UNIVERSITY OF CALIFORNIA
Santa Barbara

A Feasibility Study of Commercial Food Scrap Diversion For the City of Santa Barbara

A Group Project Proposal submitted in partial satisfaction of the requirements for the degree of
Master's in Environmental Science and Management
for the
Donald Bren School of Environmental Science & Management

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The Group Project is required of all students in the Master's of Environmental Science and Management (MESM) Program. It is a three-quarter activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This final Group Project report is authored by MESM students and has been reviewed and approved by:

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Abstract

The City of Santa Barbara currently diverts 55% of its solid waste from the Tajiguas landfill. The City seeks to continue increasing its diversion, and has set a target of 70% diversion by the year 2010.

This project was undertaken to aid the City in planning methods to obtain its target diversion by focusing on a waste stream currently untapped by the City – food scrap generated by the commercial sector. First, we sought to understand the activities that currently exist within the City of Santa Barbara and in other cities throughout California and the nation. Next, we characterized the City's current waste dynamics and surveyed Santa Barbara food scrap generators to provide more detailed information on the type of food scrap produced and potential for participation in a diversion program. Finally, we investigated techniques for treating food scrap and analyzed food scrap diversion in the context of the City's other diversion methods.

The results of our analysis led to an understanding that the City could potentially gain 2.7% additional diversion by targeting commercial food scrap. While this diversion alone would not enable the City to reach its 70% goal, our optimization model, which incorporates all of the divertible streams, indicates that the City could reach its goal by increasing diversion in other commercial and residential programs. We conclude that commercial food scrap diversion would be feasible, and the City should pursue a more complete investigation as part of enhancing the City's overall diversion strategy.

Faculty Advisor: Patricia Holden

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Executive Summary

Problem Statement /Goal

Food scrap makes up approximately 20% of material going into the Tajiguas landfill. It is the largest, single waste stream for which there is no city wide recycling program. Due to the limitations on the future life of the Tajiguas landfill, the City of Santa Barbara is considering options for increasing diversion of waste. One option is diversion of food scrap generated by the commercial sector in the City. The goal of this study is to provide information and recommendations to the City of Santa Barbara regarding a commercial food scrap diversion program.

Significance of Project

The results of this project provide information in four areas: 1. Identification of the largest food scrap generators and which of these could be targeted for collection efficiency, 2. Food scrap generators' willingness to participate, 3. The most feasible composting technology, and 4. Lessons learned from other cities in California. Additionally, the study estimates the additional diversion that could be achieved through implementation of a commercial food scrap diversion program and provides an economic model of how best to reach the 70% goal set for 2010 by examining other waste streams currently being diverted.

Background Information

The Tajiguas Landfill, located 26 miles west of Santa Barbara and immediately north of Highway 101, is an 80-acre site located in a confined canyon, providing landfill disposal for the unincorporated areas of the south coast of Santa Barbara County, the City of Santa Barbara, Santa Ynez Valley, and the Cuyama Valley. The Tajiguas Landfill began accepting waste in the late 1960s as a County-owned and operated venture.
According to the August 2003 County Waste Characterization Study, the City of Santa Barbara County contributes 47% of the total waste disposed in the landfill. Tajiguas has recently been permitted for a volume expansion which will increase its life by approximately fifteen years. Through increased diversion, it may be possible to gain more than fifteen years of disposal at Tajiguas.

In 1989, the California Integrated Waste Management Act, AB 939, mandated that jurisdictions divert fifty percent of their solid waste from the landfill by 2000. The City of Santa Barbara has been successful in implementing recycling programs for a number of different waste streams, reaching a 55% diversion level. However, in September 2002, the City Council set new, more aggressive waste diversion goals of 60% by 2005 and 70% by 2010. In order to meet these levels, consideration must be given to diverting other types of material. Since food scrap represents the largest, single waste stream, consideration is being given to diverting a part of this stream. On the basis that the largest individual contributions to the food scrap waste stream are made by businesses in the commercial sector, and the commercial sector has fewer generators than the residential sector, a program to target the largest commercial food scrap generators is being proposed.

There are several jurisdictions in California that have implemented food scrap diversion programs in the past ten years. Lessons learned from other cities in developing a successful program for the City of Santa Barbara include: these programs initially focused on the largest commercial food scrap generators, 50% diversion of the commercial food scrap stream is a realistic goal, feeding humans with edible food scrap is a priority, haulers are given financial incentives to collect source separated food scrap, and pilot food scrap diversion programs are most successful when they are used as a learning tool for a long-term program.

Results/discussion:

The study provides information on the franchised hauled commercial sector of the City of Santa Barbara. The amount of food waste attributed to this sector amounted to 10,624 tons in 2003. If 50 % of this waste stream were targeted for collection, it would amount to collecting 17 tons per day, 6 days per /week.

The study compiled a list of 529 food scrap generators within the commercial sector and identified the top 20%. Results show that by collecting from the top 20% food scrap generators (109 businesses), 50% of the commercial food waste stream would be captured.

A survey was sent to the 529 food generators identified by the study. The survey aimed to assess the willingness to participate in a food scrap diversion program, the potential benefits and challenges of a program and the outreach and education necessary for successful implementation. The survey results show us that the top benefits associated with participation in a food scrap diversion program are the benefit to the environment, "it's the right thing to do", and reduced odor. The top obstacles are limited space, odor problems and vectors. The survey results also show that restaurants and schools have the greatest willingness to participate in food scrap diversion. These sectors feel that outreach is important, particularly in the form of bi-lingual (English and Spanish) printed materials and on-site staff training. Both sectors feel that recognition awards would be beneficial.

The survey confirmed that there is an amount of food scrap comprising unserved and unsold portions that could be directed to human consumption. The food distribution agencies in Santa Barbara would welcome further food donations, including unserved portions from restaurants, provided food is fresh and does not pose a health risk. The agencies think that food donors are concerned about liability issues with food donations and this prevents many from donating. In fact, donors are protected from liability by the Good Samaritan Act. Agencies also think that donors are not informed about donation opportunities and the types of food donations most needed.

The study considered composting technologies and evaluated the most feasible options. Wright Environmental's in-vessel system ranked highest between the six alternatives for converting food scrap to compost. This aerated, continuously fed, in-vessel technology has high capital costs but these are offset by small land requirements, low environmental impacts, and demonstrated ability with food scrap. The second highest alternative was the agitated, aerated, and continuously fed in-vessel system offered by Hot Rot. Although the Hot Rot equipment has some mechanical advantages in that it is both agitated and aerated, it lacks the demonstrated ability of the Wright Engineering equipment.

It is estimated that in-vessel treatment is a more economically feasible treatment of food scrap than the current method of landfilling food scrap or the common method of open-air windrow composting. The capital, operational, and maintenance costs of treating food scrap with an in-vessel system are expected to be $25/ton. Using a net present value calculation over a 15 year period, in-vessel treatment is projected to be 48% less expensive than landfilling. With additional screening and curing following the treatment process, in-vessel treatment technology produces a nutrient rich compost with a marketable value in the range of $10-$28/ton.

If a commercial food scrap program were implemented and successful in collecting 50% of the commercial food waste stream, this would result in a 2.7% increase in overall City diversion, therefore bringing up the current 55% rate to 57.7%. In order for the City to increase diversion to the 70% goal, diversion of other commercial and residential waste streams must be increased. A model based on tipping fees provided by the study offers the City a tool for calculating the impacts of costs on waste diversion. Under the current structure, maximizing diversion of commingled recyclables is the most cost-effective, followed by food scrap diversion. A combination of waste stream diversion is necessary to get the City to its 70% diversion goal by 2010.

Recommendations:

The food scrap diversion study supports the following five recommendations:

1. The City of Santa Barbara should consider implementing a commercial food scrap diversion program. The review of existing treatment technology showed continuously fed, in-vessel systems are the best alternative for Santa Barbara. When capital, operating and maintenance costs are considered; an in-vessel system is more economically feasible than the current practice of dumping food scrap in the landfill or composing it in open-air windrows. However, in determining the overall feasibility of this program it is recommended that a further cost benefit analysis be performed that includes collection, transportation charges, the costs of implementation of the new program, as well as the economic benefits of the compost produced.

2. If the City decides to move forward with a commercial food scrap diversion program, based on the experience of other cities in California, it is recommended to begin with a pilot program that is viewed as a long term long-term learning tool and evolves into a city wide program. For the purposes of solid waste permitting, a pilot program may be presented as a research project and as such will face fewer restrictions

3. Collection should be directed to the top 20 % of the food scrap generators to achieve a 50 % diversion. Based on the integration of the willingness to participate, the City should target education facilities for the initial food scrap collection efforts as well as restaurants and food stores.

4. Given the challenges that Santa Barbara faces with feeding homeless and low-income families, in addition to the high importance placed by California Integrated Waste Management Board on using food scraps to feed humans, it is recommended that the City consider the ways in which to assist efforts to use food scrap to feed humans. Suggestions include providing education for food scrap generators about human re-use opportunities and liability protection under the Good Samaritan Act, and providing grant support to organizations trying to facilitate this process.

5. In order to meet the 70% waste diversion goal set by the City of Santa Barbara, it is recommended that a more detailed economic analysis be done on all of the associated costs, including current and plausible future recycling programs. As more detailed costing information becomes available it can easily be integrated into the economic model provided by this study, thus allowing the City to project future scenarios for optimizing waste diversion in relation to cost. The preliminary model results suggest that in order meet the diversion goal, both a commercial and a residential food scrap diversion program will be needed.

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List of Commonly Used Terms, Initials and Acronyms

Aerated Static Pile – A composting process that uses an air distribution system to either blow or draw air through the pile. Little or no pile agitation or turning is performed.

Aerobic Decomposition – The biological decomposition of organic substances in the presence of oxygen.

Agricultural Material – Material of plant or animal origin, which result from the production and processing of farm, ranch agricultural, horticultural, aquacultural, silvicultural, floricultural, vermicultural, or viticultural products, including manures, orchard and vineyard prunings, and crop residues.

Amendments – Materials added to stabilized or cured compost to provide attributes for certain compost products, such as product bulk, product nutrient value, product pH, and soils blend. Amendments do not include septage, biosolids, or compost feedstock.

Anaerobic Digestion – The biological decomposition of organic substances in the absence of oxygen.

Bays – Covered concrete areas for batch composing material using forced aeration.

Bin – A dumpster of 2, 3, 4, 6 or 8 yd^3 into which trash is emptied. They are used by businesses and multi-family residential units and collected by front-end hauler trucks.

Biofilter – A bed of organic material through which foul air passes and is treated by adsorption and microbial activity to remove odor and selected chemicals from the air stream.

Bioreactor – A landfill that works to break down refuse more quickly than a traditional landfill by increasing the moisture content, increasing the surface area of the refuse, and stabilizing the pH of the landfill.

Biosolids – Solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in a treatment works. Biosolids includes, but is not limited to, treated domestic septage and scum or solids removed in primary, secondary, or advanced wastewater treatment processes. Biosolids does not include ash generated during the firing of sewage sludge in a sewage sludge incinerator or grit and screenings generated during the preliminary treatment of domestic sewage in a treatment works.

Bulking Agent – Material (wood, sawdust, yard waste, etc.) that is added when composting to absorb excess moisture and provide structure.

Chipping and Grinding Operations and Facilities – An operation or facility, that does not produce compost, but mechanically reduces the size or otherwise engages in the handling, of compostable material.

Compostable Material – Any organic material that when accumulated will become active compost.

Client – The Public Works Department, City of Santa Barbara.

Compostable Material Handling Operation or Facility – An operation or facility that processes, transfers, or stores compostable materials. Handling of compostable materials results in controlled biological decomposition. Handling includes composting, screening, chipping and grinding, and storage activities related to the production of compost, compost feedstocks, and chipped and ground materials.

Commercial Food Scrap Diversion Program – A diversion program that aims to recover food scrap from the commercial sector within a city.

Commercial Sector – Businesses within a City. For the purposes of this report these are businesses that generate food scraps such as restaurants, hotels, grocery stores, schools, retirement homes.

Co-Compost – A mixture of organic matter including biosolids that has undergone autothermal aerobic degradation by microbial activity and can be used as a fertilizer or soil amendment.

Compost – Organic matter (not including bio-solids) that has undergone autothermal aerobic degradation by microbial activity and can be used as a fertilizer or soil amendment.

Commercial Food scrap – Food scraps generated by the commercial sector in a City.

Conversion – The retrieval and transformation of food from its original form into a new food/product source.

Container – A standard Container is any plastic or galvanized metal container with tight fitting cover, thirty-three (33) gallons or less in capacity, with handle and side bails.

Curing – The final stage of the composting process that occurs after compost has undergone pathogen reduction and after most of the readily metabolized material has been decomposed and stabilized.

Diversion – The act of redirecting a specific type of material from the landfill (i.e. food scrap, paper, plastic, etc.)

Diversion Targets – Legislated goals set by the State of California for reducing the amount of solid waste disposed of in landfills through source reduction and recycling.

Enclosed Composting Process – A composting process where the area that is used for the processing, composting, stabilizing, and curing of organic materials, is covered on all exposed sides and rests on a stable surface with environmental controls for moisture and airborne emissions present.

Feedstock – Any compostable material used in the production of compost or chipped and ground material including, but not limited to, agricultural material, green material, food material, biosolids, and mixed solid waste. Feedstocks shall not be considered as either additives or amendments.

Fertilizers – Any of a large number of natural and synthetic materials containing nutrients and other desired properties that can be added to soil to increase its fertility.

Food Bank – An organization receiving donations of non-prepared foods (i.e. packaged, bottled, tinned and some produce) for distribution to local food agencies serving needy people.

Food Content – Amount of food predicted to exist within a particular waste stream.

Food Database – Database that contains waste collection information for all of the food scrap generators within the City of Santa Barbara.

Food Donation – Donation of food material from a food facility to a charitable organization.

Food Establishment – Any room, building, or place, or portion thereof, maintained, used, or operated for the purpose of storing, preparing, serving, manufacturing, packaging, transporting, salvaging, or otherwise handling food at the retail level.

Food Facility – Includes all of the following:
(1) Any food establishment, mobile food facility, vending machine, produce stand, swap meet prepackaged food stand, temporary food facility, satellite food distribution facility, stationary mobile food preparation unit, mobile support unit, and mobile food preparation unit.
(2) Any place used in conjunction with the operations described in paragraph (1), including, but not limited to, storage facilities for food-related utensils, equipment, and materials.
(3) A certified farmers' market.

Food Generating Categories – Categories used by the California Integrated Waste Management Board based on Federal Standard Industrial Codes used in calculating estimated food generation from trash service level within the food database.

Food Scrap Generator – Businesses within the City of Santa Barbara that contribute to the food scrap waste stream.

Food Material – Any material that was acquired for animal or human consumption, is separated from the municipal solid waste stream, and that does not meet the definition of agricultural material.

Food Scrap – Any food material (pre-consumer or post-consumer) within trash which may be collected and diverted from the waste stream such as kitchen trimmings, unserved/unsold portions, left-over plate scrapings, grocery store salvage food, spoiled produce and stale bakery items. This term is synonymous with food waste.

Food Scrap Diversion – Diverting food scraps away from landfill, involving recovery and re-use or treatment.

Food Scrap Generator/Producer– An entity producing food scraps.

Food Scrap Recovery – The retrieval of food scrap by some method in order to prevent its disposal into landfill.

Food Scrap Re-Use – The retrieval of food scrap in order to be recycled as a food source for humans and animals. With re-use, the food is not altered from its original form.

Franchise Fee – A fee charged by a franchise hauler for the collection and disposal of refuse from either the commercial or residential sector.

Franchised Commercial – Waste that is generated by the commercial sector of the City of Santa Barbara and is collected by a franchised hauler (BFI or Marborg).

Franchised Residential – Waste that is generated by the residential sector of the City of Santa Barbara and is collected by a franchised hauler (BFI or Marborg).

Garbage – Commercial or residential wet or dry animal or vegetable waste material.

Green Waste – Waste consisting of leaves, tree trimmings, weeds, grass and other organic materials derived from vegetation. Also referred to as yard waste. Green waste does not include food material, biosolids, mixed solid waste, material processes from commingled collection, wood containing lead-based paint or wood preservative, mixed construction or mixed demolition debris.

In-vessel Treatment – A process in which compostable material is enclosed in a drum, silo, bin, tunnel, reactor, or other container for the purpose of producing compost maintained under uniform conditions of temperature and moisture where air-borne emissions are controlled.

Leachate – A liquid waste stream from a composting/landfill operation that requires further treatment before disposal.

Mulch – A protective covering of various substances, especially organic matter, placed around plants to prevent evaporation of moisture and control weeds.

Non-attainment – A pollutant is designated non-attainment if there was at least one violation of a State standard for that pollutant in the area.

Odor control – Regulation of odor emissions through treatment using biological processes.

Pathogens – Organisms capable of producing diseases in humans or animals.

Piles – Rows of composting material in a windrow composting system.

Pilot Program – Temporary facility constructed and operated on a small scale to demonstrate the effectiveness and feasibility of a process.

Rendering – Recovery and treatment (usually by heat) of grease, cooking oil, and some meat and bone waste to create a new product, such as animal feed or soaps.

Recyclable material – Magazines, newspapers (including clean office paper), corrugated cardboard, cereal boxes, junk mail empty glass bottles and aluminum cans or other similar materials which are designated capable of being recycled by the city or a collector authorized by contract with the City to regularly collect recyclable materials.

Recycling – The act of minimizing waste generation by recovering and reprocessing usable products that might otherwise become waste.

Roll Off Containers – Large containers that are serviced by the contracted haulers for businesses. Accounts for these businesses are managed by the haulers and are not found within the City of Santa Barbara's Financial Management System.

Rubbish – Synonymous with trash

Self-Haul Disposal – Materials, primarily trash, that are hauled by individual private businesses, not the franchised haulers.

Silos – Individual containers used for in-vessel composting in a batch operation using forced aeration.

Solid Waste – Waste material typically disposed of in landfills or recycled. It does not include waste materials discharged to sanitary sewers or material generated by wastewater treatment processes such as biosolids.

Source Reduction – Reducing amount of potential waste at production source, i.e. serving smaller portions in restaurants.

Source Separation – Separating trash into different components for recycling purposes, i.e. commingled recyclables, green waste, food scraps

Static Pile – A composting process that is similar to the aerated static pile except that the air source may or may not be controlled.

Substream – Material fraction of a specific waste stream.

Target Sector – Franchised commercial food scrap generators within the City of Santa Barbara.

Tipping Fee – The fee schedule associated with disposal of certain materials including trash, commingled recyclables, green waste, construction and demolition and food scraps.

Trash – Normal accumulation of combustible and/or non-combustible waste materials which are not included in the "garbage' terms and shall include paper, rags, cartons, boxes, wood shavings or chips, furniture, bedding, rubber, leather, tree branches, yard trimmings, cans, bottles metals, mineral matter, glass, crockery, dirt, dust, grass clippings, weeds and leaves.

Trash Service Level – Data collected from the City of Santa Barbara's Financial Management System that reveals the amount of trash hauled for each business within the Food database (measured in cubic yards per week).

Treatment – The retrieval and forced decomposition of food from its original form into a soil amendment or other byproduct.

Treatment Train – The necessary steps in treating food scraps to produce compost, including collection, transportation, mixing food scraps with a bulking agent, composting, curing, screening and marketing.

Tunnel – A type of in-vessel container used to treat food scrap.

Vector – Organisms that carry pathogens from one host to another, such as rodents and insects.

Vermiculture – A method of producing compost using worms to assist in the breakdown and mixing of organic matter.

Waste Components – Material type characterized within the County of Santa Barbara's Waste Characterization Study performed in August 2003.

Waste Stream – Flow of solid waste coming from a specific sector.

Windrow Composting Process – The process in which compostable material is placed in elongated piles. The piles or "windrows" are aerated and/or mechanically turned on a periodic basis.

Wood Waste – Solid waste consisting of wood pieces or particles that are generated from the manufacturing or production of wood products, harvesting, processing or storage of raw wood materials, or construction and demolition activities.

Yard Trimmings – Any waste generated from the maintenance or alteration of public, commercial or residential landscapes including, but not limited to, yard clippings, leaves, tree trimmings, prunings, brush, and weeds.

Abbreviations

AB – Assembly Bill
ACP – Association of Compost Producers
AHP – Analytical Hierarchy Process
ASP – Aerated Static Pile
BFI – Brown Ferris Industries
BSE – Bovine Spongiform Encephalopathy
CAA – Clean Air Act
CARB – California Air Resources Board
CCR – California Code of Regulations
CEQA – California Environmental Quality Act
CFR – Code of Federal Regulations
CIWMB – California Integrated Waste Management Board
CPI – Consumer Price Index
CUP – Conditional Use Permit
EA – Environmental Agency
EHS – County of Santa Barbara Environmental Health Services
EIR – Environmental Impact Review
EPA – Environmental Protection Agency
FMS – Financial Management System
GLCRS – Ground Leachate Collection & Recovery System
LEA – Local Enforcement Agency
LLCRS – Liner Leachate Collection & Recovery System
LVMWD – Las Virgenes Municipal Water District
MJSWTG – Multijurisdictional Solid Waste Task Group
MSW – Municipal Solid Waste
NH_3 – Ammonia
NPV – Net Present Value
ORA – Organic Recyclers Anonymous
OSHA – United States Department of Labor Occupational Health and Safety Association
PM – Particulate Matter
PM_{10} – Particulate Matter of 10 microns or less in size
ROWD – Report of Waste Discharge
SBAQPCD – Santa Barbara Air Quality Pollution Control District
SCAQMD – South Coast Air Quality Management District
SIC – Federal Standard Industrial Codes
SWRCB – State Water Resources Control Board
VOC – Volatile Organic Compound
WCD – Waste Characterization Database
WCS – Waste Characterization Study

1. Background

1.1 AB 939

The 1989 California Integrated Waste Management Act, AB 939, directs jurisdictions to prepare an Integrated Waste Management Plan. One purpose of the plan is to identify all the elements of the solid waste management process. In addition, these management plans work to promote jurisdictional goals for waste reduction and diversion. These practices are outlined in order of priority as: 1) source reduction (including reduce and reuse), 2) recycling and composting, and 3) environmentally safe transformation and land disposal. They are geared toward reducing the total amount of solid waste in an effort to prolong the life of landfills. The Act mandates jurisdictions to divert 50% of solid waste from state landfills by January 1, 2000 [1]. AB939 was the impetus for recycling programs implemented in Santa Barbara and throughout California during the 1990s.

1.2 City of Santa Barbara

1.2.1 Location

Santa Barbara is a coastal city located 95 miles north west of Los Angeles (Figure1-1). It covers an area of 19 square miles forming part of South Santa Barbara County (Figure 1-2). Other cities in the County include Goleta, Buellton, Carpinteria, Guadalupe, Lompoc, Santa Maria and Solvang. The population of the City at year-end 2000 was 92,325. Businesses in the City comprise: 56% service companies, 10.4% retail trade and 8.5% manufacturing [2].

Figure 1-1: Map of California showing the location of Santa Barbara [3]

Figure 1-2: Map of the City of Santa Barbara showing delineation of the City boundaries [3]

1.2.2 Waste

The City of Santa Barbara has established a list of principles and goals for program development and planning for the City's Solid Waste Management Program.

- To develop cost-effective diversion programs,
- To provide secure and reliable service to residents and businesses in the City,
- To minimize the City's exposure to actions under the Federal Comprehensive Environmental Response Compensation and Liability Act (CERCLA),
- To explore long-term options for waste disposal and
- To strengthen long-term control of its waste stream

These goals are incorporated into the City's short, medium and long term strategies, which provide a foundation for planning and implementation. One of the short-term strategies is to develop and implement a pilot food scrap diversion and composting program for a minimum of 25 restaurants in the City for a period of one year.

The City of Santa Barbara disposes of its waste in two locations; the County owned transfer station located in Santa Barbara and County owned Tajiguas landfill located 26 miles west of the City of Santa Barbara. The transfer station is primarily used by self-haulers for disposal because the landfill is not open for public disposal. It receives about 300 tons/day [4]. Approximately 60% of material received at the transfer station is recycled and the remaining 40 % is sent to Tajiguas landfill.

There are two trash haulers in Santa Barbara: Browning Ferris Industries (BFI) and Marborg Industries. Until June 2003, trash in the City was solely collected by BFI. In June 2003, Marborg was awarded half of the contract for collection of the City waste. The City manages the trash accounts for the haulers and businesses have trash accounts with the City. The haulers invoice the City for trash collection and the City passes on these costs to the account holders after adding an 11% tax.

The City of Santa Barbara disposes 113,390 tons of waste per year at Tajiguas Landfill [5]. This represents 47% of overall Santa Barbara County waste disposed at Tajiguas. Of the disposed waste from residential and commercial sectors 19.5% comprises food scrap as shown in Appendix A-1.

1.2.2.1 Tajiguas Landfill

Figure 1-3: Photograph of the Tajiguas landfill [6]

The Tajiguas Landfill, located 26 miles west of Santa Barbara and immediately north of Interstate Highway 101, is an 80-acre site located in a confined canyon (Figure 1-3). It provides landfill disposal for the unincorporated areas of the south coast of Santa Barbara County, the City of Santa Barbara, Santa Ynez Valley, and the Cuyama Valley. The Tajiguas Landfill began accepting waste in the late 1960s as a County-owned and operated venture. About 700 tons/day are disposed at Tajiguas by franchised haulers and trucks from the transfer station [4]. Tajiguas is the only landfill used by the City of Santa Barbara.

Tajiguas was bench-filled several years ago – the slopes were steepened from 3:1 to 2:1, which provided additional disposal capacity. This has created a very large flat area at 400 ft level, which is in the coastal zone and cannot be extended higher. It is estimated that Tajiguas will reach its current capacity late in the year 2005 [6]. It has recently been permitted for a volume extension, which will increase its life by approximately fifteen years. The expansion will cost approximately $30million. To cover the expansion costs, the County plans on increasing disposal fees [4].

Some of the alternatives to disposal at Tajiguas include transporting waste to other landfills, incineration, siting a new landfill and waste conversion. The first three options are not considered to be optimal. Economically, it makes sense to maximize existing landfills: they have already undergone the lengthy permitting process, are already constructed, staffed and operating, and are incorporating and upgrading the most current environmental safeguards while guaranteeing uninterrupted waste disposal for residents and businesses. It also makes sense environmentally to work with existing landfills rather than impacting other areas, and to institute technological advances as they become economically viable and proven effective. Preservation of undeveloped areas is a worthy trade-off, when considering the overall impact on the environment [6].

The number of additional years gained as a result of the expansion, estimated to be 15, is dependent on the success of diversion programs. Through increased diversion, it may be possible to gain more than fifteen years, thereby delaying the implementation of the alternative to disposal at Tajiguas.

A number of successful management practices have been implemented at Tajiguas. These include water collection through a groundwater leachate collection and recovery system (GLCRS) and a liner leachate collection and recovery system (LLCRS), which uses a series of swales, channels and tanks [4]. There are also extensive management programs in place to control litter and dust, and to cultivate knowledge and practice of health and safety matters. With regards to methane gas produced at Tajiguas, this is collected through wells ranging in depth up to 200ft. The gas is converted to electricity in a cogeneration plant on site and fed into the power grid. The quantity of electricity produced provides power for 2,000-3,000 homes per day [4].

1.2.3 Solid Waste Multi-Jurisdictional Task Force

The County Board of Supervisors and the Santa Barbara City Council established the Solid Waste Multi-Jurisdictional Task Group in June 2001. The Task Group is designed to provide the communities within Santa Barbara County with a forum to discuss and plan long-term solid waste management strategies and facilities. Representatives from each city in the County have participated in the initial discussions [7]. Although Tajiguas has recently been permitted for an extension, the new estimated closure date is 2020. It may be a few years more or less, depending on the success of diversion programs. Nevertheless, a long-term countywide plan for solid waste management that addresses disposal of the County's waste after Tajiguas closes is necessary. The Group comprises a Technical Advisory Committee, which is divided into Subgroups shown in Appendix A-2.

In October 2003, the Biosolids, Commercial Recycling, Greenwaste, Construction & Demolition and Alternatives to Disposal Subgroups published reports (Appendix A-2). Each of these reports addresses countywide issues relating to the targeted waste stream and makes recommendations on how management of the waste stream could be improved. The results are pertinent to the management of solid waste in the City of Santa Barbara and to this study.

The Biosolids and Alternatives to Disposal reports examined a variety of treatment technologies and used ranking criteria to select an optimal technology. An understanding of this was important for the work done on treatment methods in this study. The Commercial Recycling report provided valuable information about commercial recycling initiatives in the City and throughout the County. The Green Waste Report considers the use of County green waste as a feedstock for composting with other waste streams, such as biosolids and food scrap. There are links between the waste streams generated by different jurisdictions within the County and there may be efficiencies of scale by combining waste streams in new treatment approaches. The Solid Waste Multi-Jurisdictional Task Group aims to integrate the results of the different subgroups in order to find optimal solutions for the County.

1.3 Recycling in the City

1.3.1 Current Recycling Efforts

Pursuant to AB939, the City implemented a range of successful recycling programs, which have enabled it to reach an overall 55% diversion level in the year 2001, surpassing the AB939 target of "50% by 2000"[8].

Recycling programs are geared to both the residential and commercial sectors of the City. Appendix A-3 part a) provides a list of materials included in the programs. The programs are:

- Construction and Demolition Debris
- Green Waste
- Commingled Recycling
- Cardboard Plus

The construction and demolition debris program is specifically oriented to the building sector and not applicable to the majority of businesses in Santa Barbara. Green Waste is a popular residential program, which may also be used by businesses involved in landscape maintenance such as golf courses and hotels. The commingled recycling program is targeted to residential and commercial entities. The Cardboard Plus program is for businesses only. Businesses can save money by introducing or increasing recycling services. The City's rates for trash, green waste and commercial recycling are structured to provide an incentive to recycle more and throw away less. Cardboard Plus service is provided at 45% of the cost of trash service and commingled service is provided at only 60% of the cost of trash [9].

However, the contribution of the commercial sector to the City's recycling programs is less when compared to the residential sector. About 10% of the waste produced by the commercial sector is currently recycled, while 45% of the residential sector is recycled [10]. Consideration has been given to making recycling mandatory in the City, particularly in light of recent County regulatory changes. Effective September 1, 2003, the County of Santa Barbara implemented a mandatory commercial recycling program for businesses and multi-family dwellings in the unincorporated areas of Santa Barbara County. Under this program, materials currently accepted under the residential recycling program (excluding green waste) will be prohibited from being disposed in the trash [11]. These materials are listed in Appendix A-3, part b).

