City of San José

San José/Santa Clara Water Pollution Control Plant Master Plan

TASK NO. 4
PROJECT MEMORANDUM NO. 10B
FOOD WASTE SEPARATION

FINAL DRAFT
August 2009

in association with

2700 YGNACIO VALLEY ROAD • SUITE 300 • WALNUT CREEK, CALIFORNIA 94598 • (925) 932-1710 • FAX (925) 930-0208
pw://Carollo/Documents/Client/CA/San Jose/7897A00/Deliverables/Task 4.0/PM No.10/7897AT4PM10B.doc (FINAL DRAFT)

CITY OF SAN JOSÉ

SAN JOSÉ/SANTA CLARA WATER POLLUTION CONTROL PLANT MASTER PLAN

TASK NO. 4
PROJECT MEMORANDUM NO. 10B
FOOD WASTE SEPARATION

TABLE OF CONTENTS

Page No.

LIST OF TABLES

LIST OF FIGURES

FOOD WASTE SEPARATION

1.0 INTRODUCTION

This Technical Memorandum (Tech Memo) describes the results of a literature survey conducted on current food waste separation programs related to municipal wastewater flow.

1.1 Purpose

The purpose of this task was to perform a planning-level assessment of food waste separation practices which would reduce the per capita wastewater flows and pollutant loadings to the San José/Santa Clara Water Pollution Control Plant (WPCP) over the 30-year planning horizon. The scope of work indicates a literature survey be conducted of several representative case studies and a summary table be generated on per capita food waste generated. Using this information, an estimate on per capita load reduction at the WPCP was developed assuming a percentage of the food waste will be collected and removed from the sanitary waste stream. Other upstream waste minimization practices (urine separation and additional water conservation) were evaluated and are summarized in separate project memoranda.

1.2 Background

The San José/Santa Clara WPCP is one of the largest advanced wastewater treatment facilities in California. It treats and cleans the wastewater of over 1.5 million people that live and work in the 300-square mile area encompassing San José, Santa Clara, Milpitas, Campbell, Cupertino, Los Gatos, Saratoga, and Monte Sereno (San José, 2009). The technical advisory group (TAG) for the San José/Santa Clara WPCP master planning committee advised the City to further evaluate the potential for upstream changes that would impact the need and timing of future facilities at the WPCP. In response to the City's Zero Waste goal, the City will implement a variety of waste conversion technologies to meet the goal of zero waste by 2022. This means that food waste previously sent to the landfill will need to be diverted elsewhere. At the same time the City would like to explore the reduction in per capita wastewater flows and loads sent to the WPCP by reducing the amount of in-sink residential garbage disposals, also known as food waste disposers (FWD). Several alternative disposal methods exist, including; home composting, conversion to animal feed, redistribution to food banks, rendering, incineration, central collection and composting, anaerobic digestion, gasification and plasma arc, and others. This project memorandum focuses on the affects of in-sink residential disposal reduction on the WPCP and provides summaries of what similar municipalities have experienced with regards to food waste diversion.

2.0 OVERVIEW

2.1 Food Waste Overview

Food leftovers are the single-largest component of the waste stream by weight in the United States. Food waste includes uneaten food and food preparation scraps from residences or households, commercial establishments like restaurants, institutional sources like school cafeterias, and industrial sources like factory lunchrooms (U.S. EPA, 2009). In the U.S., approximately 12.5 percent of the total municipal solid waste (MSW) generated is food waste. This equates to approximately 210 lb/capita/year, or 0.58 lb/capita/day (U.S. EPA, 2007). Table 1 presents the results of several studies that estimate the per capita food waste generation. Included in the table are the results of independent studies, FWD sponsored studies, studies based in the U.S., and foreign studies. The results indicate an average generation rate slightly lower than that estimated by the U.S. EPA.

