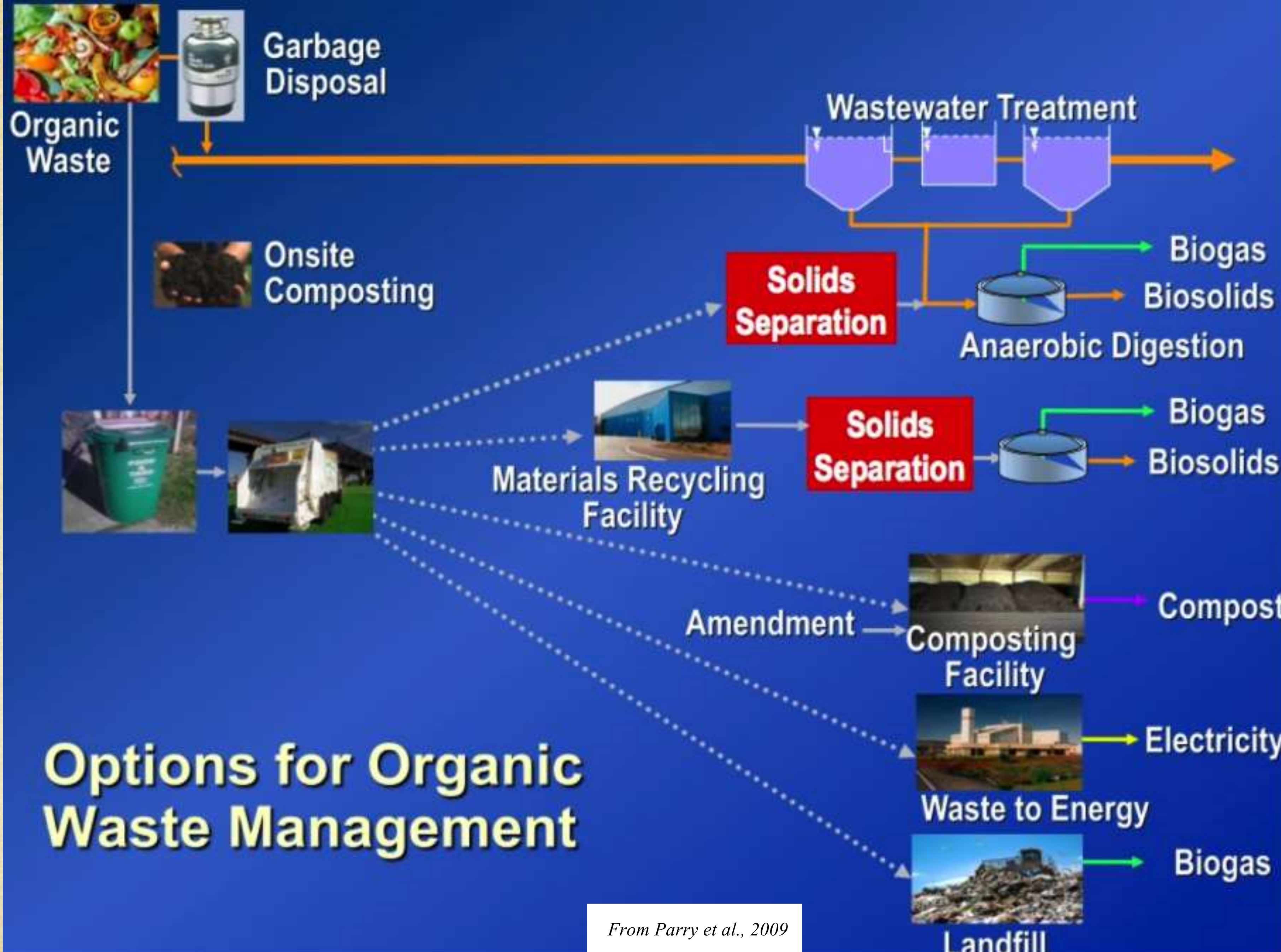


From Parry et al., 2009

Why Codigestion?