1.3.2 Recycling Goals

The City of Santa Barbara has set its own waste diversion goals of 60% by 2005 and 70% by 2010. This amounts to an annual increase of 2% [8]. In order to meet these levels, consideration must be given to establishing collection programs for materials that are not currently being diverted. According to the South Coast Waste Characterization study done in 1997, food scrap was determined to be 10.5% (25,727 tons) of the total waste going into the Tajiguas landfill [12]. Currently, due to an increasing population and the success of recycling programs for other materials, it is now estimated that food scrap constitutes 19.5% of the total amount of waste disposed at the landfill (22,074 tons)[5]. It is the single largest waste stream for which there is currently no formal recycling program. Based on this information, a program designed to address food scrap diversion in Santa Barbara could be the next step in diversifying the City's recycling program and capturing more divertible waste.

1.4 Landfill Dynamics

1.4.1 General Overview of Landfill Creation/Structure

Municipal solid waste landfills (MSW), such as Tajiguas, are generally composed in layers. Most systems contain the following elements [13]:

- Bottom and lateral side liners
- Leachate collection and removal system
- Gas monitoring, collection and control system
- Cover system
- Stormwater runoff management
- Groundwater monitoring

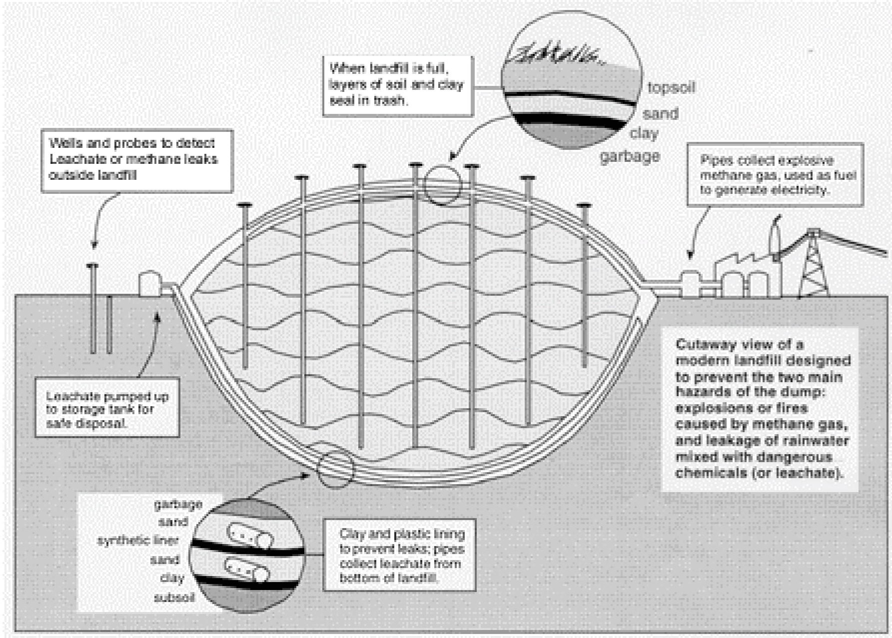

Figure 1-4: Diagram of an MSW landfill [14]

Typically, refuse is deposited into the landfill daily. Upon deposition, the refuse is mechanically compacted and covered with soil or another inert material in order to prevent refuse migration and/or vector problems. Most landfills are created in cells. Each cell is individually lined and designed to hold a certain volume of refuse. Once a cell is filled, it is covered and closed to further disturbances (Figure 1-4). Creating landfills cell by cell aids in the stability of the landfill and in reduction of vectors.

1.4.2 What Actually Happens in a Landfill

1.4.2.1 Decomposition

Prior to 1987, little research had been conducted to understand what was actually happening to the refuse placed in landfills. Tests in labs could project processes occurring in a landfill, but no one had actually excavated a landfill. Dr. Bill Rathje and colleagues undertook groundbreaking research and created the Garbage Project at the University of Arizona [15].

Using archeological excavation techniques, the Project bored several shafts into a landfill and collected waste at 10-foot intervals. The waste was then categorized according to its constituency, weight, and volume. The researchers dated the material by its depth in the landfill [16]. Upon excavation, they found they could also date it using items found as dates were often displayed on recovered items, such as newspapers.

The Garbage Project revealed that decomposition of refuse in a landfill is an extremely slow process. Many items that would be considered easily biodegraded were found to be just the opposite in fact, due to the anaerobic conditions. Items such as grass and hotdogs found at considerable depth were still recognizable.

1.4.2.1 Methane production over time

As waste decomposes in a landfill, a variety of gases are produced. There are several phases of gas generation, which may occur concurrently. These are outlined in Table 1-1.

Phase	Name	Primary Activity Signaling the End of Phase
I	Aerobic	No oxygen in the landfill gas (several hours to 1 week)
II	Aerobic/Acid Generation	Formation of free fatty acids is at its peak and methane generation begins (1 to 6 months)
III	Transition to Anaerobic	Methane and carbon dioxide concentrations stabilize and no nitrogen in the landfill gas (3 months to 3 years)
IV	Anaerobic	Methane and carbon dioxide concentrations begin to reduce and some nitrogen (air) returns to the system (8 to 40 years)
V	Transition to Stabilization	Landfill gas is primarily air and all anaerobic decomposition is complete (1 to 40 or more years)

Table 1-1: Summary of MSW landfill gas generation phases [14]

Total time of gas generation occurring in a landfill may be from 10 to 80 years or more. Figure 1-5 conveys dynamic changes in gas generation levels over time.

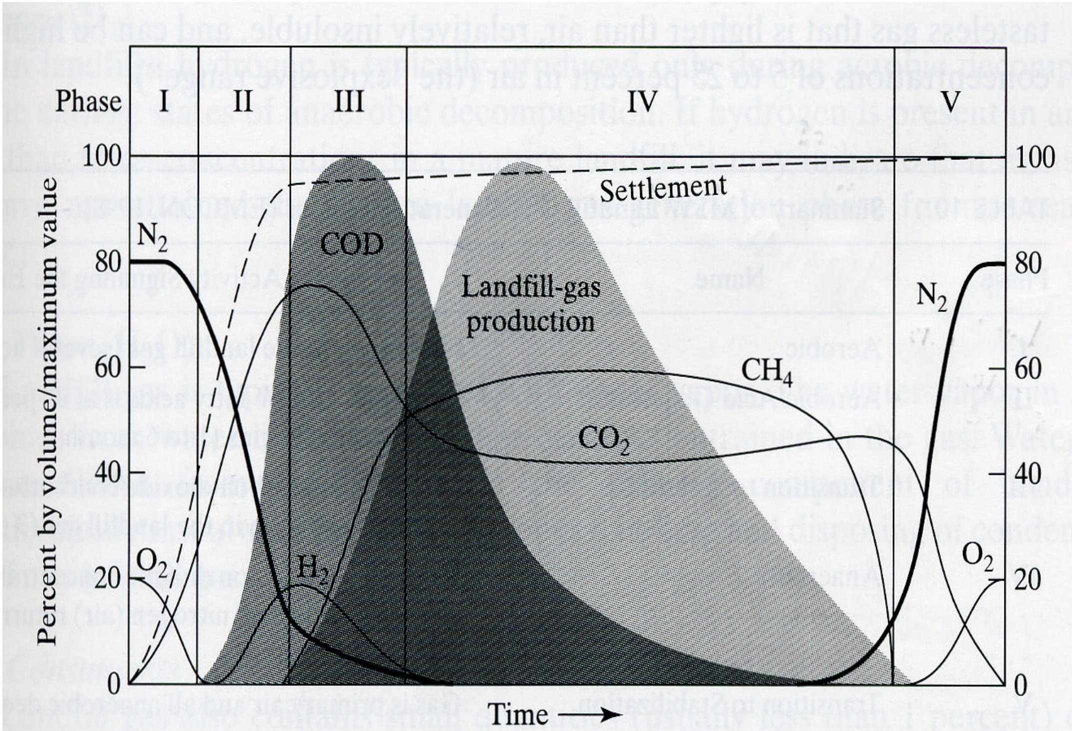

Figure 1-5:Landfill gas composition over time [13]

Interestingly, landfill gas contains only 45 to 58 percent methane compared with natural gas, which is 80 to 99 percent methane {[13, 17]Consequently, landfill gas produces only about half as much energy as natural gas when burned. Other constituents of landfill gas include carbon dioxide, nitrogen, and trace contaminants. Table 1-2 shows a breakdown of landfill gas constituents.

Component	**Percent**
Methane (CH_4)	45 to 58
Carbon Dioxide (CO_2)	35 to 45
Nitrogen (N_2)	<1 to 20
Oxygen (O_2)	<1 to 5
Hydrogen (H_2)	<1 to 5
Water Vapor (H_20)	1 to 5
Trace Constituents (including Non-Methane Organic Substances)	<1 to 3

Table 1-2: Typical constituents in municipal solid waste landfill gas [13]

Some trace contaminants may pose health problems. Trace contaminants can include hazardous substances, such as benzene and toluene. When these substances are combusted with methane, they may produce highly toxic substances, such as dioxins [17].

1.4.3 Food Scrap Usefulness in a Landfill

Concerns were raised early in this study that removal of food from the Tajiguas landfill could produce negative consequences. There were two main concerns: that removal of food would reduce the possibility of mitigation for hazardous substances, and that removal of food would decrease landfill gas production, thereby decreasing usable energy from the landfill. Both of these concerns are addressed in the following discussion.

1.4.3.1 Possibility to remediate hazardous substances

The basis for this belief is that food, and more generally organic material, has been shown to be effective in reducing hazardous substances in composting. Landfills, as described earlier, normally do not provide conditions similar to those in compost. In fact, landfills have been shown to create conditions with very little microbial activity that would lead to metabolization of hazardous substances.

Several variations of the traditional landfill design have been attempted in part to influence faster decomposition and reduce toxicity. Bioreactor landfills are one such design. In a bioreactor landfill, the moisture content is increased and the refuse may also be shredded in order to promote biological decomposition activity. Bioreactor landfills have been shown under laboratory conditions to go through all stages of biological activity in 3 to 5 years [13].

The remaining question is whether bioreactor landfills can lead to an overall reduction in toxicity. Generally, research has shown that this can be the case. One project has shown that pH plays a substantial role in concentrations of undissociated volatile fatty acids, which are directly linked with toxicity [18]. With bioreactors, pH is normally kept neutral, which should lead to lower toxicity [13].

There are several concerns with bioreactors, though. These are outlined below:

Leachate recycling: The most attractive style of bioreactor involves recycling leachate back into the landfill as a means of sustaining a higher level of moisture content. The concerns with this are:

- High initial cost to set up the leachate recycling system
- Heavy metals must still be removed from the leachate
- Although currently allowed, the future status of regulations regarding leachate recycling is uncertain

Landfill stability: The addition of moisture into the landfill may produce a complete failure of the landfill. Qian, et al. provide information about two such occurrences at bioreactor landfills [13]. In one instance the failure occurred after 48 hours of rainfall, and the waste was actually liquefied. In the other, the failure produced a slide, which lasted for 20 minutes, and moved the slide mass approximately 1,500 m downslope.

It is important to note, in closing, that Tajiguas is not a bioreactor landfill, nor is it likely to be converted to one in the future. Bioreactor landfills are still in the demonstration phase for the most part; therefore it is unlikely that full-scale operations will be operational for several years [19].

1.4.3.2 Usefulness of landfill gas

There is no argument that organic material must be present in order to promote decomposition and landfill gas production. Concerns have been raised that removal of food scrap from the landfill may decrease usable landfill gas for production of energy. Mike Ewall director of the Green Energy Leadership Team would argue that a reduction in landfill gas may be a better goal than finding a way to use it [17]. Landfill gas, and more specifically methane, is generally acknowledged as a greenhouse gas. As such, it makes more sense to promote reduction in its production. Additionally, flaring or combusting methane as part of landfill gas may lead to the release of toxic substances, such as dioxins. Mr. Ewall continues by arguing that if the ultimate goal is to produce renewable energy rather than just managing landfill gas, it might be more reasonable to look to true "green" energy, such as solar or wind [17].

It is ultimately beyond the scope of this project to fully investigate and characterize the effects of removing food from the landfill. However, if the City of Santa Barbara chooses to proceed with a food scrap diversion program there is merit to investigating the effects further.

1.4.4 Use of Space for Landfills/Postclosure use of Landfills

1.4.4.1 Landfills: U.S. and California

According to the EPA [20], there are 3091 active landfills in the United States. Two hundred and seventy-eight are located in California. The EPA lists seven active sites in Santa Barbara County: City of Lompoc Sanitary Landfill, Foxen Canyon Sanitary Landfill, New Cuyama Sanitary Landfill, Tajiguas Sanitary Landfill, City of Santa Maria Refuse Disposal Site, Vandenberg Air Force Base Landfill, and Ventucopa Sanitary Landfill. Although, some of these are not currently used as landfills (such as Ventucopa), they are still active as transfer stations. Between the seven sites, the County of Santa Barbara is losing approximately 860 acres of otherwise usable land to landfills. In a county where the price per/acre of open rangeland exceeded $8,000 as of 2001, the true value of this land is not being realized [21].

1.4.4.2 Use of land upon landfill closure

With proper long-term engineering and cover strategies, landfills can serve various purposes upon closure. Some of these include: recreational facilities, such as nature areas and golf courses, and industrial development. It is very likely, though, that a significant amount of restrictions will be placed on development. For example, structures with pilings that puncture the landfill liner may not be allowed. Regarding California specifically, the California Code of Regulations has very stringent and explicit guidance for post-closure land use pursuant to Title 27, section 21190 [22].

Landfills generally present several problems upon closure [13]:

- Continued methane production that must be monitored and managed.
- Potential odor/vector control problems if not covered properly.
- Potential settling of the refuse in the landfill.

Additionally, the EPA has guidelines for post-closure care of a landfill [23]. This includes monitoring and management of various landfill elements for a minimum of 25 years. Elements include: cover maintenance, surface water runoff management, continued leachate management and treatment, and proper reporting of maintenance and management activities.

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2. *The Project*

2.1 Goal

The goal of this study is to provide information and make recommendations to the City of Santa Barbara regarding the feasibility of a commercial food scrap diversion program.

2.2 Research Objectives and Approaches

In order to determine the feasibility of a food scrap diversion program for the City of Santa Barbara and to be able to make recommendations, a number of objectives were identified. These formed the basis for research, data analysis, modeling and conclusions. The objectives and approaches are:

a) To gain an understanding of how municipal solid waste is managed in the City of Santa Barbara.

Food Scrap diversion would constitute a new practice in an existing waste management program that would have to change. Research included familiarization with City and County publications, reports and documents, personal interviews with local solid waste management staff, site visits to local facilities and riding on garbage trucks.

b) To understand existing food recycling efforts in the City of Santa Barbara with regards to the infrastructure that could support utilizing food scrap to feed people and animals and the capacity for expanding human and/or animal reuse.

In lieu of composting, CIWMB recommends the use of food scrap to feed people and animals. Managers of the food distribution agencies in Santa Barbara were interviewed to obtain current information about the quantities and types of food that the agencies handle and to determine additional food requirements.

c) To gain an understanding of food diversion programs that exist in other cities of California and the United States

As further background and contextual information, an understanding of other cities' food diversion programs was considered valuable, particularly in terms of identifying commonalities of programs. A literature search was done on food scrap diversion programs in other U.S. cities to determine how these operate and their applicability to Santa Barbara. In view of state regulations and guidelines, particular emphasis was then placed on further research into the cities of California. Correspondence with managers of food scrap diversion programs provided recent information on details and successes of the programs. Information gained was incorporated into the study and summaries of the programs are provided for the City for reference.

d) To complete a waste characterization study to determine who generates food scrap and how much food scrap the largest generators produce.

An understanding of the current municipal solid waste stream being disposed at the landfill is necessary in determining the feasibility of the food scrap diversion program. Analysis included the creation of a database that lists all food scrap producers that have accounts with the franchises haulers within the City of Santa Barbara. Estimations of food scrap volume for each food scrap generator were made. This allowed for a list of top food scrap producers to be compiled. The Client can use this list for implementation of the food scrap diversion program.

e) To determine the willingness to participate in a food scrap diversion program, to identify the potential benefits and challenges which food scrap generators envisage and the outreach/education necessary for implementation.

Implementation of a successful food scrap diversion program will require the City to effectively facilitate the participation of the community of commercial food scrap generators. The food scrap producers' perspective was gained in a survey of the commercial franchised hauled sector of food scrap producers. Survey responses provide a measure of willingness to participate in a food scrap diversion program, as well as identification of the perceived benefits and obstacles associated with participation. Gaining insight into the specific motivations that influence different sectors provides an understanding of what makes it more feasible for certain categories of food scrap producers to participate in a collection program.

f) To establish the regulatory framework around food scrap diversion and treatment.

Research was completed on the federal, state and local regulations pertaining to food scrap in commercial facilities, donation of edible food scrap and collection and treatment of food scrap. Specifically, regulations pertaining to solid waste, air quality and water quality associated with composting were studied, to assist in determining the most appropriate technology for the City.

g) To identify the potential treatment methods for food scrap and to perform a cost analysis of the best treatment alternative.

From the framework of the Multi Jurisdictional Solid Waste Task Group reports, composting was selected as the most applicable for the City of Santa Barbara's food scrap. Composting technologies were divided into windrow and in-vessel. Commercially available systems representing a sample of each system type were technically evaluated. A cost analysis was performed comparing the highest ranked treatment alternative to landfilling and open air composting.

h) To determine the impact of a commercial food scrap diversion program on the overall diversion rate. Furthermore, to consider how the cost of food scrap diversion compares *with other existing diversion programs in the City and what combination of diversion approaches the City could take to reach its 70% goal by 2010.*

The additional diversion obtained by implementing a commercial food scrap diversion program was calculated using the estimated food scrap tonnage and the 2002 reporting year generation. In order to assist the City in reaching its 2010 diversion goal of 70%, a model was created into which data on other waste streams could be incorporated. This allowed for an estimate to be made of the required diversion of new and existing recycling programs that would be needed to meet the 70% overall diversion goal.

i) To make recommendations to the City regarding the feasibility of a commercial food scrap diversion program, incorporating results from the above findings.

Conclusions from background research, case studies, the waste characterization study, willingness to participate, the regulatory framework, treatment technology analysis, cost analysis of treatment alternatives, and optimal diversion modeling were integrated to arrive at a number of recommendations for the City.

2.3 Project Significance

The results of this project will provide information that will aid in the City's decision on the implementation of a commercial food scrap diversion program. It will provide an assessment of the likely impact on waste diversion from Tajiguas and assist in understanding how best to reach the 70% goal set for 2010. Additionally, it will provide information on which businesses to target for collection efficiency, feasible composting technology suggestions, implementation materials preferred by food scrap generators and experiences of other cities in California. These are all applicable to a future pilot program in commercial food scrap diversion. This report could also serve as a reference document for other cities in California considering a similar approach.

2.4 Project Stakeholders

The Client for this study is the City of Santa Barbara Public Works Department. Other major stakeholders in a commercial food scrap diversion program include Santa Barbara City Government, the County of Santa Barbara Solid Waste Management Division, Santa Barbara County Environmental Health, State Water Resources Control Board, California Air Resources Board, Santa Barbara Air Quality Pollution Control District, BFI, Marborg, food scrap generators and their employees, the supplier of treatment technology and the public. A stakeholder map is presented in Appendix A-4.

In order to get input from solid waste professionals during the study period, an advisory committee was formed comprising stakeholders' representatives, Bren School faculty members and other knowledgeable parties. The Committee consisted of:

- Chris Archer, Manager, International House of Pancakes
- David Borgatello, Vice President, Marborg Industries
- Patricia Holden, Associate Professor, Bren School of Environmental Science and Management
- Everett King, Senior Program Specialist, Solid Waste and Utilities Division, County of Santa Barbara Public Works Division
- Stephen MacIntosh, Environmental Programs Supervisor, Water Resources Division, Public Works Department, City of Santa Barbara - Project Client
- Darrell Reno, Former General Manager, BFI
- Erika Romer, Project Coordinator, Lazy Acres
- Mark Rousseau, Energy & Environmental Manager, Housing, UCSB
- Thor Schmidt, Site Manager, BFI

Formal review meetings were held with the Advisory Committee on June 4, 2003 and December 9, 2003. To ensure that the Client's needs were met, communication between the group and the Client was regular and included participation in a number of additional meetings.

3. Regulatory Framework for Food Scrap Diversion and Treatment

Consideration of the legal framework affecting food facilities' handling of garbage as well as legal issues related to treatment of food scrap is a necessary step in assessing the feasibility of a food scrap diversion program.

3.1 Regulations Pertaining to Food scrap at Retail Food Facilities

Food facilities in Santa Barbara are regulated by the California Health and Safety Code Division 104: Environmental Health, Part 7: Retail Food, Ch.4: Retail Food Practices, also known as the California Uniform Retail Food Facilities Law. Specifically, Article 8: Sanitation Requirements for Food Facilities section 114035 addresses Disposal of Waste as follows[24]

Section 114035. Disposal of Waste
"Each food facility shall be provided with any facilities and equipment necessary to store or dispose of all waste material. All food scrap and rubbish containing food scrap shall be kept in leak proof and rodent proof containers and shall be contained so as to minimize odor and insect development by covering with closefitting lids or placement in a disposable bag that is impervious to moisture and then sealed. Trash containers inside a food facility need not be covered during periods of operation. All food scrap and rubbish shall be removed and disposed of in a sanitary manner as frequently as may be necessary to prevent the creation of a nuisance".

Additionally, Santa Barbara City Municipal Code Ch.7.16: Garbage and Refuse Collection and Disposal provide the local laws for food scrap handling and disposal. This ordinance states[25]:

Section 7.16.021 Mandatory Collection by Licensed or Contract Collector of Refuse.
"It shall be mandatory that trash collection service be provided for every dwelling and food serving business located within the City, as follows:

A. Every dwelling as defined in Section 28.04.170 of this Code located within the City limits shall be provided with adequate refuse collection service by agreement with the waste collection service authorized by the City to collect waste where the dwelling is located. Such refuse service shall regularly remove refuse and waste material often enough to prevent accumulation of material constituting a nuisance, or which attracts flies, rodents or other vectors, but no less often than once in every seven days."

3.2 Regulations and Permits Pertaining to Food Scrap Composting

3.2.1 Federal

The federal regulation relevant to composting is Title 40 – Protection of the Environment. Section 503 covers composting involving bio-solids. The regulations do not apply specifically to compost made from food scrap, although some states have chosen to apply 40CFR503 (Title 40, Section 503 from the Code of Federal Regulations) to food scrap composting.

3.2.2 State and Local

The California Integrated Waste Management Board is the primary state agency regulating composting facilities. The Local Enforcement Agency (LEA) is Santa Barbara County Public Health Department Environmental Health Services. Additionally, the State Water Resources Control Board and California Air Resources Board play a role in obtaining and maintaining a solid waste facility permit [26].

3.2.2.1 Solid Waste

The California Code of Regulations (CCR) Title 14 division 7 chapter 3.1: Compostable Materials Handling Operations and Facilities Regulatory Requirements would regulate a facility using food scrap as a feedstock to produce compost[27]. Such a facility would be required to obtain a Compostable Materials Handling Facility Permit in accordance with the requirements of Title 27, California Code of Regulations, Division 2, Subdivision 1, Chapter 4, Subchapter 1 and Subchapter 3, Articles 1, 2, 3 and 3.1 (commencing with section 21450) prior to the start of operations[28]. In addition, a compost facility would have to be added to the Non-Disposal Facility Element of the County Integrated Waste Management Plan and a California Environmental Quality Act (CEQA) document is required.

CCR Title 14 Division 13 is known as CEQA [29]. CEQA's legislative intent is to maintain a high quality environment for the people of California and to apply the same review measures to public and private projects. The review process revolves around an Environmental Impact Review (EIR). Chapter 3: Guidelines for Implementation of CEQA Article 15002 explains that an EIR is prepared *"when the public agency finds substantial evidence that the project may have a significant effect on the environment. (See: Section 15064(a)(1)). When the agency finds that there is no substantial evidence that a project may have a significant environmental effect, the agency will prepare a "Negative Declaration" instead of an EIR"*.

All compostable material handling operations are required to produce an odor impact minimization plan as follows[27]:

Section 17863.4. Odor Impact Minimization Plan.
"*(a) All compostable material handling operations and facilities shall prepare, implement and maintain a site-specific odor impact minimization plan. A complete plan shall be submitted to the EA with the EA Notification or permit application.*
(b) Odor impact minimization plans shall provide guidance to on-site operation personnel by describing, at a minimum, the following items. If the operator will not be implementing any of these procedures, the plan shall explain why it is not necessary.

> *(1) An odor monitoring protocol which describes the proximity of possible odor receptors and a method for assessing odor impacts at the locations of the possible odor receptors; and,*
> *(2) A description of meteorological conditions effecting migration of odors and/or transport of odor-causing material off-site. Seasonal variations that effect wind velocity and direction shall also be described; and,*
> *(3) A complaint response protocol; and,*
> *(4) A description of design considerations and/or projected ranges of optimal operation to be employed in minimizing odor, including method and degree of aeration, moisture content of materials, feedstock characteristics, airborne emission production, process water distribution, pad and site drainage and permeability, equipment reliability, personnel training, weather event impacts, utility service interruptions, and site specific concerns; and,*
> *(5) A description of operating procedures for minimizing odor, including aeration, moisture management, feedstock quality, drainage controls, pad maintenance, wastewater pond controls, storage practices (e.g., storage time and pile geometry), contingency plans (i.e., equipment, water, power, and personnel), infiltration, and tarping.*

(c) The odor impact minimization plan shall be revised to reflect any changes, and a copy shall be provided to the EA, within 30 days of those changes.
(d) The odor impact minimization plans shall be reviewed annually by the operator to determine if any revisions are necessary.
(e) The odor impact minimization plan shall be used by the EA to determine whether or not the operation or facility is following the procedures established by the operator. If the EA determines that the odor impact minimization plan is not being followed, EA may issue a Notice and Order (pursuant to section 18304) to require the operator to either comply with the odor impact minimization plan or to revise it.
(f) If the odor impact minimization plan is being followed, but the odor impacts are still occurring, the EA may issue a Notice and Order (pursuant to section 18304) requiring the operator to take additional reasonable and feasible measures to minimize odors."

Composting of food scrap obtained from a pilot program in food scrap diversion may qualify as a research composting operation. Research composting operations are handled separately with respect to solid waste[27]:

Article 17862. Research Composting Operations.
"(a) An operator conducting research composting operations shall not have more than 5,000 cubic-yards of feedstock, additives, amendments, chipped and ground material, and compost on-site at any one time, and shall comply with the EA Notification

requirements set forth in Title 14, Division 7, Chapter 5.0, Article 3.0 (commencing with Section 18100) of the California Code of Regulations, except as otherwise provided by this Chapter.
(b) An operator conducting research composting operations utilizing within-vessel processing, may exceed 5,000 cubic-yards of feedstock, additives, amendments, chipped and ground material and compost, if the EA determines that such increased volume will not pose additional risk to the public health, safety and the environment.
(c) In addition to the EA Notification requirements set forth in Title 14, Division 7, Chapter 5.0, Article 3.0, Section 18103.1 (a)(3), the operator shall provide a description of the research to be performed, research objectives, methodology/protocol to be employed, data to be gathered, analysis to be performed, how the requirements of this subchapter will be met, and the projected timeframe for completion of the research operation.
(d) The EA Notification for a research composting operation shall be reviewed after each two-year period of operation. Review criteria shall include the results and conclusions drawn from the research."

3.2.2.2 Water Quality

The State California Water Code requires anyone who discharges or proposes to discharge waste to report the discharge to the State Water Resources Control Board. The disposal of food scrap (as in a composting facility) is such a waste discharge. The Report of Waste Discharge (ROWD) is a technical report describing how any potential adverse effects on water quality posed by the project will be addressed. Provided the project meets code, a permit is issued specifying "waste discharge requirements", which would likely include storm water controls, leachate capture and treatment, monitoring and others. Water, which is sent to municipal water treatment plants, does not require a permit, but does require the authorization of the treatment facility [30].

3.2.2.3 Air Quality

California has 15 air basins and 58 counties. Santa Barbara County is part of the South Central Coast Air Basin, which comprises San Luis Obispo, Santa Barbara and Ventura Counties. During the year 2002, this air basin was in non-attainment for ozone and PM_{10} by state standards. As composting operations emit volatile organic compounds and ammonia, which are pre-cursors to ozone and PM_{10} [31], handling of air quality issues is an important consideration.

The State regulatory body is the California Air Resources Board. Local authority is vested in the Santa Barbara Air Quality Pollution Control District (SBAQPCD). Their general permit rule 201 would apply if there were a potential to emit air contaminants. Additionally Rule 305 regulates particulate matter emissions from point sources in the South County and would apply to a composting operation that has a stack [32].

In July 2003, the South Coast Air Quality Management District (SCAQMD) passed more stringent air quality regulations that are targeted to composting operations. These regulations do not apply to Santa Barbara City because Santa Barbara is not part of this air quality district, however, they are important in that they show the potential direction for composting legislation in the South Central Coast. Rule 1133, "Composting and Related Operations – General Administrative Requirements", establishes administrative requirements for all new and existing composting and related operations. The objective of this proposed rule is to create an informational database through a one-time registration process, with annual updates. Rule 1133.1, "Chipping and Grinding Activities" regulates these activities in order to minimize NH_3 and VOC emissions from inadvertent decomposition associated with stockpiling. Rule 1133.2, "Emission Reductions from Co-Composting Operations" has the objective of reducing VOC and NH_3 emissions from co-composting. It requires all active co-composting to be done within the confines of an enclosure, which meets certain conditions. This will have a significant impact on the choice of technology for co-composting.

3.2.3 Land Use and Permitting

A composting facility would require a conditional land use permit. Within the City limits, the zone that might be suitable for locating a composting facility is M-1, Light Manufacturing Zone [33].

If a composting facility was located within County limits, a conditional use permit would also be required and the facility would have to be located on agricultural land, zones AG-I and AG-II [34].

