Evaluation of Food Waste Importation to Supplement Energy Production at the South Treatment Plant
July 2006

Introduction/Background

The East Bay Municipal Utilities District in Oakland, California (EBMUD) began importing food waste suitable for anaerobic digestion to its wastewater treatment plant in 2004. The project is designed to increase methane gas production for delivery to the plant's underutilized reciprocating engine generators. The project has been successful despite some recurring problems with undesirable materials in the food waste (silverware, plates, etc) that have damaged equipment. The District believes its goal of a 4-year capital payback period will be realized if these issues can be resolved. The King County Department of Natural Resources and Parks (DNRP) has also been considering opportunities to increase methane production at its South Treatment Plant in Renton, Washington. This report summarizes an initial investigation by the Wastewater Treatment Division (WTD) with input from the Solid Waste Division (SWD) of the feasibility of implementing a food waste importation program at the South Treatment Plant.

Summary of Key Conclusions and Recommendations

WTD recommends a phased approach to the importation of organics as a means to increase energy production at the South Treatment Plant.

1. *The importation of food waste to the South Treatment Plant to supplement energy production is not cost-effective at this time.*
2. *King County should continue to pursue importation of liquid wastes that show potential for energy generation. This is potentially the lowest capital and operating cost option, and has the potential to generate a significant amount of energy.*
3. *If it is determined that liquid waste can not generate sufficient energy, King County should consider further discussions with food waste haulers to determine when there might be sufficient quantities of separated food waste available and the feasibility of screening and grinding food waste at an offsite location.*

Case Studies

East Bay Municipal Utilities District – EBMUD has implemented a food waste digestion program (as well as a liquid waste digestion program) designed to increase gas production and energy recovery at its 160 mgd wastewater treatment facility. The District has contracted with a local solid waste hauler who had already been segregating food waste from restaurants and stores in an effort to reduce the quantity going to landfills (driven by local regulatory pressure and landfill costs). Most of the separated waste was trucked 60 miles to a compost facility at

substantial cost to the hauler. Thus the hauler was interested in reducing hauling costs and tipping fees by delivering the waste to the local wastewater treatment plant.

After inspection of the food waste, the District was troubled by the size range of the material and more significantly, the presence of metals, tableware, glasses, plates, and plastic items. Odor from the waste was also a significant concern. The District determined that the food waste would need to have the undesirable materials removed from the waste and the remaining waste would need to be ground, screened and slurried before it could be added to the digesters. After evaluating numerous onsite screening and grinding alternatives, the District determined that onsite food waste "pre-processing" would not be feasible. Instead, the solid waste hauler agreed to provide the grinding and screening services at a local transfer station.

Pre-processed food waste is currently being delivered to the treatment plant in covered, 20-cubic yard end-dump trucks at 20 to 30 percent solids. The screened and ground food waste is dumped into two in-ground receiving tanks where it is combined with dilution water and mixed to keep the solids in suspension. The slurry is then pumped at about 10 percent solids, through a conventional in-line grinder to the digester feed system. The receiving tanks are covered to control odors and the collected odors are delivered to a two-stage treatment system (biotower/activated carbon). The capital cost of the onsite food waste facilities was $3.5 million (2004 dollars).

Operational testing began in May, 2004. The equipment and control systems generally performed as designed but the nature of the food waste, as delivered, led to some issues that are still being resolved. Even though the food waste was ground and screened to one-half inch size, undesirable materials were still in the waste. In particular, knives and forks, broken glass and china were present in the delivered material. These materials have led to downtime and some serious damage to pumps. EBMUD reports that additional facility modifications may be necessary to address this issue.

The plant is currently receiving five trucks of food waste per week (about 20 tons/day or 5200 tons/year) and digester gas production has increased significantly. EBMUD reports that energy production has increased by an average of about 0.6 MW since the food waste program began.