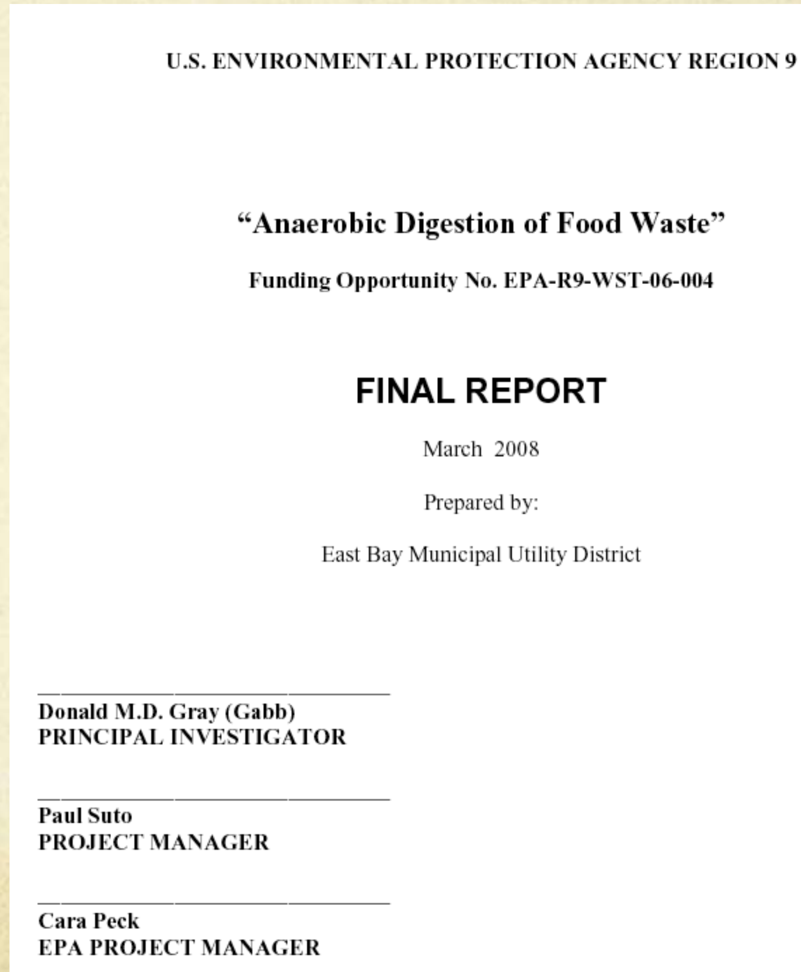
- Increase biogas energy production
- Reduce fossil fuel consumption
- Reduce operating / energy costs
- Minimize carbon footprint
- Increase the plant's value to the community by recycling challenging liquid "wastes"
- Can improve digester performance & biosolids quality
- Be a true Water Resource Recovery Facility (WRRF)

WWRFs & Co-Digestion

- Pilot studies: Boston (MWRA), Metro Vancouver, Orange County Sanitation District, Dallas Water Utilities, San Francisco Public Utilities Commission, City of Los Angeles
- Whey receiving: Gloversville-Johnstown, NY
- Multiple feedstocks: Des Moines, IA; Essex Juntion, VT
- FOG receiving: Austin Water Utility, City of Tacoma
- Deicing fluid receiving: Philadelphia Southwest Plant,
- Active food waste / FOG / organics receiving: East Bay Municipal Utility District (EBMUD) – NET ENERGY PRODUCTION
- Nationally, Wastewater treatment uses 2-3% of all energy produced

EPA-Funded Research on Food Waste Digestion at East Bay MUD

- Evaluation of food waste digestion vs. municipal ww solids digestion
- Bench scale
- Evaluated:
  - Minimum MCRT
  - VS & COD loading
  - VS destruction
  - CH_4 production rates
  - Process Stability
  - Meso & thermo AD operating temperatures



U.S. ENVIRONMENTAL PROTECTION AGENCY REGION 9

"Anaerobic Digestion of Food Waste"

Funding Opportunity No. EPA-R9-WST-06-004

FINAL REPORT

March 2008

Prepared by:

East Bay Municipal Utility District

Donald M.D. Gray (Gabb)
PRINCIPAL INVESTIGATOR

Paul Suto
PROJECT MANAGER

Cara Peck
EPA PROJECT MANAGER

EPA United States Environmental Protection Agency

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Turning Food Waste into Energy at the East Bay Municipal Utility District (EBMUD)

EBMUD Project Home | Food Waste | Food Waste at Wastewater Facilities | EBMUD's Process | EBMUD Study

EBMUD Helps Mitigate Climate Change Through Anaerobic Digestion

Fact: Food Waste Contributes to Climate Change

Food waste is one of the least recovered materials in the municipal solid waste stream and is one of the most important materials to divert from landfills. Food that is disposed of in landfills decomposes to create methane, a potent greenhouse gas that contributes to climate change.