4. Food Scrap Recovery

4.1 Trash Collection

Figure 4-1: Marborg 11 ton front loader truck

During August 2003, members of the group rode on BFI and Marborg trucks to experience the challenges presented with trash collection and the potential implementation of a food scrap diversion program. The routes traveled were collecting from businesses and multi-family residential units. The trucks were front loaders with a capacity of 11 tons (Fig 4-1). The customers' bins were 2, 3 and 4 yd^3.
The trucks are manned by a driver only, who gets out of the cab at each stop to position the bin for the front loader forks, operates the lift and returns the bin to its position. In some cases, such as restaurants, bins are too full and heavy for the driver to move alone due the weight of food scrap. The haulers encourage restaurants not to have bins larger than 3 yd^3 due to the weight of food scrap, however, this is not always observed. On average, the driver will make two rounds of 20-30 stops each. At the end of each round he drives out to Tajiguas to dump the load. On Mondays and Fridays the hauler will often make a third round and a third trip to Tajiguas. On average, a truck covers 110-160 miles per day and uses 45 gallons of gas. Collection and transportation constitute a large portion of trash disposal costs [35]; they are important considerations for the haulers in a commercial food scrap diversion program. If food scrap is source separated, a business may potentially have three bins; one for regular trash, another for food scrap and a third for commingled recyclables. One of the challenges for a hauler participating in a food scrap collection program will be to devise cost-efficient collection routes. In other cities this has been achieved through the use of a truck with two compartments, enabling the driver to make one pass only [36]. Another challenge to address is that food scrap has high moisture content, leading to potential leakage problems. Truck containers must be well sealed to prevent this. One alternative is to collect food-contaminated paper with the food scrap[37]. Some of the moisture is absorbed and the paper provides a source of carbon for the composting process.

During the rides, it was clear that, in many cases, businesses had neither recycling containers nor bins. Large quantities of cardboard, paper, glass and green waste could be seen in the trash bin.   In some cases, the Marborg driver left these bins for the last round, explaining that he would take those loads to the Marborg recycling site to remove the recyclable materials. However, despite this effort, the trucks being emptied at Tajiguas contain large quantities of recyclable materials that are not being recycled by businesses. This is supported by the earlier stated fact that the percentage of commercial waste that is recycled is 10%.

A commonly cited problem related to trash and recycling bin locations is space constraint. In certain cases, businesses use small enclosed areas to locate their bin and there is barely enough room for the bin(s) they have.

City Municipal Code regulates bin placement as follows [25]:

Section 7.16.060 Placing Containers for Collection.
"*No refuse, bin, container or bundle shall be placed or kept on or in any public street, alley, sidewalk, footpath or any public place whatsoever but shall be placed and kept on the premises of the service customer in such a manner as to be readily accessible, preferably on a paved area, for removal of contents. Owners or occupants of premises shall locate refuse on or in private property, at the rear side or back of residences, multiple unit premises, or commercial or institutional buildings. When in a position exposed to public view from streets, alleys, walkways or public parking lots, all such containers, bins or bundles on commercial or institutional premises shall be screened from such public view in a manner compatible with adjacent architecture.*"

4.2 Case Studies of Cities Currently Implementing Food Scrap Diversion Programs

Diversion of food scrap from landfill is an aspect of municipal solid waste management, which is being considered or has already been implemented in cities throughout Europe and North America. In many European countries, such as the Netherlands, Austria, Germany, Denmark, and Switzerland, food scrap is typically combined with yard trimmings and collected at curbside [38].   In North America, there are a number of public and private sector initiatives, which target commercial and residential food scrap.

An understanding of food scrap diversion programs was included in the study to aid in establishing a reference framework. Research focused on cities within the United States and specifically California, due to the directives set by CIWMB that affect all jurisdictions in California, the similarity of waste characterization and the regulatory framework. Appendix B-1 provides a list of North American locations, which have public sector food scrap diversion programs or pilot programs.

4.2.1 California

There are a number of jurisdictions in California that have implemented food scrap diversion programs during the last ten years. These programs have worked with large generators of food scrap, including restaurants, supermarkets, hotels, schools and hospitals. Many lessons can be learned from these efforts in developing a successful program for the City of Santa Barbara. Jurisdictions in California, which have examined food scrap diversion, tested pilot programs and in some cases now have operating citywide programs are listed in Appendix B-1.

In addition to public sector projects, there are a number of private sector initiatives. In the Los Angeles area, Community Recycling & Resource Recovery targets grocery store food waste. This company provides a collection service from grocery stores' warehouses and takes the waste to their facility for composting. College campuses including UCSB, UC Davis and UC Berkeley compost their cafeteria wastes. A number of elementary schools are using vermiculture for their food waste (for example, Laytonville and Sierra Elementary School in El Dorado County). Other campuses, such as San Francisco State, are using in-vessel composting systems. On-site composting, whether high or low-tech, offers the benefit of avoiding collection costs, which represent the bulk of waste handling costs [38].

While there are numerous examples of food scrap diversion efforts, the programs in San Francisco, San Jose and Berkeley have been running for several or more years and provide key components for a long-lived successful program. The information sought in personal communications with the program managers is detailed in Appendix B-2. The summary facts for each City are provided in Appendix B-3 and described in detail below.

4.2.1.1 San Francisco

The population of San Francisco at year-end 2000 was 776,730 [39]. When the City was considering how to meet the AB939 50% diversion target, food scrap represented 20% of the waste stream. Commercial food scrap diversion started out as a pilot program in 1996 and expanded citywide by 1998 [40]. Residential food scrap collection began its expansion across the city in February 2000. This made San Francisco the first large US city to initiate citywide food scrap collection. The collection of food scrap and other compostables from San Francisco's residential households and neighborhood small businesses is achieved through a three cart color-coded program called "Fantastic Three"[41]. Recycling is, however, voluntary in San Francisco.

Two haulers operate in the City, although one covers the majority of the food scrap generators. The same company, Norcal Waste Systems, owns both haulers. Norcal also owns the composting facility located 65 miles away. Food scrap is collected from 1800 businesses including the majority of large restaurants totaling 1,000. Large grocery stores and some institutions such as schools, hotels, medical centers and the university are included. Approximately 35-45% of commercial food scrap is currently diverted and the goal is to reach 50%. Approximately 70,000 tons/yr are collected of which about 80% is food scrap and the remainder is food contaminated paper and other compostable material (not including green waste). The composting technologies used are AgBag and windrow.

Incentives for participating business and haulers are important for the success of food scrap diversion programs. In San Francisco there are financial incentives for both the businesses to participate as well as the haulers. Businesses receive a 25% discount on collection of food scrap; commingled recyclables collection is free of charge. The City has a Diversion Incentive Account with the haulers and the transfer station, which motivates haulers to reach certain diversion levels[35]. Another incentive for businesses is the annual award program for businesses participating in recycling named the CORY Awards. Primarily the haulers do outreach.

The City has provided grant money for programs aimed at human re-use of edible food scrap, namely the Foodbank and Food Runners. The latter is an organization that collects unserved restaurant portions and distributes them to food agencies whose clients are low income or homeless people. Food Runners in San Francisco is currently delivering approximately 15 tons of food per week that would otherwise be thrown away [42].

4.2.1.2 San Jose

The population of San Jose at year-end 2000 was 895,000[39]. The City bases its recycling programs on voluntary participation. Between 1999 and 2001, the City expanded organics collection beyond its successful residential yard trimmings program by starting two commercial food scrap composting pilot programs. The pilots were funded in part by grants from the City of San Jose [43]. Since then, the City has implemented a commercial food scrap diversion program. There are three trash haulers in San Jose; Waste Management Inc. is the main collector of food scrap. Large commercial food scrap generators such as grocery stores and restaurants are targeted for participation, but the food scrap is not source separated by the generators. Some of the food scrap generators are not even aware that the program is operating, as there is no additional charge for the service. The hauler, to facilitate one pass at each business location, uses a two-container truck. The hauler collecting from the participating businesses picks up the trash and takes it to the Z-Best composting facility in Gilroy, 40 miles away. There the waste is debagged, the recyclables are removed and the food scrap is ground. It is then composted using AgBag technology followed by windrow curing. Approximately 180tons/day are collected from food scrap generators and they have an 80% recovery rate after recyclables are removed. The goal of the City of San Jose is to reach 50% diversion of commercial food waste. The incentive for the hauler is that it is not required to pay a franchise fee for food waste [36].

4.2.1.3 Berkeley

The population of Berkeley at year-end 2000 was 102,700[39] and the City bases its recycling programs on voluntary participation. The City of Berkeley began its pilot food scrap collection program in 1997 after a waste stream analysis showed that 25 percent of the city-collected refuse from the commercial sector was food scrap. In implementing the pilot program, the city set out to solicit the participation of the largest food scrap generators. It did this by obtaining a list of all food-generating businesses (using appropriate SIC codes) provided by Alameda County and then following up with personal visits with business owners and managers. The city also targeted food-generating businesses in close proximity to each other to increase the program's collection efficiency. Two-person city crews do the collection. The recycling program manager, field representative, and recycling operations supervisor do outreach, education, and monitoring [38].

The City of Berkeley is fairly unique in providing refuse collection services to its residential and commercial sectors. The city collects about 300 tons/month of commercial food scrap from almost 100 businesses participating in the program. Berkeley has a no-Styrofoam food service ordinance, so disposable restaurant plates and cups are paper or cardboard and these are included in the food scrap. Most of the businesses participating in the food scrap diversion program also recycle cardboard, brown bags, mixed papers, bottles, and cans under the city's commercial recycling service. Recovery of food scrap brings the recycling rate of these businesses to 50 percent or higher. The City of Berkeley reports a 42 percent overall recycling rate [38].

The city hauler collects food scrap up to six days per week. Food scrap generators pay 80% of the cost of normal refuse service for the separate organics collection service. City crews combine collected food scrap with plant debris at the city's transfer station. Grover Landscape Services picks up the organic material in long-haul trailers, shreds it and composts it at its open windrow facility in Modesto, Calif., about 50 miles away. Grover gives the City up to 10% by weight of food scrap as finished compost [37].

A consulting firm was hired to do outreach, assessment and training to speed up the process. They produced multi-lingual posters with pictures and provided colored, labeled bins or carts for refuse, recycling and composting.

4.2.1.4 Santa Cruz

Santa Cruz County has taken a different approach from the above cities. Instead of collecting commercial food waste, the County has acted as a facilitator. (The county allocates about $150,000 per year in waste reduction grants). It has provided seed money via its grants program to a private consulting firm specializing in organic waste diversion, Organic Recyclers Anonymous (ORA). ORA have received three grants (totaling $36,000) to develop links between food scrap generators and end users, including food banks, farmers, renderers, commercial compost operators, and animal feed manufacturers. ORA also helped food scrap generators to develop on-site food diversion systems such as vermiculture and in vessel composting. The County further facilitated food recovery by mailing a letter on its letterhead from the director of public works to food scrap generators in the county. The letter informed businesses about ORA's project and research. It included a list of potential food scrap users who might benefit from receiving food scrap at the same time as helping the food scrap generators by reducing their trash bills. Local chambers of commerce and the local health department have further helped spread the word about opportunities to divert food scrap to valuable end uses [38].

4.2.2 Marketing Compost made from Food Scrap

The companies in the business of making compost from food scrap obtained from the cities studied (i.e. Norcal Waste Systems, Z Best and Grover Landscape Services) sell the compost at prices ranging from $10-$28 per ton (see Appendix B-3). They market their products to agricultural users and nurseries primarily. The treatment process is a determining factor in the end quality and in the final price at which the compost is sold[44-46].

4.2.3 Implications for the Project

In planning a commercial food scrap diversion program, the City of Santa Barbara may wish to consider the commonalities of programs in other cities of California. These are:

- 50% food diversion within the commercial sector is the goal set by other cities in California.
- Other Cities targeted the largest commercial food scrap generators first.
- Using food scrap to feed humans is addressed in other cities' food scrap diversion programs.
- Food scrap is composted. Technologies used are windrow and AgBag. Agricultural producers and nurseries are market users of compost made from food scrap.
- Costs are assessed as collection + transport + landfill fee (or alternative treatment).
- There are financial incentives for the haulers to collect food scrap separately. San Francisco operates a "Diversion Incentive Account" for haulers.
- There are financial incentives for the businesses to participate or businesses are not aware of the program.
- Food contaminated paper and all food products are collected together. This facilitates the participants' involvement.
- Grant money has been made available to support human re-use programs
- Outreach is critical for the success of programs.
- Front loading trucks are used for large generators. Large generators often use two smaller bins, rather than one large bin due to weight of food scrap.

- A truck with split container – 1 wet, 1 dry allows for one pass only and lessens collection costs.
- Pilot programs are most successful when they form the start of a long-term program and are used as a learning tool, rather than being implemented only for a short time and then stopped.

4.3 Human Re-Use

In keeping with the CIWMB priority of using food scrap to feed needy people, research was completed to understand the existing programs of food donations in Santa Barbara. The goal was to evaluate the quantity and nature of the food scrap currently being recycled, to understand the flow of food scrap, to locate the key agencies involved and to identify opportunities for program expansion.

4.3.1 Santa Barbara Foodbank and Food Distribution Agencies.

Within the County of Santa Barbara there are over 150 social service agencies and community groups providing food for needy people [47]. Within the City, there are six key organizations. They are the Foodbank, Catholic Charities, the Salvation Army, the Westside Community Center, the Community Kitchen and the Rescue Mission. Personal communication with representatives from these agencies allowed key information to be understood. Based on the information provided by the above organizations, a diagram illustrating the flow of food donations in the City was compiled (Appendix B-4 Figure 4-1).

The mission of the Foodbank of Santa Barbara County is "*to collect and distribute nutritious foods, to provide education, and to network with the community to feed the hungry in Santa Barbara County*"[47]. During 2003, the Foodbank of Santa Barbara County distributed almost 3,000 tons of food from its two warehouses in Santa Barbara and Santa Maria [47]. Approximately 1,000 tons were distributed within the City of Santa Barbara [48].

The Foodbank differentiates itself from the other organizations in that it does not handle any prepared foods; only packaged, tinned, bottled and some fresh produce. Additionally, it acts as a supplier to the other food distribution agencies. Donations to the Foodbank come from the USDA, America's Second Harvest Program, Ag Against Hunger, businesses, food drives and individuals. Most of the Foodbank's inventory is donated or purchased at a very discounted price. Some of it is "salvage" goods from grocery stores, which might otherwise be sent to landfill. It is, however, difficult to quantify how much of the food donated to the Foodbank would otherwise go to landfill.

The Foodbank is at maximum capacity in terms of donations, which it receives. It currently refuses approximately 1000 tons of food per year due to insufficient warehouse capacity. As the diagram in Appendix B-4 illustrates, the space constraints on the

Foodbank have an effect on the agencies depending on supplies from the Foodbank. This is the focus of a current capital campaign that aims to build an additional warehouse in Santa Maria.

The organizations providing meals for needy people solicit food donations in addition to those received by the Foodbank. For the most part, they are staffed by volunteers and therefore limited in the effort that can go into obtaining food donations. They are required to purchase provisions to supplement the Food Bank donations; this is a drain on their financial resources. In total, these agencies produce about 350,000 meals per year and distribute 225 tons of groceries [49-53]. The agencies complain that they receive an imbalance of goods, with an excess of certain products such as bread and a lack of other foods such as meat and produce. They are also in competition with each other for food donations given the lack of structure in this arena within the City.

On the whole the agencies welcome further food donations including unserved portions of prepared food from restaurants and catering companies provided food is fresh and does not pose any health risks. Most of the agencies have a truck, which could be available for collecting food. The overall opinion of the agencies is that food donors are concerned about liability issues associated with food donations and this prevents many from donating. Agencies believe that education targeted at potential donors, geared to understanding the regulatory framework in addition to the types of food, would lead to increases in donations.

4.3.2 Regulatory Framework for Food Donations

4.3.2.1 Charitable Food Donations

The California Health and Safety Code (Division 104: Environmental Health, Part 7: Retail Food, Ch.4: Retail Food Practices, Article 19: Food Facility Food Donations) regulate food donations by food facilities. Sections 114435-114455 cover the requirements for any food facility to donate food to a food bank or to any other nonprofit charitable organization for distribution to persons free of charge. Section 114450 provides the food facility with immunity from civil or criminal liability as follows [24]:

Section 114450. Immunity from Civil Liability
"No food facility that donates food as permitted by this article shall be subject to civil or criminal liability or penalty for violation of any laws, regulations, or ordinances regulating the labeling or packaging of the donated product or, with respect to any other laws, regulations, or ordinances, for a violation occurring after the time of the donation."

4.3.2.2 Good Samaritan Act

In addition to the above, the Good Samaritan Act, passed in 1996, excludes a person or nonprofit food organization from civil or criminal liability that, in good faith, donates or distributes donated foods for food relief. The purpose of this act was to encourage food donations and protect donors.

4.4 Implications for the Project

The Foodbank of Santa Barbara County is a well-established organization annually diverting approximately 3000 tons of food in the County of which 1000 tons is within the City of Santa Barbara. It is currently constrained by the size of its warehouse facilities, which has a knock-down effect on the food distribution agencies depending on it for food donations.

Beyond this, educating businesses in Santa Barbara about donation opportunities and liability protection is important. Some effort directed towards matching donors with agencies is needed. Having identified the need for food donations, a quantification of edible food available in the target sector will assist in understanding how much food scrap could potentially be diverted to human use and whether a program such as Food Runners would be beneficial in Santa Barbara.

4.5 Reuse and Conversion as Animal Feed

Reuse and conversion are methods of collecting and processing food scrap in order to use as animal feed. Each method has its own path from human disposal to animal. These will be discussed individually below.

4.5.1 Reuse for animal feed

Food scrap, either pre or post-consumer may be fed to animals; this approach is called "re-use for animal feed". Depending on the type of food and what kind of animals it will be fed to, the food may require processing before reuse. Two major areas of legislation that require processing for certain animals and certain types of food are the Swine Health Protection Act and rules for ruminants regarding Bovine Spongiform Encephalopathy (BSE). The Swine Health Protection Act concerns the feeding of post-consumer food scrap to swine. The Act requires, in part, that most post-consumer scrap be cooked at a specified temperature for 30 minutes before being fed to swine. The rules for ruminant feeding are concerned with lessening the possibility that BSE (also known as Mad Cow disease) will be distributed between cattle. In part, the rules prevent using animal proteins in ruminant feed [54]. One of the major impacts of legislation such as these is a significant restriction on the total amount of food scrap that could be diverted as reuse for animal feed.

Regarding our specific area, there were no willing receivers of reusable food scrap found. The Santa Barbara Zoo was contacted to determine if it could accept food scrap. The Zoo was unwilling to accept food scrap due to stringent standards required under its accreditation by the American Zoological Association. Terry Brennan from the California Integrated Waste Management Board was contacted as well to inquire about any swine operations willing to accept scrap in the local area. He reported that he knew of no operations in the Santa Barbara area [55].

4.5.2 Conversion for animal feed

Converting food scrap into animal feed involves some kind of processing before being fed. One example of this is dehydrating food into a pelletized form. A difficulty with conversion is the moisture content of food. Nutrients are found mostly in the dry portions of food, but a substantial amount of food scrap may only contain 20% dry matter [54]. Consequently, large amounts of energy may be required to process the food into 80% dry matter (a preferable percentage for feeding). As with reuse, there are no known businesses in the local area converting food scrap into animal feed. With no readily available outlet, this process was not considered further.

4.5.3 Rendering

Rendering involves recovery of grease, cooking oil, and some meat and bone waste. Heat processing is then used to convert the waste into a new product, such as animal feed or soap.

County Sanitation, a Santa Barbara County rendering business listed on CIWMB website was contacted to further understand the current rendering possibilities in the Santa Barbara area. It was found that County Sanitation was only a transporter of the waste to a Los Angeles-based company, Darling International. Darling International was contacted and reported that their operation only accepted grease and cooking oil waste for use in the production of soaps.

In further conversation with the project client, it was also revealed that grease and cooking oil are not included as “food scrap”[56]. This would lead to the conclusion that diverting these products would not provide benefits within the construct of this project.

5. City of Santa Barbara Waste Stream Analysis

5.1 Waste Characterization Study

In August 2003, the County of Santa Barbara released a waste characterization study (WCS) that analyzed the waste streams disposed at the Tajiguas landfill. The purpose of the analysis was to provide information that could be used to aid waste diversion policies and programs. The analysis looked in detail at waste generation amounts for 58 different waste components and identified the source of material generation by jurisdiction (Appendix C-1). The WCS documented the following jurisdictions as sources of waste: the City of Santa Barbara, the City of Goleta, and unincorporated areas within the County of Santa Barbara. The study divided each jurisdiction's waste stream into three sub streams in order to narrow the region of identifiable production. The sub streams were defined by the generator types and method of disposal transport: franchised residential, franchised commercial, and self-haul (residential and commercial)[5].

The results of the study provided the most recent data on the overall waste stream into the Tajiguas landfill. The analysis projected the annual disposal of waste from all sources to be 239,806 tons for 2003. In addition, the study included estimates of the percent waste contribution from the jurisdictions within the County of Santa Barbara (Figure 5-1). According to the analysis, the City of Santa Barbara contributes 47% of the total waste disposed at Tajiguas. This projected annual contribution for 2003 accounts for 113,390 tons of waste disposed at Tajiguas.

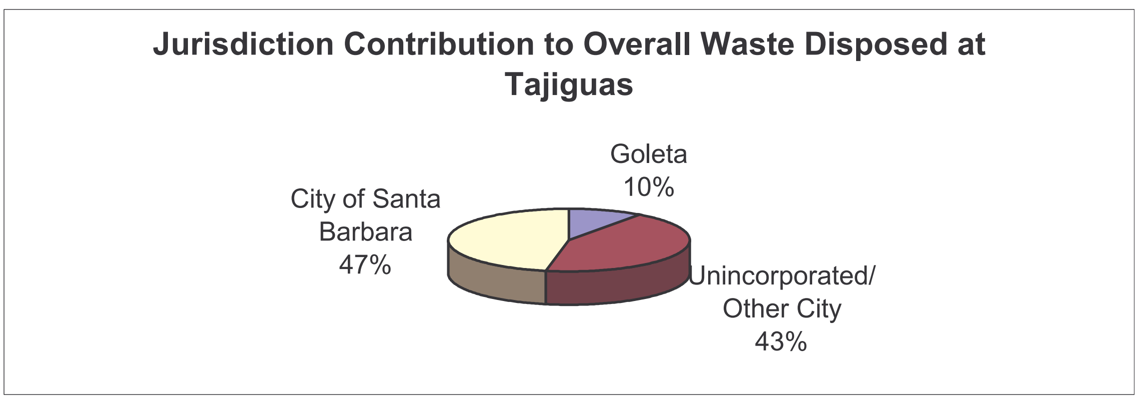


Figure 5-1: Breakdown by jurisdiction of the waste disposed into the Tajiguas landfill [5].

As mentioned earlier, the WCS also analyzed the jurisdictional contribution for each sub stream. The composition of the waste stream for the City of Santa Barbara allowed for analysis of the waste components from the sector that would be most influenced by a commercial food scrap diversion program (Figure 5-2)[5].

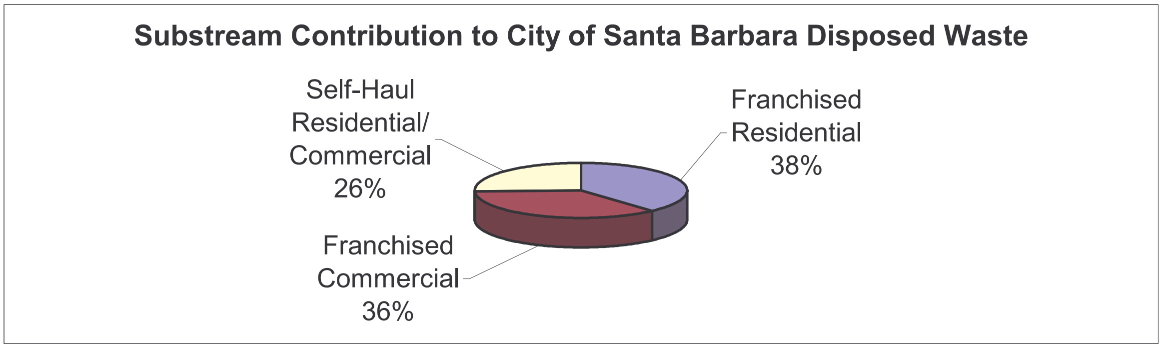


Figure 5-2: Composition of waste disposed at Tajiguas by the City of Santa Barbara [5].

5.2 Franchised Commercial Waste Stream Analysis

According to the Solid Waste Program staff, the proposed food scrap diversion program will focus on franchised commercial waste producers. In order to understand the impacts of the program, the amount of food scrap coming from the target sector needs to be understood. City staff provided the raw data for the franchised commercial sector from the WCS so that analysis on material from franchised commercial waste could be conducted [57]. This allowed for calculation of percent composition of food scrap and other recyclable materials within this specific waste stream (Figure 5-3). The classification of waste components for each recycling program is outlined in Appendix C-2. The results indicate that food scrap compromises 26% of the target sector waste stream making it the largest individual waste component.

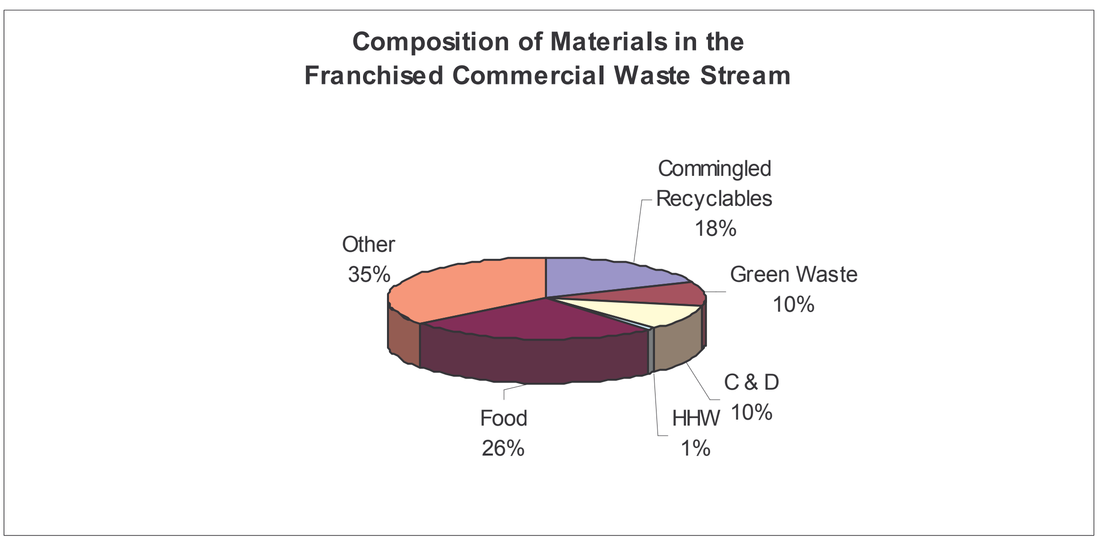


Figure 5-3: Percent composition of materials disposed from the City of Santa Barbara's franchised commercial waste stream [5].

The most current estimate for the City of Santa Barbara's contribution to Tajiguas, is 113,390 tons [5]. Information provided by the City of Santa Barbara's Solid Waste

Specialist, Karen Gumtow indicates the amount projected by the WCS is inaccurate. She believes the City's contribution to the landfill is 95,006 tons [57]. The imprecision of the estimates within the study was acknowledged, yet the information from the WCS was used for the analysis here because the WCS is the most current published document. Using this amount and the percentages provided by the WCS, the amount of waste collected from the franchised commercial sector of the City of Santa Barbara can be estimated to be 41,013.40 tons for the year 2003 [5]. Using this estimation the amount of materials disposed has been projected in tons. This analysis of the current divertible streams allows for calculation of the impacts of changes in recyclable streams on the overall diversion rate (Table 5-1).

Material	Tons/Year
Food	10,624.38
Commingled Recyclables	7,552.79
Construction and Demolition	4,029.16
Green Waste	3,969.63
Household Hazardous Waste	389.25
Other	14448.19
Total	41,013.40

Table 5-1: Stream projections based on percent composition of the commercial franchised sector and the total waste disposed for 2003 [5].

5.3 Methods of Estimating Diversion

5.3.1 CIWMB Methodology

The CIWMB has an established methodology for calculating diversion rates. Jurisdictions work with the CIWMB to decide upon a base year. Base year data is the amount of waste generated in the decided year, including that which is disposed and diverted. It is approved by the CIWMB and diversion rates for the following years are relative to data for that particular year. The City of Santa Barbara's base year is 1998, and the base year generation is 183,763 tons [58].

The base year generation data is adjusted to correct for factors that contribute to waste production. The CIWMB uses an equation to estimate reporting year generation (RY):

$$RY = B_R F_R + B_{NR} F_{NR} \qquad \text{Equation 5-1}$$

where B_R is the base year residential waste generation in tons, F_R is the residential adjustment factor, B_{NR} is base year non-residential waste generation in tons, and F_{NR} is the non-residential adjustment factor. The adjustment factors are determined by annual employment, population, taxable sales, and the state consumer price index (CPI). The base year generation is adjusted through the use of the adjustment factors, so that it includes changes that occur in the local markets and influence the jurisdictions. Each adjustment factor (residential and non-residential) has an independent equation:

$$F_R = \frac{1}{2}\left(\frac{PR}{PB}\right) + \frac{1}{2}\left(\frac{ER}{EB} + \left[\frac{CB}{CR}\right]\left[\frac{TR}{TB}\right]\right) \qquad \text{Equation 5-2}$$

and,

$$F_{NR} = \frac{1}{2}\left(\frac{ER}{EB} + \left[\frac{CB}{CR}\right]\left[\frac{TR}{TB}\right]\right), \qquad \text{Equation 5-3}$$

where F_R is the residential adjustment factor, F_{NR} is the non-residential adjustment factor, PR is the reporting year population, PB is the base year population, ER is the reporting year employment, EB is the base year employment, CR is the reporting year consumer price index, CB is the base year consumer price index, TR is the reporting year taxable sales, and TB is the base year taxable sales. Diversion (D) is then defined by the following equation:

$$D = 1 - \frac{DA}{RY}, \qquad \text{Equation 5-4}$$

where DA is the reported year disposed amount and RY is the estimated reporting year generation tonnage [58]. Because the information obtained is based on amount disposed (not amount recycled), the calculation assumes that lower disposal amounts for the reported year indicate higher recycling rates for that particular year after adjustment of the base year generation.