Key elements that make the food waste program successful at EBMUD:

- Regulatory pressure to reduce waste material going to landfills.
- The private hauler was already segregating food wastes from local restaurants and "food stores" due to regulatory pressures including a statewide 50% recycling requirement for all municipalities.
- The hauler was delivering food waste at significant cost to a compost operation located 60 miles from food waste sources.
- EBMUD wastewater treatment plant is located in close proximity to food waste sources.
- The hauler found it cost-effective to perform significant offsite waste pre-processing (screening and grinding) prior to delivery to open up a local delivery site.
- EBMUD was able to charge a tipping fee and still provide a lower cost option to the hauler.

- EBMUD had excess digestion and cogeneration capacity at the treatment plant.
- EBMUD's purchased energy rate is relatively high which increases the value of gas produced for onsite energy production.
- EBMUD was awarded a $550,000 grant by the California Energy Commission for construction of onsite facilities for unloading, slurrying, pumping and odor control.
- The combination of (a)zero cost for food waste collection, pre-processing and delivery, (b)positive tipping fee revenue, (c)significant energy production and (d) a $0.55M grant funding allowed this $3.5M project to pencil out as cost-effective for EBMUD.

When comparing these success elements to King County's situation, the most significant element is the very high cost of alternative delivery locations. In other words, the solid waste hauler is saving money by going to EBMUD, even though they are providing offsite screening and grinding services, and paying a tipping fee of up to $35/ton. By contrast, privately owned Cedar Grove Compost owns a facility in Maple Valley that is less than 10 miles away from the South Treatment Plant. This distance is not likely to provide the haulers a strong economic incentive to provide pre-processing of the food waste.

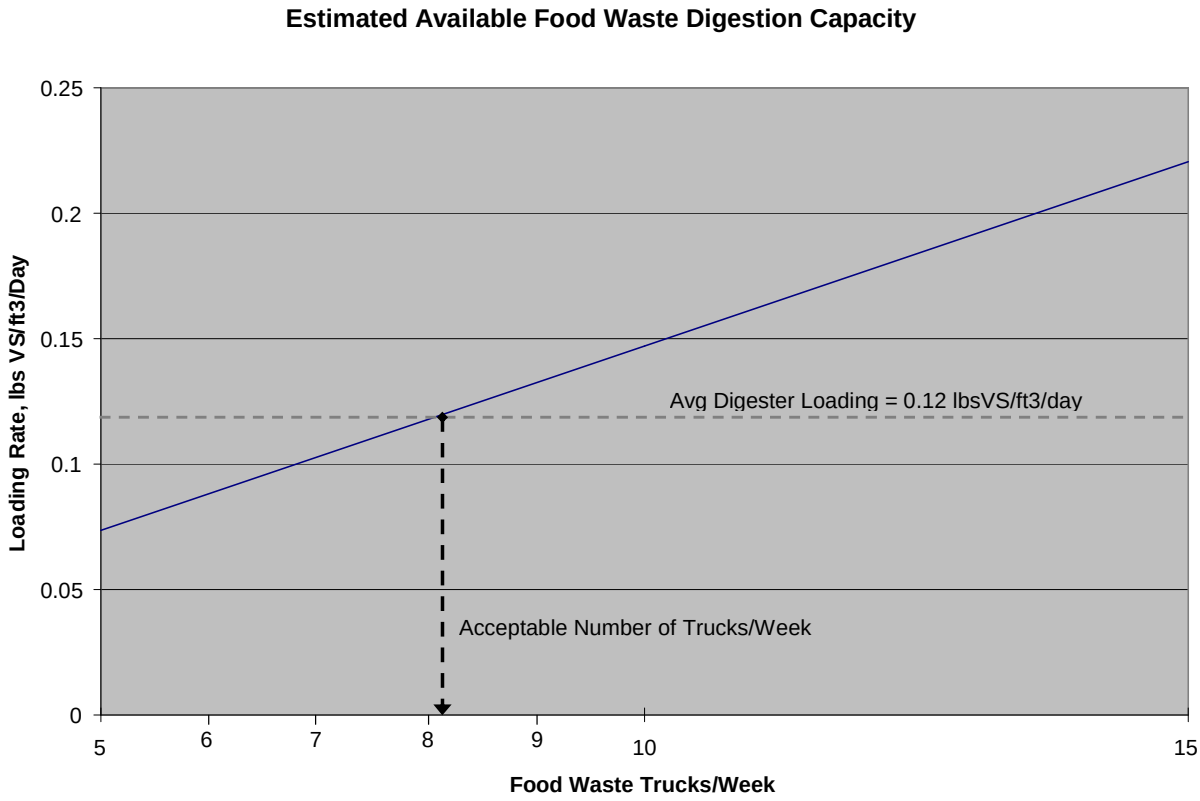
Sacramento Municipal Utilities District (SMUD) – SMUD contracted with the University of California, Davis to conduct a feasibility study to identify biomass waste stream sources and quantities, as well as the potential for biomass-to-electricity conversion using anaerobic digestion. Identifying food waste generators and waste streams was the first step towards the potential implementation of anaerobic digesters within the District. SMUD is currently conducting an economic study of possible decentralized digestion projects. This information would be provided to businesses that are generating food waste so they can determine if there is benefit to investing in a digester project. Information gathered by the study to date appears to favor installation of anaerobic digesters at food waste sites rather than importing food waste to a wastewater treatment plant.

