Issue Paper 14 Preliminary Recommendations and Implementation Plan

14.1 Background

During the last nine months, R. W. Beck has evaluated and presented to the SWAC a variety of technologies and strategies to reduce, reuse, recycle and/or compost solid waste on Kauai through 2020. Based on the feedback R. W. Beck received from the SWAC and our professional experience, our preliminary recommended programs and strategies to accomplish this goal are included in Section 14.3.

While the goal of the County and the SWAC is to minimize the amount of waste that requires disposal, a portion of the waste stream will still require some type of final disposal. To determine the most appropriate type of final disposal facility for Kauai, R. W. Beck first analyzed four different alternatives to landfill disposal. These alternatives included:

- Anaerobic Digestion (AD)
- Waste-To-Energy (WTE)
- Pyrolysis/Gasification
- MSW Composting

Attachment A is a matrix that represents an overview of each of these alternatives that was presented to the SWAC in March of 2006.

Based on the feedback received from the SWAC, R. W. Beck narrowed this list to two preferred technologies for further consideration, WTE and AD, R. W. Beck then developed planning level cost estimates and facility sizing requirements for both of these alternatives. During the July, August and September SWAC meetings, SWAC members reviewed this technical information, which included operations, costs and support system requirements associated with WTE and AD. This information is summarized in issue papers 10 and 10A (Attachments B and C).[1]

At the September SWAC meeting, the SWAC and R. W. Beck discussed the status of commercially operating AD facilities in the United States. Based on feedback from the SWAC, our research and the limited time that the County has to replace the Kekaha Landfill, R. W. Beck recommended that the County not pursue AD at this time. In addition, the SWAC requested that R. W. Beck evaluate the financial feasibility of a WTE facility that would receive only County collected solid waste. Finally, the SWAC requested that the planning level costs and facility site acreage requirements associated with WTE be compared to the continued use of a landfill for the ultimate disposal of County waste.

[1] Since these issue papers were initially distributed to the SWAC, some numbers have been updated to reflect more recent costs for disposal of non-combustibles and ash at a monofill. Also, some terminology has been modified to clarify the WTE system. The numbers and semantics in Issue Paper 14 reflect the most recent data and terminology.

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Therefore, based on the results of the September SWAC meeting, R. W. Beck conducted a comparative analysis of the following disposal technologies:

- WTE facility that would receive all County solid waste;
- WTE facility that would receive only County collected solid waste; and,
- Landfill that would receive all County solid waste.

14.2 Final Disposal Options

As previously discussed, the final disposal options evaluated, with input from the SWAC, included:

1. A WTE Facility for all County-disposed waste, including non-combustibles and ash;
2. A WTE Facility for only County collected and disposed waste, including non-combustibles and ash; and,
3. A new Subtitle D Landfill for all County disposed waste.

Table 14-1 summarizes the cost and land use requirements associated with each option. The key assumptions are then summarized in Section 14-2.

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Table 14-1
Disposal Option Comparisons

	WTE Facility for All County-Disposed Waste	WTE Facility for Only County-Collected Disposed Waste[1]	Landfill for All County Disposed Waste[1]
2011 Projected Waste Receipts	115,430 tons	50,800 tons	115,430 tons
Development Costs for WTE or landfill	$88 to $98.3 million	$38 to $43 million	$9.8 million for first cell $17.3 million for additional three cells Total – $27.1 million
Developing Costs for an Upfront Mixed Waste Recycling Processing Facility	$13 to $15.5 million	An upfront, mixed waste recycling processing facility is not included in this option[1]	An upfront recycling processing facility is not included in this option[1]
2011 Expenses for WTE or landfill[2]	$16.2 to $18.5 million	$8.0 to $9.1 million	$8.8 million
2011 Expenses for Upfront Mixed Waste Recycling Facility[2]	$4.5 to $5.3 million	An upfront mixed waste recycling facility is not included in this option[1]	An upfront mixed waste recycling facility is not included in this option[1]
2011 Energy Produced	44 million kWh to 49 million kWh[3]	21 million to 23 million kWh [4]	The landfill will not produce enough methane gas to generate energy
2011 Energy Revenue from WTE facilities and landfills[5]	$6.1 to $6.8 million	$2.7 to $3.0 million	$0
2011 Revenues from Upfront Mixed Waste Recycling Facility	$0[6]	An upfront mixed waste recycling facility is not included in this option	An upfront mixed waste recycling facility is not included in this option
Net Annual Costs (Expenditures Minus Revenues) for a WTE facility or landfill	$10.1 to 11.7 million	$5.3 to $6.1 million	$8.8 million
2011 Tipping Fee for WTE or landfill ($/ton)	$87 to $101	$104 to $120	$76
2011 Tipping Fee for an Upfront Mixed Waste Recycling Facility ($/ton)	$39 to $46	An upfront mixed waste recycling facility is not included in this option	An upfront mixed waste recycling facility is not included in this option
Waste Requiring Disposal	27,000 to 30,000 tons of non-combustible waste and ash.	14,000 to 17,000 tons non-combustible waste and ash[7]	115,430 tons of solid waste

