding Piled

Foodwaste Collection at TGH Prep Station

Centrally Located Foodwaste Cart in TGH Kitchen

Collected Foodwaste in Cart



Instructional Poster for Kitchen Staff

Rolling Cart to Refrigerator for Storage

Carts Stored in Refrigerator Prior to Delivery

Cart Delivery

Foodwaste Being Emptied From Carts

Foodwaste Being Emptied From Carts

Foodwaste Piled on Animal Bedding

Mixing Foodwaste and Animal Bedding

Forming Windrow

Capping: Feather for Aeration and Porosity

Capped Windrow

Turning the Windrow

Windrow Temperature Reading

Sampling for Analysis

Windrow

Curing

Vegetables Presented to TGH Staff

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SECTION 3.0
FINDINGS AND CONCLUSIONS

The purpose of this on-farm composting project was to research and demonstrate the feasibility and proper design and operational procedures for on-farm composting in accordance with FDEP Chapter 62-709 F.A.C. Criteria for Organics Processing and Recycling Facilities. The information obtained from the project has been used in other FORCE training and education to promote increased food waste composting throughout Florida and demonstrate efficient and environmentally-sound practices.

The project evaluated composting of pre-consumer vegetative waste (PCVW) from Tampa General Hospital (TGH) and animal bedding from Lowery Park Zoo at Sweetwater Organic Farm (Sweetwater) in Tampa. Major findings and conclusions are provided below.

Food Waste Collection and Delivery

Success of the food waste collection and delivery activity at TGH was due in large part to the work of Ian Andes, a summer intern at TGH who provided daily coordination and communications between the hospital and farm. The presence of such a program "champion" or "coordinator" is critical. Overall, the collection of PCVW from TGH worked well. Contamination was limited and hospital personnel were responsive to requests from Sweetwater to address contamination issues when they arose. The instructional poster developed for TGH was effective in providing concise and graphic information for kitchen staff.

Because of the project's limited time frame (only four weeks of food waste collection and delivery to the farm) as well as the limited project budget, certain opportunities to improve the collection and delivery system could not be implemented. The 64-gallon collection carts donated by the City of Tampa, while being free, were too large for food waste collection. Because food waste can be so heavy, collection carts should be smaller and thus easier to maneuver and empty. If and when a permanent collection program is implemented at TGH, specially designed food waste collection carts in the range of 30 to 50 gallon size are recommended.

Also during the project, TGH staff decided to use plastic liners in the collection carts to reduce the amount of work effort needed to clean the carts. It was difficult and time-consuming to remove these bags from the food waste after being dumped at Sweetwater. TGH utilized its own equipment to sanitize the empty carts coming back from Sweetwater. For a permanent program to operate efficiently, it is recommended that if collection carts are used, then either plastic bags be eliminated (cart could be hosed out at Sweetwater and then sanitized at TGH) or certified compostable bags be used.

TGH utilized a truck and staff from its internal fleet department to deliver the carts of PCVW to Sweetwater. The larger carts used for the project were difficult to empty at the farm because they weighed as much as 200 pounds each. Also at times during the project, TGH was not able to maintain the regular delivery schedule because the truck was needed for other functions. Consequently, additional effort was needed to coordinate with Sweetwater to ensure food waste could be properly handled when delivered, and in one instance KCI staff delivered the food waste when the TGH truck was unavailable for use. Again, given that this was a short term pilot project, inefficiencies in collection and delivery were to be expected. If and when a permanent collection is implemented at TGH, it would be necessary to have the collection assets dedicated to the service. TGH should also consider third-party options such as collection service provided as part of a larger food waste collection route or dedicated enclosed box service.

Receiving and Mixing

Incoming PCVW was dumped onto a prepared bed of a animal bedding (AB). Visible contaminants were picked out manually and the food waste quickly covered over with another layer of AB. These minimized the potential for odors, leachate and scavengers. The quantity of AB used was based on the quantity of food waste and the mix recipe. Two key characteristics of the AB differed from what was initially anticipated: moisture content was higher and C:N ratio was lower. This was due to the higher than expected ratio of manure to bedding material in the Lowery Park material. Based on these characteristics, the mix recipes were modified to increase the ratio of AB to PCVW. Based on lab analyses, it was determined that, by itself, the Lowery Park AB had excellent properties for composting (moisture content of 50% – 60% and C:N ratio of 25:1 – 30:1.)

Consequently, when Sweetwater considers the potential for establishing a more permanent food waste composting operation, it should consider utilizing a different bulking agent. In particular, the farm occasionally receives chipped wood and yard waste from landscape contractors, which the farm uses for mulch. This material would likely be an excellent bulking agent for PCVW. Sweetwater has indicated that it plans to expand its farming operations and will need to likewise expand its compost production. Composting food waste with the wood and yard waste appears to be the most effective way to do so.