Table 1 Per Capita Food Waste Generation
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Source	Total Food Waste Generated lb/capita/day	Portion of Total (that can pass through disposer) lb/capita/day	Percentage of Total
Karlberg and Norin (1999)	0.45	0.27	60
Kegebein, et al.	0.24-0.36	0.166	55
Terpstra (1995)	0.57	-	-
CECED (2003)	0.50	-	-
Diggelmann and Ham (1998)	0.29	0.21	72
CRC (2000)	0.53	-	-
Karrman, et al. (2001)	0.45	0.3	67
Average	0.47	0.24	64
Source: In-Sink-Erator, 2006			

The water consumption due to the use of FWDs has also been estimated by several studies and is presented in Table 2. The average per capita water use is approximately one gallon per day.

Table 2	**Per Capita Water Consumption Due to Food Waste Disposer Use San José/Santa Clara Water Pollution Control Plant Master Plan City of San José**
Source	**Water Consumption (gal/capita/day)**
New York City (1998)	1.0
Karlberg and Norin (1999)	1.19
De Koning and Van Der Graaf (1996)	1.19
Bolzonella, et al. (2003)	0.27
Kegebein, et al.	1.0
Terpstra (1995)	1.18
CECED (2003)	1.0
Griffith University (1994)	1.06
CRC (2000)	0.78
Average	0.96
Source: In-Sink-Erator, 2006	

In San José, approximately 80 percent of residences have an in-sink disposer compared to a market penetration of about 50 percent nationally (US Census, 1998). This relatively high market penetration can add a significant amount of flow and load to the WPCP. The macerating and flushing of food waste down the drain transfers the problem from solid waste facilities to wastewater treatment facilities. Below is a list of several challenges household disposal of food waste presents:

- Increased strain on the collection system due to the extra physical loading of sewage contributed by residential food waste.
- Increased nutrient levels can potentially affect discharge quality.
- Increased BOD, TSS, and COD concentrations of influent wastewater.
- Additional water usage.
- Increased energy consumption from the disposer itself and the excess aeration and solids treatment.
- Additional Fats, Oil, and Grease (FOG) delivered to the system through food waste.
- Additional load on the treatments plant's solids handling facilities.
- Excess greenhouse gases may be generated in the collection system.

- Flat and long sewer lines provide problems with clogging and corrosion and require additional maintenance.

These challenges equate to additional costs for the wastewater authority to treat the additional pollutant loading and disposal of the additional biosolids created. Table 3 presents the additional organic loading of wastewater where FWDs are used. The table shows that FWDs can have a substantial effect on wastewater strength.

Table 3 Extra Organic Loading of Wastewater Attributed to FWDs
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

	BOD grams/capita/day		**Specifications Sections grams/capita/day**	
Normal Domestic Wastewater:	**Range**	**Typical**	**Range**	**Typical**
Without contribution from ground kitchen wastes	59-109	81.7	59-113	90.7
With contribution from ground kitchen wastes	82-118	99.8	91-150	117.9
% Increase per capita		25		33
Source: Metcalf and Eddy, 1991				

The increased loads will require larger solids-handling facilities and biological treatment units. Table 4 also indicates that FWDs significantly increase loading on treatment facilities.

Table 4 Extra Organic Loading of Wastewater Attributed to FWDs
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

	grams/capita/day			
Constituent	**Range**	**Typical without Ground-Up Kitchen Waste**	**Typical *with* Ground-Up Kitchen Waste**	% Increase Load
BOD	50-120	80	100	25.0
COD	110-295	190	220	15.8
TSS	60-150	90	110	22.2
Oil and Grease	10-40	30	34	13.3
Source: Crites and Tchobanoglous, 1998				

Table 5 summarizes several findings on the effects to treatment plant loading due to the use of food waste disposals. According to Boland et. al., the studies below include both independent and FWD-manufacturer commissioned studies.