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Table 14-1
Disposal Option Comparisons

	WTE Facility for All County-Disposed Waste	WTE Facility for Only County-Collected Disposed Waste[1]	Landfill for All County Disposed Waste[1]
Land Requirements	78 Square Acres[8]	66 Square Acres[9]	158 Square Acres[10]

Notes
[1] These options do not include a pre-processing facility due to lower waste quantities for the "County only" option and the recommendation that the County develop a curbside recycling program if the "landfill" option is recommended.
[2] Includes debt service and O&M costs
[3] Based on 475-525 kWh per ton combusted and 93,498 tons of waste combusted.
[4] Based on 450 to 500 kWh per ton combusted and 45,710 tons of waste combusted.
[5] Based on $0.131 per kWh. This value is what the Renewable Energy Technology Assessments report issued by KIUC in 2005 projected for 2011.
[6] The County does not currently receive revenue from recyclables.
[7] Does not include the approximately 65,000 tons of commercial waste that will require disposal.
[8] Based on 16 square acres for a lined monofill with a life of 20 years and 62 acres for a 500 foot buffer surrounding the lined monofillo.
[9] Based on 8 square acres for a lined monofill with a life of 20 years and 50 acres for a 500 foot buffer surrounding the lined monofillo.
[10] Based on 60 square acres for a lined landfill with a life of 20 years and 98 acres for a 500 foot buffer surrounding the lined monofillo.

14.2.1 WTE for All County Disposed Waste

The data in this section represent planning level cost estimates to determine a range of first-year tipping fees for the WTE facility that is designed to accept all solid waste in the County that requires disposal. This data is not intended for project financing, but is intended for comparison to other alternative technologies. If the County decides to move forward with the development of the proposed WTE facility, a more detailed analysis would need to be completed. For planning purposes, the implementation time required for the proposed facility is estimated at approximately five years.

- 10 percent of the incoming material would be considered "non-combustible" and disposed at a monofill;
- Mixed Waste Recovery Facility:
  - 10 percent of the incoming material would be recycled;
  - The WTE facility would be initially sized to process 450-tpd of waste. Long-term the facility could require expansion; and,
  - In 2011, the WTE facility will receive approximately 115,430 tons of material, 10 percent of which will be sorted out in the pre-processing facility and 10 percent of which will be recycled.
- WTE Combustion Capacity:
  - 90 percent annual facility availability factor;
  - At the 450-tpd rated capacity, the WTE facility will combust a maximum of 147,800 tons per year with the assumed availability factor; and,

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- In 2011, the WTE facility will combust approximately 94,000 tons.