5.3.2 Diversion Projections

The primary focus of this paper is to investigate how diverting food scrap will affect the City of Santa Barbara's diversion rate. To present a more adequate analysis, research has been conducted to determine the impact of increased recycling rates for existing programs in addition to the impacts from a food scrap program. The information gathered through analysis conducted is based on recycling capabilities, not actual amounts disposed. For that reason the equation used in calculating potential diversion rate (d) is:

$$d = \frac{r}{ry}, \qquad \text{Equation 5-5}$$

where r is the amount of recyclable material in the waste stream that is capable of being recycled and ry is the estimated reported year generation for the City of Santa Barbara for

2002. Because the City of Santa Barbara is currently at a 55% diversion rate, *d* must be added to 55% for the total projected diversion[8]. Any further mention of diversion from this point on refers to calculation based on equation (5-5) and represents potential diversion rates, not actual rates calculated using the CIWMB methodology.

5.3.2.1 Franchised Commercial Diversion Estimates

These equations allowed for calculating the impacts of fluctuations of the materials shown in Table 5-1 on the overall waste stream. The additional diversion that could be gained from increased recycling within existing programs is shown in Table 5-2. These projections are based on a *ry* value of 196,581 tons [58] (Appendix C-3). With a goal of recovering 50% of the food scrap produced by the franchised commercial sector the City could increase their current diversion rate of 55% by an additional 2.7%.

5.3.2.2 Other Diversion Estimates

Analysis conducted on the amounts of divertible materials within the franchised commercial sector reveals that the establishment of a food scrap diversion program along with increases in other recycling markets can help the City reach an increased diversion of approximately 13%, assuming 100% recovery and capture rates.

Material	*Tons/Year*	**Additional Diversion (%)**
Food	10,624.38	5.40
Commingled Recyclables	7,552.79	3.84
Construction & Demolition	4,029.16	2.05
Green Waste	3,969.63	2.02
HHW	389.25	0.20
Total	26,565.21	13.51

Table 5-2: Diversion calculation showing potential impacts of recycling materials at 100% recovery rate.

Analysis on the commercial franchised sector revealed that the city would not be able to obtain their diversion goal of added diversion of 15%. To address the influences of other sectors on reaching the City's goal, further research was conducted to determine the material streams for the franchised residential sector (Appendix C-4). Information on this sector of the City allows for a more adequate analysis of optimal diversion amounts.

5.4 Identification of Food Scrap Generators

5.4.1 The Food Database

Understanding food scrap production within the commercial sector of the City of Santa Barbara plays an important role in assessing the feasibility of a food scrap diversion program. The analysis conducted included construction of a database that contained information on food scrap generators within the City of Santa Barbara's commercial franchised sector. Throughout this analysis the database will be referred to as the food database.

The food database was constructed to ensure adequate representation of food scrap generators through the merger of food scrap generator lists. The first was extracted from the business license permit list that was provided by the Client. The list included information on Santa Barbara area businesses from December 2002. From the list, the food generating categories and the businesses within the categories were compiled into the database (Appendix C-5). The County of Santa Barbara Environmental Health Services (EHS) provided the second data set. These lists included business names and contact information, which was used later in the study. In addition, efforts were made to evaluate the list to make sure that it contained all of the food scrap generators. To ensure that there was adequate representation of educational facilities the local schools were added. They had not been included in either the business license list or the EHS list. The lists were compared to prevent repetition of entries.

The City of Santa Barbara manages the billing of the trash accounts for the contracted haulers. The accountholder information is stored in a database referred to as the Financial Management System (FMS). Each business in the food database was researched using this system and was analyzed for reported weekly hauled trash (cubic yards per week). This information was added to the food database.

5.4.2 Limitations of the Food Database

Businesses that were in the food database, but not found in the FMS system, were removed due to the fact that their absence in the FMS system indicates that they are not within the City limits. Businesses that have roll-off containers are also excluded from the City FMS system, and therefore they were also excluded from the food database. This limited the projection of food scrap generators to those that are managed within the City's billing system. Upon completion, the food database contained information on 529 food scrap producing businesses within the City of Santa Barbara's commercial franchised sector.

5.5 Assessment of Food Scrap Generators

5.5.1 Projection of Food Scrap Contribution by Generators

After the food database was constructed, it was available for use in other areas of the study. It provided the foundation for identifying the major food scrap generators from the target sector. The data that was collected from the City FMS system revealed business contribution to the waste stream. Upon completion of the trash service level for all businesses within the food database, it became apparent that some of the businesses did not have their trash hauled under accounts in their business name. Because of space constraints and methods of property management many businesses share trash accounts. This is applicable for small-shared buildings, large shopping complexes, and City owned properties (Stern's Wharf and Santa Barbara Harbor) that are rented to private business owners. These situations limit the information that can be obtained from the FMS system. It is likely that some accountholders are sharing with other businesses (food scrap producing and/or non food scrap producing). However, it has been assumed that the contribution of non-accountholders to the account holding businesses waste is equivalent, and vice versa. To limit inaccuracy that would occur in attempting to tease out the amount contribution for non-accountholders within shared accounts, only businesses that were documented accountholders in the FMS were used for assessment of food scrap generators.

The account holding food scrap generators provided the foundation for determining the major food scrap generators within the City of Santa Barbara. The California Integrated Waste Management Board (CIWMB) Waste Characterization Database (WCD) was used to investigate the amount of food scrap generated by the businesses within the food database. The WCD is a resource that can be used by jurisdictions that are interested in analyzing their waste streams. It helps to determine the waste components of businesses' waste streams. It is based on sampling data of business waste streams within Southern California and accounts for disposed waste only. The database does not include materials that are part of recycling streams [59]. For this study each business within the food database was analyzed for food content.

The WCD groups businesses into 39 categories based on Federal Standard Industrial Classification (SIC) codes (Appendix C-6). The applicable categories for food scrap producing business were extracted from the WCD SIC codes [59]. Because the SIC codes used in WCD were broadly defined, a more detailed description was necessary for proper classification of the food scrap generators. This information was obtained from the United States Department of Labor Occupational Safety and Health Association (OSHA) (Appendix C-7). The department provides a description of each SIC code through a search engine available on-line, which allows for a more accurate classification of food scrap generators for the food database [60].

Once the food scrap generators were classified according to SIC codes, the percent food scrap was calculated [59]. This was done by for each business by using the following equation:

$$F = T\,P, \qquad \text{Equation 5-6}$$

where F is the food production in cubic yards per week, T is the trash level for each individual business in cubic yards per week, and P is the percent food estimated by the WCD (Table 5-3). Calculating the food production per business allows the major food scrap generators to be identified through sorting.

Business SIC Grouping (CIWMB)	*SIC Major Group (CIWMB)*	*Percent Food*
Retail Trade- Food Store	54	39.80%
Retail Trade- Eating and Drinking Places	58	56.00%
Services-Hotels/Lodging	70	28.00%
Services-Medical/Health	80	12.10%
Services-Education	82	20.30%
Services-Other Misc.	83	12.60%

Table 5-3: Percent food contribution for business grouping [59].

5.6 Identification of Major Food scrap generators

5.6.1 Top Generators

The target businesses in this study were selected in an attempt to maximize economic efficiency. Upon examination of the food scrap generator waste generations it became apparent that the smaller accounts would be less likely to produce food at a rate that would be economically efficient to collect. Research conducted by the City of Portland, Oregon revealed that a food scrap diversion program would not be feasible for food producing businesses that had less than eight cubic yards of trash hauled per week [61]. In order to achieve this, only businesses that had eight or more cubic yards of trash (T) were included in the potential target list. The inclusion of these businesses resulted in a target list consisting of 109 food scrap generators within the City of Santa Barbara. These top food scrap generators represent 20% of the total food scrap generator population (Appendix C-8). Due to the confidentiality of the information obtained a list of the top generators is available for the Client only.

To provide the City of Santa Barbara with guidance in administering the food scrap diversion program, the influence of food scrap generators within the top 20% was analyzed. Figure 5-4 represents the influence of food scrap production by category within the top producers. It reveals that most food scrap is generated by Eating and Drinking Places (74%) and Food Stores (14%). Independently these results indicate that implementation of a food scrap diversion program should begin by encouraging participation from businesses in these categories.

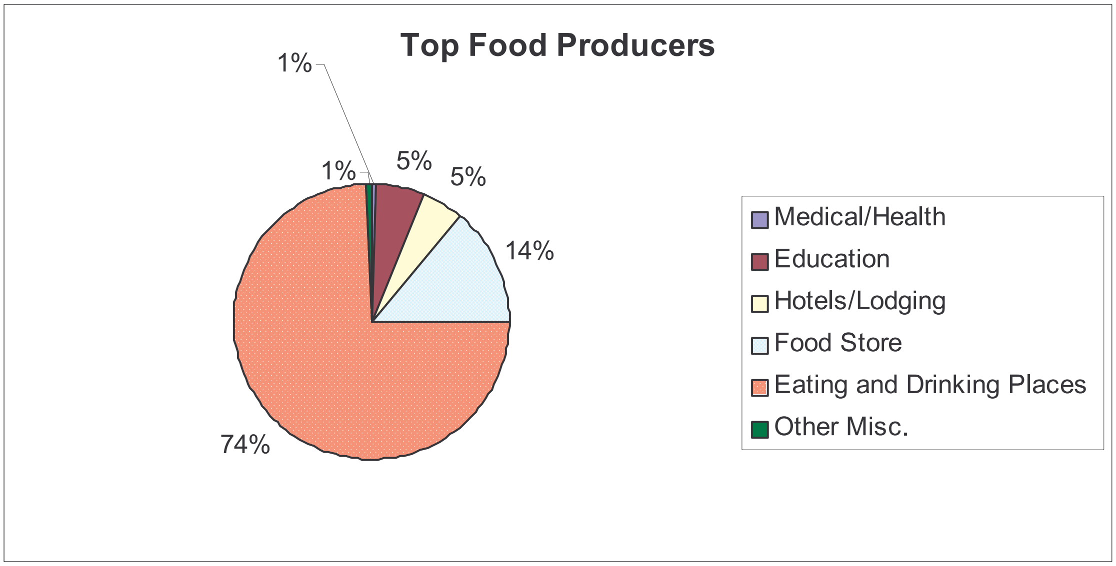


Figure 5-4: Graphical representation of the composition of the top 20% food generating businesses by category.

5.6.2 Projection of Food Scrap Quantities

Quantification of the amount of food scrap produced by the top food scrap generators can further aid the City in identifying target businesses for the food scrap diversion program. The percent food calculated for the top food scrap generators using equation 5-6 was further adjusted to predict the potential food scrap collection. Calculation of food (F) as described above assumes a 100% fullness factor (F_f) and a 100% capture rate (C_r). In reality, bins will not be completely full and the recovery of food scrap may be inefficient. To correct equation 5-6, the fullness factor and capture rate were included in calculating the collectable food (F_c):

$$F_c = T * P * F_{f} * C_{r.} \qquad \text{Equation 5-7}$$

These added variables are expected to vary by business and may fluctuate through time. Other food scrap recovery programs, such as Portland Oregon, have used similar equations in calculating food residual generation quantities. The projection made in analysis of Portland's food scrap stream assume that used bin capacity varies between businesses and that a fullness factor of 80% is an adequate realistic disposal option. Also, solid waste specialists utilized two capture rates in calculating collectable food scrap. A conservative rate of 40% was used to estimate the amount of collectable food during the first phases of implementation, and a higher rate of 60% was used to estimate the capturable food scrap after businesses became more familiar with the program [61].

Conversion of measurements from volume to weight allows for the food scrap collection projections to be made in tons. A value of 750 lbs of organics per cubic yard was used in this study. The transformed collectable food projection sums per category are shown in Table 5-5. The quantified projections per category help in determining the amount of food scrap that can be collected in the initial phase of a food scrap diversion program.

Capture Rate = 40%	Medical/ Health	Other Misc.	Educ ation	Hotels/ Lodging	Food Store	Eating and Drinking Places	**Total**	Additional Diversion
F_c (tons/week)	<1	<1	5	4	14	75	**99**	0.05%
F_c (tons/year)	36	28	279	231	723	3921	**5217**	2.65%

Table 5-4: Quantities of collectable food scrap by category

It has been observed that food scrap diversion programs in other cities of California aimed at achieving 50% diversion of the commercial food scrap stream (chapter 4.2.3). Assessment of the major food scrap generators within the City of Santa Barbara's franchised commercial sector has revealed that targeting the top 20% could potentially result in 2.65% diversion (Table 5-5). This projection indicates that it is possible for the city to achieve a goal of 50% food scrap diversion from this sector from an implemented food scrap diversion program (section 5.3.2.1). If a higher capture rate were applied, as might be the case when the program is established, this would increase diversion.

5.7 Implications on the Overall Project

Understanding the waste stream generation in the target sector plays an important role in determining the feasibility of the City of Santa Barbara's food scrap diversion program. The analysis that has been conducted on the waste stream has provided a projection of the amount of recyclable materials that are being disposed at Tajiguas. This information is useful in determining how influential a food scrap diversion program will be on the City's future diversion. It also allows for multiple waste streams to be assessed determining how their fluctuations may alter future diversion by using a model for determining the optimal level of diversion for each recycling program.

The information presented in this chapter supports further research conducted to determine the feasible technologies by projecting potential food scrap amounts. It also supports the attempt to obtain information from the food scrap generators through a survey of the food scrap generators. The food database also serves as a compiled list that provided the infrastructure for the willingness to participate survey. Selected material from this waste characterization study, willingness to participate survey, and technological feasibility all feed into the model synthesis, which serves as an aid for the City of Santa Barbara's attempt to increase their diversion quantities.

6. Food Scrap Generator Survey

6.1 Survey Design

A vital factor in the success of a food scrap diversion program is effective education and outreach to the community of food scrap generators. Rather than assuming to know the willingness of the commercial sector to participate, and the most effective way to structure a food scrap diversion program, this study sought to obtain information and ideas directly from those establishments likely to be included in the program. The food scrap generators' perspective was obtained in a survey of the City's franchised hauled commercial sector.

T*he research questions focused on:*

- Estimating the amount of food available for human re-use
- Interpreting the willingness of commercial establishments to participate in a food scrap diversion program
- The perceived benefits and constraints associated with participation
- The specific types of infrastructure that may facilitate successful participation

In addressing these questions the survey is structured in three main parts. Part 1 of the survey aims at a better understanding of the waste characterization. This section includes general questions regarding the size of the establishment and type of service provided as well as their current waste management practices. Part 2 of the survey attempts to get at peoples' perceptions towards the benefits and constraints associated with participation. This section asks a specific question regarding their willingness to participate in a food scrap diversion program. Part 3 of the survey discusses potential physical and educational infrastructure that can be provided by the City. This section of the survey deals with issues involving implementation and the preferred methods of collection. A copy of the Food Scrap Diversion Survey and cover letter are available in Appendix D-1.

Prior to distribution, feedback was solicited from Professor Bruce Kendall (Assistant Professor of Applied Ecology and Statistics at the Bren School of Environmental Science and Management), and Professor Catherine Ramus (Assistant Professor of Organizational and Environmental Management at the Bren School of Environmental Science and Management), and a pilot test was performed on a few select commercial establishments. This initial feedback was used to improve the understandability of the survey and consequently the usefulness of the responses. Other available resources and past experiences were consulted in developing the survey questions. For example, the firm Applied Compost Consulting, Inc. (Oakland, CA) was employed by the City of Portland, OR to conduct a similar type of survey [62]. This firm has also been actively involved in the planning of successful food scrap diversion programs in San Francisco, Oakland, Berkeley and elsewhere. Communication with Steve Sherman, the consultant responsible for preparing the Portland survey, provided useful insight into the value of the food scrap generator survey in designing a successful food scrap diversion program [62]

6.2 Methods of Research

6.2.1 Sample Selection

The sample population is derived from the same food database created for the waste characterization study (Section 5.4). The food database was constructed to ensure the identification of all of the potential food scrap generators within the City of Santa Barbara's franchised hauled commercial sector. The food database contains business names and contact information for 529 food scrap generators. These establishments represent both large and small sized generators, and include the major categories of food scrap producers identified by the waste characterization study (Section 5.6).

6.2.2 Survey Procedure

In an effort to identify the appropriate person to answer the survey, all of the 529 food scrap generators were contacted by telephone. In most cases the name of the manager or owner of the establishment was obtained. This information allowed for the survey cover letters to be personalized. The survey and cover letter were mailed via the U.S. Postal service on December 1st, 2003. To assist the respondents in returning the survey a postage paid pre-addressed return envelope was also included. The cover letter encouraged the recipient to send the survey back within two weeks. In an effort to increase the response rate, after the initial two-week period, follow up phone calls were made to those respondents who had not yet replied. However, many of these food service establishments become increasingly busier during the December holiday season, which made it difficult to continue pursuing these individual businesses. Because the increased level of service experienced by some establishments may not be the same across all sectors of food scrap generators the time of year when the survey was sent out introduces a potential source of sample bias. Consequently, re-sampling the survey population at a different time of year may improve the response rate.

The cover letter notified the recipient that each survey is uniquely coded so that the individual generators can be matched with a measure of the capacity of waste hauled. The cover letter also assured respondents that the results of the survey would not be used in any other way to identify their establishment. Due to issues of confidentiality the results of the survey cannot be used to simply identify those establishments with a high willingness to participate in a food scrap diversion program. Rather, the survey results provide a more general evaluation of the food scrap generators' perspective.

The overall survey response rate is 14%. The highest response rate is for the category of educational facilities where 36% of the sample population returned the survey. The lowest response rate is for grocery stores where only 11% of the sample population returned the survey. The response rates for the other categories of food scrap generators are medical facilities 21%, restaurants 13%, and hotels 14%. These response rates have important implications on the reliability of the survey results. As such, conclusions drawn from those categories of generators with a high response rate are stated with a greater degree of certainty.

6.2.3 Data Analysis

The survey responses were analyzed using the computer software statistical package SPSS 11.5. In most instances the results are reported as a relative frequency of the respondent population. In certain cases the mean, sum, or count is reported.

The calculation of pre-consumer food scrap that may be available for human re-use is made using the following equations:

$$\mathrm{Y}_{\mathrm{fst}} = \left(\frac{W \times D}{S} \times F\right) \times F_{fst} \qquad \text{Equation 6-1}$$

Where, Y_{fst} is the yards of food scrap according to type (i.e. kitchen trimmings, pre-consumer, scraps from plates), W is the yards of waste collected per week, F is the CIWM factor for food scrap according to commercial sector (%), D is the dumpster capacity full (%), S is the number of establishments sharing the dumpster and, F_{fst} is the type of food scrap (%).

$$T_{fst} = \left(\frac{Y_{fst}}{T_{rp}}\right) \times 100 \qquad \text{Equation 6-2}$$

Where T_{fst} is the type of food scrap reported as a proportion of the total waste produced by the respondent population (%), Y_{fst} is the yards of food scrap according to type, T_{rp} is the total yards of waste produced by the respondent population.

The willingness to participate value is normalized using the following equations:

$$WTP_0 = \left(\left(\frac{R_0}{100}\right) \times N\right) \times 0 \qquad \text{Equation 6-3}$$

$$WTP_1 = \left(\left(\frac{R_1}{100}\right) \times N\right) \times 1 \qquad \text{Equation 6-4}$$

$$WTP_2 = \left(\left(\frac{R_2}{100}\right) \times N\right) \times 2 \qquad \text{Equation 6-5}$$

$$WTP_3 = \left(\left(\frac{R_3}{100}\right) \times N\right) \times 3 \qquad \text{Equation 6-6}$$

$$WTP_4 = \left(\left(\frac{R_4}{100}\right) \times N\right) \times 4 \qquad \text{Equation 6-7}$$

$$WTP_m = \left(\left(\frac{R_m}{100}\right) \times N\right) \times 0 \qquad \text{Equation 6-8}$$

Where $WTP_{(0\text{-}4)}$ is the different levels of willingness to participate according to the specific commercial sector, $R_{(0\text{-}4)}$ is the percent of the respondent population with the particular level of WTP, N is the number of generators per sector in the general sample population.

$$mean(T_{wtpf}) = \frac{(WTP_0 + WTP_1 + WTP_2 + WTP_3 + WTP_4 + WTP_m)}{N} \qquad \text{Equation 6-9}$$

where T_{wtpf} is the total willingness to participate according to the food scrap generator sector.

6.3 Research Findings

6.3.1 Sample Distribution

Across all categories of food scrap producers 14% of the survey population responded to the survey. While sample size is very important, it is not the only determinant of a representative sample [63]. In comparing the survey population and the respondent population several other factors are considered.

To ensure that each type of generator is adequately represented in the respondent population the relative frequency for each category was calculated (Tables 6-1and 6-2). These results indicate that education facilities are over represented in respondent population. This is also an indication that educational facilities have a higher response rate than the other categories of food scrap generators (Figure 6-1)

	Frequency	**Relative Frequency**
Restaurant	344	64.8%
Grocery	91	17.2%
Hotel	57	11.0%
Education	22	4.2%
Medical	14	2.6%
Other	1	0.2%
Total	**529**	

Table 6-1: General sample population

	Frequency	**Relative Frequency**
Restaurant	44	59.5%
Grocery	10	13.5%
Hotel	8	10.8%
Education	8	10.8%
Medical	3	4.1%
Other	1	1.3%
Total	**74**	

Table 6-2: Respondent population

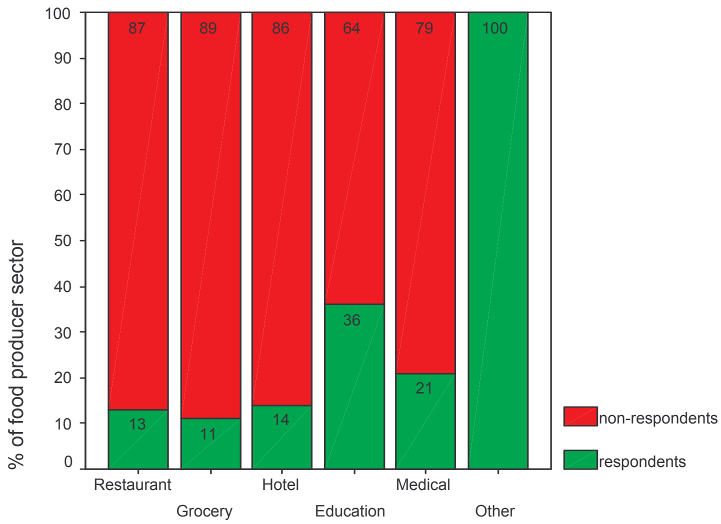


Figure 6-1: Graphical representation of the survey response rate

For the "Other" food scrap generator sector the survey population only includes one generator. This establishment responded to the survey and consequently there is a 100% response rate for this category. Because this establishment's participation in a food scrap diversion program will have a minimal effect on the amount of waste that may be diverted they have not been included in the bulk of this analysis. However, a detailed evaluation of the survey results provided by the "Other" sector of food scrap generator is provided in the conclusions of this report. While the response rate is relatively high for education (36%) and medical (22%), it is relatively low for hotels (14%), restaurants (13%) and grocery (11%). Given these results conclusions made in regards to the education and medical sector can be stated with a greater degree of certainty than those made for the hotel, restaurant, and grocery sectors.

In determining whether both large and small food scrap generators are included in the respondent population, SIC code data obtained on the number of employees at each establishment was compared to survey responses concerning the number of people that the establishment gives service to each day (Appendix D-2). The results of this comparison indicate that in all categories there is both a large and small food scrap generator represented in the respondent population. It actually seems that the respondent population tends to be skewed towards the larger sized generators. Since one of the overarching goals of this collection program is to facilitate the participation of the large food scrap producer the survey results may actually provide greater insight into this target population.

6.3.2 Estimate of the Amount of Food Available for Human Reuse

One of the main objectives of this study is an evaluation of the potential for collecting pre-consumer food scrap and distributing them to charity organizations. While the recent WCS provides an estimate of the percent food according to business sector, the study does not make a distinction regarding the type of food scrap being produced (i.e. kitchen trimmings, un-served portions, or scraps from plates). To estimate the amount of food scrap available for human re-use, as well as to identify the categories of food scrap generators that produce the largest amount of pre-consumer food scrap, a distinction of this kind is required.

Survey questions regarding the collection of food scrap intended for human reuse were structured so that the responses can be used to predict the magnitude of this contribution. The results of this analysis reveal that the categories of food scrap generator with the largest amount pre-consumer food scrap are grocery (31%), medical (30%), and hotel (28%) (Figure 6-2). It is relatively easy to understand that grocery stores tend to have less food scrap coming off plates. In contrast restaurants and education facilities have a greater proportion of scrap from plates and a lower proportion of the type of food scrap that is suitable for human re-use . These results are however more meaningful when considered in relation to other factors such as willingness to participate in a collection program, the perceived benefits and obstacles associated with participation, as well as the legal framework regulating the donation of food scrap.

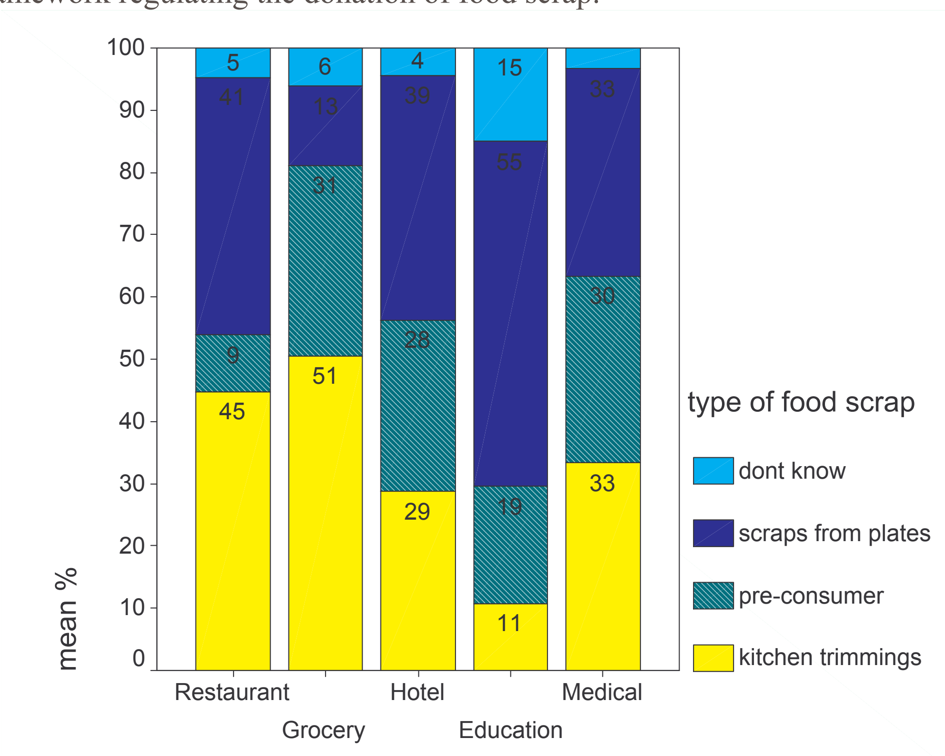


Figure 6-2: Food scrap characterization according to survey results.

In trying to estimate the amount of food scrap available for human reuse it became apparent that there are several variables which confound this calculation. The Survey results sought to obtain information that would allow for this calculation to be made. Survey respondents provided estimates of the percent capacity that their dumpster is filled when it is collected, the number of establishments sharing the dumpster, and the percent type of food scrap that their waste is composed of. These factors were combined with the CIWMB calculations of percent food according to business sector and a measure of the capacity of waste hauled (equation 6-1). These calculations suggest that approximately 10.7% of the total amount of food scrap being produced by the commercial sector of food scrap generators may be available for human re-use (Appendix D-3). To obtain an estimate of the quantity of food scrap available for human re-use this result should be applied to the amount of collectable food scrap calculated in table 5-5.

6.3.3 Interpretation of the Willingness to Participate Value

The willingness to participate (WTP) value is measured on a scale from (0) no interest to (4) very interested. For the respondent population the mean WTP is equal to 2.1. This value correlates with a "moderate interest" in participating in a food scrap collection program (Table 6-3).

	Frequency	Relative Frequency
No interest (0)	10	13.5%
Low interest (1)	15	20.3%
Moderate interest (2)	17	23.0%
High interest (3)	8	10.8%
Very interested (4)	17	23.0%
Missing (0)	7	9.4%
Total	74	
Mean (WTP)	2.1	

Table 6-3: Value of willingness to participate revealed from survey responses.

The distribution of those establishments which have expressed a WTP value higher than or equal to 3 are presented in table 6-4. These results indicate that more than 13% of the education sector expressed a high to very high interest in participating in a collection program. For the other sectors of food scrap generator there is a considerably lower percentage of the overall survey population that is highly interested or very interested in participation. In particular, none of respondents from the hotel sector expressed a high or very high interest in participating in a food scrap collection program.

Type of Generator	# of Survey Respondents	% of the Survey Population
Restaurants	17	4.94%
Grocery	4	4.39%
Education	3	13.63%
Medical	1	7.14%

Table 6-4: Percentage food scrap generator sector with a WTP value ≥3

In making the calculation of WTP according to generator type the data is normalized taking into consideration the response rate for each category in relation to general survey population (Equation 6-9). One of the most interesting findings of the survey research is the relatively high value for mean WTP associated with the education sector (Figure 6-3). As previously discussed, the education sector also has a relatively high response rate. As such, the WTP value calculated for this sector should be considered a reliable measure. Given these results the education sector should be considered a very good target for initial food scrap collection efforts.

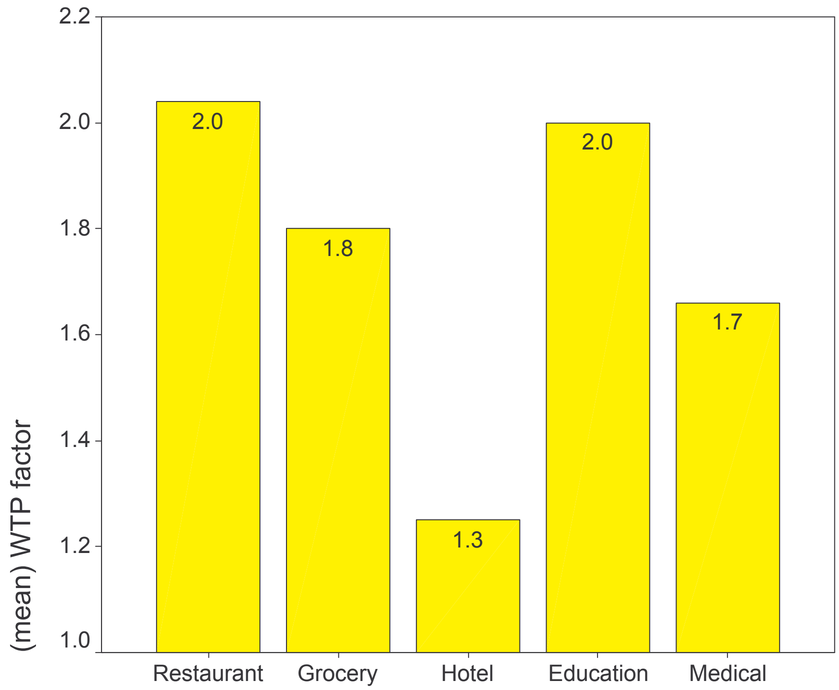


Figure 6-3: Mean willingness to participate value for each food scrap generator category

The lowest WTP value is associated with the hotel category. While this category also has a low response rate it may be possible to relate these two factors. In this case the low response rate can also be interpreted as an indication of low willingness to participate. The medical sector also has a slightly lower WTP value. However, given the high response rate for the grocery sector these results should be considered a reliable measure. While restaurants and grocery stores both seem to have a relatively high WTP value the low response rate for these categories makes it difficult draw a reliable conclusion. A better understanding of the WTP value is gained by integrating these results with the survey responses related to the specific types of benefits and obstacles experienced by these different sectors.