Materials were mixed for composting on a designated section of the farming site on bare ground. During the mixing process, it was noted that it was relatively easy for soil to get mixed up into the compost materials. The immediate effect is increased bulk density of the compost mixture, reduced pore space, and reduced ultimate value of the compost. Additionally, the mixing site becomes pitted out, making it harder for equipment to maneuver and increasing the potential for water pools to form. It is recommended when Sweetwater implements a more permanent food waste composting program, a dedicated mixing area be constructed that includes a durable working surface such as crushed lime rock or compacted sand and gravel.

Composting and Curing

Active composting met the necessary requirements for time, temperature and turnings (15 days at 131ºF with 5 turnings). The smaller than expected volume of PCVW from TGH presented a challenge because test windrows were smaller than anticipated. While the windrows were large enough to maintain the thermal mass and energy for sustained thermophilic composting, the windrows were much more susceptible to weather conditions. Heavy rain fell during the initial weeks of the project, and given the relatively small size (and thus higher surface to volume ratio) the windrows became too wet, which in turn suppressed thermophilic decomposition. Corrective actions were taken, namely windrows were turned to re-aerate them and release excess water vapor and the pile was shaped to encourage it to shed (rather than absorb) rain water.

Bulk density of the compost piles also was higher than what was projected during the planning phase. This was due to the higher moisture content of the AB from Lowery Park as well as the straw and hay used as bedding is more compactable than wood waste. This may have been exacerbated by soil mixed into the material as noted above. Consequently, bulk density was higher and porosity was lower in the windrows than originally expected. While conditions in the compost mixture were still within acceptable ranges, it was determined that material for the capping layer needed to be carefully selected and applied in order not to discourage air flow into the windrow.

Ultimately as documented in the temperature records, composting and curing proceeded well. Turning was effective at maintaining aerobic conditions in the windrows as indicated on the temperature charts. Temperature remained in the mesophilic range throughout the curing phase, which is commonly experienced with compost mixtures that include straw and hay.

Conditions of the composting site at Sweetwater were impacted by significant rainfall; at times during the project standing water was present near the project windrows. Composting at the farm currently occurs on open ground adjacent to cultivated garden beds, and the ground surface is uneven and pitted in places due to the accumulated impact of windrow turning operations over time. The active composting area should be smoothed, filled, and re-graded to provide a gentle (1% - 2%) slope to encourage good drainage.

Environmental Control

The three most common environmental and public health issues encountered at food waste composting sites are odors, scavengers and flies, and leachate. Odor monitoring recorded minimal malodors during the initial two weeks of active composting. The project windrows as well as Sweetwater's ongoing composting operation were not causing any offsite odor impacts. Three weeks into active composting, fly maggots were observed near the surface of both project windrows. This was most likely caused by the high rainfall and consequently suppressed temperatures in the outer layer of the windrow, thereby allowing fly eggs sufficient time to incubate and hatch in that material. The windrows were turned to subject maggot-containing materials to high temperatures, and maggots were destroyed and did not reoccur. Throughout the active composting, no problems occurred with scavengers such as birds, rodents, etc. This is attributed to the capping layer of AB placed on the windrows which masked the presence of food waste in the windrows until it had sufficiently decomposed to no longer attract scavengers.

Compost Testing

The project had an extensive sampling and lab analysis protocol in compliance with FDEP contractual requirements, which included each week's raw mixture, the animal bedding, and then the finished compost from each windrow. The lab results demonstrate that the composting method employed effectively killed pathogens despite the high levels initially present in the animal manure and bedding. The finished compost produced by the project had excellent characteristics. Testing determined that, after approximately 60 days of active composting and 70 days of curing, the finished compost was very stable and mature and suitable for a wide range of potential uses at Sweetwater.

Economics

In order to assess the economic costs and benefits of composting at Sweetwater Farm, KCI developed estimates of current costs to compost AB only versus projected costs for composting a combination of AB and PCVW.

KCI first developed the cost estimate for the current AB composting operation based on information provided by Sweetwater regarding the average number of hours per week spent on compost-related tasks, the quantity of AB composted, and estimated unit costs for equipment and labor plus other miscellaneous cost including lab analysis, monitoring equipment and supplies. According to Sweetwater staff, the current composting operation requires an average of eight hours and handles approximately 60 cubic yards of incoming AB per week. Estimated annual costs for the AB composting at Sweetwater are summarized in Table 4 below.

Table 4: Estimated Annual Expense for AB Composting

Item	Quantity	Units	Unit Cost	Total
Annual Operating Cost				
Front End Loader & Operator	350	hrs/yr	$40	$14,000
Labor	74	hrs/yr	$15	$1,110
Equipment and Supplies				$850
Lab Analysis				$400
Total Annual Cost				$16,360
Per Ton of Feedstocks				$12
Per Ton of Finished Compost				$27

KCI then developed a cost estimate for composting of AB and PCVW based on the same base-case operational parameters adjusted for the additional materials, equipment, and labor inputs required to handle the PCVW. KCI has assumed an average of six cubic yards per week of food waste which equates to a 10:1 mix ratio of AB to PCVW. This ratio was derived from the moisture and C:N ratio of the materials handled during the project.