- WTE Capital Cost. The estimated capital cost includes provision for the construction of the WTE facility excluding electrical interconnection for energy recovery. The 450-tpd facility would consist of two furnace-boilers. The estimate assumed the following components:
  - No direct costs for land for facility site;
  - Waste Receiving and Storage – three days enclosed waste storage;
  - Waterwall Furnace-Boilers – grate, low NOX units, SNCR systems, flue gas recirculation, auxiliary fuel burners, and economizers;
  - Air Pollution Control Equipment – spray dryers, baghouses, carbon injection, continuous emissions monitoring system, and stack; and,
  - Balance of Plant – operations control center, metals recovery from residue, 14-MW turbine-generator, air-cooled condenser, and water treatment system.
- Capital "Hard" Cost – $170,000 to $190,000 per tpd of installed capacity for 450-tpd, which is equivalent to approximately $76.5 to $85.5 million.
- Mixed Waste Recycling Facility Capital "Hard" Cost - $25,000 to $30,000 per tpd of installed capacity for 450 tpd, which is equivalent to $11.3 to $13.5 million.
- WTE Project Development "Soft" Cost – 15 percent of the capital cost includes engineering, permitting, financing, air emission offsets, spare parts, start-up, and contingency, which is equivalent to $11.5 to $12.8 million.
- Mixed Waste Recycling Facility Project Development "Soft" Cost – 15 percent of the Capital Cost includes engineering, permitting, financing, air emission offsets, spare parts, start-up, and contingency, which is equivalent to $1.7 to $2.0 million.
- Annual Debt Service Requirements:
  - Financing costs of 2 percent of the principal amount of the bond issue;
  - Interest rate on the bonds of 5 percent;
  - Revenue bonds a repayment period of 20 years; and,
  - Level debt service payments for 20 years.
- Operating & Maintenance (O&M) Expenses:
  - The O&M expenses include provision for labor, parts and supplies, extraordinary renewals and replacements, general and administration, operator profit, electricity, fuel, and "normal" pass-throughs such as chemicals, insurance, and utilities. This does not include property taxes, host fees, or residue disposal;
  - Mixed Waste Recycling Facility O&M Expenses - $30 to $35 per ton of solid waste processed; and,
  - WTE Facility O&M Expenses – $60 to $70 per ton of solid waste processed and combusted at 450 tpd. O&M costs are based on industry standards that have been adjusted for facility size and location.

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- Pre-and post processing Waste Generation and Disposal:
  - For planning purposes, R. W. Beck estimates that all of the "non-combustibles" and residual ash will require monofill disposal, which is equivalent to 11,543 tons of "non-combustible" waste and 14,025 to 18,700 tons of ash;
  - This monofill will require approximately 78 acres for the footprint and the supporting infrastructure (i.e. roads, leachate management) and buffer for 20 years of disposal capacity. Of that acreage, 16 square acres will be for the lined monofill and 62 acres will be for a 500 foot buffer surrounding the lined monofill;
  - The lined monofill would be developed one cell at a time, with each cell requiring approximately four square acres each. The monofill would have a total of 4 cells, with each cell having a disposal capacity of 5 years; and,
  - Disposing of the "non-combustibles" waste and ash a monofill will cost the County $86 per ton based on an annual debt service of $0.9 million and O&M costs of $1.7 million divided by 30,243 tons.
- Electricity Production Capability and Revenues:
  - Net electrical generation will range from 475-525 kWh per ton of waste processed, assuming solid waste with a higher heating value ("HHV") of 5,000-5,200 Btu per pound; and,
  - In 2011, the facility would deliver the excess power to Kaua'i Island Utility Cooperative (KIUC) at the energy charge of $0.131 per kWh. This value was obtained from the Renewable Energy Technology Assessments report issued by KIUC in 2005. This report projected energy prices in Kauai for future years, including 2011.
- Mixed Waste Recovery Facility Revenues:
  - For this analysis, it was conservatively estimated that the County would not receive revenue from sale of recyclable materials recovered at the mixed waste recovery facility.
- Revenues from Post Processing Ferrous Metal Recovery:
  - R. W. Beck conservatively estimates no revenues being generated from the sale of ferrous metals.
- Schedule:
  - Three years to obtain permits, site facility, select a vendor, and obtain financing; and
  - Two years to construct and acceptance test the facility.

14.2.2 WTE for Only County Collected and Disposed Waste

The data in this section represent planning level cost estimates to determine a range of first-year tipping fees for the WTE facility that is designed to accept only County-collected solid waste in the County that requires disposal. This facility would not include a mixed waste recycling facility. R. W. Beck does not recommend a mixed waste recycling facility due to

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the reduced quantity of waste that would be available to divert recyclables, approximately 139-tpd. This quantity would not result in the County being able to benefit from the economies of scale associated with this type of facility. "Non-combustibles" would still be diverted from the WTE through pre-processing. Under this scenario, recyclables would be only diverted through curbside and drop-off recycling for residential recyclables, and point of generation and drop-off for commercial recyclables.