Table 5 Summary of Effects of Adding FWDs
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Author of Study	BOD Increase	TSS Increase	COD Increase	Nitrogen Increase	Phosphorus Increase	Water Usage Increase
Metcalf and Eddy (1991)	25%	33%	-	-	-	-
Crites and Tchobanoglous (1998)	25%	22%	16%	-	-	-
NILIM (2005)	20%	20%	20%	10%	10%	-
Marashlian and El-Fadel (2005)	17-62%	2-7%	-	-	-	-
Nilsson, et. al. (1990)	-	33%	-	12%	negligible	4.3 L/capita
U.S. EPA (2002)	-	40-90%	20-65%	-	-	-
Karlberg and Norm (1999)	16%	-	-	3%	5%	3-6 L/house/day
De Koning (2004)	66 g/capita/day	60 g/capita/day	95 g/capita/day	2.1 g/capita/day	0.3 g/capita/day	-
Fujiu et. al. (2004)	19%	18%	20%	7%	8%	-
NYC Dept. of Environmental Protection (1997)	0.072 lb/capita/day	0.047 lb/capita/day	0.100 lb/capita/day	No change	negligible	1 gal/capita/day

Source: Adapted in part from Boland, et al., 2008

In addition, several studies have estimated the annual energy consumption by household food waste disposers to be 3-4 kWh/household/year (Boland et. al., 2008).

Food waste disposers also present many advantages that are summarized below (Gitter, 2006):

- Reduced transportation emissions and costs.
- Excess biogas produced for clean energy at the treatment plant.
- Convenient and easy for residents.
- Promotes nutrient recycling if biosolids from plant are land applied.
- High carbon content of food waste improves the overall WWTP nitrogen and phosphorus nutrient removal process.

2.2 Alternatives to FWDs

Several technologies are available for waste minimization. These include thermal, biological, chemical, and mechanical technologies capable of converting municipal solid waste (MSW) into useful products. Most of these technologies are in full-scale operation in locations such as Europe, Israel, Japan and Canada, but the U.S. has only small pilot scale demonstrations. San José has expressed interest in and intent to develop renewable energy from MSW in an effort to meet the zero-waste goal by 2022 and be a leader in sustainability. Diverting food waste from the landfill and the sewer system will require implementation of an alternative conversion technology. Technologies that are considered appropriate for consideration in San José at this time due to their proven history of full scale operation are described below. Other developing technologies for food waste conversion are not detailed here due to lack of full scale implementation and are beyond the scope of this study.

2.2.1 Anaerobic Digestion

Anaerobic digestion is the process where microbes breakdown biodegradable waste in the absence of oxygen. This process produces biogas which can be captured and used as a source of clean energy. Waste mass is reduced and stabilized, and the remaining biosolids can be used as a soil amendment. San José WPCP uses anaerobic digestion to treat their wastewater sludge. The biogas produced at WPCP is converted to electricity and used as a source of power for plant operations. Digested biosolids are dried in nearby lagoons and then used as alternate daily cover at Newby Island landfill.

The East Bay Municipal Utility District (EBMUD) is currently using its excess treatment capacity by feeding food waste and FOG into its low solids anaerobic digesters. Here the feedstock is screened to remove undesirable materials before being diluted and pumped to the digester. Generally, the total solids reduction and energy values are similar to normal wastewater treatment plant digesters. The advantage of adding FOG to the digesters is that it can be easily emulsified and breaks down quickly to provide an increase in biogas production.

San José has begun evaluating the potential of adding FOG to their digesters and a 2009 report by Environmental Engineering & Contracting, Inc. recommended the City pursue a FOG waste to energy program and presented an estimate of the amount of material potentially available within the plant's service area and vicinity. Currently five of the 16 WPCP digesters are out of service and in need of rehabilitation. Under current operating conditions, and the plant's established standby criteria (PM 3.4), the currently available digester volume is adequate only for today's flows and loads (PM 3.5). When additional digester capacity is in operation, the plant will have sufficient excess capacity to pursue adding FOG and food waste to their digesters.