South Treatment Plant Digestion and Gas Handling Capacity

The South Treatment Plant currently has available digestion, gas recovery and energy production capacity that could be used to convert food waste to energy. The facility is currently operating 3 of 4 available primary digesters. In order to process imported food waste, the fourth digester could be put into service to provide necessary capacity to reliably process the additional organic loading. Digester loading is typically described in terms of the mass of volatile solids (biodegradable organics) that can be fed per cubic foot of digester volume each day (lbs VS/ft3/day). By predicting the amount of volatile solids in each delivery of food waste, a rough estimation of the amount of food waste that could be added to the South Plant digestion process by bringing an additional digester online can be calculated. Although the food waste would be distributed evenly to all digesters, the digester volume that is available for food waste is assumed to equal the volume of the additional digester that would be brought online.

As shown in Figure 1, it is estimated that capacity is available for about 8 truck deliveries per week (at 20 yards/truck). This is equivalent to about 8,300 tons of food waste each year. It should be noted that this would fully utilize the readily available digestion capacity. Additional wastewater solids produced as a result of future growth within the service area would need to be

managed by operating the digesters more aggressively or reducing the number of food waste deliveries. Similarly, more food waste could be accepted if there is a drop in wastewater solids, e.g., solids loadings to South Plant are expected to drop 8% when Brightwater starts operations in 2010.



Sufficient gas recovery (a.k.a. gas scrubbing system) and energy production capacity exists at the South Treatment Plant to convert the methane gas produced by this level of food waste digestion. However, an accurate estimate of the actual value of the additional gas production will require a detailed evaluation of the total gas production and the resulting net efficiency of the available gas recovery and energy production equipment when operating at that level of production. For the purposes of this analysis, it is assumed that all of the methane gas produced by digestion of food waste will be converted to energy at 33 percent efficiency. However, the South Treatment Plant has the potential to increase the production efficiency to up to 40% with effective use of heat recovery and/or the steam turbine.

Local Food Waste Collection

In the last 2 years, a growing number of suburban cities, the City of Seattle, and the unincorporated area, have established curbside residential food waste collection programs. The residential programs combine food waste with yard waste in the same container. This allows food waste to be cost-effectively collected as part of the yard waste program. Unfortunately, woody debris, such as that found in yard waste is not readily biodegraded in the anaerobic

digesters and would create substantial operating issues and costs with little or no beneficial gas production.

More recently, commercial food waste has become a target for curbside collection. The City of Seattle has a program currently collecting a small percentage of food waste from food waste generating businesses. The cities of Bellevue, Redmond and Kirkland recently completed a two year commercial collection food waste pilot and are determining how/when to move to full scale. This collected food waste is delivered to a compost facility for processing.

Food waste collected from commercial generators is currently not co-mingled with yard waste. However, the haulers have been interested in co-collecting with residential yard/food waste accounts along the way where it maximizes route efficiencies. The City of Seattle's commercial food scraps program currently has a contract with Cedar Grove until 2014 at a very low price. Cedar Grove recently opened a new state-of-the-art compost facility in Everett, Washington and much of their residential yard/food waste is processed there. With two facilities in the region permitted to compost foodwaste, they have plenty of capacity and are aggressively pursuing additional material for processing.