- More about the importance of diverting food waste from landfills

Fact: Food Waste Can Be Transformed Into A Natural Fertilizer

Of the less than 3% of food waste recovered from the waste stream, composting is the prominent diversion method. Composting, either in your backyard or in a commercial facility, creates a natural fertilizer with many beneficial qualities.

- More information on composting

Fact: Food Waste Can Be Used to Generate Renewable Energy

Watch Anaerobic Digestion Video Below

Join the Discussion

Greenversations Question:

http://www.epa.gov/region9/waste/features/foodtoenergy/index.html

Findings

Compared to wastewater solids, food waste…

- produces as much or more energy / ton of processed material fed into digesters
- Food waste digestion happens at a quicker rate
- VSD = 70 to 80% (compared to ~50 – 60% for wastewater solids)
- Food waste AD produces ~1/2 the residuals (by weight)
- MCRT of 15 days for food waste maximizes CH_4 concentration (65 – 70%), but 10 days is OK too
- In short: food waste is more readily biodegrable

Table ES-1. Energy Benefit Comparison of Anaerobically Digested Food Waste and Anaerobically Digested Municipal Wastewater Solids.

Parameter	Unit	Food Waste 15-day MCRT AVG (Range)	Food Waste 10-day MCRT AVG (Range)	Municipal Wastewater Solids 15-day MCRT AVG (Range) (5)
Methane Production Rate	ft^3/dry ton applied(1)	13,300 (9,800 – 17,000)	9,500 (6,600 – 14,400)	10,000 (7,500 – 12,600)
	ft^3/wet ton delivered(2)	3,300 (2,500 – 4,300)	2,400 (1,700 – 3,600)	NA(6)
	m^3/ dry metric ton applied(1)	420 (300 – 530)	300 (200 – 450)	310 (230 – 390)
	m^3/wet metric ton delivered(2)	100 (75 – 135)	75 (50 – 110)	NA(6)
	ft^3 per day/ 1,000 ft^3 digester volume	2,300 (1,100 – 3,200)	2,600 (1,800 – 3,800)	750 (550 – 930)
Electricity Production Rate(3)	kWh/dry ton applied(1)	990 (730 – 1,300)	710 (490 – 1,080)	750 (560 – 940)
	kWh/wet ton delivered(2)	250 (190 – 320)	180 (130 – 270)	NA(6)
	kWh/dry metric ton applied(1)	1,100 (800 – 1,400)	780 (540 – 1,190)	830 (620 – 1,040)
	kWh/wet metric ton delivered(2)	280 (200 - 350)	200 (140 - 300)	NA(6)
	kWh per year/ 1,000 ft^3 digester volume	43,700 (21,300 – 62,100)	57,000 (43,000 – 73,700)	14,600 (10,700 – 18,000)
Household Energy Equivalent Rate(4)	households/year/ 100 tons/day	1,100 (800 – 1,400)	800 (550 –1,200)	NA(6)
	households/year/ 100 metric tons/day	1,200 (880 – 1,500)	880 (600 – 1,300)	NA(6)
	households per year/ 1,000 ft^3 digester volume	7.3 (3.6 – 10.3)	8.4 (5.8 – 12.3)	2.4 (1.8 – 3)

Notes:
1. Dry ton applied refers to food waste solids applied to the digesters after processing a wet ton delivered load.
2. Wet ton delivered refers to food waste tonnage (including water) delivered by the hauler prior to processing.
3. Calculated based on 1 ft^3 CH_4 = 1,000 BTUs and 13,400 BTUs = 1 kWh.
4. Calculated based on 2001 EIA residential energy survey for CA where average household energy use is 6,000 kWh annually.
5. Based on data from previous EBMUD bench-scale pilot study. Digesters were fed thickened waste activated sludge and screened primary sludge.
6. Data is not typical of municipal wastewater solids loading to digesters.
7. For annual data, 100 tons/day food waste assumes processing at 5 days per week, 52 weeks per year.
8. For annual data, it is assumed municipal wastewater solids loading occurs 5 days per week, 52 weeks per year.
9. A typical food waste load delivered weighs approximately 20 tons, and has a 28% TS content.
10. Approximately 10% of the delivered food waste as total solids (TS) mass is discharged in reject stream.
11. Data range presented is from stable digester operating periods for both mesophilic and thermophilic digesters.
12 .AVG= Average. NA=Not Applicable.