Included in the expense estimate is $12,000 to build a durable all-season receiving and mixing pad from durable with compacted structural fill. Also included in the estimate is a tip fee charged for incoming food waste. For the purpose of this estimating exercise, the tip fee was set at $15 per ton, which is much lower than prevailing disposal costs and should be sufficient to provide economic incentive to TGH or other generators to deliver food waste for composting. The estimated costs for composting AB and PCVW based on these assumptions are provided in Table 5.

Table 5: Estimated Annual Expense for AB & PCVW Composting

Item	Quantity	Units	Unit Cost	Total
Annual Cost of Site Improvements	$12,000	8 yrs	@ 7%	$2,010
Annual Operating Cost				
Front End Loader & Operator	417	hrs/yr	$40	$16,680
Labor	82	hrs/yr	$15	$1,230
Equipment and Supplies				$850
Lab Analysis				$400
Total Annual Cost				$21,167
Revenue				
Food Waste Tip Fee	172	Tons	$15	$2,574
Net Cost (Revenue)				$18,593
Per Ton of Feedstocks				$12
Per Ton of Finished Compost				$27

This initial assessment indicates that charging a tip fee for incoming food waste can compensate for the additional costs to compost it. Clearly, Sweetwater would need to implement new materials handling procedures to make food waste handling as efficient as possible. For example, the farm may decide to prohibit any food waste delivered in plastic bags; it may require that the generator or hauler be responsible for cleaning collection costs; or it may require that deliveries be limited to predetermined hours.

As mentioned earlier in this report, Sweetwater may also want to consider composting food waste with chipped wood and yard waste rather than with animal bedding. The wood and yard waste provide a more suitable bulking agent for food waste, and from an economic standpoint they are comparable to AB as a free source of additional compost feedstock – it may even be possible to charge a nominal tip fee for this material as well to help offset operational costs.

Conclusion

The purpose of this project was to encourage composting operations in Florida that take advantage of the newly revised FDEP compost regulations that allow registration facilities to handle clean source-separated food waste along with yard trash and/or manure and exempt on-farm composting operations that comply with normal farming practices as described in the regulations.

The project achieved its research objectives of determining the technical feasibility of composting pre-consumer vegetative waste with animal bedding and manure using simple turned windrow composting technology. The finished compost was of very high quality, meeting the regulatory standards for Type YM compost, and was produced in approximately four months. The compost methods employed met regulatory disinfection standards for pathogen destruction. The project achieved its demonstration objectives by providing valuable information that was incorporated into FORCE training and educational materials widely distributed to the organics recycling community in Florida.

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Appendix A
Delivery Logs

Compostable Food Waste Recycling Logbook

Source: Tampa General Hospital

Destination: Sweetwater Organic Farm

Date Delivered: 23-Jun-10

Delivery #: 1

Recorded By: Peter Engel

Notes: very clean, minor contamination easily removed; noted one spoon

Container	Size (gal)	% Full	Net Weight (lb)	Contaminants/Comments
1	64	75%	not recorded	
2	64	66%	not recorded	
3	64	50%	not recorded	coffee grounds
4	64	100%	not recorded	
5	64	50%	not recorded	
6	64	100%	not recorded	coffee grounds & produce
7	64	50%	not recorded	
8	64	75%	not recorded	dumped in plastic bag
9				
10				
Total Net Weight				**lbs**
Total Volume			**1.8**	**cy**
Estimated Weight			**1,989**	**lbs**
based on bulk density of		**1,109**	**lbs/cy**	

Compostable Food Waste Recycling Logbook

Source: Tampa General Hospital

Destination: Sweetwater Organic Farm

Date Delivered: 28-Jun-10

Delivery #: 2

Recorded By: Ian Andes

Notes: minimal coffee grounds compared to last delivery; minor contaminants; good overall mix

Container	Size (gal)	% Full	Net Weight (lb)	Contaminants/Comments
1	64	75%	not recorded	3-4 mayo packets
2	64	75%	not recorded	three plastic gloves
3	64	66%	not recorded	
4	64	66%	not recorded	
5	64	50%	not recorded	
6	64	80%	not recorded	
7	64	50%	not recorded	
8				
9				
10				

Total Net Weight		**lbs**
Total Volume	**1.5**	**cy**
Estimated Weight	**1,623**	**lbs**
based on bulk density of	**1,109**	**lbs/cy**

Compostable Food Waste Recycling Logbook

Source: Tampa General Hospital

Destination: Sweetwater Organic Farm

Date Delivered: 1-Jul-10

Recorded By: Jessica DelGrosso

Notes: Moderate contamination (pulled out by hand)