One of the major haulers for King County, Waste Management, has indicated that their supply of collected pure food waste (not mixed with yard waste) is limited at this time due to the infancy of commercial collection. They have contractual commitments to the foodwaste at this time. Furthermore, neither of the major haulers in King County are currently set up to provide grinding and screening pretreatment.

At this time it appears that any food waste deliveries to the South Plant would need to start with very small volumes with no guarantee of increased volumes in the future due to the competitive market. The establishment of a private food waste grinding and screening facility for small volumes of food waste would appear to be unlikely.

Conceptual Project Development

As a first step towards evaluating the feasibility of importing food waste to the South Treatment Plant, the following project concept has been assumed:

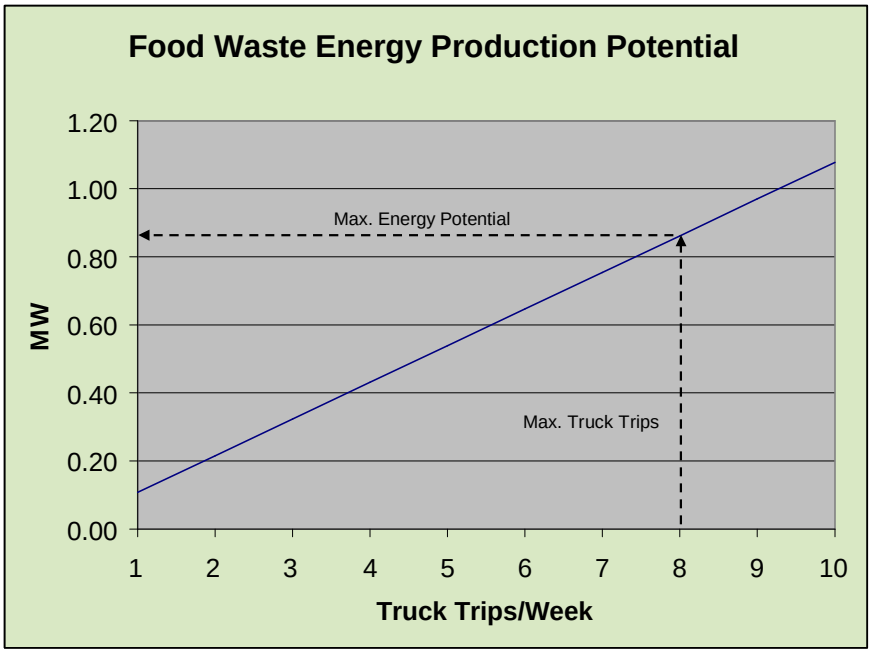
1. King County would contract with one or more solid waste haulers to screen, grind and deliver 5,000 to 10,000 tons of food waste per year to the South Treatment Plant.
2. King County would accept the properly pre-processed food waste in exchange for a tipping fee (to be negotiated) from the hauler.
3. Onsite facilities for unloading (by dump truck), slurrying, mixing, grinding and pumping the pre-processed food waste and necessary odor control facilities would approximate the facilities being used by EBMUD.
4. The onsite food waste receiving facilities would be constructed on the north end of the site, adjacent to the existing digesters.
5. Food waste trucks would enter and exit the site from the east entrance (off of Oakesdale Ave.) and travel across the site on existing roadways without significant permit or security issues.

The above assumptions, along with numerous other assumptions (e.g. process performance, electricity rates), will be used as a basis for development of preliminary cost estimates.

Energy Production Potential

By all accounts, typical food waste has a high volatile solids content and is readily biodegraded in the anaerobic digestion process. As a rule of thumb, anaerobic digestion of solids produces about 8 cubic feet of methane gas for every pound of volatile solids destroyed. KCWTD estimates that the methane gas produced from digestion of one ton of food waste would generate roughly 38 kW of power. This is consistent with the production experienced by EBMUD.

The potential energy production is directly related to the amount of food waste delivered to the digesters as shown in Figure 2 below. Assuming that King County can receive and process a maximum of 8300 tons per year (eight 20-ton truckloads per week), it is estimated that the food waste would result in a maximum of about 0.85 MW of power generation.