2.2.2 Composting

Composting is an aerobic process where biodegradable material is broken down using bacteria to produce amendment. Organic wastes (e.g., food wastes, yard trimmings, manure) are combined into proper ratios in piles, rows, or vessels. Bulking agents (e.g., wood chips) are added to accelerate the breakdown of organic material. The final product, compost, is used as a soil amendment or as a medium to grow plants. Many municipalities have composting facilities and the practice is growing.

There are different methods of composting and each has their advantages and disadvantages. The methods of composting include unaerated static pile composting, aerated static pile composting, aerated windrow pile composting, in-vessel composting, and vermicomposting. Unaerated static piles are well suited for smaller operations and cannot accommodate meat or grease. Aerated static piles and windrows require frequent turning and careful moisture and temperature control but are able to accommodate meat and grease. In-vessel composting are moisture and temperature controlled systems that can accommodate meat and grease and process larger amounts of waste in a smaller footprint. Vermicomposting uses red worms to break down the waste into worm castings which are high value compost. Meat and grease are not acceptable in vermicomposting systems. Establishments that compost on-site avoid collection costs that generally represent the majority of waste handling costs. In-vessel and vermicomposting are generally applicable for on-site composting.

As with any product, there must be a demand or a market must be created through partnerships to ensure the compost can be sold. Demand for nutrient rich compost should be high in the San José area because of nearby agriculture but this should be evaluated prior to full-scale implementation.

2.3 The Current Food Waste Environment

Municipalities around the world are looking for sustainable and economic methods of dealing with food waste and several papers have been published on the subject.

In Israel, research by Galil and Yaacov has concluded that at a 60 percent market penetration the additional amounts of sludge are expected to be lowest in the case of biological treatment at 24 to 38 g/capita/day, and the highest in the case of primary chemical sedimentation followed by biotreatment, 67 to 100 g/capita/day. In addition, the authors concluded the energy potential from biogas will increase 50 to 70 percent depending on the treatment sequence, and the additional capital investment cost to the treatment plant would increase by 23 to 27 percent, while operation and maintenance cost would increase 26 to 30 percent.

In 2008, the City of Raleigh, North Carolina, approved a ban on the installation of new garbage disposals but the ban was rescinded a month later after resistance from disposer manufacturers.

Worcestershire County in the United Kingdom is in favor of FWDs and in 2006 offered rebates to residents installing FWDs in their kitchen.

UC Davis and UC Berkeley are using vermicomposting to divert their cafeteria wastes from disposal.

The City of San José continues to be a leader in recycling and has a very successful yard trimmings recycling program in place. A 1998 study found that 24 percent of the material San José was sending to landfills consisted of food residuals (Krueger, 2000). This led the City to explore several composting technologies at the University of California's Bay Area Research and Extension Center (BAREC), the Newby Island landfill, and at the Z-Best Composting Facility. These pilot studies were conducted using food waste from large generators such as grocery stores. In order to expand and food waste diversion program to the residential sector San José will need to provide green waste bins and eliminate their popular yard trimmings program which allows residents to pile yard waste in the street.

3.0 LITERATURE SURVEY OF REPRESENTATIVE CASE STUDIES

Below is a summary of representative case studies surveyed. The survey focused on effects of food waste diversion on wastewater treatment facilities as well as the overall diversion program including institutional arrangements and lessons learned.

3.1 The City and County of San Francisco

San Francisco has been a pioneer in source separated organics diversion and is a leader in recycling and sustainability. When California legislature passed a law in 1989 requiring 50 percent waste diversion from landfills by 2000 San Francisco began an aggressive organics waste separation program. Since yard trimmings account for only 5 percent of the City's waste stream, food waste needed to be diverted to reach the States' requirement. The City has set tougher goals of 75 percent waste diversion by 2010 and 100 percent by 2020. San Francisco's comprehensive program is formed through partnerships with local food banks, haulers, and end users. Food waste disposer market penetration in San Francisco is about 55 percent (US Census, 1998).