This data is not intended for project financing and is intended only for comparison to other alternative technologies. If the County decides to move forward with the development of the proposed WTE facility, a more detailed analysis would need to be completed. For planning purposes, the implementation time required for the proposed facility is approximately five years.

- WTE Processing Capacity:
  - Approximately 80 percent of the waste is received is combusted;
  - 85 percent annual facility availability factor;[2]
  - At the 225-tpd rated capacity, the WTE facility will combust a maximum of 82,125 tons per year with the assumed availability factor; and,
  - In 2011, the WTE facility will combust approximately 45,710 tons.
- WTE Capital Cost. The estimated capital cost includes provision for the construction of the WTE facility excluding electrical interconnection for energy recovery. The 225-tpd facility would consist of one furnace-boiler. The estimate assumed the following components:
  - No direct costs for land for facility site;
  - Waste Receiving and Storage – three days enclosed waste storage;
  - Waterwall Furnace-Boilers – grate, low NOX units, SNCR systems, flue gas recirculation, auxiliary fuel burners, and economizers;
  - Air Pollution Control Equipment – spray dryers, baghouses, carbon injection, continuous emissions monitoring system, and stack; and,
  - Balance of Plant – operations control center, metals recovery from residue, 14-MW turbine-generator, air-cooled condenser, and water treatment system.
- Capital "Hard" Cost – $170,000 to $190,000 per tpd of installed capacity for 225-tpd, which is equivalent to approximately $38.2 to $42.8 million.
- WTE Project Development "Soft" Cost – 15 percent of the capital cost includes engineering, permitting, financing, air emission offsets, spare parts, start-up, and contingency, which is equivalent to $5.7 to $6.4 million.
- Annual Debt Service Requirements:
  - Financing costs of 2 percent of the principal amount of the bond issue;

[2] The availability factor is less than a WTE facility for all waste because this facility would only have one boiler. For a WTE facility for all waste, the facility would have two boilers. Therefore, if one boiler is not operating, the second boiler could be used.

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- Interest rate on the bonds of 5 percent;
- Revenue bonds with a repayment period of 20 years; and,
- Level debt service payments for 20 years.

- Operating & Maintenance (O&M) Expenses:
  - The O&M expenses include provision for labor, parts and supplies, extraordinary renewals and replacements, general and administration, operator profit, electricity, fuel, and "normal" pass-throughs such as chemicals, insurance, and utilities. This does not include property taxes, host fees, or residue disposal; and,
  - WTE Facility O&M Expenses – $60 to $70 per ton of solid waste processed and combusted at 225 tpd. This is based on industry standards that have been adjusted for facility size and location.
- Pre-and post processing Waste Generation and Disposal:
  - For planning purposes, R. W. Beck estimates that all of the "non-combustibles" and ash will require monofill disposal, which is equivalent to 5,079 tons of "non-combustible" waste and 9,142 to 11,428 tons of ash;
  - This monofill will require 58 acres for the footprint and the supporting infrastructure (i.e. roads, leachate management) and buffer. Of that acreage, 8 square acres will be for the lined monofill and 50 acres will be for a 500 foot buffer surrounding the lined monofill;
  - The lined monofill would be developed two cells at a time, with each cell requiring approximately two square acres; and,
  - Disposing the "non-combustible" waste and ash a monofill will cost the County $102 per ton based on an annual debt of approximately $770,000 and an O&M cost of approximately $925,000, and 16,507 tons of waste.
- Electricity Production Capability and Revenues:
  - Net electrical generation will range from 450-500 kWh per ton of waste processed, assuming solid waste with a higher heating value ("HHV") of 5,000-5,200 Btu per pound; and,
  - In 2011, the facility will deliver the excess power to Kaua'i Island Utility Cooperative (KIUC) at the energy charge of $0.131 per kWh. This value was obtained from the Renewable Energy Technology Assessments report issued by KIUC in 2005. In future years, KIUC will likely begin paying a capacity charge as well.
- Revenues from Post Processing Ferrous Metal Recovery:
  - R. W. Beck conservatively estimates no revenues being generated from the sale of ferrous metals.
- Schedule:
  - Three years to obtain permits, site facility, select a vendor, and obtain financing; and,
  - Two years to construct and acceptance test the facility.