Preliminary Cost/Benefit Analysis

A simple Excel spreadsheet cost model was developed relying heavily on information provided by EBMUD's published literature and discussions with their engineering consultant (Brown & Caldwell). The purpose of the cost analysis was to determine if importation and digestion of food waste could produce sufficient net operating revenue to offset the capital expenditure necessary to receive and process the food waste within a reasonable period of time. Given that

the project would be implemented "voluntarily" (i.e. not required to meet discharge permits) and is intended to be a revenue generator, a relatively short capital payback period is desirable. A 5-year simple payback period objective has been assumed for this analysis. EBMUD anticipates that they will be able to meet their stated objective of a 4-year payback period. However, their capital costs were partially offset by a $0.55M construction grant, they have concurrently implemented a successful liquid waste importation program, they have been able to charge relatively high tipping fees and the gas produced was assumed to have a higher value because of their significantly higher cost of electricity ($0.10/kWh v. $0.065/kWh for the South Treatment Plant).

Capital costs are assumed to be identical to the EBMUD project. Operating costs are based on a verbal description of the types of operation and maintenance support required for the EBMUD project. The following assumptions were also included in the analysis:

- 1000 btu/cubic foot of methane produced
- Power generation efficiency = 33%
- Energy valued at $0.065/kWh
- O&M labor costs assume 0.5 FTE operations, 1.0 FTE maintenance
- Utilities, equipment repair and replacement = $20,000/year
- Gas scrubbing costs are assumed to be 25% of net energy revenue.
- Dewatering, haul & application of biosolids produced by digestion of food waste = $43/wet ton recycled ($24/ton of food waste delivered).
- No cost included for screening and grinding of food waste (assumes hauler will pre-process)
- Capital cost = $3,500,000

Based on the above assumptions, positive net operating revenue can only be achieved as a result of implementing a food waste program with a capacity of 10,00 tons/year or greater. Energy production revenue (or value) is estimated at $441,000/year at 7500 tons/year delivered and $588,000/year at 10,000 tons/year delivered. However, operating costs are estimated at $468,000/year and $586,000/year respectively. Operating costs are summarized in Table 1.

Table 1. Estimated Operating Revenue/Cost Summary

ITEM	7,500 TONS/YEAR	10,000 TONS/YEAR*
Energy Production Value	$441,000	$588,000
O&M Costs	($468,000)	($586,000)
Net O&M Savings	($27,000)	$2,000

*Exceeds estimated processing capacity at South Treatment Plant (8300 tons/year).

Since the net operating savings are not sufficient to offset the capital cost over a reasonable payback period a tip fee will need to be collected. As can be seen in Table 2 below, it will be necessary to charge an estimated $60/ton tip fee to meet the five-year payback period objective even if food waste deliveries are increased to 10,000 tons/year (which exceeds the estimated

available capacity to process food waste). At 7,500 tons/year, the tip fee would need to be set at greater than $90/ton.

Table 2. Estimated Payback Period Based on Tipping Fee

7,500 TONS/YEAR (1 TRUCK/DAY—7 DAYS/WK)		10,000 TONS/YEAR* (2 TRUCKS/DAY—5 DAYS/WK)	
Tipping Fee ($/Ton)	Simple Payback (Years)	Tipping Fee ($/Ton)	Simple Payback (Years)
20	26	20	16
30	17	30	11
40	12	40	8
50	10	50	7
60	8	60	6
70	7	70	5

*Exceeds estimated processing capacity at South Treatment Plant (8300 tons/year).

It is important to note that the hauler would not only be required to pay the tipping fee but would also be expected to pre-process (screen and grind) the food waste prior to delivery to the site. At this time, solid waste haulers do not have a facility capable of this function. This would increase the hauler's costs and lower the tipping fee that would be deemed financially attractive. As a point of reference, the City of Seattle currently pays a tipping fee between $20 and $25/ton to deliver food waste to Cedar Grove composting. It is anticipated that new contracts being considered for other cities will be in the $30 to $40/ton range. By comparison, the rate that King County would need to charge to achieve a 5-year payback period would not be considered competitive. The payback period objective would need to be increased to 15 years or greater with a guaranteed delivery of 7500 tons per year in order to reduce the estimated tipping fee to a competitive range.