Container	Size (gal)	% Full	Net Weight (lb)	Contaminants/Comments
1	64	50%	not recorded	plastic bag
2	64	75%	not recorded	bread, fruit
3	64	85%	not recorded	wax paper, bread, melons
4	64	75%	not recorded	melons, bread, sandwich meat
5	64	75%	not recorded	coffee grounds, plastic bottles, plastic bags, knife,
6				to-go-containers
7				
8				
9				
10				

Total Net Weight			**lbs**
Total Volume		**1.1**	**cy**
Estimated Weight		**1,265**	**lbs**
based on bulk density of	**1,109**	**lbs/cy**	

Compostable Food Waste Recycling Logbook

Source: TGH
Destination: Sweetwater Farms
Date Delivered: 7-Jul-10
Delivery #: 4
Recorded By: Ian Andes
Notes: Moderate contaminants reported by Roberto Saenz

Container	Size (gal)	% Full	Net Weight (lb)	Contaminants/Comments
1	64	66%		
2	64	75%		
3	64	75%		
4	64	50%		
5	64	50%		
6	64	66%		
7	64	90%		6 small clear plastic bags, 3 blue gloves, 1 metal spoon,
8	64	90%		1 clear plastic bowl, 1 small butter cup,
9				
10				
Total Net Weight				**lbs**
Total Volume			**1.8**	**cy**
Estimated Weight			**1,975**	**lbs**
based on bulk density of		**1,109**	**lbs/cy**	

Compostable Food Waste Recycling Logbook

Source: TGH

Destination: Sweetwater Organic Farm

Date Delivered: 7/12/2010

Delivery # 5

Recorded By: Ian Andes

Notes: Found 2 blue gloves, 1 clear plastic bowl, 1 small styrofoam bowl, 1 butter cup, 1 opened salad dressing pouch, 10 sealed plastic bags containing scallions, 3 small clear plastic bags with shredded carrots, 2 pieces of cellophane

Container	Size (gal)	% Full	Net Weight (lb)	Contaminants/Comments
1	64	60%		
2	64	80%		
3	64	80%		
4	64	80%		
5	64	80%		
6	64	80%		
7	64	90%		
8	64	90%		
9	64	90%		
10				
Total Net Weight				**lbs**
Total Volume			**2.3**	**cy**
Estimated Weight			**2,565**	**lbs**
based on bulk density of		**1,109**	**lbs/cy**	

Compostable Food Waste Recycling Logbook

Source: TGH

Destination: Sweetwater Organic Farm

Date Delivered: 7/15/2010

Delivery # 6

Recorded By: Ian Andes

Notes: I blue glove, 2 pieces clear plastic, 2 butter cups

Container	Size (gal)	% Full	Net Weight (lb)	Contaminants/Comments
1	64	90%		
2	64	80%		
3	64	75%		
4	64	75%		
5	64	66%		
6				
7				
8				
9				
10				
Total Net Weight				**lbs**
Total Volume			**1.2**	**cy**
Estimated Weight			**1,356**	**lbs**
based on bulk density of		**1,109**	**lbs/cy**	

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Appendix B
Laboratory Analyses

Lab Analysis Raw Mixture Prior to Composting

		Sample								Average
Parameter	**Units**	**Mix1a**	**Mix1b**	**Mix2a**	**Mix2b**	**Mix3a**	**Mix3b**	**Mix4a**	**Mix4b**	
pH	S.U.	5.9	6.3	4.5	5.1	6	5.6	4.5	5.5	5.4
Moisture	%	50.2	53.55	48.21	63.72	53.92	53.9	49.79	42.27	51.9
C:N Ratio	x:1	18	15	21	24	18	15	25	28	20.5
Total Carbon	%	7.65	6.99	8.22	7.24	7.53	4750	9.73	13.07	601.3
Total Nitrogen	%	0.43	0.48	0.4	0.3	0.43	0.31	0.39	0.46	0.4
Bulk Density	g/cc	0.27	0.55	0.75	0.53	0.7	0.85	0.61	0.47	0.6
CO2 OM Evolution	mgCO2-C/gOM/day	3.17	3.59	2.13	1.64	5.11	8.67	0.63	2.85	3.5
CO2 Solids Evolution	mgCO2-C/gTS/day	5.03	3.38	1.74	2.25	3.85	6.39	0.62	3.91	3.4
Conductivity	mS/c	3.18	3.93	2.86	20	2.55	3.33	6.02	5.43	5.9
Fecal Coliform	mpn/g	6954000	11786956	309423	150611	117870	521304	6954000	4134483	3866081
Man-made Materials	%	nd	nd	nd	1.2	nd	nd	nd	nd	
Volatile Solids	%	45.67	34.91	33.55	45.65	18.13	52.95	39.9	38.58	38.7
Stability Rating		Mod Unstable	Stable	Stable	stable	mod. Unstable	unstable	very stable	stable	
Total Organic Carbon	%	6.27	5.45	7.35	7.24	6.75	4.75	8.88	13.07	7.5