6.3.4 Evaluation of the Perceived Benefits and Obstacles Associated with Participation

An evaluation of the perceived benefit according to the different categories of food scrap generator indicate that medical facilities perceive little or no benefit associated with participation in a food scrap diversion program (Figure 6-4). These findings correlate with the slightly lower WTP value calculated for the medical sector.

These results also indicate that for the restaurant and grocery categories the majority of the respondent population believes that there is an overall benefit to participating in a food scrap diversion program (Figure 6-4). These findings correlate with the slightly higher WTP value calculated for these 2 categories.

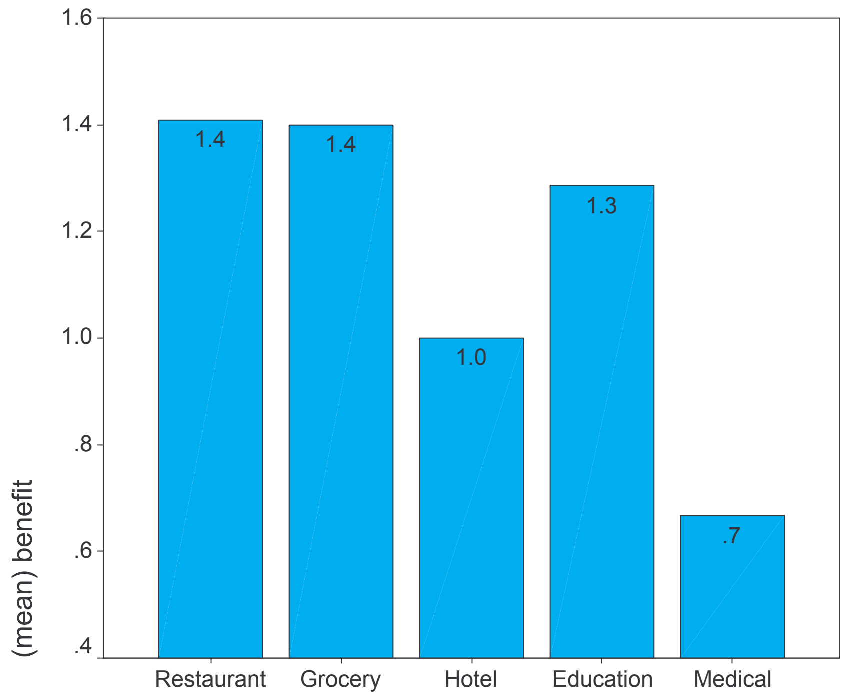


Figure 6-4: Perceived overall benefit to participation according to the categories of food scrap generator.

An analysis of the specific types of benefits and obstacles faced by these establishments suggests that they are influenced by a broad set of environmental and social concerns as well as the "bottom line" of business management. The top three benefits associated with participation in a food scrap diversion program, in order of frequency are: 1) benefit to the environment, 2) it's the right thing to do, and 3) reduced odor (Figure 6-5). Interestingly, these results are similar to the findings of the survey performed in Portland, OR [62]. In further understanding these results it is useful to examine the specific benefits identified by the different categories of food scrap generator (Figure 6-5). Of importance is the notion that the restaurant, education and hotel categories all recognize a wide variety of benefits associated with participation of which cost savings is a less important factor. In contrast, the grocery and medical categories recognize fewer types of benefits associated with participation of which cost savings is a much more important factor.

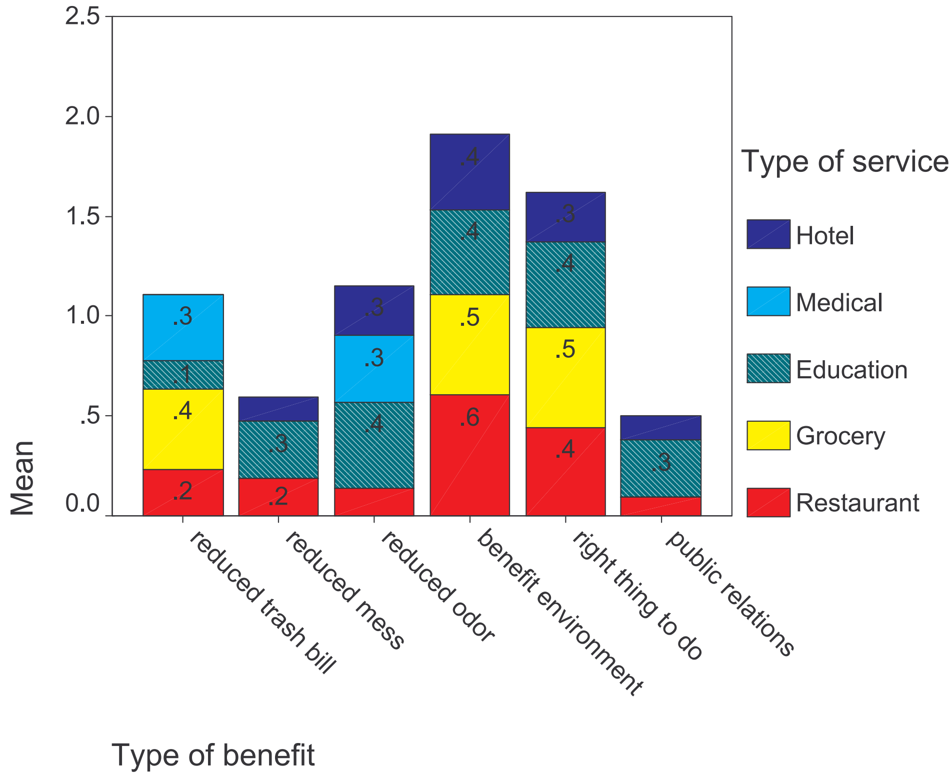


Figure 6-5: Perceived benefits to participation according to the category of generator.

The top three obstacles associated with the collection of food scrap, in order of frequency are: 1) limited space, 2) odor problems, and 3) vectors (Figure 6-6). These results assert the idea that cost is not always the most important motivating factor. A closer look at the specific obstacles associated with participation also reveals the different factors motivating these categories of food scrap generator. The results of this comparison indicate that while all sectors identify a variety of obstacles associated with participation, the education category actually identified fewer types of obstacles of which limited space is the greatest concern and increased cost is not a concern.

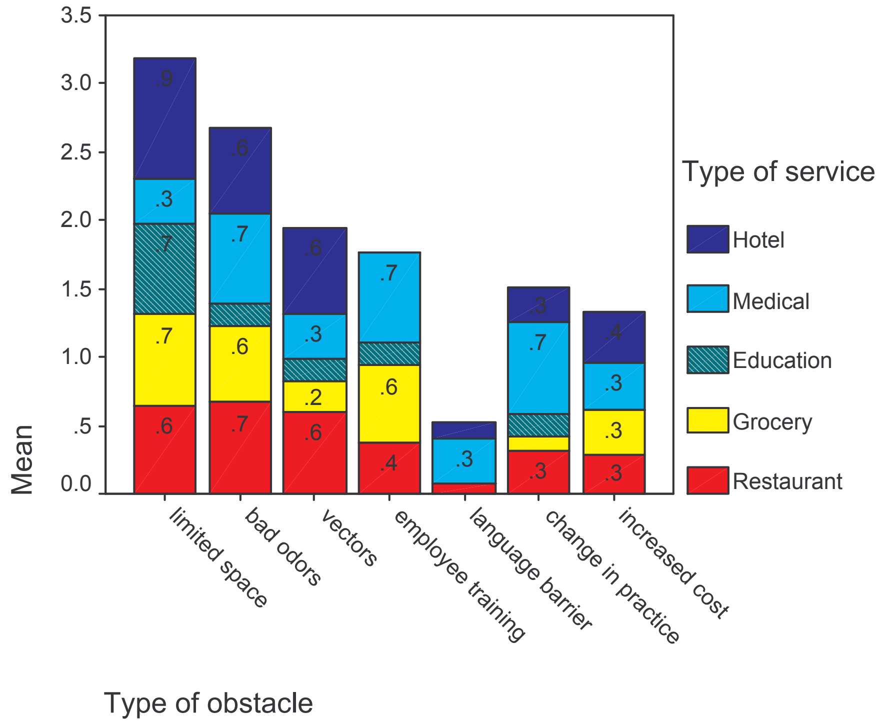


Figure 6-6: Perceived obstacles to participation according to the category of generator.

6.3.5 Determination of the Educational and Physical Infrastructure Needs

The survey responses also give an indication of the physical infrastructure that the City will need to provide. In regards to the preferred number of collections per week 34% of the survey respondents requested three times per week and 34% requested five times per week (Appendix D-5). These results may actually reflect the frequency of their existing waste collection service. In response to questions regarding whether or not the City should provide interior bins for food scrap collection 31% of the respondents expressed that they would be "very useful". While some generators indicated that several different sizes of interior containers would be useful, the most popular size is the twenty-gallon rolling cart.

The survey results clearly show that effective community outreach will require the City to provide educational materials in both English and Spanish. The most frequently requested printed educational materials are posters and brochures. In addition to printed educational materials the survey respondents would also like the City to provide on-site employee training.

6.4 Implications for the Overall Project

As this food scrap diversion program develops it will be critical for the City to find creative ways to engage the commercial sector and better facilitate their successful participation. The results of the Food Scrap Generator Survey offer the City useful insight into the motivations influencing participation, and provide the City with several practical recommendations in the implementation of a food scrap diversion program.

6.4.1 Restaurants

As the largest contributors to the food scrap waste stream the success of this diversion program will rest on gaining the participation of this sector. The survey results indicate that the overall response rate for this sector was 13% and their WTP value equal to 2.0 was relatively high as compared to other sectors. The respondents in the restaurant sector have a wide variety of motivations driving their business decisions. Many of them are indeed motivated by financial gain and lowered cost. However, a larger proportion of the sector are motivated by indirect factors involved in business success. A significant number of respondents indicated that they are interested in participating due to their own personal sense of responsibility towards the community and the environment. The respondents from this sector expressed interest in the different forms of educational infrastructure including workshops, recognition awards, on-site staff training, and printed materials. However, printed materials and on-site staff training are the most popular types of educational material. The preferred forms of printed material are posters and brochures. Thirty two percent of this sector indicated that it would be "very helpful" if the City was to provide interior food scrap collection containers. The preferred sizes for these containers are the 20-gallon rolling cart and the 9.6 quart bucket.

6.4.2 Grocery

The relatively low response rate equal to 11% makes it difficult to draw reliable conclusions regarding the grocery sector. However, the survey results still do provide useful information regarding these establishments. In particular the composition of the food scrap generated by this sector contain a higher proportion of un-served portions. As such, this category of generator is a good source of pre-consumer food scrap for donation to charity organizations. This sector should also have fewer problems associated with the legal liability of donating food. This sector has the second highest WTP value equal to 1.8. While this sector perceives there is a benefit to participation they identified fewer specific types of benefits of which cost savings is particularly important. The respondents from this sector expressed interest in the different forms of educational infrastructure including workshops, recognition awards, on-site staff training, and printed materials. However, printed materials and on-site staff training are the most popular types of educational material. The preferred forms of printed material are posters and brochures. Fifty percent of this sector indicated that it would be "very helpful" if the

City was to provide interior food scrap collection containers. The preferred sizes for these containers are the 35-gallon and 20 gallon-rolling cart.

6.4.3 Hotels

The Hotel category of food scrap generator has a relatively low response rate equal to 14% and the lowest WTP value equal to 1.3. These results suggest that the low response rate is related to the low WTP value. As such, many hotels did not return the survey because they are not interested in participating a food scrap collection program. Hotels also perceived less of an overall benefit to participation. Consequently, hotels should not be considered a target sector for initial food scrap collection efforts.

6.4.4 Education

One of the most compelling findings of the survey research is the relatively high willingness to participate, equal to 2.0, expressed by the education sector. This sector also has the highest response rate equal to 36%. Again, it is possible to associate these two factors and conclude that the high response rate is an indication of a high willingness to participate. Education facilities also perceive there to be a high overall benefit to participation. It is important to note that of the specific types of benefits identified by this sector cost savings were the least important. In addition the greatest obstacle limiting their participation is limited space.

Comments provided in the conclusion section of the survey illuminate some of the important factors motivating the education sector. One school wrote, "This school is committed to helping children learn the importance of recycling and composting waste". Given the pressing environmental problems facing today's society it seems that schools have assumed the role of teaching future generations about the connection between human behavior and environmental problems. Clearly, this sector of food scrap generator possesses a very powerful and unique motivation for participation. Consequently, the education sector should be the main target of a food scrap collection program.

The types of educational infrastructure identified by this sector include recognition awards, on-site staff training, and printed materials. However, overall printed materials are the preferred type of educational material, and brochures are the most popular type of printed material. While the 20 gallon rolling cart was the preferred size of interior container, the majority of this sector (38%) indicated that it is "not helpful" for the City to provide interior containers.

6.4.5 Medical

This sector of food scrap generator has a relatively high response rate equal to 21%, and a slightly lower WTP value equal to 1.7. Because these 2 factors are seemingly in conflict with each other a better understanding of this sectors willingness to participate can be obtained by considering their perceptions towards the benefits and obstacles associated with participation. The medical sector actually has the lowest overall perceived benefit score. The identified only two benefits associated with participation of which reduced cost is very important. This sector also expressed that all of the specific obstacles to participation were of concern. Given these results the medical sector should not be a target of initial food scrap collection efforts.

6.4.6 Other

There is only one food scrap generator included in this category and consequently their participation in a collection program will have a minimal effect on the amount of waste that may be diverted. The response rate for this category is 100% and their WTP value is equal to 2.0. The types of food scrap produced by this sector are primarily kitchen trimmings and food scraps from plates. The specific benefits to participation identified by this sector are benefit to the environment, and reduced mess. The specific obstacles to participation identified by this sector are vectors and employee training. This establishment expressed that it would be useful for the City to provide a 20-gallon rolling cart for the collection of food scrap. Additionally, they requested that the City provide printed educational material in the form of a poster.

7. Food Scrap Treatment Technologies

7.1 Identification of Treatment Alternatives

7.1.1 General Discussion

When identifying treatment alternatives, the study used a broad approach and analyzed the City food scrap stream within the context of the larger countywide solid waste issues. The Multi Jurisdictional Solid Waste Task Group, MJSWTG, produced a strategic countywide biosolids master plan that identified 13 different product-manufacturing technologies. [64] Composting was selected as the most applicable of the technologies for food scrap. The decision was based on the size for the City's food scrap waste stream, the research on cities with food scrap diversion programs, and infrastructure of the collection system for the County and City of Santa Barbara. Brief descriptions of other technologies associated with food scrap but not evaluated in this report are discussed in section 7.1.3

7.1.2 Composting Technologies

In comparing the different composting technologies, only mixing the food scrap with bulking agent and composting the mixture were included. Other steps, which were not considered, include collection of food scrap from generators, curing after composting, screening of the compost, and marketing the final product. Each of these steps is common for all the technologies. Therefore the comparison of technologies focused on the differences in the mixing and composting. The entire treatment process can be illustrated as a treatment train shown in Figure 7-1

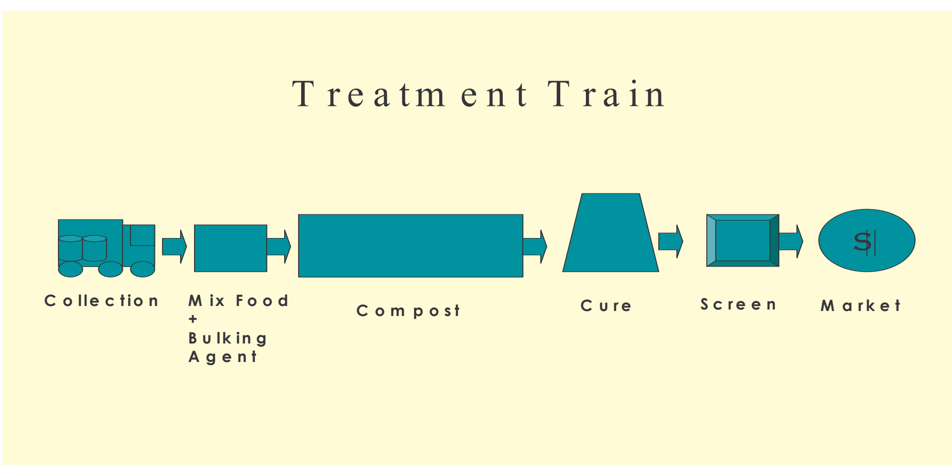


Figure 7-1: Diagram of a food scrap treatment train

The choice of commercial technologies available for the mixing and the composting steps depends on the volume of food scrap expected to be processed. For the City of Santa Barbara the equipment specification used a 10ton/day-collection amount mixed with 5 ton/day of bulking agent for a total of 15 ton/day of compostable material. This 10-ton/day collection amount was decided upon as a reasonable food quantity for a beginning food scrap diversion program for a City the size of Santa Barbara. The equipment was evaluated with regard to its ability to be scaled up as the collection quantities increase.

Bulking agent is a necessary composting ingredient for a food scrap stream. The moisture content of pure food scrap is too high to allow enough sufficient oxygen diffusion for the aerobic microbial process. The bulking agent acts to increase the porosity that facilitates oxygen delivery.

7.1.2.1 Terminology

The study of composting technologies turned up a number of different terms used to describe enclosed commercial systems that contain the processing equipment and isolating it from the surroundings. There is some confusion where traditional open air windrow technology ends and where in-vessel technology begins. There are some technologies, for example, that are covered windrow piles. For the purpose of this report the contained composting systems were divided into windrow and in-vessel composting by looking at the area necessary for the composting step and the time needed for processing. Those systems requiring areas of approximately one acre of land and residence times of 2-3 months were considered windrow operations even if they were covered. All other types of contained systems were considered in-vessel. Some of the terminology used to refer to these containers includes tunnels, pods, silos, trays, drums, bins, and bays. To help clarify the terminology, operations were differentiated by the agitation and aeration system used for oxygen delivery to the food scrap/ bulking agent mixture.

7.1.2.2 Evaluating theTechnologies

The composting technologies evaluated are included in Table 7-1. Although this table is not an exhaustive list of all the large-scale commercially available technologies, these treatment options reflect a sample of each commercially available system. Some contained composting systems, like large drums, agitated open bays or silos enclosed in a building, were intended for large-scale composting of municipal sold waste or biosolids only. These were determined to have no applicability to source separated food material and were not included in composting technologies evaluated [65]. A more detailed list of equipment suppliers is listed in Appendix E-1 Table 7-2.

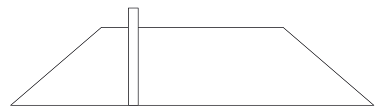
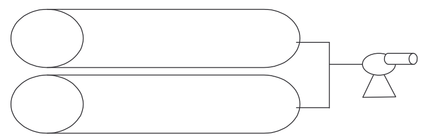
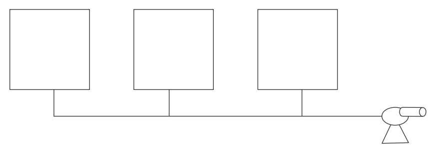
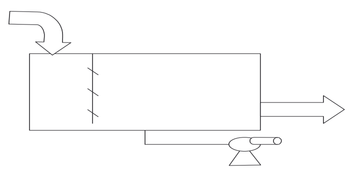
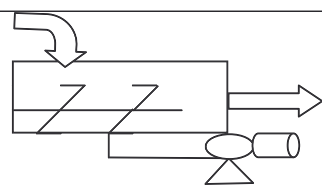
	System	Diagram	Supplier (Application Location)
Windrow	Agitated Batch		Engel & Gray (Santa Maria, CA)
	Aerated Batch		Ag- Bag (Berkley, CA)
In-vessel	Aerated Batch		Green Mountain (Prince Edward Island, Canada)
	Aerated & Agitated Continuous		Wright Engineering (Disney World, FL)
	Aerated Continuous		Hot Rot (Christchurch, New Zealand)

Table 7-1: Treatment technologies evaluated

7.1.2.2.1 Windrow Systems

As Table 7-1 shows, the treatment methods were divided into two categories, windrow and in-vessel. Within the category of windrow composting treatments two systems were considered, agitated batch and aerated batch operations. The agitated batch system is the traditional open-air windrow pile. The first supplier of a windrow system is listed as Engel and Gray. Although not actually an equipment supplier, Engel and Gray is a local composting facility currently operating in Santa Maria, California, approximately 70 miles northwest of Santa Barbara.

Figure 7-2: Open air windrow piles

The Engel and Gray facility is the closest windrow composting facility to the City of Santa Barbara and is currently permitted to accept biosolids. This facility intends to upgrade its permit to include all solid waste in 2004. Figure 7-2 shows traditional open-air windrow piles.

The aerated batch treatment offered by Ag-Bag, illustrated in Figure 7-3 is listed as a windrow system due to the large land requirement necessary for the composting step. The long pods are aerated and the temperature is monitored. There are currently four food scrap facilities in the United States that use an Ag- Bag system.

Figure 7-3: Picture showing an Ag-Bag system.

7.1.2.2.2 In-vessel Technologies

Regarding the in-vessel category, three systems were evaluated, one batch system and two continuously fed systems. The batch system was offered by Green Mountain. Figure 7-4 shows the stainless steel containers used to hold the composting material. The containers are aerated and the temperature is controlled with airflow. Leachate is generated with this system and therefore some type of leachate disposal is required. Currently, Green Mountain system is operating at a number of facilities that take food scrap.

Figure7-4: Green Mountain in-vessel system.

Wright Environmental offers a continuous, plug flow tunnel with a spinner at the front end to help fluff the material. The operation allows for airflow to control temperature and has a leachate return system built in. Wright Environmental is a large manufacturer of in-vessel equipment and lists 55 installations worldwide. Figure 7-5 shows a Wright system with a receiving building to the right of the tunnels.

Figure 7-5: The Wright Environmental in-vessel system.

Hot Rot offers a continuously agitated and aerated container. Agitation is accomplished with fluffing tines. The temperature is controlled with airflow and the system produces no leachate. The equipment manufacture is in New Zealand and there are U.S. distributors. Figure 7-6 shows a Hot Rot system with a feed hopper.

Figure 7-6: Hot-Rot in-vessel system.

7.1.2.3 Technical Comparison

Each of the suppliers was contacted to submit equipment specifications to meet the anticipated need of 10 tons/day of food scrap collected 6 days/week. Based on their responses, Table 7-2 was constructed for the technical comparison. The calculation for the size of the compost area needed for the Engel & Gray supplier is listed in Appendix E-2. The different values for C:N ratios were reported by the equipment manufacturers.

Supplier	**Size Compost Area (ft^2)**	**Retention Time**	**C:N Ratio**	**Odor Control**	**Leachate Generation**
Engel & Gray	43,200.	8-12 weeks	25:1	No	Yes
Ag-Bag	38,333.	8-10 weeks	30:1	No	No
Green Mountain	5430.	2-3 weeks	30:1	Yes	Yes
Wright Environmental	1705.	14 days	25:1	Yes	Yes
Hot Rot	1042.	10-20 days	8:1	Yes	No

Table 7-2: Technical comparison of treatment methods.

7.1.3 Other Treatment Methods

7.1.3.1 Anaerobic Digestion

Given the complexity of anaerobic digestion and the high initial investment, anaerobic digestion was not considered to be a feasible treatment option. Anaerobic bacterial processes operate in an oxygen free environment and produce a gas, commonly referred to as biogas, which is mainly composed of methane (CH_4) and carbon dioxide (CO_2). Anaerobic processes can occur naturally or in a controlled environment. On an industrial scale anaerobic processes are recreated using a feedstock of wastes such as livestock manure, and the organic fraction of municipal solid waste (MSW). In addition to producing nutrient rich compost these processes provide an opportunity to capture the biogas and use it as a source of energy. While conventional composting is an energy-consuming process, anaerobic digestion is in contrast an energy-producing process.

In the U.S. anaerobic digestion appears to have been limited to applications involving animal waste and the treatment of municipal wastewater. In North America there are only three plants that use anaerobic digestion in the treatment of MSW [66]. In Europe, however the use of anaerobic digestion in the treatment of MSW is becoming relatively common. The more than 60 plants operating throughout Europe all work using European patented technology [66].

A comparative study of six different designs of anaerobic digesters detailed some of the limitations of this technology [66]. Predicting the quality of the end products associated with anaerobic digestion is a complex issue that depends mainly on the composition of the feedstock. The aerobic solid residues produced typically require post-treatment in order to achieve pathogen free compost. The purity of the biogas produced affects the need for further treatment before it can be used. The wastewater produced during the anaerobic digestion of solid wastes is also of concern, as it will require additional treatment prior to discharge. In all of these cases, investments in separate treatment technology will be required.

7.1.3.2 Incineration

Incineration of municipal solid waste is a current practice throughout the United States, with an estimated 33.6 million tons of waste incinerated in the USA in 2001[67]. Emissions to air, such as dioxins, are a concern with combustion and Congress added Section 129 to the Clean Air Act (CAA) in 1990 specifically to address emissions from solid waste combustion.

However, combustion of food scrap separated from other waste presents a problem due to the high water content in food. Additionally, food scrap has a high nutrient value, which is not harnessed through combustion. To consider incineration of the City of Santa Barbara's total waste is beyond the scope of this project. Additionally, the County of Santa Barbara does not include combustion as a treatment alternative in its "Alternatives to Disposal Final Report" September 9, 2003. For these reasons, incineration has not been included as a treatment method in this report.

7.1.3.3 Vermiculture

Vermiculture involves composting using worms to assist in the breakdown and mixing of organic matter. Since the worms are unable to digest meat or dairy, this treatment alternative was not considered applicable to the food scrap waste stream being evaluated by this project [38].

7.2 Criteria for Evaluation

To evaluate the windrow and in-vessel treatment methods a list of criteria was developed. Three published Santa Barbara County reports were consulted to generate criteria used in previous evaluations [64, 68, 69]. These reports evaluated other similar solid waste disposal decisions such as: the alternatives for solid waste treatment once the Tajiguas landfill is closed, the decision to site a new landfill or expand Tajiguas, and the countywide options for the treatment of biosolids. The criteria used in these reports were retained if applicable to this project or rejected if outside the scope of a food scrap diversion program. The three main criteria and ten sub criteria used for the study are listed below.

7.2.1 Cost

7.2.1.1 Capital Costs

A capital cost refers to those costs associated with the initial purchase of the equipment necessary for the treatment method. For in-vessel technologies, suppliers provided the capital costs. For the windrow technologies, the capital costs were either supplied by the equipment manufacturer as in the case of Ag-Bag or considered to be zero for the existing windrow facility.

7.2.1.2 Operation and Maintenance Costs

Operation and maintenance costs refer to the costs necessary to operate a facility utilizing the particular treatment option. These costs include energy, equipment maintenance, labor, and supplies associated with the operation.

7.2.1.3 Land Requirements

Land costs are not considered capital or operating costs. However, because of the high land value in Santa Barbara County, this criterion is given a separate ranking. Land requirements include only the land required for the mixing of food with bulking agent and the actual composting of material. It does not include land required for delivering food scrap, curing compost, or screening operations.

7.2.2 Environmental Considerations

7.2.2.1 Odor control

Odor control refers to whether the treatment method is open or enclosed. Those methods with complete enclosure of the composting system and biofilters are expected to have better odor control.

7.2.2.2 Air & Water Quality Impacts

Separate from odors, air quality impacts refer to pollution associated with dust, ammonia, and diesel emissions from trucks. Air quality is important for environmental impact, regulatory compliance and permitting. Water quality impacts can be generated from storm-water runoff and storm-water infiltration as well as water generated, which may need to be treated before discharge.

7.2.2.3 Health & Safety

Health and safety considerations cover concerns associated with the operators of the treatment facility. For example, operators being exposed to fumes and dust are considered to be at risk for health problems.

7.2.2.4 Traffic

Traffic generated by trucks traveling long distances to a treatment facility increase local air pollution and traffic congestion. Smaller facilities can be located closer to food scrap generators and will contribute less air pollution and less traffic congestion.

7.2.3 Implementation Requirements

7.2.3.1 Demonstrated Ability

Demonstrated ability refers to whether or not the equipment has been operating at facilities composting food scrap in the quantities similar to those expected to be generated by the City of Santa Barbara.

7.2.3.2 Ease of Expansion

Ease of expansion is the flexibility of the process to be scaled up for increases in participation.

7.2.3.3 Public Perception

Public perception is a key factor in any treatment option. It includes public aversion to vectors and odors they may perceive as possible problems associated with food scrap even though no problems may exist.

7.3 Ranking the Alternatives

Six alternatives were ranked: the five treatment methods discussed under composting, (Windrow, Ag-Bag, Green Mountain, Wright Environmental, and Hot Rot) and a Do Nothing alternative. The Do Nothing alternative refers to continuing the existing practice of landfilling the food scrap.

To apply the evaluation criteria to the alternatives, each of the six alternatives was qualitatively analyzed according to three main evaluation criteria: cost, environmental considerations, and implementation requirements. The sub criteria outlined in the evaluation criteria section above were also qualitatively analyzed. Next, a comparative analysis was conducted to compare the six alternatives against each other. The comparative analysis was done through a two-step process. The first step involved a qualitative comparative analysis and a simple weighing to illustrate the group's rating of the importance of each sub criteria. This simple weighing was done on a 0 to 5 scale and served as a basis by which to assess the alternative through the second step, a pair-wise comparison system. A pair-wise comparison was used because there was no quantitative data to rank each of the three main criteria against each other. This pair-wise comparison was achieved though the use of the Criterium Decision Plus 3.0 software (available on www.infoharvest.com) that makes use of the Analytic Hierarchy Process (AHP), an academically recognized method to logically determine the best alternative. (See Appendix E-3, Analytical Hierarchy Process for more information on AHP).