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14.2.3 Landfill for County Waste

The overall costs for development of a new landfill may not necessarily be financed over a 20-year period. The needed development costs may be identified and funded as each new cell is developed and the previous used cells closed. This approach impacts the overall cost estimates. For comparative purposes we have assumed a landfill with 20 years of capacity would be financed, and a total of four cells would be developed. Each cell would be developed one at a time. The two cells would have 5 years of capacity and development costs for each cell would be financed for 5 years.

To construct a new landfill on Kaua‘i, the County would need to construct a lined landfill with leachate collection, as well as related facility infrastructure (e.g., roads, scale house, offices, etc.). These costs do not include real estate or permitting costs.

- In 2011, the facility will receive 115,430 tons of solid waste.
- The components of the landfill will include:
  - A 60 acre lined landfill and 98 acres for a 500 foot buffer surrounding the landfill,
  - Administrative offices,
  - One leachate collection pond,
  - Scale house and maintenance building,
  - Two scales,
  - Access roads, and,
  - A public drop-off area for solid waste, green waste and recyclables.
- Capital Development “Hard Costs” for first cell, which include site development and construction of the first cell and closure of the first cell, but does not include the purchase of land. Construction costs include excavation, installing the liner, leachate collection and methane gas recovery systems - $8.5 million.
- Capital Development “Hard Costs” for each additional cell, which includes construction and closure of each cell - $5 million per cell, but does not include the purchase of land.
- The base and the crown elevations of the new landfill will be similar to the Kekaha Landfill
- The side slopes of the landfill are $3^{1/2:}1$ (horizontal to vertical).
- The air space utilization factor is 1,300 pound per cubic yard.
- Each cell will require 15 acres and have a 5 year life expectancy.
- The lined landfill will ultimately be comprised of 4 cells for a total of 60 square acres of lined landfill with 260,000 cubic yards of capacity.
- A 500 foot buffer will surrounding the lined landfill and will require 98 square acres.
- The total acreage required for the landfill is 158 acres.
- Capital Development “Hard Costs” for the 20-year life of the facility - $38.6 million.

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- Capital Development "Soft" Costs for the 20-year life of the facility – 15 percent of the Capital Costs includes engineering, siting, permitting and financing, which are equivalent to $5.6 million.
- Annual Debt Service Requirements:
  - Financing costs of 2 percent of the principal amount of the bond;
  - Interest rates on the bonds of 5 percent;
  - Revenue bonds with 5 years of operation for the each cell and a principal repayment period of 5 years; and,
  - Level debt service payments for 5 years.
- Operating & Maintenance (O&M) Expenses:
  - The O&M expenses include provision for labor, parts and supplies, administration, operator profit, electricity, fuels, Insurance and utilities; and,
  - The O&M Expenses - $56 per ton based on annual O&M costs divided by tonnage.
- Schedule:
  - Three years to obtain permits, site facility, select a vendor, and obtain financing; and,
  - Two years to construct the facility.

14.3 Recommended Programs and Strategies

As previously discussed, the recommended disposal facility will receive waste that cannot be reduced, reused, recycled, or composted. Therefore, R. W. Beck recommends the following programs and/or strategies[3] be implemented regardless of the final disposal option selected for implementation. Table 14-2, summarizes these recommendations by program or strategy.

14.3.1 Year 1

- Currently the County's solid waste management program administrative staff that is funded by the County includes a solid waste programs administrator, a recycling coordinator, contract specialist, coordinator and clerk[4]. To fully implement the Integrated Solid Waste Management Plan, R. W. Beck recommends an expansion of the staff during the first year of plan implementation to include:
  - A deputy assistant to the solid waste programs administrator to oversee Plan implementation, procurement of service providers, siting of solid waste facilities, communicating with other County offices and DOH, program budgets and performance; and,

[3] Details on these programs were provided to the SWAC through the planning process in the form of "Issue Papers" and PowerPoint Presentations.