Finished Compost Analysis RM1/2

Finished Compost - RM1/RM2

Organic Solid Report

Parameter	Analysis As Received	Dry Weight	Units	Nutrients Lbs./Ton As Received	Detection Limit
Total Nitrogen (N)	0.42	0.6	%	8.4	0.01
Ammonium Nitrogen (N)	ND	ND	%	0	0.001
Nitrate Nitrogen (N)	0.02	0.03	%	0.4	0.01
Organic Nitrogen (N)	0.4	0.57	%	8	Calculated
Phosphorous (P205)	0.34	0.49	%	6.8	0.1
Potassium (K2O)	0.22	0.31	%	4.4	0.1
Sulfur (S)	0.08	0.11	%	1.6	0.05
Calcium (Ca)	0.76	1.08	%	15.2	0.01
Magnesium (Mg)	0.08	0.11	%	1.6	0.01
Sodium (Na)	0.05	0.07	%	1	0.01
Copper (Cu)	ND	ND	ppm	0	20
Iron (Fe)	919	1311	ppm	1.8	50
Manganese (Mn)	43	61	ppm	0.1	20
Zinc (Zn)	39	56	ppm	0.1	20
Moisture	29.9		%		0.1
Total Solids	70.1		%	14.02	
pH	7.5				
Total Carbon	4.21	6.01	%		0.05
C/N Ratio	10:01				
Chloride	0.06	0.09	%		0.02
Percent Volitale Solids		14.19	%		0.01
Organic Matter	8.9	12.7	%		0.01
Conductivity 1:5		1.7	mS/cm		0.1

Finished Compost (Heavy Metals) RM1/2

Organic Solid Report (HEAVY METALS)

Parameter	Analysis As Received	Dry Weight	Units	Detection Limit	Method	Ceiling Conc. (D.W.)*
Arsenic	0.5	0.7	mg/kg	0.5	EPA 6020	75 ppm
Boron	ND	ND	ppm	20	ICP	
Cadmium	ND	ND	ppm	0.5	EPA 6010	85 ppm
Chromium	3.5	5	ppm	1	EPA 6010	3000 ppm
Lead	ND	ND	ppm	5	EPA 6010	840 ppm
Mercury	ND	ND	ppm	0.05	EPA 7471	57 ppm
Molybdenum	ND	ND	ppm	1	EPA 6010	75 ppm
Nickel	1.3	1.9	ppm	1	EPA 6010	420 ppm
Selenium	ND	ND	ppm	10	EPA 6010	100 ppm

*Reference 40 CFR Table 1 of 503.13 for Ceiling Concentrations.

*Sample was prepared for EPA 6010 analysis by EPA Method 3050

Finished Compost (Other Analytes) RM1/2

Organic Solid Report (OTHER ANALYTES)

Parameter	Analysis As Received	Units	Detection Limit	Method
5 Day Germination	100	%	5	TMECC
7 Day Vigor	100	%	1	TMECC
Bulk Density (Loose)	573.2	lbs/cu yd	1	wt/vol
Bulk Density (Packed)	370.9	lbs/cu yd	1	wt/vol
Fecal Coliform	5	mpn/g	2	EPA 1681
Man Made Materials	ND	%	0.1	Microscope
Salmonella	ND	mpn/4 g	0.01	EPA 1682
Sieve % Passing 3in. (Dry wt.)	100	%	0.01	TMECC SIEVE
Sieve % Passing 1.5in. (Dry wt.)	100	%	0.01	TMECC SIEVE
Sieve % Passing 1in. (Dry wt.)	100	%	0.01	TMECC SIEVE
Sieve % Passing 3/4in. (Dry wt.)	100	%	0.01	TMECC SIEVE
Sieve % Passing 5/8in. (Dry wt.)	100	%	0.01	TMECC SIEVE
Sieve % Passing 3/8in. (9.25mm)	99.3	%	0.01	TMECC SIEVE
Sieve % Passing 1/4in. (Dry wt.)	98	%	0.1	TMECC SIEVE
Sieve Max. Particle Length	1.5	Inches	0.01	TMECC SIEVE
CO2 OM Evolution	0.63	mgCO2-C/gOM/day	0.01	TMECC 05.08A
CO2 Solids Evolution	0.13	mgCO2-C/gTS/day	0.01	TMECC 05.08A
Stability Rating	Very Stable			TMECC 05.08A
Total Organic Carbon	4	%	0.01	C ANALYZER
Water Soluble Phosphorous	ND	ppm	1	ICAP