The decision making process is illustrated in Figure 7-7. The goal was to select a treatment method most suitable for the City of Santa Barbara. The three main criteria were cost, environmental considerations, and implementation requirements. Ten sub criteria are identified as well. The six alternatives: Do Nothing, Windrow, Ag-Bag, Green Mountain, Wright Environmental, and Hot Rot, were then ranked according to the evaluation criteria.

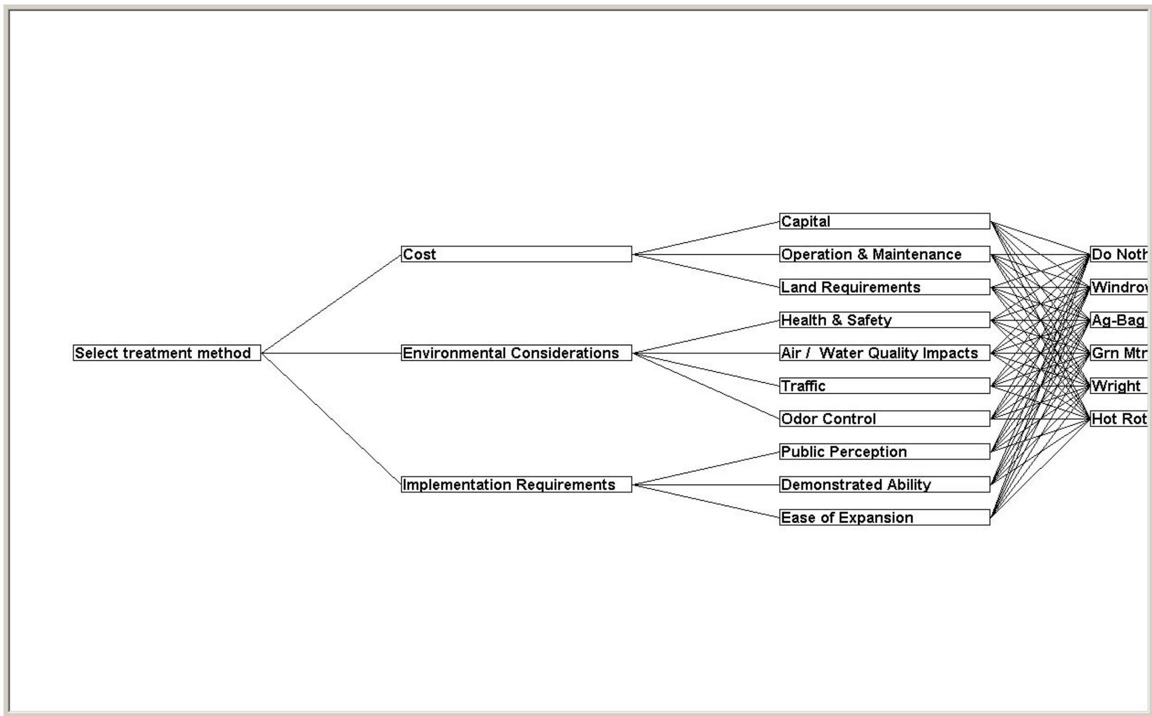


Figure 7-7:Visual structure of the decision making process

7.4 Ranking Results

Wright Environmental ranked highest between the six alternatives. The aerated, continuously fed, in-vessel technology has high capital costs but they are offset by small land requirements, low environmental impacts, and demonstrated ability with food scrap.

The second highest alternative was the agitated, aerated, and continuously fed system offered by Hot Rot. Although the Hot Rot equipment had some mechanical advantages in that it was both agitated and aerated, it lacked the demonstrated ability of the Wright Engineering equipment. The Do Nothing alternative ranked just ahead of the Ag Bag equipment, which had large land requirements.

Windrow ranked lowest due to environmental considerations, large land requirements, and public perception. In addition, future regulation of air quality in the South Central

Coast Air Basin may impact windrow operations. More detail on the legal considerations is given in section 3.2.2.3.

The results of the ranking are shown graphically below in Figure 7-8. Appendix E-4, shows the value assigned to each alternative by criterion. The alternatives were ranked against each other so a single ranking number is achieved to select the best alternative.

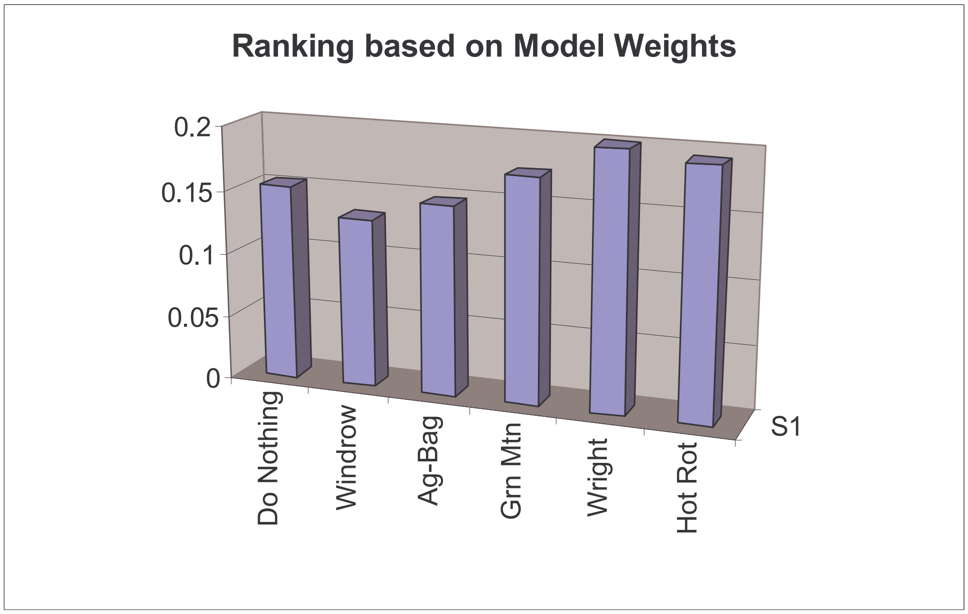


Figure 7-8: Graphical representation of ranking used in evaluation of composting technologies.

7.5 Cost Analysis

7.5.1 Costing of Alternatives

For costing purposes, the top two treatment alternatives, Wright and Hot Rot, were combined and identified as the in-vessel treatment. Although Wright ranked slightly higher than Hot Rot, both systems are continuously fed and had comparable system costs. The equipment suppliers provided the capital costs of the equipment including a feed system. These costs were associated with treatment of 10 tons of food scrap per day combined with 5 tons per day of bulking agent. The operating costs were considered to be 10% per year of the capital costs. The in-vessel treatment cost included installation and training. Installation costs were freight, pad, electrical, and water connections if necessary. It has been assumed that no structural buildings are required for the equipment or controls.

The in-vessel alternative cost was compared to two other alternatives, Do Nothing and Windrow. To obtain a value associated with the Do Nothing alternative we used the current tipping fee for refuse at the Tajiguas landfill: \$48.00/ton. Although windrow received the lowest rating in the ranking of treatment options it is included in the cost comparisons since it is the current practice of the cities reviewed that have food scrap composting. To cost out the windrow alternative the price for biosolids treatment at the Engel and Gray windrow facility in Santa Maria, California was used, plus a 5% increase was added for handling of food scrap. The 5% increase was considered necessary since compared with biosolids, food scrap has a higher variability in consistency. This variability means it may need preprocessing to reduce particle size and allow for removal of contaminants. None of the costs allowed for any future price increases.

7.5.2 Cost Analysis

A net present value (NPV) of the costs is a more accurate representation of the true costs of treating food scrap, since the food scrap treatment facility would be expected to operate for up to 15 years. In a net present value calculation the future costs are adjusted to present day dollars by calculating the future value of money using an annual interest rate. This interest rate is the value currently used by the City's finance department in their standard accounting practices. The equipment capital costs were amortized over the lifetime of the equipment, 15 years. This 15-year term was used even for the costs associated with the costs of operating the equipment for shorter timeframes like 1 year or 5 years. Once again this is the practiced used by the City's finance department for the amortization of equipment [70]. Table 7-3 shows the costs of three different alternatives brought into present day dollar amounts using the NPV. In Appendix E-5, a more detailed presentation of the NPV calculations is provided including equations used to generate the costs.

Years of Operation	**1 Year**	**5 Years**	**10 Years**	**15 Years**
In-Vessel	$25. / ton	$21. / ton	$18. / ton	$16. / ton
Do Nothing	$48. / ton	$40. / ton	$35. / ton	$31. / ton
Windrow	$42. / ton	$35. / ton	$31. / ton	$27. / ton

Table 7-3: Cost of alternatives in present day dollars. Using a NPV calculation with a 15 year term and, 6% interest rate, the cost of each alternative is given after 1, 5, 10, and 15 years of operation.

When considering the most conservative time frame of one year, the cost of treating food scrap using in-vessel technology is $25/ton. This cost represents only the cost of capital equipment and operating and maintenance costs of the in-vessel equipment compared with the current landfill tip fee ($48/ton) and the anticipated windrow-tipping fee ($42/ton). Other parts of the treatment train, like collection, transportation charges, as well as the costs of implementation of the new program, are not included. The current trucking costs are $1.20 / mile. With the closest windrow facility 140 miles roundtrip from Santa Barbara, these cost are not insignificant. Although the transportation costs are not given a numeric value in the cost analysis, they were given consideration in the ranking of the alternatives; where traffic was listed as an environmental consideration.

7.6 Implications for the Overall Project

In-vessel treatment is a more economically feasible treatment of food scrap than the current method of landfilling food scrap or the common method of open-air windrow composting. When the net present value of money (over 15 years) is taken into consideration, in-vessel treatment is 48% the amount currently charged to landfill the food scrap.

From the technology review of three in-vessel systems, Wright Environmental's continuously fed technology had the best ranking of treatment methods. Advantages include small land requirements, low environmental impacts, and demonstrated ability with food scrap.

Hot Rot is the other high ranking, continuously fed in-vessel technology that should be considered for possible use. Advantages include small land requirement, low environmental impacts, and continuous agitation of the composting vessel.

Although not quantified in this report, the economic benefits of treating food scrap to produce compost are numerous and should be considered. Compost produced from food scrap is a marketable product with a value between $10 and $28 per ton, as discussed in section 4.2.2. The City of Santa Barbara currently uses over 22 tons of mulch for the City parks [71]. Adding high quality compost as mulch could also reduce the need to purchase chemical fertilizers.

8. Modeling an Efficient Method for Optimum Diversion

8.1 Overview of the Model

In Section 5.3.2.1, the study found that the additional diversion that could be reached through implementation of a commercial food scrap diversion program is 2.7% assuming that 50% of commercial food scrap was collected. In Section 5.3.2.2, an analysis of other commercial waste streams shows that the maximum additional total diversion that could be achieved through recycling 100% of the commercial waste streams is 13.5%. However, the City currently recycles residential waste streams and incorporating these into an assessment of overall diversion may assist the City goal in understanding how best to reach the its diversion goal of an additional 15% by 2010.

A model was created to determine the optimal diversion rate of the City's current recycling programs and the potential food scrap diversion program together. It seeks to maximize the potential diversion rate, while minimizing the costs associated with the recycling programs. Utilization of the model would allow the City to identify what programs will add the most benefit from added efforts at lower costs. It is important to note up front that this model is to be viewed as an added tool for the City. Several assumptions were required and these are stated in text below. The values used may change and/or be refined periodically, and realizing this, the model and the accompanying software were created to be user friendly and easily changeable.

The model is based on diversion increases beyond the current 55% diversion rate. Therefore, the model attempts to increase overall diversion by an additional 15%, which would bring the City to its goal of 70% diversion by 2010. The model starts from a sum total of City refuse currently going into the landfill (113,390 tons/year) taken from the WCS. The reporting year generation amount, RY, is 196,581 tons. There are two streams of recyclables (Household Hazardous Waste and Other) that were not considered for the model due to insufficient data on recycling efforts. The four remaining streams are Commingled Recyclables, Green Waste, Construction and Demolition, and Food. The amounts of waste from these four streams for the commercial and residential sectors and the potential impact on diversion are shown in Table 8-1.

	Tons/Yr	**Percent Diversion at 100% Recovery**
Commercial Commingled Recyclables	7552.79	3.84%
Commercial Green Waste	3969.63	2.02%
Commercial Construction % Demolition	4029.16	2.05%
Commercial Food Scrap	10624.38	5.40%
Residential Commingled Recyclables	7443.28	3.84%
Residential Green Waste	4011.04	2.04%
Residential Construction & Demolition	2746.10	1.40%
Residential Food Scrap	10159.43	5.17%
Totals	**50535.81**	**20.54%**

Table 8-1: Potential diversion from 100% recovery of residential and commercial recyclable materials.

The first component used in the creation of the model seeks to provide a maximum diversion combination for the City's diversion program. The formula for estimating total potential diversion is:

$$d = Mf_d + Sf_d + Mr_d + Sr_d + Mb_d + Sb_d + Mg_d + Sg_d \qquad \text{Equation 8-1}$$

where d is the potential diversion rate, f_d is the potential food scrap diversion, r_d is the potential additional commingled recyclables diversion, b_d is the potential additional construction and demolition diversion, and g_d is the potential additional green waste diversion. The uppercase "M" refers to commercial streams, while the "S" refers to residential streams

The model only considers increases in the current recycling programs and does not take into account increases in production of recyclable materials due to population, Consumer Price Index, taxable sales, and employment fluctuations.

The second component used in the creation of the model seeks to provide a minimum cost combination for the City's diversion program. The formula for minimizing estimated costs (c) associated with increased diversion is:

$$c = Mf_c + Sf_c + Mr_c + Sr_c + Mb_c +Sb_c + Mg_c + Sg_{c,} \qquad \text{Equation 8-2}$$

where f_c is the cost of food scrap diversion according to the research conducted in this study, r_c is the cost associated with increasing the amount of commingled recyclables collected, b_c is the cost of increased recycling of construction and demolition materials, and g_c is the cost of increased green waste recycling. The cost value for this model takes only material disposal costs into consideration, which is incurred by the haulers, and does not include transportation costs.

The model attempts to identify the added diversion of increasing recycling rates of the existing recycling programs and the future food scrap diversion program through the use of Excel Solver. Solver provides quick calculations to multivariate scenarios. For this project an optimum level of diversion was set and Solver was instructed to perform calculations that varied the individual diversion streams to meet the set goal.

8.2 Volumes of Diversion Methods

To satisfy the first component of the model equations, data from prior assessments needed to be utilized. As explained in Chapter 5, material amounts used in the calculation of diversion in this paper were calculated using numbers reported from the Waste Characterization Study. The analysis narrowed the waste stream to estimate franchised commercial and residential amounts. Therefore, the amounts presented in Table 8-2 below represent those used in the model and represent only the franchise hauled commercial and residential sectors.

Material	Tons/Year
Commercial Food Scrap	10,624.38
Commercial Commingled Recyclables	7,552.79
Commercial Building Materials	4,029.16
Commercial Green Waste	3,969.63
Residential Food Scrap	10159.43
Residential Commingled Recyclables	7443.28
Residential Building Materials	2746.10
Residential Green Waste	4011.04
Total	50535.81

Table 8-2: Total possible recoverable amount for each diversion stream.

The recoverable amounts presented in Table 8-2 were input in the model and allowed to fluctuate in Solver under the limitations of their associated costs.

8.3 Cost of Diversion Methods

The second component of the model was created to limit the recoverable amounts based on the costs of the different programs. The costs used in the model consider only tipping fees and do not include other potential costs associated with alterations of the current programs. Costs for the different programs were collected from various sources. Food scrap cost information was obtained by performing an expense valuation over one operating year for in vessel technology. This calculation is provided in Section 7.5.1. Costs related to the diversion of recyclables, construction and demolition material, and green waste were obtained through a personal conversation with Thor Schmidt of BFI{Schmidt, February 2004 #94}. Costs are reported in $ per ton.

As explained earlier, the model does not include transportation expenses. This is due to the inability of obtaining a reliable estimate for the different material groups. In the absence of this, the model assumes that transportation expenses are similar for each diversion method. The model can be easily manipulated to utilize revised costs should they become available. The costs are outlined in Table 8-3.

Material	**Expense/Ton**
Food	$25
Commingled Recyclables	$0/($5 for residential)
Building Materials	$58
Green Waste	$35

Table 8-3: Cost for each diversion stream, commercial and residential.

While most of the costs are identical, there is one difference in cost between commercial commingled recyclables and residential commingled recyclables. This is due to a difference in where the recyclables are taken for recovery. Commercial commingled recyclables are delivered to the Community Environmental Council Recycling Center at no cost to the hauler. Residential commingled recyclables are delivered to the transfer station at a cost of $5 per ton.

8.4 Model Scenarios and Results

8.4.1 Best Case Scenario- Maximization of Diversion

The first run of the model was based on maximizing diversion at 15% while minimizing cost. Solver was instructed to minimize costs while it was allowed to fluctuate the amount of each diversion stream to reach a total additional diversion of 15%. The constraints allowed solver to divert 0% to 100% of each diversion stream presented in Table 8-2. This run also assumed full participation from the material generators within the franchised commercial and residential sectors. The results of this run are shown in Table 8-4. These results indicate that it would be preferential to collect the maximum amount of commingled recyclables from both sectors. The results also indicate that food scrap diversion from either sector would be appealing. Because of the higher cost to divert, Solver chose to not divert green waste or construction and demolition materials from either sector. The total cost per year was reported to be $399,493.34.

	Cost/Ton (Constant)	Diverted Amount (tons/yr)	Total Cost Per Year	Percent Increase in Overall Diversion	Percent Diverted from Total Tons/Yr Per Stream
Cmcl Commingled	0	7552.79	$0.00	3.84%	100.00%
Cmcl Green Waste	35	0.00	$0.00	0.00%	0.00%
Cmcl Construction & Demolition	58	0.00	$0.00	0.00%	0.00%
Cmcl Food Scrap	25	8749.58	$218,739.62	4.45%	82.35%
Res Commingled	5	7443.28	$37,216.41	3.79%	100.00%
Res Green Waste	35	0.00	$0.00	0.00%	0.00%
Res Building Materials	58	0.00	$0.00	0.00%	0.00%
Res Food Scrap	25	5741.49	$143,537.31	2.92%	56.51%
Totals		**29487.15**	**$399,493.34**	**15.00%**	

Table-8-4:Excel Solver solution with no constraints (maximizing at 15%).

While this run shows that a least cost option is available to maximize the City's diversion, it may provide an unrealistic view. Based on research of other cities' diversion programs, it seems unlikely that the City of Santa Barbara would be able to capture over 50% of available food scrap. Therefore, a second model scenario was performed to try to take this research into account.

8.4.2 Diversion/Cost Optimization

Solver was instructed to assume that only part of each waste stream could be captured overall. By doing this, the additional total diversion had to be reduced. Solver was instructed to reach a total additional diversion of 13%. The constraints on each diversion stream were assumed to be:

- Up to 50% of the commingled recyclable volume could be diverted
- Up to 70% of the green waste volume could be diverted
- Up to 70% of the building material volume could be diverted
- Up to 40% of the food scrap volume could be diverted

These constraints were based on several factors. Currently there is little participation in commingled recycling in the commercial sector, therefore we set an ambitious goal of 50% diversion. The green waste and construction and demolition material streams currently see more participation and these streams have well-established collection infrastructure, therefore we allowed a higher diversion of 70%. The food scrap diversion of 50% was based on research conducted of other cities currently diverting food scrap. This is considered a successful diversion level for a food scrap program that has been operating 2-5 years. To be consistent, we set identical constraints for the residential sector. The City may find this assumption to be untrue, and the values may be refined at that time and the Solver scenario re-run.

Assuming the previous stated constraints reduces to approximately 14.25% the overall amount of diversion that can be attained. Therefore, Solver was asked to provide the most cost effective mixture of diversion to reach an overall additional diversion of 14.25%. The results of this run are shown in Table 8-5.

	Cost/Ton (Constant)	Diverted Amount (tons/yr)	Total Cost Per Year	Percent Increase in Overall Diversion	Percent Diverted from Total Tons/Yr Per Stream
Cmcl Commingled	0	3776.40	$0.00	1.92%	50.00%
Cmcl Green Waste	35	2778.74	$97,255.91	1.41%	70.00%
Cmcl Building Materials	58	2717.26	$157,601.18	1.38%	67.44%
Cmcl Food Scrap	25	5312.19	$132,804.71	2.70%	50.00%
Res Commingled	5	3721.64	$18,608.21	1.89%	50.00%
Res Green Waste	35	2807.73	$98,270.52	1.43%	70.00%
Res Building Materials	58	1819.12	$105,508.97	0.93%	66.24%
Res Food Scrap	25	5079.72	$126,992.91	2.58%	50.00%
	Totals	**28012.79**	**$737,042.41**	**14.25%**	

Table 8-5:Excel solver solution with perceived constraints (maximizing at 14.25%).

These results indicate that it would be preferential to maximize diversion of all streams (considering the constraints) with the exception of construction and demolition materials. Solver's limited use of construction and demolition materials can again be attributed to its higher cost to divert. The total cost per year was reported to be $737,042.41.

When comparing the two Solver runs, it is interesting to note the total cost per year to divert (Table 8-5). Clearly, allowing Solver to find a solution with no constraints leads to a lower overall cost. Adding constraints forces Solver to use streams with higher diversion costs. This leads to an interesting revelation that the City might better use its efforts promoting maximum diversion in certain streams to obtain its goal and reduce overall diversion costs in the long run.

	Total Cost per Year
Run 1: No constraints/maximize at 15%	$399,493.34
Run 2: Constraints/maximize at 13%	$737,042.41

Table 8-6:Total diversion cost per year for each Excel solver run.

9. Conclusions and Recommendations

In making recommendations to the City of Santa Barbara, as to the feasibility of a commercial food scrap diversion program, the following tasks were completed:

- ❖ A comprehensive review of other Cities with food scrap diversion programs.
- ❖ The creation of a database, which identifies and categorizes all of the food scrap producers in the City.
- ❖ A survey of all of the City's food scrap producers revealing their willingness to participate in a food scrap collection program.
- ❖ An analysis of several different types of technology used in the treatment of food scrap to produce compost
- ❖ A cost analysis of the best treatment alternative compared to the current practice of landfill or open-air windrow.
- ❖ An evaluation of the potential to donate food scrap for human re-use.
- ❖ An estimate of the increase in overall waste diversion that the City can achieve through the implementation of a commercial food scrap diversion program.
- ❖ The construction of an economic model, based on both the commercial and the residential waste streams, which derives the lowest cost method for achieving the City's overall waste diversion goal of 70%.

The conclusions drawn from these analyses are discussed in greater detail below.

- ❖ A review of other Cities in California with food scrap diversion programs illuminates a number of common implementation strategies. The following factors are identified as key components in the success of their programs:

  - All of these programs began with pilot program, and rather than starting a pilot for only a short time, they are most successful when viewed as a learning tool in the implementation of a long-term program.
  - The goal of diverting 50% of the food scraps produced is typically done by targeting the largest generators first.
  - Providing financial incentives for haulers and food scrap generators facilitates better participation
  - Education and outreach to the public sector is critical in ensuring the effectiveness of the program.
  - Grant money is used to support the donation of edible food scraps to organizations that help feed homeless and low-income citizens.
  - The food scraps are typically composted using windrow and Ag-Bag treatment technology. These processes produce a nutrient rich soil amendment that is suitable for use in agriculture and landscaping.

❖ The food database identifies all of the franchised commercial hauled food generators located within the City of Santa Barbara. This database contains information pertaining to 529 food scrap generators. Further analysis of these establishments identifies the top 20% of the City's food scrap producers. All of the 109 establishments within the top 20% produce 8 yd^3 or more of hauled trash per week. The distribution of top food scrap generators, according to their SIC classification, consists of 88 eating and drinking places, 11 food stores, 4 education facilities, 4 hotels/ lodging, 1 medical/ health, and 1 unclassified establishment.

❖ Using the food database as its foundation, The Food Scrap Diversion Survey gained insight into the various motivations, which influence the different sectors of food producer and their interest in participating in a food scrap collection program. The survey results allow for a value of WTP to be derived, and for those sectors that have a relatively high interest in participating in a food scrap diversion program to be identified. The survey analysis reveals that the categories of food scrap generators with the highest WTP value are restaurants, education facilities and food stores. By focusing on these specific categories of food producers the City can more effectively design a program that address the benefits and obstacles to participation identified by that sector.

For restaurants, the most important perceived benefits associated with participation are benefit to the environment and "it's the right thing to do"; the most important obstacles associated with participation are limited space, vectors and odors. For education facilities, the most important perceived benefits associated with participation are benefit to the environment, "it's the right thing to do", and reduced odors; the most important obstacle associated with participation is limited space. For food stores, the most important perceived benefits associated with participation are benefit to the environment, "it's the right thing to do", and a reduced trash bill; the most important obstacles associated with participation are limited space, bad odors and employee training. The majority of survey respondents expressed that their interested in participating in a food scrap collection program is due to their own personal sense of responsibility towards the community and the environment. In recognizing this, the City should develop a program that promotes these ideals, which allows participants to have a tangible role in helping solve environmental problems.

❖ Wright Environmental ranked highest between the six alternatives for converting food scrap to compost. The aerated, continuously fed, in-vessel technology has high capital costs but they are offset by small land requirements, low environmental impacts, and demonstrated ability with food scrap. The second highest alternative was the agitated, aerated, and continuously fed system offered by Hot Rot. Although the Hot Rot equipment had some mechanical advantages in that it was both agitated and aerated, it lacked the demonstrated ability of the Wright Engineering equipment.

❖ A cost analysis that included capital costs and operating and maintenance costs estimated that in-vessel treatment is a more economically feasible alternative than the landfilling or open air windrow composting of food scraps. Using a Net Present Value calculation over a fifteen-year period, in-vessel treatment of food scraps is projectedto be 48% less expensive than continuing to landfill this material. The initial treatment process will produce a soil amendment that is suitable for use as landscape mulch. With further screening and curing this treatment of food scrap can produce nutrient rich compost with a market value in the range of $10-28/ton.

- ❖ An analysis of the network of food distribution agencies currently operating in Santa Barbara reveals that the Food Bank is able to recycle approximately 1000 tons of food per year in the City of Santa Barbara. Food distribution agencies rely on the Food Bank and private donations to supply enough food to feed the City's homeless and low-income citizens. The collection of edible food scrap potentially represents a new source of food for these agencies. The Food Diversion Survey results estimate that 10.7% of the total amount of food scrap being produced by the commercial sector of food producers may be available for human reuse. The survey results also indicate that food stores possess the greatest potential to provide the type of food scrap suitable for this end use. Although donors of food scrap are protected from liability by the Good Samaritan Act of 1996, there remains a common misconception that they could face legal ramifications as a result of their donations.

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- ❖ The amount of food waste attributed to the commercial franchised sector of the City of Santa Barbara amounted to 10,624 tons in 2003. If collection of 50% of this food scrap were achieved an additional 2.7% diversion would be added to the City's current overall diversion rate of 55%. This diversion rate may be achieved by collecting from the top 20% of the City's food scrap producers, at a bin fullness factor of 80%, and a food scrap capture rate of 40%. Thus, it is estimated that implementation of a food scrap diversion program will bring the City's total waste diversion rate to 57.7%.

- ❖ In order for the City to meet its 70% diversion goal, it will be necessary to increase diversion through its existing recycling programs in addition to implementing commercial and residential food scrap recycling programs. On the basis that it is unlikely that 100% of any waste stream could be captured and diverted, targets for maximum diversion were assigned to existing recycling programs. Model projections based on tipping fees indicated were set: commercial and residential commingled recycling was targeted at 50%, commercial and residential green waste at 70% and commercial and residential construction and demolition at 70%. The target set for commercial and residential food scrap was 50%. These levels of diversion will enable the City to reach close to its 70% overall diversion goal.

Based on the conclusions presented above our recommendations are:

1) The conclusions of this study support the assertion that the City of Santa Barbara should consider implementation of a commercial food scrap diversion program. The review of existing treatment technology showed continuously fed, in-vessel

systems are the best alternative for Santa Barbara. When capital costs and operating and maintenance costs are considered, an in-vessel system is more economically feasible than the current landfill tipping fee or anticipated windrow tipping fee. However, in determining the overall feasibility of this program it is recommended that a further cost benefit analysis be performed that includes collection, transportation charges, the costs of implementation of the new program, as well as the economic benefits of the compost produced.

2) If the City decides to move forward it is recommended that they begin with a pilot program that is used as a long-term learning tool for the implementation of a citywide program.. For the purposes of solid waste permitting, a pilot program may be presented as a research project and as such will face fewer restrictions.

3) Collection efforts should be directed towards the top 20% of the food producers. By focusing on a few specific categories of food scrap producers, the City can more effectively design a program that addresses the obstacles to participation expressed by that sector. Based on an integration of the WTP factor and the top 20% food producer list it is recommended that the City consider restaurants, education facilities and food stores as the target of initial food scrap collection efforts.

4) Providing food donations to feed homeless and low-income citizens is a pressing social issue that is confronted by City's throughout this country. Given that diverting food scraps for human reuse is also deemed of high importance by the CIWMB, it is recommended that the City look into ways to assist these efforts. Suggestions include providing education for food scrap generators about human re-use opportunities and liability protection under the Good Samaritan Act, and providing grant support to organizations trying to facilitate the process.

5) In order to meet the 70% diversion goal in the most effective way it is recommended that all feasible diversion streams be optimized in relation to cost. Additionally, to meet the diversion goal it is recommended that both a residential and a commercial food scrap diversion program be implemented.