The need for a relatively large quantity of food waste increases the risk of not attaining revenue generation goals. Contracts for an adequate supply of food waste would need to be assured prior to construction of the food waste receiving and delivery facilities. While the City of Seattle may issue an RFP for organics collection in several years, as noted in the Local Food Waste Collection section above, it does not appear likely that a firm source of 7,500 tons/year of food waste will be available in the near future.

Other Considerations

Liquid Waste Delivery Program – The delivery of high-COD liquid waste to the anaerobic digestion system is an interesting alternative to (or addition to) the food waste concept. It is likely that the cost of an onsite staging/delivery system for liquid waste would be substantially less expensive than for food waste. It is also anticipated that there would be no need for offsite screening and grinding facilities and onsite slurrying and grinding. A small onsite odor control facility might still be necessary. The minimal capital investment would allow for a relatively quick start to the project and would reduce the risk of not generating sufficient revenue through energy and tipping fees. This would also reduce the need for long-term contracts at the outset of

the project. Operating costs would likely be significantly lower and tipping fees might be achievable if the discharger is able to avoid onsite treatment and/or discharge fees. On the downside, only very high-COD wastes would be practical due to the cost of hauling.

EBMUD has been receiving a variety of liquid wastes as a separate but concurrent project with the food waste project. They have been receiving chicken offal (blood, guts, etc.) on a trial basis and other products which could not be disclosed.

WTD's Industrial Waste Program is currently reviewing industrial dischargers to determine if suitable liquid wastes exist within the WTD system. If suitable wastes can be found, this has the potential to be a lower risk/high reward approach to increasing energy production at the South Treatment Plant.

Septage Deliveries – The South Treatment Plant currently accepts septage from local haulers that it processes for a fee. Septage is the digested material pumped from the bottom of septic tanks. Because it has been anaerobically digested in the septic tank for an extended period of time, it has very little energy value. The liquid septage delivered to the South Treatment Plant is pumped to the front end of the treatment system to be processed along with the incoming raw sewage. The septage fee is intended to offset the cost of aerobically treating the waste at the treatment plant. Increasing the delivery of septage would increase revenues but would also result in a net increase in energy usage.

Site Access and Security – As noted above, the South Treatment Plant currently receives septage waste at the site. However, the septage facility is external to the controlled treatment plant site area and customers do not enter the operating facility. Septage haulers have access to the septage unloading area 24 hours/day, 7 days/week and are monitored by security cameras.

The anaerobic digestion system is located in the north-central part of the site -- a significant distance from current plant entrances. It would not be practical to install and operate a system that would pump the food waste slurry from an external unloading site to the digesters. Therefore, it is likely that the food waste hauler would need to access the site through the north-east entrance and travel across the site on existing plant service roads to receiving facilities constructed adjacent to the existing digesters.

Appropriate access and security measures would need to be implemented to insure that plant staff is notified prior to deliveries and is available at the time of the delivery. Other capital improvements may be necessary to achieve the appropriate level of security.

Recommendations

WTD recommends a phased approach to the importation of organics as a means to increase energy production at the South Treatment Plant.

1. Continue to pursue liquid wastes that show potential for energy generation. This would include generators within the WTD service area and, possibly, external to the service area. This is potentially the lowest capital and operating cost option, and has the

potential to generate a significant amount of energy. The Industrial Waste Program is currently evaluating organic sources within the WTD service area. The Technology Assessment and Resource Recovery Program is currently evaluating the feasibility of importing glycerin, a high-COD by-product of biodiesel production. Bench-scale digestion studies are being initiated to determine the impact of glycerin on the digestion process and potential energy production.

2. If it is determined that liquid waste can not generate sufficient energy, initiate discussions with food waste haulers to determine when there might be sufficient quantities of separated food waste available and the feasibility of screening and grinding food waste at an offsite location.

3. Prior to any decision to further pursue a food waste program, staff should inspect the EBMUD facility to get first-hand information on the status of their program and lessons learned (operating and contracting).