Finished Compost Analysis RM3/4

Finished Compost – RM3/RM4

Organic Solid Report

Parameter	Analysis As Received	Dry Weight	Units	Nutrients Lbs./Ton As Received	Detection Limit
Total Nitrogen (N)	0.48	0.66	%	9.6	0.01
Ammonium Nitrogen (N)	0.008	0.01	%	0.2	0.001
Nitrate Nitrogen (N)	0.02	0.03	%	0.4	0.01
Organic Nitrogen (N)	0.45	0.62	%	9	Calculated
Phosphorous (P205)	0.34	0.47	%	6.8	0.1
Potassium (K2O)	0.35	0.48	%	7	0.1
Sulfur (S)	0.07	0.1	%	1.4	0.05
Calcium (Ca)	0.53	0.73	%	10.6	0.01
Magnesium (Mg)	0.09	0.12	%	1.8	0.01
Sodium (Na)	0.07	0.1	%	1.4	0.01
Copper (Cu)	n.d.	n.d.	ppm	0	20
Iron (Fe)	1020	1407	ppm	2	50
Manganese (Mn)	39	54	ppm	0.1	20
Zinc (Zn)	33	46	ppm	0.1	20
Moisture	27.53		%		0.1
Total Solids	72.47		%	1449.4	
pH	7				
Total Carbon	3.91	5.4	%		0.05
C/N Ratio	8.1:1				
Chloride	0.1	0.15	%		0.02
Percent Volitale Solids		13.6	%		0.01
Organic Matter	9.9	13.66	%		0.01
Conductivity 1:5		1.9	mS/cm		0.1

Finished Compost (Heavy Metals) RM3/4

Organic Solid Report (HEAVY METALS)

Parameter	Analysis As Received	Dry Weight	Units	Detection Limit	Method	Ceiling Conc. (D.W.)*
Arsenic	0.7	1	mg/kg	0.5	EPA 6020	75 ppm
Boron	ND	ND	ppm	20	ICP	
Cadmium	ND	ND	ppm	0.5	EPA 6010	85 ppm
Chromium	4.1	5.7	ppm	1	EPA 6010	3000 ppm
Lead	ND	ND	ppm	5	EPA 6010	840 ppm
Mercury	ND	ND	ppm	0.05	EPA 7471	57 ppm
Molybdenum	ND	ND	ppm	1	EPA 6010	75 ppm
Nickel	1.1	1.5	ppm	1	EPA 6010	420 ppm
Selenium	ND	ND	ppm	10	EPA 6010	100 ppm

*Reference 40 CFR Table 1 of 503.13 for Ceiling Concentrations.
*Sample was prepared for EPA 6010 analysis by EPA Method 3050

Finished Compost (Other Analytes) RM3/4

Organic Solid Report (OTHER ANALYTES)

Parameter	Analysis As Received	Units	Detection Limit	Method
5 Day Germination	100	%	5	TMECC
7 Day Vigor	100	%	1	TMECC
Bulk Density (Loose)	1281.4	lbs/cu yd	1	wt/vol
Bulk Density (Packed)	1618.6	lbs/cu yd	1	wt/vol
Enteric Viruses	n.d.	PFU/4g	1	EPA 625/R-92/013 (mod)
Fecal Coliform (Dry wt.)	n.d.	mpn/g	2	EPA 1681
Man Made Materials	n.d.	%	0.1	Microscope
Salmonella	n.d.	mpn/4 g	0.01	EPA 1682
Sieve % Passing 3in. (Dry wt.)	100	%	0.01	TMECC SIEVE
Sieve % Passing 1.5in. (Dry wt.)	100	%	0.01	TMECC SIEVE
Sieve % Passing 1in. (Dry wt.)	100	%	0.01	TMECC SIEVE
Sieve % Passing 3/4in. (Dry wt.)	100	%	0.01	TMECC SIEVE
Sieve % Passing 5/8in. (Dry wt.)	99.6	%	0.01	TMECC SIEVE
Sieve % Passing 3/8in. (9.25mm)	98.2	%	0.01	TMECC SIEVE
Sieve % Passing 1/4in. (Dry wt.)	96.8	%	0.1	TMECC SIEVE
Sieve Max. Particle Length	1.5	Inches	0.01	TMECC SIEVE
CO2 OM Evolution	0.48	mgCO2-C/gOM/day	0.01	TMECC 05.08A
CO2 Solids Evolution	0.11	mgCO2-C/gTS/day	0.01	TMECC 05.08A
Stability Rating	Very Stable			TMECC 05.08A
Total Organic Carbon	4	%	0.01	C ANALYZER
Viable Helminth Ova	n.d.	ovum/4g dry	NA	EPA/625/R-92/013-1999
Water Soluble Phosphorous	ND	ppm	1	ICAP