Appendix A

Appendix A-1

Composition Estimates by Weight, City of Santa Barbara Trash Overall [5]

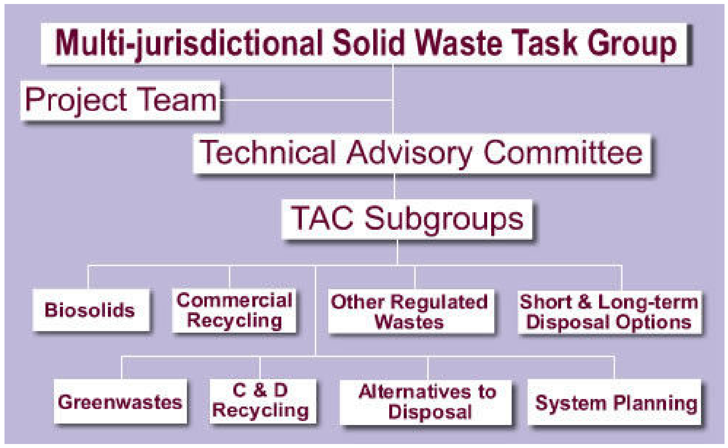
Waste Stream	**Tons**	**Mean**
Organics	44,782	39.5%
Paper	22,137	19.5%
Construction and Demolition	15,487	13.7%
Plastic	10.864	9.6%
Metal	9,020	8.0%
Glass	2,650	2.3%
Household Hazardous	736	0.6%
Special	5,772	5.1%
Mixed	1,941	1.7%
Total	**113,390**	**100%**

Organics Composition by Weight of City of Santa Barbara Trash Overall [5]

Organics	**Tons**	**Mean**
Food	22,074	19.5%
Leaves and Grass	9,127	8.0%
Prunings	2,549	2.2%
Stumps	122	0.1%
Textiles	1,704	1.5%
R/C Organic	9,205	8.1%
Total	**44,782**	**100%**

Appendix A-2

Multi-jurisdictional Solid Waste Task Group [7]



Appendix A-3

Recycling materials and programs in the City and County

Part a) City of Santa Barbara Recycling Programs and Materials

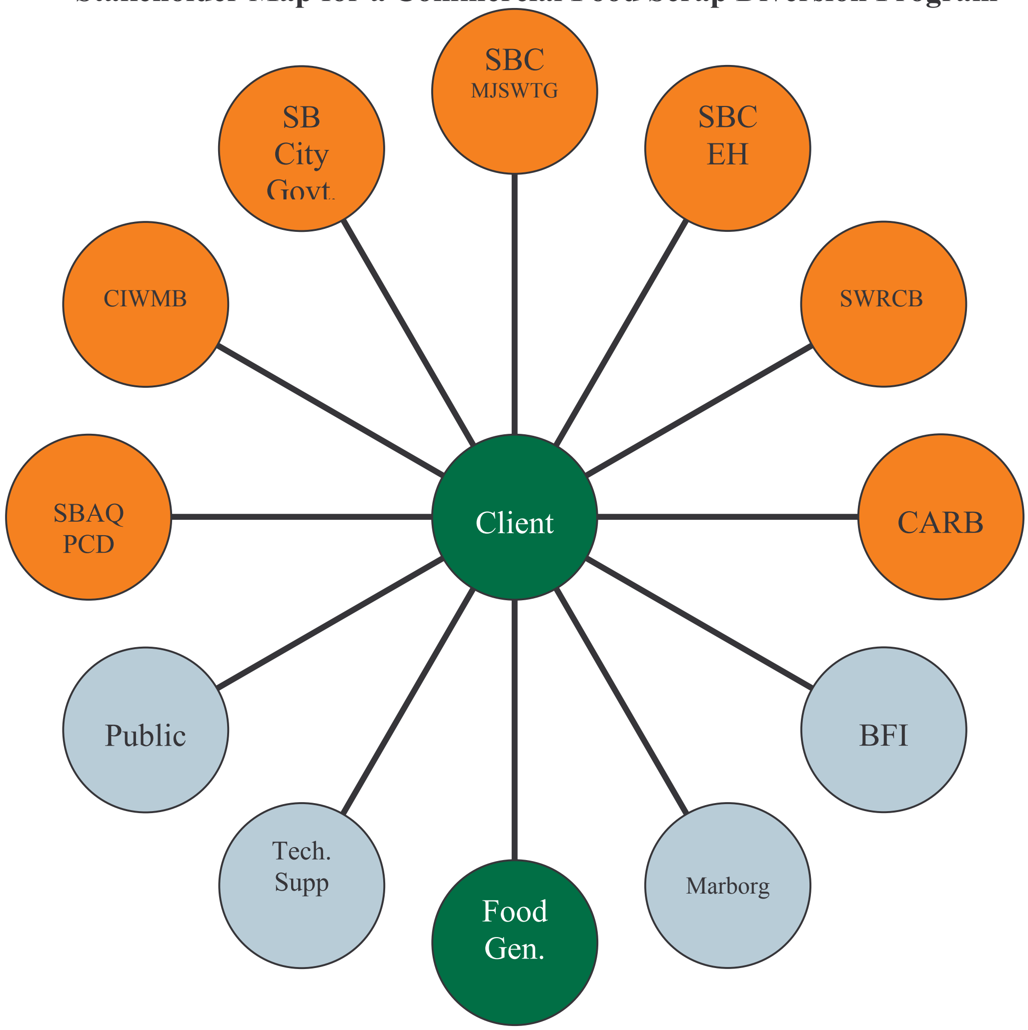
- Construction and Demolition Debris
- Green Waste
- Commingled Recycling (residential and commercial) comprising
    - Junk mail
    - #1 PETE plastic containers
    - #2 HDPE plastic containers
    - Paperboard (e.g., cereal and tissue boxes)
    - Newspapers and all inserts
    - Magazines
    - Cardboard
    - Mixed paper (all types of paper)
    - Phonebooks
    - Paper bags
    - Aluminum cans, foil and pie plates
    - Cans of all types (steel, tin, bi-metal)
    - Glass containers, bottles, and jars
- "Source Separated" or "Cardboard Plus" (Commercial only) comprising:
    - Cardboard
    - Metal, including heavier items
    - Lumber
    - Wood Pallets
    - Newsprint (bagged)
    - Office paper (bagged)

Part b) Materials included in the mandatory County commercial recycling program

- Aluminum foil and pie plates
- Cans (e.g. aluminum, steel, tin, bimetal)
- Cardboard
- Glass containers, bottles, and jars
- Mixed paper (all colors, glossy and non-glossy paper, worksheets, office and computer paper, junk mail, and magazines)
- Newspapers
- Shredded paper (bagged)
- Plastic containers #1 and #2.

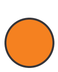
Appendix A-4

Stakeholder Map for a Commercial Food Scrap Diversion Program



Key to Abbreviations

Client – City of Santa Barbara Public Works Department
CIWMB – California Integrated Waste Management Board
SBC MJSWTG – Santa Barbara County Multi Jurisdictional Solid Waste Task Group
SBAQPCD – Santa Barbara Air Quality Pollution Control District
CARB – California Air Resources Board
SWRCB – State Water Resources Control Board
SBCEH – Santa Barbara County Environmental Health
SB City Govt. - Santa Barbara City Government
BFI – Browning Ferris Industries
Food Gen. – Food scrap generators
Tech.Supp – Technology Suppliers


indicates a public sector entity

Appendix B

Appendix B-1

Cities in North America with Food Diversion Programs or Pilot Programs

- Chapel Hill & Carborro, N.C.
- Plano, Texas
- Portland, Oregon
- Seattle, Washington
- Minneapolis and St.Paul, Minnesota
- Hutchinson, Minnesota
- Atlanta, Georgia
- Lewiston, Maine
- Toronto, Canada
- Prince Edward Island, Canada
- Caledon, Markham and Kingston, Ontario
- Mission, British Columbia

Cities in California with Food Diversion Programs or Pilot Programs

- San Francisco
- San Jose
- Berkeley
- San Bernadino
- Rancho Mirage
- West Contra Costa County
- Palm Springs
- Chula Vista
- Ventura County
- San Leandro
- Sonoma County
- Rancho Mirage

Appendix B-2

A List of Questions Posed to Program Managers of Food Diversion Programs in San Francisco, San Jose and Berkeley

- What is the City population?
- Is recycling voluntary or mandatory?
- What is the landfill tip fee?
- How many haulers operate in the City?
- Was there a pilot program?
- Does the city collect food scrap from commercial, residential or both?
- Is the food scrap source separated?
- How many food scrap generators are there in the City?
- How many businesses are involved in the program?
- How many tons per year are collected?
- What percentage of commercial food scrap is diverted?
- Are food scrap used for feeding animals and/or people?
- Did the City provide a grant for using food scrap for feeding people?
- Is there an incentive for the haulers to have a food scrap diversion program?
- Is there an incentive for businesses to participate?
- How often are food containers collected?
- What are the treatment costs?
- What are the trash costs?
- What type of treatment methods are used?
- What is the distance to the treatment facility?
- What is the end product obtained from the treatment method?
- Is the City providing outreach and education?
- Is there an award scheme for businesses?
- What other special conditions exist in the City?

Appendix B-3

Summary of Key Facts of Food Scrap Diversion Programs in California

	San Francisco	**San Jose**	**Berkeley**
Population	776,730	895,000	102,700
Voluntary Recycling	Yes	Yes	Yes
No. Haulers	2-private	3-private	City Hauler
Pilot Program	1996	2000	1997
Commercial/Residential	Both	Both	Commercial
Outreach/Education	Yes – City & Hauler	Yes – City & Hauler	Yes – City & Hauler
Source separated food	Yes	No	Yes
Food Contaminated Paper with Food	Yes	Yes	Yes
No. Food scrap generators	6,000	3,000	540
No. Businesses involved	1,800	300	100
Tons/yr.	70,000	55,000	3,600
% Commercial Food scrap Diverted	35-45%	50% goal	N/A[3]
Re-use for humans/animals	Both	Human	Human
Incentives for Business	25% discount from trash rate $/ton	Same rate – may not know about program	20% discount from trash rate $/ton
Incentives for Haulers	Yes - Diversion Account w/ City	Yes – no franchise fee	Not applicable – City Hauler
Treatment	Windrow + AgBag	AgBag + curing	Windrow
Distance to Compost Facility – miles	65	40	50
Landfill Tip Fee $/ton	17	35	N/A[3]
Treatment cost [1] $/ton	100	140	102
Trash Cost[2] $/ton	150	125	117
Compost sales Price $/ton	10	14 – wholesale 28 – retail	18

1 Cost represents collection + transport + treatment
2 Cost represents collection + transport + landfill tip fee
3. Information not provided by City program manager

Appendix B-4

Key Information Sought from Representatives of Food Distribution Agencies

- An understanding of how the agency is organized
- The agency's goal
- The amount of food handled by the agency annually
- The number of meals prepared by the agency
- How the agency obtains food
- The nature and amount of food donations currently made to the agency
- The type of person eligible to receive from the agency
- The type of food needed by the agency
- The problems associated with food donation

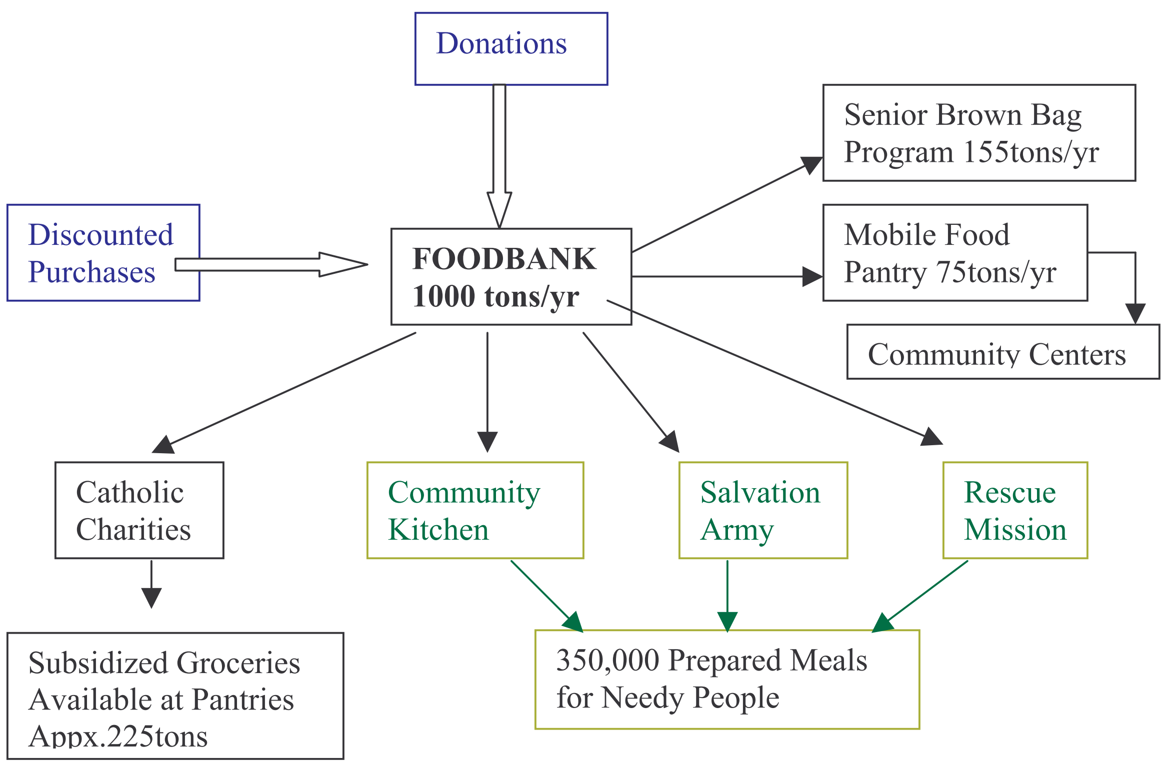


Diagram Illustrating Flow of Food Donations in the City of Santa Barbara

Appendix C

Appendix C-1

Waste Components (as defined by the 2003 WCS)

Subclass ID	Component Category
1.	Uncoated Corrugated Cardboard
2.	Paper Bags
3.	Newspaper
4.	White Ledger
5.	Colored Ledger
6.	Computer Paper
7.	Other Office Paper
8.	Magazines and Catalogs
9.	Phone Books and Directories
10.	Other Miscellaneous Paper
11.	Remainder/Composite Paper
12.	Clear Glass Bottles and Containers
13.	Green Glass Bottles and Containers
14.	Brown Glass and Containers
15.	Other Colored Glass Bottles and Containers
16.	Flat Glass
17.	Remainder/Composite Glass
18.	Tin/Steel Cans
19.	Major Appliances (white goods)
20.	Other Ferrous
21.	Aluminum Cans
22.	Other Non-Ferrous
23.	Remainder/Composite Metal
24.	Electronics
25.	HDPE Containers
26.	PETE Containers
27.	Miscellaneous Plastic Containers
28.	Film Plastic
29.	Durable Plastic
30.	Remainder/Composite Plastic
31.	Food
32.	Leaves and Grass
33.	Prunings and Trimmings
34.	Branches and Stumps
35.	Agricultural Crop Residues
36.	Manures
37.	Textiles
38.	Remainder/Composite Organic

39.	Concrete
40.	Asphalt Paving
41.	Asphalt Roofing
42.	Clean Lumber
43.	Gypsum Board
44.	Rock, Soil and Fines
45.	Remainder/Composite Construction and Demolition
46.	Paint
47.	Vehicle and Equipment Fluids
48.	Used Oil
49.	Batteries
50.	Remainder/Composite Household Hazardous
51.	Ash
52.	Sewage Solids
53.	Industrial Sludge
54.	Treated Medical Waste
55.	Bulky Items
56.	Tires
57.	Remainder/Composite Special Waste
58.	Mixed Residue

Appendix C-2

The recycling streams were assumed to be composed of the following materials:

Food	
Subclass ID	Component Category
31	Food

Commingled Recyclables	
Subclass ID	Component Category
1	Cardboard
2	Bags
3	Newspaper
4	White Ledger
5	Colored Ledger
6	Computer
7	Office
8	Magazines
9	Directories
12	Clear Containers
13	Green Containers
14	Brown Containers
15	Other Containers
18	Tin Cans
21	Aluminum Cans
25	#2 Containers
26	#1 Containers

Construction & Demolition	
Subclass ID	Component Category
39	Concrete
41	Asphalt Roofing
42	Lumber
43	Gypsum Board
44	Rocks and Soil
45	R/C Const and Demo

Green Waste	
Subclass ID	Component Category
32	Leaves and Grass

33	Prunings
34	Stumps

Other	
Subclass ID	Component Category
10	Miscellaneous
11	R/C Paper
17	R/C Glass
20	Ferrous
22	Nonferrous
23	R/C Metal
27	Other Containers
28	Film
29	Durable
30	R/C Plastic
37	Textiles
38	R/C Organic
51	Ash
55	Bulky Items
56	Tires
57	R/C Special
58	Mixed Residue
16	Flat Glass

Appendix C-3

Data Used for Calculating the Estimated Reported Generation Year (2002) [58]

Base Year	1998
Base Year Generation Amount (tons)	183763.00
Base Year Residential Generation Rate (%)	70.00
Base Year Non Residential Generation Rate (tons)	30.00

	Base Year	Reporting Year (2002)
Population	391300.00	406200
Taxable Sales (X1000)	4024280.00	5068430
Employment	168800.00	179900
Consumer Price Index	163.70	186.1

(PR/PB)	1.04
(ER/EB)	1.07
(CB/CR)	0.88
(TR/TB)	1.26

Residential Factor	1.06
Non Residential Factor	1.09

Estimated Reporting Year 2002 Generation (tons)	196581.5

Appendix C-4

Analysis of Franchised Residential Waste Stream Contribution to Overall Diversion.

		Weight (lbs)	Weight (tons)	Percent of Particular Diversion Stream	Total Tons/Yr Diversion Per Stream	Percent Diversion at 100% Recovery
Franchised Residential	Food	651.20	0.33	0.23	10159.43	5.17%
(Total Disposed 43425.96 tons)	Commingled Recyclables	477.10	0.24	0.17	7443.28	3.79%
	C & D	176.02	0.09	0.06	2746.10	1.40%
	Green Waste	257.10	0.13	0.09	4011.04	2.04%
	HHW	22.63	0.01	0.01	353.05	0.18%
	Other	1199.47	0.60	0.43	18713.04	9.52%
	Sub-Total	2783.52	1.39		43425.96	22.09%

Appendix C-5

List of food producing service types that were extracted from the Business License List

Type of Service
Rest Homes and Nursing Homes
Hotels with Transient Occupants
Motels with Transient Occupants
Bed and Breakfast
Retirement Home
Retirement Home with Transient Occupants
Fast Food Places
Food Product/Processing of Manufacturing
Seafoods – Wholesale
Seafood/Retail and Wholesale
Hospitals
Catering
Catering Services
Groceries with Beer and Wine
Groceries with Liquor
Groceries
Meat/Fish or Delicatessen
Produce
Bakeries
Bakeries/Wholesale
Food Places
Restaurants with Beer and Wine
Restaurants/Café
Restaurants with Liquor
Cabaret/Restaurant
Delicatessen
Delicatessen with Beer and Wine
Food Products Wholesale
Hospital
Hospital-Non Profit

Appendix C-6

Waste Characterization Database Federal Standard Industrial Classification (SIC) codes descriptions:

Business SIC Grouping	SIC Codes Included
Agriculture	01. Agricultural Production - Crops
Fisheries	02. Agriculture Production - Livestock & Animal Specialties
	07. Agricultural Services
	09. Fishing, Hunting, & Trapping
Communications	48. Communications
Construction	15. Building Construction - General Contractors & Operative Builders
Contractors	16. Heavy Construction other than Building Construction
	17. Construction - Special Trade Contractors
Finance	60. Depository Institutions
Insurance	61. Nondepository Credit Institutions
Real Estate	62. Security & Commodity Brokers, Dealers, Exchanges, & Services
Legal	63. Insurance Carriers
	64. Insurance Agents, Brokers, & Service
	65. Real Estate
	67. Holding & Other Investment Offices
	81. Legal Services
Forestry	08. Forestry
Manufacturing:	36. Electronic & Other Electrical Equipment & Components, except Computer Equipment
Electronic Equipment	
Manufacturing:	35. Industrial & Commercial Machinery & Computer Equipment
Industrial Machinery	
Manufacturing:	24. Lumber & Wood Products, except Furniture
Lumber & Wood Products	
Manufacturing:	33. Primary Metal Industries

Primary/Fabricated Metal	34. Fabricated Metal Products, except Machinery & Transportation Equipment
Manufacturing:	37. Transportation Equipment
Transportation Equipment	
Manufacturing:	22. Textile Mill Products
Apparel / Textile	23. Apparel & other finished products made from Fabrics & Similar Materials
Manufacturing:	28. Chemicals & Allied Products
Chemical / Allied	
Manufacturing:	25. Furniture & Fixtures
Furniture / Fixtures	
Manufacturing:	38. Measuring, Analyzing, & Controlling Instruments; Photographic, Medical and Optical Goods; Watches and Clocks
Instruments / Related	
Manufacturing:	21. Tobacco Products
Other	29. Petroleum Refining & Related Industries
	30. Rubber & Miscellaneous Plastics Products
	31. Leather & Leather Products
	32. Stone, Clay, Glass, & Concrete Products
	39. Miscellaneous Manufacturing Industries
Manufacturing:	26. Paper & Allied Products
Paper/Allied	
Manufacturing:	27. Printing, Publishing, & Allied Industries
Printing/Publishing	
Manufacturing:	20. Food & Kindred Products*
Food/ Kindred*	
Mining	10. Metal Mining
	12. Coal Mining
	13. Oil & Gas Extraction
	14. Mining & Quarrying of Nonmetallic Minerals, except Fuels

Public Administration	43. United States Postal Services
	91. Executive, Legislative, and General Government, Except Finance
	92. Justice, Public Order, and Safety
	93. Public Finance, Taxation, and Monetary Policy
	94. Administration of Human Resource Programs
	95. Administration of Environmental Quality and Housing Programs
	96. Administration of Economic Programs
	97. National Security and International Affairs
Retail Trade: Automotive Dealers & Service Stations	55. Automotive Dealers & Gasoline Service Stations
Retail Trade: Building Materials & Garden	52. Building Materials, Hardware, Garden Supply and Mobile Home Dealers
Retail Trade:	54. Food Stores†
Food Stores†	
Retail Trade:	53. General Merchandise Stores
General Merchandise	
Stores	
Retail Trade:	56. Apparel & Accessory Stores
Other	57. Home Furniture, Furnishings and Equipment Stores
	59. Miscellaneous Retail
Retail Trade:	58. Eating & Drinking Places†
Restaurants†	
Services:	73. Business Services
Businesses	
Services:	82. Educational Services†
Education†	
Services:	70. Hotels, Rooming Houses, Camps, & Other Lodging Places†

Hotels/Lodging†	
Services:	80. Health Services†
Medical/Health†	
Services:	78. Motion Pictures
Motion Pictures	
Services:	72. Personal Services
Other Misc.†	75. Automotive Repair, Services, & Parking
	76. Miscellaneous Repair Services
	79. Amusement & Recreation Services
	83. Social Services†
	73. 84. Museums, Art Galleries, & Botanical & Zoological Gardens
Services: Other Professional	86. Membership Organizations
	87. Engineering, Accounting, Research, Management, & Related Services
	89. Miscellaneous Services
Transportation:	40. Railroad Transportation
Other	41. Local & Suburban Transit & Interurban Highway Passenger Transportation
	44. Water Transportation
	46. Pipelines, Except Natural Gas
	47. Transportation Services
Transportation: Air	45. Transportation by Air
Trucking Warehousing	42. Motor Freight Transportation & Warehousing
Utilities	49. Electric, Gas, & Sanitary Services
Wholesale Trade:	50. Wholesale Trade - Durable Goods
Durable Goods	
Wholesale Trade:	51. Wholesale Trade - Nondurable Goods
Nondurable Goods	

* No food scrap generators included in the food database fell under this category.
† Category used for food database.

Appendix C-7

Descriptions of food scrap producers [60].

Business SIC Grouping (CIWMB)	SIC Major Group (CIWMB)	Industry Group (OSHA)	Business Description (OSHA)
Retail Trade : Food Stores	54. Food Stores	541: Grocery Stores	Convenience stores, food Markets,
		542: Meat and Fish (seafood) Markets	See Industry Group description
		543: Fruit and Vegetable Markets	See Industry Group description
		544: Candy, Nut, and Confectionery Stores	See Industry Group description
		545: Dairy Products Stores	See Industry Group description
		546: Retail Bakeries	Bagel stores, bakeries, cookie store pretzel stores.
Retail Trade: Restaurants	58. Eating and Drinking Places	581: Eating and Drinking Places	Cafes, carry-out restaurants, catere dining rooms, fast food restaurants, stands, hot dog stands, pizza parlors, pizze and sandwich bars or shops.
Services: Education	82. Educational Services	821: Elementary and Secondary Schools	See Industry Group description
Services: Hotels/Lodging	70. Hotels and Rooming Houses	701: Hotels and Motels	See Industry Group description
		702: Rooming and Boarding Houses	See Industry Group description
Services: Medical/Health	80. Health Services	805: Nursing and Personal Care Facilities	Skilled nursing care facilities, inter and nursing and personal care facilities.
Services: Other Misc.	83. Social Services	832: Individual and Family Social Services	Meal delivery programs, communit

Appendix C-8

Distribution of the Top 20% Food scrap generator List by category

Category	*Number of Businesses*
Medical/Health	1
Education	4
Hotels/Lodging	4
Food Store	11
Eating and Drinking Places	88
Other Misc.	1
Total	109

Appendix D

Appendix D-1

Food Scrap Diversion Survey and Cover Letter

UNIVERSITY OF CALIFORNIA

BERKELEY • DAVIS • IRVINE • LOS ANGELES • MERCED • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CR

Donald Bren School of
Environmental Science and Managem
Santa Barbara, CA 93106-2030
Phone: (805) 893-5524
e-mail: food@bren.ucsb.edu

December 1, 2003

Dear (NAME),

Re: *Food Scrap Diversion Survey*

As a food generator in the City of Santa Barbara you have been selected to participate in a survey that is part of a study being done by the Bren School of Environmental Science and Management at UCSB. This is your opportunity to influence the future of solid waste management practices in the City of Santa Barbara. Please take the time to read this letter and to respond to the enclosed survey.

It is estimated that food scraps constitute approximately 20% of the total amount of waste disposed at Tajiguas, the landfill used by the City. Food scraps are currently the largest contributor to the landfill for which there is no established diversion method. Therefore, a program designed to address food scrap diversion in Santa Barbara is one of the next steps in diversifying the City's recycling program.

Your input is important to our understanding of the food generators' perspective and therefore to the outcome of the project. The results of this survey will provide a foundation on which economic feasibility and treatment methods can be based. This survey is uniquely coded so that your business can be identified and matched with a measure of the capacity of waste hauled. The results will in no other way be linked to your business. Please take approximately 5 minutes to complete the survey and to return it in the enclosed postage paid envelope by *Monday, December 15th, 2003.* Thank you in advance for your cooperation.

Sincerely,

Priya Verma
MESM Candidate
Bren School of Environmental Science
And Management, UCSB

Food Scrap Diversion Survey

BUSINESS CHARACTERIZATION

1. What is the primary service provided by your establishment? *(Circle one or fill in)*

Restaurant   Grocery Store   Education   Health Care/Assisted Living   Hotel/Motel

Other: ____

2. Please provide an estimate of the average number people that your establishment gives service to each day? *(Circle one)*

1-29   30-99   100-299   300-499   500-999   >1000   N/A

3. Which trash hauler picks up your garbage? *(Circle One)*

BFI   MarBorg   Self Haul   Don't Know

4. Does your establishment currently recycle? *(Circle one)*

Cardboard   Yes   No   Don't Know

Paper /Plastics/Glass /Metal   Yes   No   Don't Know

Other *(Fill in)* ______________________________

5. a) Do you know how full your dumpster is when it is collected? *(Circle one)*

Yes   No   Don't Know

b) If yes to 5a, please estimate how full the dumpster is when it is collected? *(Circle one)*

Less than 20%   20-39%   40- 59%   60-79%   80-100%

6. a) Do you share the dumpster with another business establishment? *(Circle one)*

Yes   No   Don't Know

b) If yes to 6a, please identify the other businesses that share the dumpster: *(Circle one or fill in)*

Don't Know   Name(s):_________________________

7. a) Does your establishment pay its own trash disposal bill? *(Circle one)*

Yes   No   Don't Know

b) If no to 7a, who pays the trash disposal bill? *(Fill in)* ____________________

PLEASE TURN OVER

WASTE CHARACTERIZATION

The following questions ask about food scrap which, for the purposes of this survey can either be kitchen trimmings, un-served/un-sold portions, or served but uneaten food.

8. What percentage of your trash, by volume, would you estimate is food scrap ? *(Circle one)*

Less than 20% 20-39% 40- 59% 60-79% 80-100%

9. What percentage of your food scrap is handled in the following ways? *(Fill in)*

Trash ___________%
Garbage Disposal ___________%
Other ___________%

10. Out of your total food scrap produced (100%) what percentage are: *(Fill in)*

Kitchen trimmings _________%
Un-served/Un-sold portions _________%
Scraps from plates (i.e. partially eaten) _________%
Don't Know _________%

PERCEPTIONS

The following questions ask about your perceptions in relation to participating in a food scrap diversion program. The currently established pilot program involves the delivery of clean carts provided by the City for food scrap collection. The City has arranged contracts with local trash haulers to have these carts picked up on a frequent basis and replaced with clean carts. To facilitate this process, participants will be expected to separate their food scrap along with food contaminated paper out of their waste stream.