The City uses a three-stream sort system, also known as the "Fantastic Three", in which residents receive three 32-gallon colored carts. A black cart is for landfill trash, a green cart for green waste including food waste, yard trimmings, and other compostables, and a blue cart for mixed fiber and container recyclables. Collection service is provided weekly and residents are charged for extra trash but not green waste and recyclables. Residents pay about $19.94 a month (2005), which is typical for the bay area (Farrell, 2005). The fee is assessed by the volume of their trash cart. This encourages residents to recycle and divert food wastes to keep their garbage fees down. The City had difficulty in citizen outreach because of the high number of residents that don't speak English. At multifamily buildings it was more difficult to implement the 3 bin system because of coordination difficulties. These buildings were provided information about the program and were allowed to participate if a tenant or manager agrees to be the coordinator. The response has been positive and the number of multifamily participants continues to grow.

400 tons of food scraps from the City are composted every day, 90 percent of which is used as a soil amendment for vineyards in Napa and Sonoma Counties. A recent law approved by the City's Board of Supervisors enacts tough recycling rules that the City hopes will help it achieve its goal of zero waste by 2020. The law allows for fines of $100 for small businesses and single-family homes and up to $1000 for large businesses and multiunit buildings. City officials indicated that fines would only be levied for the most egregious cases and would not take effect until 2011.

Below are lessons learned from San Francisco's organics diversion program (Farrell, 2005):

- Provide financial incentives to haulers. This gives haulers incentive to meet program goals.
- Start small to demonstrate, but don't call it a pilot program. The City recommends that you call it a demonstration program but you continue going once you start.
- Go for the low-hanging fruit. Get the easiest participants first such as supermarkets and large food service operations.
- Provide customers with lots of options for containers and service. Provide small and large containers and offer collection daily.
- Provide financial and other incentives to participants.

- Get management support and buy in at all levels.
- Make the program simple, easy and convenient as possible. Color coded bins and pictorial graphics can help accomplish this.
- Provide free on-site assistance and staff training when setting up a customer for the food scrap program.

In addition to the City's comprehensive food diversion for composting program, studies have been conducted on the feasibility of using food waste as feedstock for the City's anaerobic digesters. Preliminary studies indicate that this is a feasible alternative that should be pursued (Zhang et. al, 2006) (Schafer, 2008).

3.2 Alameda County

Residential food waste collection is available at over 311,000 single family homes in 13 cities in Alameda County. Several waste stream characterization studies determined that food waste constituted 24 percent of the compostable organics stream. Waste is collected and taken to several composting facilities including Newby Island and the Z-Best facility. The County estimates that voluntary participation in the food waste program is 25 percent, which equates to 10,000 tons per year.

Berkeley began diverting food waste in 1997 after a waste stream characterization indicated 25 percent of City collected refuse from the commercial sector was organic waste, while 12 percent was food waste. The commercial food waste collection program has grown and the City now allows residents to place food scraps in their green bin for weekly pickup. Home composting bins are also offered to the public at a discounted price of $38. Home composting lessons are provided by the City for free. Food waste bins have a tendency to get extremely dirty and require cleaning often. Berkeley and San Francisco have mitigated this problem by offering organic biodegradable liner bags for businesses and residents to purchase. Berkeley has been the recipient of some grants provided by Alameda County to encourage food waste diversion. The County also provides a technical assistance hotline, videos, composting classes, print media, and awards in an effort to increase composting of food waste in the county.

Oakland also has commercial and residential food waste diversion programs in place. In 2005, 12,000 tons of commercial food scraps were diverted from the waste stream and 34,000 tons were diverted from the residential food scrap and yard trimmings recycling program. The market penetration for FWDs in Oakland is approximately 69 percent (US Census, 1998). Oakland, like other cities in Alameda County, continues to pursue food waste diversion practices and technologies.