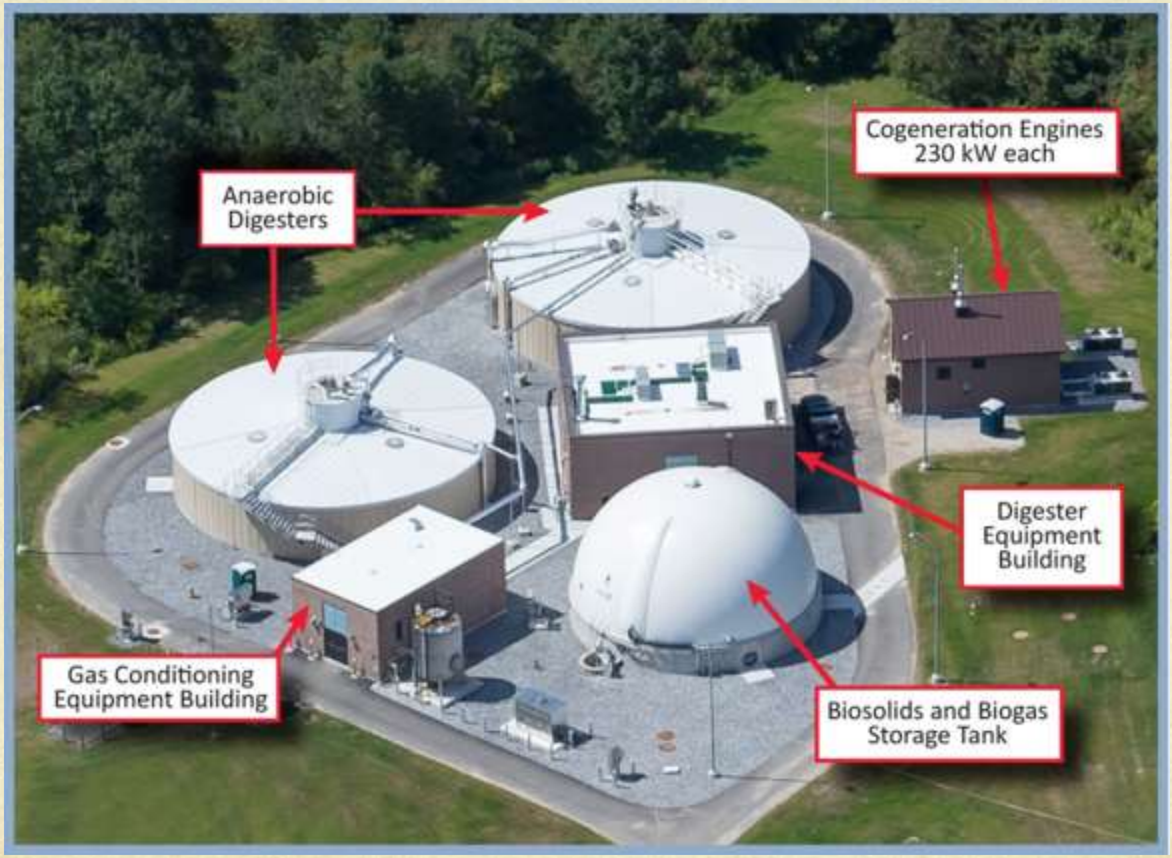
Food Waste vs. Wastewater Solids Comparison		
Parameter	**Food Waste Pulp**	**Wastewater Solids**
Volatile Solids in Feed (%)	85-90	70-80
Volatile Solids Loading (lbs/ft3-day)	0.60 +	0.20 max
COD Loading (lbs/ft3-day)	1.25 +	0.06-0.30
Total Solid Fed (%)	10 +	4
Volatile Solids Reduction (%)	80	56
Hydraulic Detention Time (days)	10	15
Methane Gas Produced (meter^3/ton)	367	120
Gas Produced (liters/liter of digested volume)	58	17
Biosolids Produced (lbs/lbs fed)	0.28	0.55