11. a)**Do you perceive there would be benefits to participating in a food scrap diversion program?** *(Circle one)*

Yes No Don't Know

b) **If yes, what do you perceive as the potential benefits to your establishment by participating in a food scrap diversion program?** *(Circle all that apply or fill in)*

Save on Monthly Trash Bill

Reduce Mess / Clean Up Time

Reduce Odor

Good for the Environment

It's the Right Thing to Do

Public Recognition

Other:____

PLEASE CONTINUE ONTO NEXT PAGE

12. How interested would you be in participating in a commercial food scrap diversion program? *(Circle one)*

None Low Moderate High Very Interested

13. What do you perceive as potential obstacles to participate effectively? *(Circle all that apply or fill in)*

Limited Space

Smell/Odor

Vectors (rats, flies)(*be specific*) :______________________

Employee Training and Cooperation

Employee Language Barrier

Changes in Current Practices

Extra Costs

Other:________________________

EDUCATIONAL SUPPORT

14. What types of education materials would work well for training your employees with a new food scrap diversion program? *(Check all that apply)*

A.	Form:	Brochure___	Poster____	Stickers___	Magnets___
B.	Language:	English_____	Spanish_____	Chinese_____	Other_____

Other____

15. In terms of education, would any of the following help your establishment participate? *(Circle all that apply)*

Provide printed education materials?	YES	NO	UNSURE
Help train your staff and set up a program?	YES	NO	UNSURE
Provide business recognition/awards programs?	YES	NO	UNSURE
Provide workshops?	YES	NO	UNSURE

PHYSICAL SUPPORT

16. How many times per week do you think the food scrap cart should be collected? *(Circle one)*

1 3 5

PLEASE TURN OVER

Masters Group Project/Food Survey, University of California Santa Barbara, Bren Hall, CA 93106-5131

17. How useful would it be to you for the program to provide small interior receptacles in addition to an exterior food scrap cart? *(Circle one)*

Not Useful at all   Somewhat Useful   Moderately Useful   Useful   Very Useful

18. What type or size interior bins would be helpful? *(Circle all that apply)*

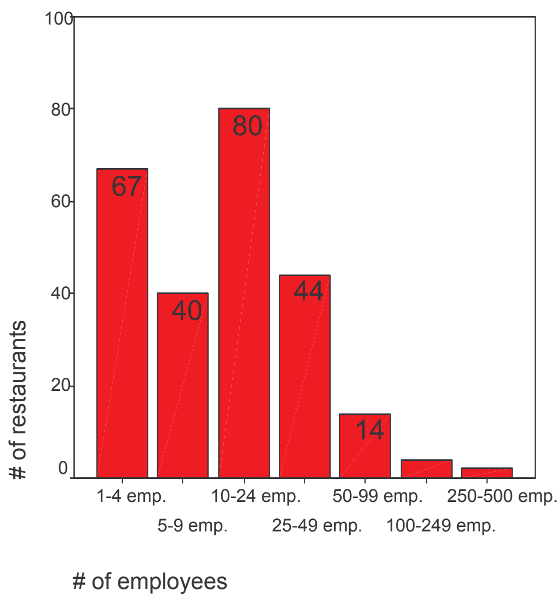
5.5 qt Bucket   9.6 qt Bucket   20 gallon Rolling Cart   35 gallon Rolling Cart

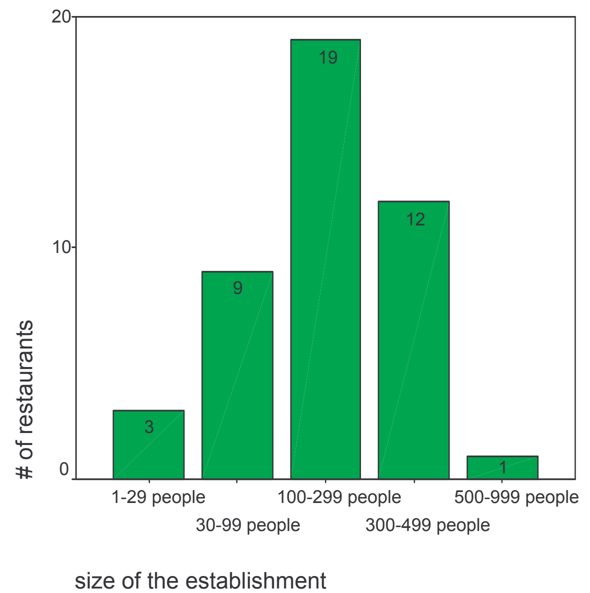
CONCLUSION

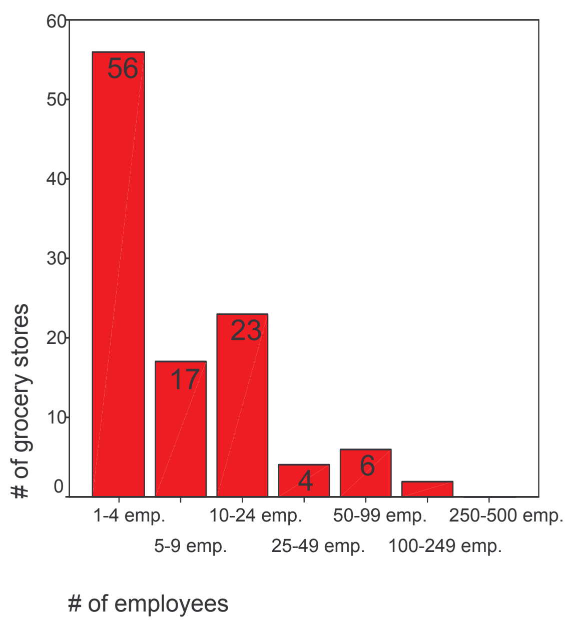
19. Please provide any additional comments:

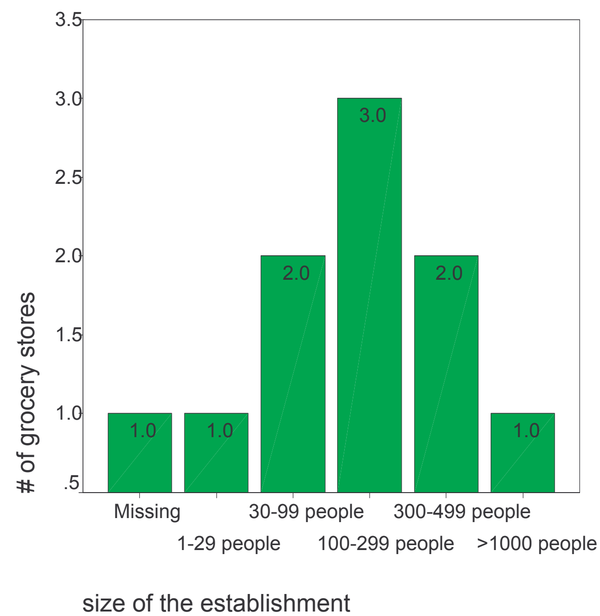
Appendix D-2

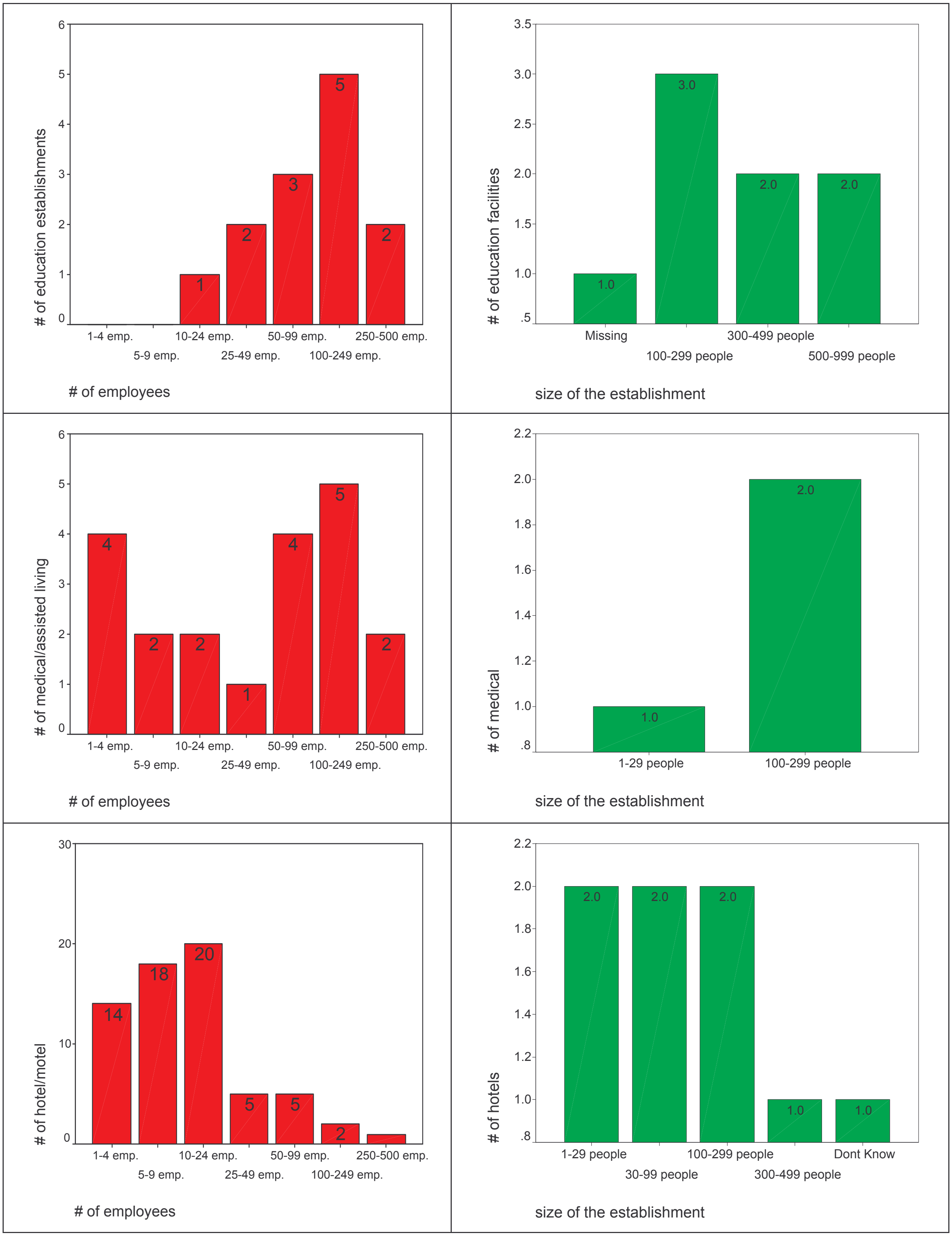
Distribution of the survey population according the SIC Code data	Distribution of the respondent population according to the average number of people given service to per day











# of education establishments
0
1
2
3
4
5
6
1
2
3
5
2
1-4 emp.
5-9 emp.
10-24 emp.
25-49 emp.
50-99 emp.
100-249 emp.
250-500 emp.
# of employees
# of education facilities
.5
1.0
1.5
2.0
2.5
3.0
3.5
1.0
3.0
2.0
2.0
Missing
100-299 people
300-499 people
500-999 people
size of the establishment
# of medical/assisted living
0
1
2
3
4
5
6
4
2
2
1
4
5
2
1-4 emp.
5-9 emp.
10-24 emp.
25-49 emp.
50-99 emp.
100-249 emp.
250-500 emp.
# of employees
# of medical
.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
1.0
2.0
1-29 people
100-299 people
size of the establishment
# of hotel/motel
0
10
20
30
14
18
20
5
5
2
1-4 emp.
5-9 emp.
10-24 emp.
25-49 emp.
50-99 emp.
100-249 emp.
250-500 emp.
# of employees
# of hotels
.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.0
2.0
2.0
1.0
1.0
1-29 people
30-99 people
100-299 people
300-499 people
Dont Know
size of the establishment

Appendix D-3

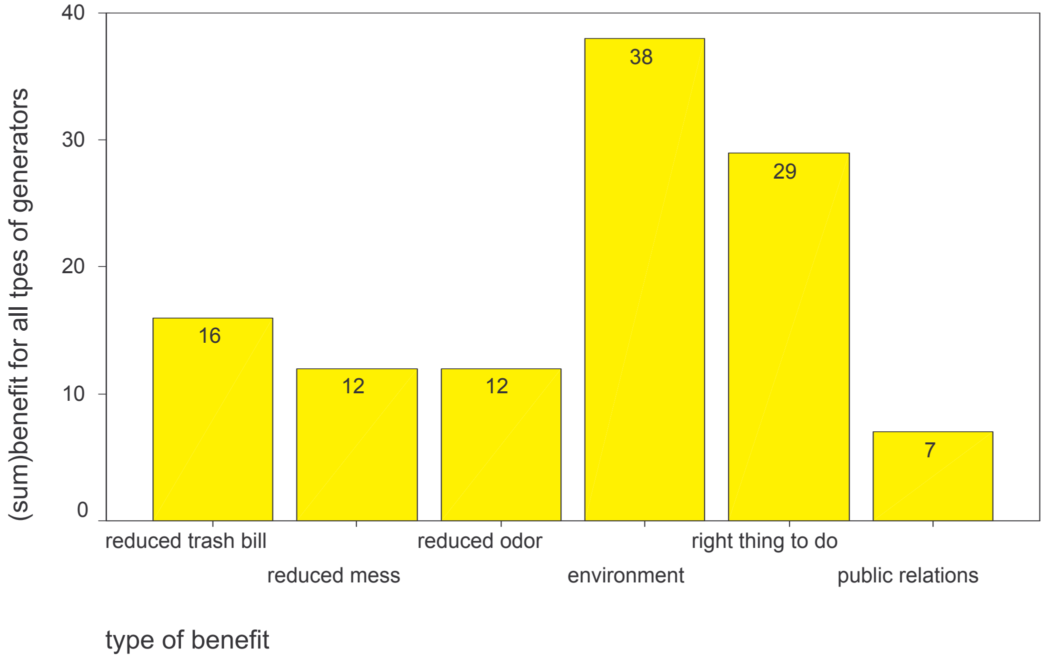
Estimation of Food Scrap Available for Human Re-Use

Sum of service type	Yd^3 hauled/week (W)	%capacity full/100 (D)	# of Establishments Sharing the bin (S)	CIWMB%FS/100 (F)	TOTAL Yd^3 FOOD SCRAP	kitchen trimmings	Unserved Unsold portions	Scraps from plates	Don't Know
						Y_{fst}			
Restaurant	259.00	34.20	102.00	24.64	105.17	46.31	7.32	39.95	11.59
Grocery	75.00	9.00	15.00	3.98	29.77	19.14	5.77	4.06	0.48
Hotel	59.00	7.00	13.00	1.01	6.80	2.11	1.25	3.06	0.38
Education	30.00	5.80	7.00	1.62	6.09	0.97	1.64	3.05	0.43
Medical	33.00	2.00	3.00	0.36	3.39	1.02	1.02	1.11	0.24
Other	36.00	0.80	1.00	0.22	6.45	2.58	0.00	2.58	1.29
				Total	**157.67**	**72.13**	**17.00**	**53.81**	**14.41**

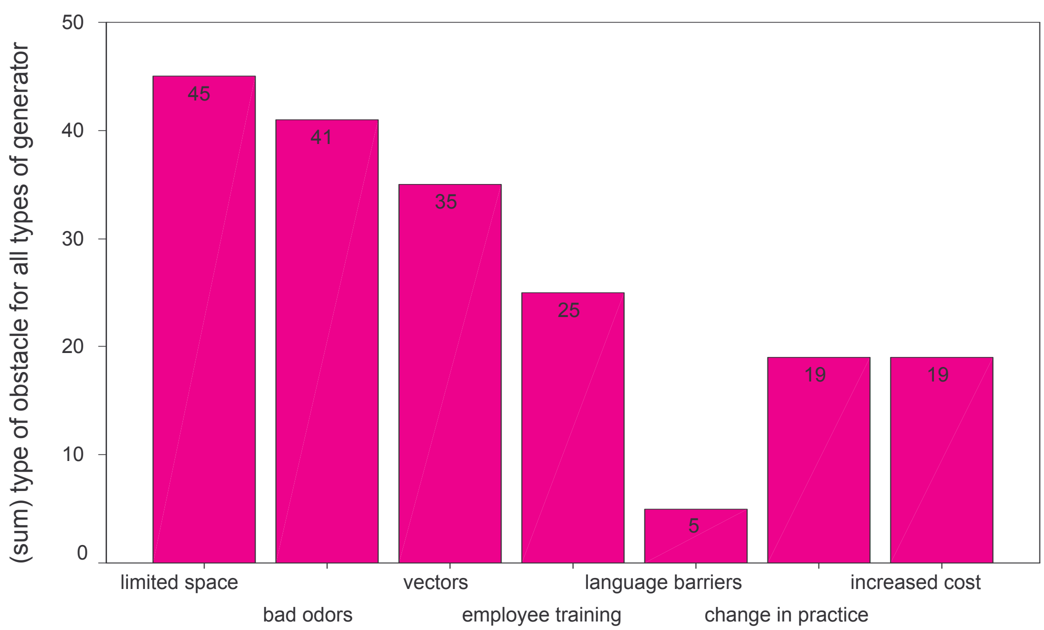
Type of food scrap	% of the total food scrap produced
Trimmings	45.75
Pre consumer	10.78
scraps from plates	34.13
Don't Know	9.14

Appendix D-4

Benefits Associated With Participation in a Food Scrap Collection Program

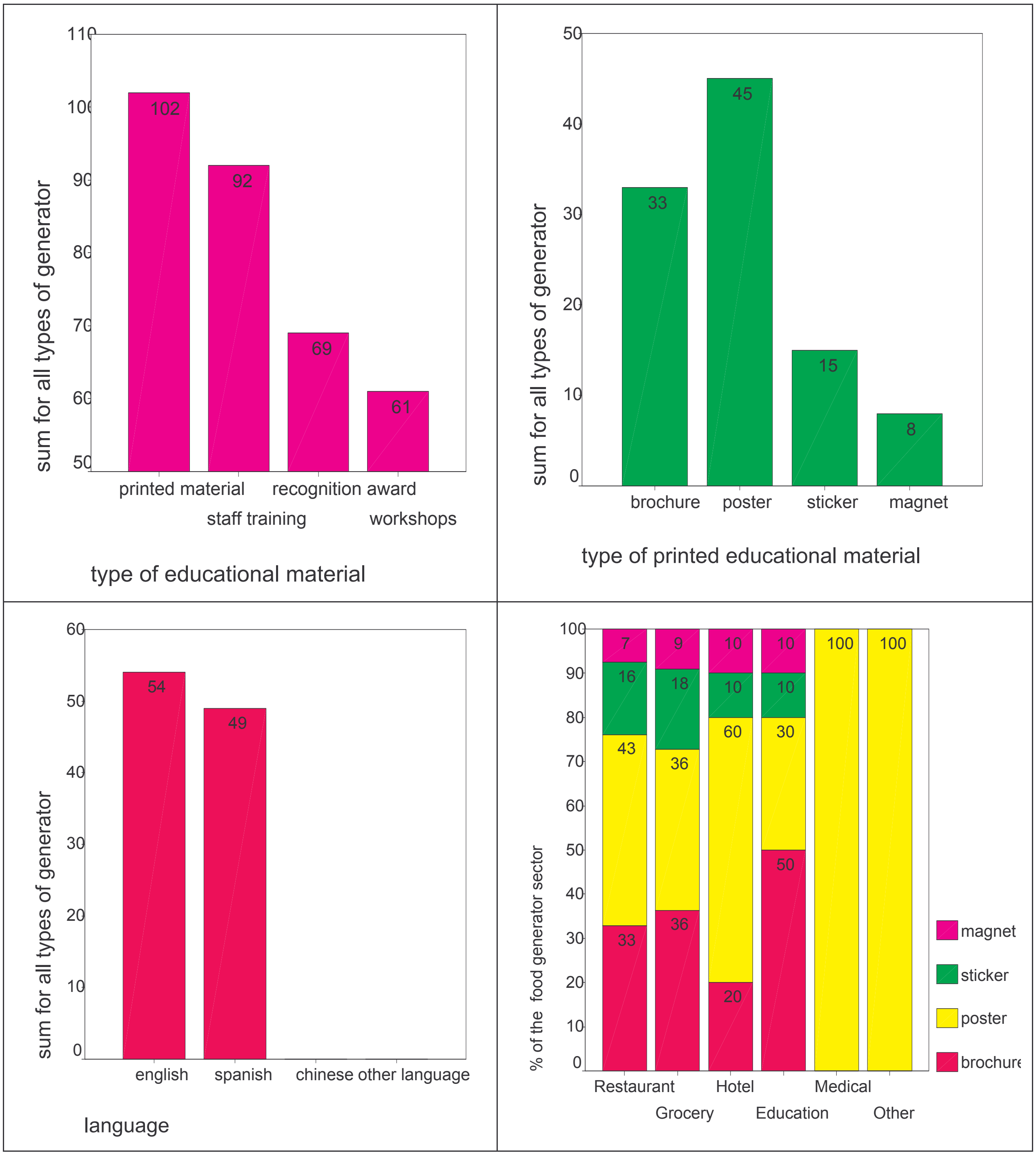


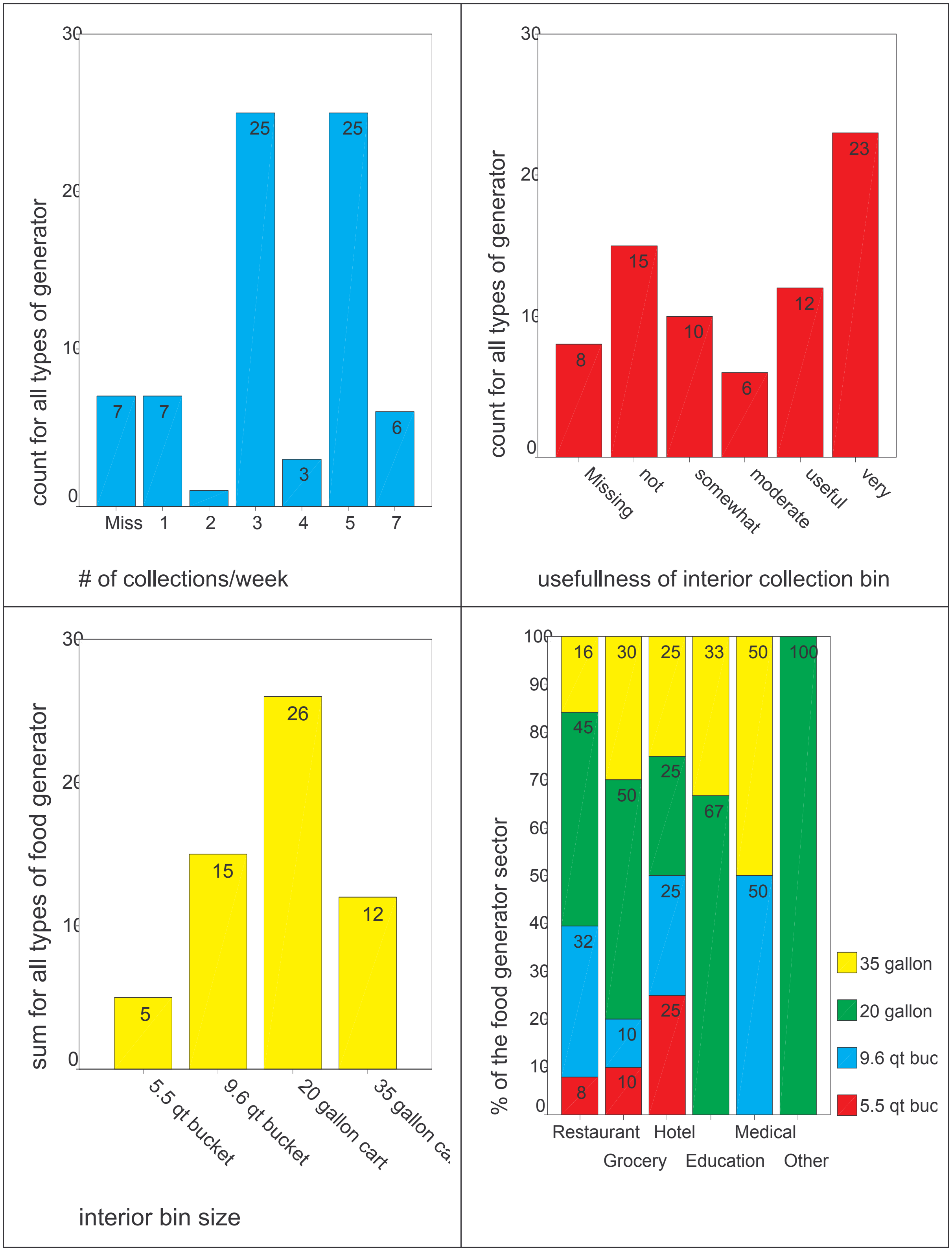
Obstacles Associated With Participation in a Food Scrap Collection Program



Appendix D-5

Physical and Educational Infrastructure Needs





count for all types of generator
30
20
10
0
7
7
25
3
25
6
Miss
1
2
3
4
5
7
# of collections/week
count for all types of generator
30
20
10
0
8
15
10
6
12
23
Missing
not
somewhat
moderate
useful
very
usefullness of interior collection bin
sum for all types of food generator
30
20
10
0
5
15
26
12
5.5 qt bucket
9.6 qt bucket
20 gallon cart
35 gallon ca
interior bin size
% of the food generator sector
100
90
80
70
60
50
40
30
20
10
0
16
30
25
33
50
100
45
50
25
67
25
50
32
10
25
8
10
25
35 gallon
20 gallon
9.6 qt buc
5.5 qt buc
Restaurant
Hotel
Medical
Grocery
Education
Other

Appendix E

Appendix E-1

Suppliers of In-Vessel Composting Equipment

Supplier	Type	System Process	Customers	Contact	Web Site www.
Hot Rot	Agitated / aerated bin	Continuous	Christchurch, New Zealand	805-884-6118	Hotrotsystems.com
Wright Environmental	Plug flow static bed	Continuous	Disney World, Florida	905-881-3950	Wrightenvironmental.com
Ag-Bag	Aerated bags	Semi-batch	San Francisco, CA	800-334-7432	Ag-bag.com
Green Mountain	Aerated bin	Batch	Prince Edward Island, Canada	800-610-7291	Gmt-organic.com
Farmer Automatic	Agitated bay	Continuous	Register, Georgia	912-681-2763	Farmerautomatic.com
Stinnes Enerco	Aerated bin	Batch	Nova Scotia, Canada	905-855-8270	Stinnesenerco.com
NaturTech	Aerated bin	Batch	McCade , MN	320-253-6255	Composter.com

Appendix E-2

Estimating the size of the compost area:

Quantity Food Scrap Collected	10 tons/day
Quantity with Bulking Agent	15 tons/day
Days/3 months	72 collection days
Material 15*72	1080 tons material to compost
Density of food + bulking agent	40 lb/ft^3
Material (2000lb/ton)	2160000lb material to compost
Convert to volume w/ 40 lb/ft^3	54000 ft^3
Assume 1 pile is 5ft x 5ft triangle	4320ft long
In area 54000 ft^3 / 2.5ft	21600 ft^2 compost area needed
Create rows with space in between	43200 ft^2 compost w/ rows
Area in acre (43560 ft^2 /acre)	0.991736 acres

Result:

Estimate 1 Acre of land for composting 10 tons of food scrap.

Assumptions:

25:1 C:N Ratio
60% moisture in food
Piles are triangles 5 ft at the base
Density of food + bulking agent is 40 lb/ft^3 going into the tunnel
25-35% weight reduction after composting
20% volume loss after composting
Windrow experiences a 27% volume loss after composting due to extra agitation

Appendix E-3

The Analytical Hierarchy Process

"*The Analytic Hierarchy Process (AHP) is a powerful and flexible decision making process to help people set priorities and make the best decision when both qualitative and quantitative aspects of a decision need to be considered. By reducing complex decisions to a series of one-on-one comparisons, then synthesizing the results, AHP not only helps decision makers arrive at the best decision, but also provides a clear rationale that it is the best. Designed to reflect the way people actually think, AHP was developed in the 1970's by Dr. Thomas Saaty, while he was a professor at the Wharton School of Business, and continues to be the most highly regarded and widely used decision-making theory. In 1983, Dr. Saaty joined Dr. Ernest Forman, a professor of management science at George Washington University, to co-found Expert Choice. The AHP software engages in decision makers in structuring a decision into smaller parts, proceeding from the goal to objectives to sub-objectives down to the alternative courses of action. Decision makers then make simple pairwise comparison judgments throughout the hierarchy to arrive at overall priorities for the alternatives. The decision problem may involve social, political, technical, and economic factors. The AHP helps people cope with the intuitive, the rational and the irrational, and with risk and uncertainty in complex settings. It can be used to: predict likely outcomes, plan projected and desired futures, facilitate group decision making, exercise control over changes in the decision making system, allocate resources, select alternatives, do cost/benefit comparisons, evaluate employees and allocate wage increase*s". (www.expertchoice.com)

Appendix E-4

Ranking Results for Treatment Technologies using AHP

Sub Criteria	Do Nothing	Windrow	Ag-Bag	Grn Mtn	Wright	Hot Rot	**Model Weights**
Capital	0.238	0.238	0.19	0.143	0.095	0.095	0.111
Operation & Maintenance	0.167	0.083	0.167	0.167	0.208	0.208	0.101
Land Requirements	0.143	0.095	0.095	0.19	0.238	0.238	0.121
Health & Safety	0.16	0.12	0.16	0.16	0.2	0.2	0.076
Air / Water Quality Impacts	0.143	0.095	0.143	0.143	0.238	0.238	0.089
Traffic	0.143	0.095	0.095	0.19	0.238	0.238	0.071
Odor Control	0.136	0.091	0.136	0.182	0.227	0.227	0.098
Public Perception	0.136	0.091	0.136	0.182	0.227	0.227	0.121
Demonstrated Ability	0.179	0.179	0.179	0.179	0.179	0.107	0.101
Ease of Expansion	0.083	0.208	0.167	0.208	0.167	0.167	0.111
Ranking based on Model Weights	**0.153**	**0.132**	**0.148**	**0.175**	**0.2**	**0.193**	

Appendix E-5

Net Present Value Calculations for In-Vessel Technology, Landfill and Windrow

NPV = SUM*(1/IR-1/(IR(1+IR)^n))

Assumes:

IR= interest rate =6%
n= years of operation
Term is 15 years
In-vessel equipment capital costs are $1,000,000.
Capital cost = $1,000,000./15 = $66666.67
O& M costs are 10%/yr of Capital cost= $10,000./yr
10 T/day * 312 days/yr = 3120 T/yr

NPV for In-vessel Tech

Years	1	5	10	15
Capital cost	66666.67	66666.67	66666.67	66666.67
O&M costs	10000.00	10000.00	10000.00	10000.00
SUM	76666.67	76666.67	76666.67	76666.67
NPV	76666.67	322947.89	564273.34	744605.76
NPV /ton=	**24.57**	**20.70**	**18.09**	**15.91**

NPV for landfill @$48/ton ($48/ton* 3120 ton/yr= $149760/yr)

Years	1	5	10	15
Capital cost	0.00	0.00	0.00	0.00
Tipping fee	149760.00	149760.00	149760.00	149760.00
SUM	149760.00	149760.00	149760.00	149760.00
NPV	149760.00	630843.60	1102246.64	1454506.41
NPV /ton=	**48.00**	**40.44**	**35.33**	**31.08**

NPV for Windrow @$42/ton ($42/ton*3120 ton/yr= $131040/yr)

Years	1	5	10	15
Capital cost	0.00	0.00	0.00	0.00
Tipping fee	131040.00	131040.00	131040.00	131040.00
SUM	131040.00	131040.00	131040.00	131040.00
NPV	131040.00	551988.15	964465.81	1272693.11
NPV /ton=	**42.00**	**35.38**	**30.91**	**27.19**

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