3.3 New York City

FWDs have been banned in New York City since the 1970s in areas served by a combined collection system. The ban was introduced to protect surrounding water bodies from the discharge of organic wastes and to prevent deterioration of the collection system. The plumbing industry and others had repeatedly called for an end to the ban and in 1995 the City initiated a 21-month study to determine the potential effects of permitting the use of FWDs in combined sewer areas. A maximum market penetration rate of 1 percent of households per year was used for the study. This rate resulted in an estimated penetration of 33 percent in the year 2035. Below is a summary of the results of the survey:

- Introduction of FWD units may cause increases in suspended solids and oil and grease in the sewer system.
- Based on video recordings conducted before and after the study, it was concluded that no significant adverse impacts on the sewer system are expected.
- Water consumption increased 1 gallon per capita per day.
- Wastewater treatment costs would increase but the City considered these costs to represent a “de minimis impact” to the overall cost of maintaining the City’s wastewater infrastructure.
- Projected increase in BOD in New York Harbor by 2005 resulting in a 0.01 mg/L decrease in DO.
- Positive effect on solid waste management by decreasing the operating costs.

The results of the survey led the New York City Department of Environmental Protection to recommend lifting the ban on FWDs. The survey did raise a cautionary flag at high penetration rates and recommended monitoring the installation of FWDs to prevent worst-case scenarios from being realized.

4.0 SUMMARY

Food wastes constitute a large portion of MSW. In recent years many municipalities have been exploring the possibility of diverting food wastes and producing a usable product. Curbside collection of organic waste is growing as haulers and composting sites are expanding. In addition to curbside collection, many residents are using on-site conversion technologies such as vermicomposting, backyard composting, and in-vessel systems. The benefits of food waste diversion are well documented and the U.S. EPA has established a food waste recovery hierarchy as presented in Figure 4-1.

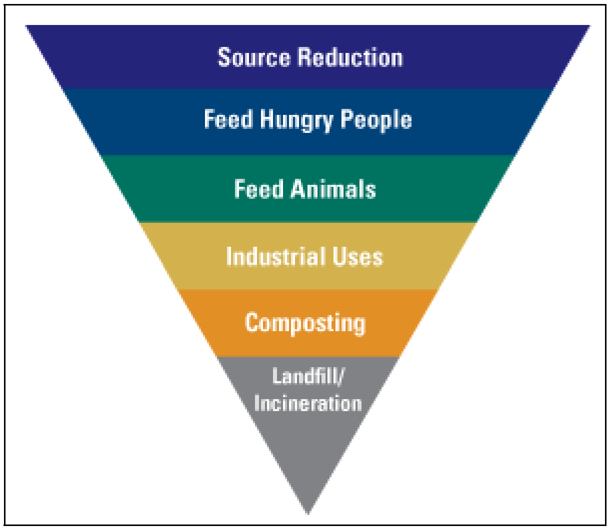

Figure 1 EPA's Food Waste Recovery Hierarchy

Separation of food wastes allows businesses to inventory the excess food they are creating and then implement source reduction practices to save money.

Successful food waste collection programs contain the following elements:

- Provide residents with bins to place their yard trimmings and food wastes into.
- Collect wastes weekly at a minimum but offer more frequent collection.
- Consider providing residents with household bins for their food wastes.
- Educate the public on all aspects of the diversion program.

A successful food waste collection program could also significantly reduce the amount of material disposed of through FWDs. The estimated potential reductions in plant influent BOD and TSS loadings if the use of FWDs were discontinued in the WPCP service area are shown in Table 6. A reduction in influent BOD and TSS would decrease the amount of primary and secondary sludge, decrease the loading to the digesters and reduce the amount of digester gas produced. Although much of the food waste material in the plant influent will settle out as primary sludge, some carry over to the secondary treatment system causing the consumption of additional oxygen and aeration capacity. So the reduction or elimination of food waste in the influent would also reduce the power consumption in the liquid stream treatment.