[4] A bottle redemption coordinator works for the County, but is funded by the state.

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- A community/business waste diversion specialist to conduct residential/commercial education and outreach, facility recycling at special events, oversee special waste management and collection events for HHW and electronics, manage Kauai recycles, the County green waste programs, and County procurement policies; work with businesses and the hospitality industry to increase recycling, modify County ordinance to facilitate business recycling, design and institute a tourist recycling program, enforce bans targeted toward business.

- Contract with a collection management firm to assist the collection supervisor implement the automated collection program and revise relevant ordinances.
- Begin redesigning transfer stations to accommodate the establishment of drop-off recycling, and possibly redemption centers, at all transfer stations.
- Evaluate the feasibility of increasing the number of redemption centers in the County.
- Procure residential curbside recycling. R. W. Beck recommends that the County contract for curbside recycling services. If the County waste is delivered to a WTE facility with a pre-processing/recycling facility, R. W. Beck recommends that County only subsidize a small portion of the host to provide service to households. The remaining costs would be born by households who desire the curbside recycling service. If County waste is delivered to a WTE facility without a pre-processing/recycling facility, R. W. Beck recommends that the County subsidize a significant portion or all of the cost of this service.
- Evaluate procuring point of generation recycling collection for commercial establishments.
- Promote the Aloha Shares Network to encourage the reuse of consumer products.
- Conduct operational efficiency study.
- Work with hospitality industry to develop a tourist recycling campaign.
- Begin modifying County solid waste ordinances to address:
  - Allowing commercial establishments to use the recycling drop-off sites;
  - Requiring businesses of a certain size or producing a minimum amount of recyclable material to establish recycling programs for glass, cardboard, and green waste;
  - Prohibiting the disposal of commercially generated cardboard, green waste, and glass at the Transfer Stations (with minimum amount in loads defined);
  - Defining the amount of cardboard in a commercial load that is banned from disposal (i.e. loads containing a minimum of 1 cubic yard loose old corrugated cardboard (OCC));
  - Requiring waste haulers and recyclers to obtain a hauler's license;
  - Modifying ordinance penalty fees; and,
  - Restructuring commercial tipping fees at the landfill and transfer stations to encourage the recycling of commercial green waste, bottle bill containers and corrugated cardboard.

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- Evaluate consolidating County collected recyclables and recyclables generated by small retailers with recyclables that they are backhauling by large retailers to the mainland (i.e. OCC).
- Develop and implement a program to assist businesses in complying with pending SW ordinances.
- Evaluate activity in the backyard composting program, order more composting bins, and actively promote the program.
- Establish a once a year electronics collection/recycling event.

14.3.2 Year 2

- Implement automated refuse collection system in Lihue.
- Use non-utilized crews and rear load packer trucks to provide every other week curbside green waste collection in Lihue.
- Upgrade Kapaa Transfer Station.
- Work with other Hawaii Counties to establish electronic producer responsibility legislation.
- Develop and implement a program to facilitate recycling at special events.
- Allow small businesses and farmers to bring farm-related chemicals to the HHW collection events for a fee.
- Disseminate public information on the proper handling, storage and disposal of home medical wastes, particularly sharps.
- Strengthen County's recycled product procurement policies and practices.
- Institute modified innovative recycling grant program.

14.3.3 Year 3

- Implement automated refuse collection system in Kawaihau and North Shore.
- Use non-utilized crews and rear load packer trucks to provide every other week curbside green waste collection in Kawaihu and North Shore.
- Upgrade Hanalei Transfer Station.
- Implement a Source Reduction promotion campaign.
- Promote "food waste to animal feed" program to local farmers and restaurants.
- Assist private composting facilities with food waste composting.
- Fund a feasibility study to identify concerns and barriers associated with developing markets for compost by-product.
- Combine recycling drop bin locations, deposit beverage container redemption centers, and transfer stations.