Appendix C
Active Composting and Curing Temperature Charts

Active Composting Chart RM1/2

On-Farm Composting Pilot

RM 1/2

		Sampling Locations - Temperature (F)																
		1 foot deep			*3 feet deep*			*1 foot deep*			*3 feet deep*			*Windrow Temperature*	*pH*	*Windrow Turning*	*Water Addition*	
Date	*Day*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*					*Rain Fall*
06/23/10	0		**Start RM1**															
06/24/10	1	130	132	122	114	118	112							121.3333				
06/25/10	2																	
06/26/10	3																	
06/27/10	4	120												120	6.5			
06/28/10	5																	3.2
06/29/10	6																	0.6
06/30/10	7																	0.7
07/01/10	8	122	130	136	123	128	132		**Start RM2**					128.5	6.7	105		0.2
07/02/10	9	133	132	132	121	127	127	136	141	131	116	120	122	128.1667				1.5
07/03/10	10																	2
07/04/10	11	120												120	6.7			1.7
07/05/10	12	116						114						115	7			1.5
07/06/10	13	115						117						116	6.8			0.4
07/07/10	14	124	122	120	123	125	126	123	125	128	123	122	122	123.5833				0.6
07/08/10	15																	0.1
07/09/10	16	128	132	129	120	124	127	125	122	124	122	122	121	124.6667		105		0
07/10/10	17		**Combined w/ RM2 on 7/9/10**															not recorded
07/11/10	18																	not recorded
07/12/10	19							132						132	6.6			0
07/13/10	20							148	148	151	131	129	132	139.8333				0
07/14/10	21																	0
07/15/10	22							143	147	144	132	132	130	138		105		0
07/16/10	23																	1.2
07/17/10	24																	not recorded
07/18/10	25							132						132	6.5			not recorded
07/19/10	26															105		1.4
07/20/10	27							138	136	141	133	132	133	135.5				0.1

07/21/10	28																	0
07/22/10	29															105		0
07/23/10	30							147	142	146	138	133	138	140.6667				0
07/24/10	31																	not recorded
07/25/10	32																	not recorded
07/26/10	33							133						133	6.6	105		1.6
07/27/10	34							138	143	144	134	137	134	138.3333				
07/28/10	35							133						133	6.8	105		
07/29/10	36																	
07/30/10	37							135	139	138	131	132	131	134.3333				
07/31/10	38																	
08/01/10	39																	
08/02/10	40							132						132	6.4			0.1
08/03/10	41							135	141	138	137	133	136	136.6667				1.2
08/04/10	42																	0.4
08/05/10	43							131						131	6.6			1.2
08/06/10	44							140	143	142	134	140	126	137.5				
08/07/10	45																	
08/08/10	46																	
08/09/10	47							132						132	6.7	105		1
08/10/10	48							124	122	130	119	122	122	123.1667				
08/11/10	49																	0.2
08/12/10	50																	1.3
08/13/10	51																	
08/14/10	52							134	136	133	128	122	124	129.5				
08/15/10	53																	
08/16/10	54																	
08/17/10	55							132	140	140	127	129	117	130.8333				
08/18/10	56																	2
08/19/10	57																	
08/20/10	58							114	122	123	112	112	118	116.8333				
08/21/10	59																	
08/22/10	60																	

Curing Log RM1/2

On-Farm Composting Pilot

RM1/2

Week	Date	Day	*Sampling Locations - Temperature (F)* Point 1 1ft	Point 1 3ft	Point 2 1ft	Point 2 3ft	Point 3 1ft	Point 3 3ft	*Pile Temperature*	*pH*	*Pile Turning*	*Rainfall Amt.*	*Rainfall Date*
1												0.2	08/21/10
	08/27/10	7	104	106	104	107	104	106	105.2			3	08/23/10
2			108	102	106	101	106	101	104.0			1.4	08/27/10
	09/03/10	14	108	103	104	104	108	104	105.2			1.7	08/30/10
3			*102*		*102*		*102*		*102.0*	*6.8*		*0.1*	*09/02/10*
	09/10/10	21	*99*		*99*		*99*		*99.0*	*6.8*		*0.5*	*09/07/10*
4			*97*		*97*		*97*		*97.0*	*6.8*		*0.3*	*09/09/10*
	09/17/10	28	106	106	111	103	107	99	105.3			0.1	09/17/10
5			103	108	108	105	104	101	104.8				
	09/24/10	35	100	100	108	103	106	98	102.5				
6			108	105	106	104	109	106	106.3	*6.8*	*85*		
	10/01/10	42	108	112	106	113	109	110	109.7				
7			105	104	111	105	105	110	106.7				
	10/08/10	49	101	106	98	108	105	106	104.0				
8			102	104	99	107	102	108	103.7				
	10/15/10	56	100	107	100	106	99	107	103.2				
9			94	101	94	100	94	101	97.3				
	10/22/10	63	92	98	96	100	95	100	96.8			0.1	10/18/11
add'l			94	100	94	99	95	100	97.0				
obsrv.	10/29/10	70	93	100	98	101	96	100	98.0		*85*		
	SAMPLE COLLECTED FOR ANALYSIS ON 10/3												