If source separated food waste is added directly to the digesters, instead of being processed through the treatment plant, the net energy produced at the plant would be somewhat greater (not taking into consideration the energy required to collect, process and deliver the material.).

Table 6	**Potential Reduction in WPCP Influent Flows and Loads if Food Waste Disposer Use in Discontinued San José/Santa Clara Water Pollution Control Plant Master Plan City of San José**			
Constituent	**Unit Rate**	**Total Potential Reduction(1)**	**2040 Projection (With FWDs)(2)**	**Potential Percent Decrease**
Flow	0.96(2) gallons/capita/day	1.5 mgd	182 mgd	0.8%
BOD	20 g/capita/day	31,000 kg/day 68,400 lb/day	487,000 lb/day(3)	14%
TSS	20 g/capita/day	31,000 kg/day 68,400 lb/day	421,000 lb/day(4)	16%

Notes:
(1) Based on 2040 projected service population of 1,938,577 (PM 3.6, Table 7) and current 80% service area penetration of FWDs.
(2) Table 4.
(3) PM 3.8. Table 8, medium load projection.
(4) PM 3.8, Table 9, medium load projection.

The affects of food waste disposers on wastewater treatment plants and collection systems has been well documented. As the City plans to meet their zero waste goals and maximize the efficient use of wastewater collection and treatment infrastructure, these estimates provide a framework for considering the programs impact on and/or use of the WPCP as part of that plan.

REFERENCES

REFERENCES

1. Alameda County Waste Management Authority. 2003. Alameda County Integrated Waste Management Plan. February 26.

2. Boland, Conall, et al. 2008. *Examining the Use of Food Waste Disposers*. Environmental Protection Agency.

3. Crites, Ronald and Tchobanoglous, George. 1998. *Small and Decentralized Wastewater Treatment Systems*. 1st edition. McGraw-Hill.

4. Environmental Engineering & Contracting. 2009. San José/Santa Clara Water Pollution Control Plant FOG Program Evaluation and Enhancement Study. City of San José Environmental Services Department. March 27.

5. Farrell, Molly. 2005. *63 Percent Diversion and Rising.* Biocycle. February.

6. Gitter, Michael. 2006. *Summary of Research Regarding the Environmental Efficacy of Food Waste Disposers*. In-Sink-Erator. October 27.

7. Hickman, Leo. 2006. *Is it OK to Use a Food Waste Disposer*. The Guardian. August 8.

8. Metcalf & Eddy. 1991. *Wastewater Engineering Treatment, Disposal and Reuse*. 3rd edition. McGraw-Hill.

9. New York City Department of Environmental Protection. 1998. *The Impact of Food Waste Disposers in Combined Sewer Areas of New York City*.

10. Platt, Brenda. 2002. *Food Waste Recovery: A Model for Local Government Recycling and Waste Reduction*. California Integrated Waste Management Board. Publication #310-02-001. June.

11. San José's City Website. http://www.sanjoseca.gov/esd/wastewater/water-pollution-control-plant.asp . Accessed June 16, 2009.

12. Schafer, Perry. 2008. Organic Waste Processing. Project Memorandum. October 7.

13. The City of Raleigh website. Accessed June 17, 2009.

14. U.S. Census Bureau. 1998. http://www.census.gov/hhes/www/housing/ahs/metropolitandata.html Accessed June 15, 2009.

15. US EPA Website. http://www.epa.gov/wastes/conserve/materials/organics/food/fd-basic.htm Accessed June 16, 2009.

16. US EPA. 2008. Municipal Solid Waste in the United States: 2007 Facts and Figures. United States Environmental Protection Agency, Office of Solid Waste. November.

17. Zhang, Ruihong, et al. 2006. *Characterization of Food Waste as Feedstock for Anaerobic Digestion*. Bioresource Technology. April 24.

This project memorandum was prepared by Bill Kennedy and Kyle Sandera and reviewed by Tracy Stigers.