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14.3.4 Year 4

- Implement automated refuse collection system in Koloa-Poipu-Kalaheo and West Side.
- Use non-utilized crews and packer trucks to provide every other week green waste collection in Koloa-Poipu-Kalaheo and West Side.
- Identify site for a centralized, composting facility.
- Initiate permitting process for a centralized, composting facility.
- Upgrade Hanapepe Transfer Station.
- Develop a permanent facility for HHW and electronics recycling.
- Evaluate the County providing automated curbside, residential recycling.
- Adopt a County product stewardship policy and support State and national product stewardship efforts.
- Conduct a Cost of Service study to determine Pay-As-You Throw Rates.
- Begin modifying solid waste management ordinances to:
  - Establish PAYT fee structure;
  - Ban residential green waste from the landfill; and,
  - Evaluate disposal bans on commercial OCC.

14.3.5 Year 5

- Begin operations of centralized composting facility.
- Upgrade Lihue Transfer Station.
- If feasible, implement automated curbside residential recycling.
- Institute an island-wide, hybrid PAYT program for residential customers if feasible.

14.3.6 Year 6

- Promote expansion of Hawai‘i processing capacity and end-use demand for scrap tires.

14.3.7 Year 7

- Begin collecting pre-consumer commercial food waste and deliver to the centralized composting facility.
- Evaluate accepting biosolids at the centralized composting facility.

14.3.8 Years 8-10

- No new programs or strategies.
- Monitor and evaluate programs and strategies.

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14.3.9 Programs and Strategies by Functional Category

Table 14 -2 identifies the previously listed programs and strategies by functional category, and identifies the implementation year for each.

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Table 14-2: Programmatic Implementation Schedule

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Source Reduction	Promote the Aloha Shares Network to encourage the reuse of consumer products. Evaluate activity in the backyard composting programs, order more composting bins, and actively promote the program.				Institute an island-wide, hybrid PAYT program for residential customers.		
Recycling and Bioconversion[1]	Evaluate consolidating with large retailers to backhaul recyclables. Evaluate the feasibility of increasing the number of redemption centers in the County	Institute modified innovative recycling grant program. Procure residential curbside recycling Evaluate procuring point of generation recycling collection for commercial establishments		Identify site for a centralized, composting facility. Complete permitting process for a centralized, composting facility.	Begin operations of centralized composting facility.		Evaluate accepting biosolids at the centralized composting facility.
Special Waste Management		Disseminate public information on the proper handling, storage and disposal of home medical wastes, particularly sharps.					
Household Hazardous Waste/ Electronics Waste	Establish a once a year electronics collection/recycling event. Costs are approximately $50,000 to $60,000 to contract for collection and processing.	Allow farmers and small businesses to bring farm-related chemicals to the HHW collection events for a fee.		Develop a permanent facility for HHW and electronics recycling.			
Public/Business Education[2]	Develop and implement a program to assist businesses in complying with pending SW ordinances. Work with hospitality industry to develop a tourist recycling campaign.	Develop and implement a program to facilitate waste reduction and recycling at special events. Implement tourist recycling	Promote "food waste to animal feed" program to local farmers and restaurants Assist private composting facilities with food waste composting	Promote the reuse and recycling of pallets Educate residents on the PAYT program			
Collection Operations	Conduct operational efficiency study. Contract with a collection management firm to assist the County's collection supervisor implement the automated collection program and revise relevant ordinances.	Implement automated refuse collection system in Kawaihau and North Shore. Use non-utilized crews and packer trucks to provide every other week curbside green waste collection in Kawaihu and North Shore.	Implement automated refuse collection system in Koloa-Poipu-Kalaheo and West Side. Use non-utilized crews and packer trucks to provide every other week green waste collection in Koloa-Poipu-Kalaheo and West Side.	Evaluate feasibility of automated curbside, residential recycling.	If feasible, implement automated curbside residential recycling.		Begin collecting pre-consumer commercial food waste and deliver to the centralized composting facility ($400,000).
Landfill and Transfer Stations	Begin redesigning transfer stations to accommodate the establishment of drop-off recycling at all transfer stations.	Upgrade Kapaa Transfer Station ($2.5 million)	Upgrade Hanalei Transfer Station ($1.0 to $1.5 million).	Upgrade Hanapepe Transfer Station ($1.0 to $1.5 million).	Upgrade Lihue Transfer Station ($1 to $1.5 million).		