Active Composting Log RM3/4

On-Farm Composting Pilot

RM 3/4

		Sampling Locations - Temperature (F)																
		1 foot deep			*3 feet deep*			*1 foot deep*			*3 feet deep*							
Date	*Day*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*Windrow Temperature*	*pH*	*Windrow Turning*	*Water Addition*	*Rain Fall*
07/09/10	0		**Start RM3**															0
07/10/10	1																	not recorded
07/11/10	2																	not recorded
07/12/10	3	137												137	6.5			0
07/13/10	4	156	157	158	137	141	145							149				0
07/14/10	5																	0
07/15/10	6	147	146	152	140	138	140		**Start RM4**					143.8333		105		0
07/16/10	7		**Combined w/ RM4**															1.2
07/17/10	8																	not recorded
07/18/10	9							137						137	6.5			not recorded
07/19/10	10															105		1.4
07/20/10	11							139	146	137	131	137	132	137				0.1
07/21/10	12																	0
07/22/10	13															105		0
07/23/10	14							147	148	148	137	143	144	144.5				0
07/24/10	15																	not recorded

07/25/10	16																	not recorded
07/26/10	17							145						145	6.7	105		1.6
07/27/10	18							152	157	156	142	142	146	149.1667				
07/28/10	19							142						142	6.7	105		
07/29/10	20																	
07/30/10	21							150	157	152	146	148	149	150.3333				
07/31/10	22																	
08/01/10	23																	
08/02/10	24							149						149	6.7			0.1
08/03/10	25							156	160	152	148	147	146	151.5				1.2
08/04/10	26																	0.4
08/05/10	27							148						148	6.8			1.2
08/06/10	28							157	158	156	151	145	146	152.1667				
08/07/10	29																	
08/08/10	30																	
08/09/10	31							147						147	6.6	105		1
08/10/10	32							138	139	138	134	133	134	136				
08/11/10	33																	0.2
08/12/10	34																	1.3
08/13/10	35																	
08/14/10	36							150	151	151	142	137	135	144.3333				
08/15/10	37																	
08/16/10	38																	
08/17/10	39							144	156	153	144	137	138	145.3333				

08/18/10	40																	2
08/19/10	41																	
08/20/10	42							140	138	142	130	128	131	134.8333		105		
08/21/10	43																	0.2
08/22/10	44																	
08/23/10	45																	
08/24/10	46							137	135	134	134	137	136	135.5				
08/25/10	47																	
08/26/10	48																	
08/27/10	49							129	135	130	121	126	120	126.8333				
08/28/10	50																	
08/29/10	51																	
08/30/10	52																	1.7
08/31/10	53							125	133	136	120	121	123	126.3333				
09/01/10	54																	
09/02/10	55																	
09/03/10	56							127	136	130	124	132	124	128.8333				

Curing Log RM3/4

On-Farm Composting Pilot

RM3/4			*Sampling Locations - Temperature (F)*										
			Point 1		*Point 2*		*Point 3*		*Pile Temperature*	*pH*	*Pile Turning*	*Rainfall Amt.*	*Rainfall Date*
Week	*Date*	*Day*	*1ft*	*3ft*	*1ft*	*3ft*	*1ft*	*3ft*					
1			110		110		110		110.0	*6.7*		*0.2*	*08/21/10*
	09/10/10	7	113		113		113		113.0	*6.8*		*3*	*08/23/10*
2			116		116		116		116.0	*6.8*		*1.4*	*08/27/10*
	09/17/10	14	137	128	134	131	134	121	130.8	*6.9*		*1.7*	*08/30/10*
3			*134*	*127*	*125*	*125*	*124*	*119*	*125.7*			0.1	09/02/10
	09/24/10	21	*132*	*120*	*123*	*119*	*134*	*125*	*125.5*			0.5	09/07/10
4			*125*	*115*	*127*	*118*	*126*	*116*	*121.2*			0.3	09/09/10
	10/01/10	28	127	117	131	120	126	120	123.5	*7.1*	*85*	*0.1*	*09/17/10*
5			126	119	132	122	127	116	123.7				
	10/08/10	35	122	125	130	125	125	125	125.3				
6			124	121	123	127	125	122	123.7				
	10/15/10	42	120	123	124	127	122	124	123.3				
7			114	115	115	119	117	120	116.7				
	10/22/10	49	113	121	115	118	112	118	116.2				
8			112	118	115	117	113	120	115.8				
	10/29/10	56	111	116	115	116	114	121	115.5				
9			115	121	116	120	115	121	118.0				
	11/05/10	63	103	116	102	115	103	118	109.5		*85*		
add'l													
obser-												1.5	11/04/10