Benefits of Codigestion to a Municipality

- All types of organic waste can be treated in one plant
- Efficient recovery of biogas, a renewable energy source
- Closed system with a minimum of smell/odor
- Energy can be recovered as electrical power, combined heat & power, compressed biogas (CBG) upgraded to vehicle fuel
- Revenue from tip fees (SF Bay agencies $0.03-$0.15/gallon)

es

LAWPCA Anaerobic Digestion Facilities



System Description

- Two concrete digesters
  - 65 feet diameter, 25 foot side wall depth
  - ~700,000 gallons each
  - Sized for 15 day SRT at maximum month flows and loads
  - Concrete, submerged fixed covers
- Pump mixing system
- Sludge recirculation through HEX for heating
- Digested sludge storage tank with membrane cover
- Outside waste acceptance – modify existing septage receiving station

Codigestion Impacts on a WRRF

- Challenges:
  - Preprocessing: off-site? Pumpable? Truckable?
  - Control of incoming wastes/need to establish permit program
  - Pretreatment of wastes to remove debris and protect equipment
  - Ensuring sufficient digester capacity
  - Potential for process upsets – need to provide uniform feed
  - Effect on biosolids and/or organics end use
  - Unknown effect on nutrient content in sidestream
  - Odor potential at receiving area and during maintenance
  - **Public outreach**

Available wastes in LAWPCA region

1. **Fats, Oils, Grease (FOG)**
2. **2. Airplane De-icing Fluids (Glycols)**
3. **Other Glycol Sources**
4. **Pioneer Plastics / Pionite**
5. **Waste Oils**
6. **Machine Coolant (Halogens)**
7. **Glycerin**
8. **Landfill and Transfer Station Leachate**
9. **Dairy Waste (whey, washwater)**
10. **Brewery Waste**
11. **Organic Portion of Municipal Solid Waste (mostly consumer food waste)**
12. **Food Processing Wastes**
13. **Beverage Bottlers**
14. **Slaughterhouse Wastes**

Estimating Financial Benefits

Tipping Fees are important, but additional factors to consider include, but are not limited to:

- Additional revenues or cost offsets from increased biogas production.
- Costs of infrastructure needed to accept, store, and meter in the outside wastes.
- Costs to process the additional solids, including dewatering, polymer, labor, etc.
- Costs to manage the additional biogas, including cleaning, storage, and combustion.
- Feed rate of LAWPCA solids – 58,000 gals/day

Tipping fees

- **a.** Current Rates for FOG run from $0.6 per gallon (Anson-Madison)to $0.14per gallon (South Berwick)
- Other wastes, Including Food Processing may have higher tipping Fees
- Transportation and Handling have a huge impact on the "received at plant" price.
- Markets in Maine remain immature.

These Materials can be hard to handle!

Conclusions

- LAWPCA built digesters for solids reduction.
- Taking in outside wastes is optional; not banking on it.
- There is competition for wastes – lots of potential digester & composting projects.
- Generators not interested in long-term contracts
- Municipal AD has benefit of existing infrastructure for managing solids & side stream.
- Phased implementation to taking outside wastes helps operators adjust.

Combined Heat and Power (CHP) System Selection

- Estimated biogas production = 170,000 ft^3/day
- Cogeneration systems considered
  - Microturbines
  - Reciprocating Engines
  - Two – 230 kW engines (received $330,000 Efficiency Maine Grant)
- Electricity used on site:
  - Provides all power for new digestion equipment
  - Reduces amount of power purchased from the utility for WW treatment
- Heat Reclaimed from engines
  - Provides heat for anaerobic digesters

Biogas Treatment

- Biogas Treatment System
  - Foam separator and condensate/sediment removal traps
  - H_2S removal using Iron Sponge or SulfaTreat media
  - Moisture removal and gas boosting skid
  - Siloxane removal system to be added in the future, if necessary

Sure, a Pretty Picture, but aren't we supposed to be using that gas?

Project Benefits

- Benefits that justify capital and O&M costs:
  - Reduces total solids by approximately 40%.
  - Eliminates the need to add lime to biosolids prior to land application.
  - Reduces biosolids odors, making land application program more acceptable.
- Eliminates transportation and tipping fees to haul biosolids to distant landfill.
- Produces biogas to generating electricity/heat for use on site.
- Potential for additional revenue from acceptance of outside wastes.