[1] Also see "Collections Operations" category for action items pertaining to curbside collection of green waste, automated residential curbside recycling, PAYT, and collection of commercial pre-consumer food waste, as well as the "Legislative/Ordinances" category for an item pertaining to a possible landfill ban of green waste.
[2] Also see "Collection Operations" category for the action item pertaining to promotion and education in support of a PAYT system.

Table 14-2: Programmatic Implementation Schedule

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Legislative/ Ordinances	Begin modifying County solid waste ordinances to address: a. Allowing commercial establishments to use the recycling drop-off sites; b. Requiring businesses of a certain size or producing a minimum amount of recyclable material to establish recycling programs for glass, cardboard, and green waste; c. Prohibiting the disposal of commercially generated cardboard, green waste, and glass at the Transfer Stations (w/ minimum amount in loads defined); d. Defining the amount of cardboard in a commercial load that is banned from disposal (i.e. loads containing a minimum of 1 cubic yard loose OCC spell-out); e. Requiring waste haulers and recyclers to obtain a haulers' license; f. Modifying ordinance penalty fees; and, g. Restructuring commercial tipping fees at the landfill and transfer stations to encourage the recycling of commercial green waste, bottle bill containers and corrugated cardboard.	Work with other Hawai'i counties to establish electronic producer responsibility legislation.		Begin modifying solid waste management ordinances to: ▪ Establish PAYT fee structure; and, ▪ Ban residential green waste from the landfill.			
Market Development		Strengthen County's recycled product County's recycled product procurement policies and practices	Conduct a feasibility study to identify concerns and barriers associated with using organic waste materials ($40,000).	Adopt a County product stewardship policy and support State and national product stewardship efforts.		Promote expansion of Hawaii processing capacity and end-use demand for scrap tires.	
Implementation Strategies	Expand County Solid Waste Planning/Program/Recycling Staff to include: a. A manager to oversee Plan implementation, procurement of service providers, siting of solid waste facilities, communicating with other County offices and DOH, program budgets and performance; b. A collection coordinator to oversee institution of automated collection of solid waste, improve the efficiency of County collection services, modify County ordinances to enhance County collection services, monitor County waste bans; c. A recycling coordinator to conduct residential/commercial education and outreach, facility recycling at special events, oversee special waste management and collection events for HHW and electronics, manage Kauai recycles and the County green waste programs; and, d. A business coordinator to work with businesses and the hospitality industry to increase recycling, modify County ordinance to facilitate business recycling, design and institute a tourist recycling program, enforce bans targeted toward business. Including benefits (50%), R. W. Beck estimates these positions to cost $300,000 annually.						

Attachment A

ALTERNATIVE SOLID WASTE REDUCTION TECHNOLOGIES MATRIX

R·W·BECK

Kaua‘i County ISWMP
Alternative Solid Waste Reduction Technologies Matrix

Technology	Applicability to Kaua‘i Waste Stream	Commercial Status	Risks (i.e., technology, environmental, financial)	Waste Diversion Potential
Anaerobic Digestion	Based on a 2006 waste characterization analysis, the overall waste stream is composed of nearly 70% of organics including, but not limited to, food waste, yard waste, paper, and wood. This estimate excludes the yard waste that is separated from the mixed refuse by homeowners and business that is managed separately at the various transfer stations. AD can be applied to this fraction of the waste stream to convert organics into biogas and digestate solids.	A few pilot facilities using MSW as feedstock have operated in the U.S. in the past. The wastewater treatment industry has used AD to manage biosolids and generate biogas for decades. There are more than 100 commercially operating facilities using the organic fraction of the MSW stream and/or organic industrial wastes located in Europe, with a few in other locations including Canada.	Technology risks may include inadequate materials processing because of an underperforming digestion process caused by contaminated feedstock, inadequate moisture content, etc. Environmental risks may include odor from pre-processing and/or digestion activities, exceedance of air emissions limits when using the biogas as a fuel, and the inability to site a facility due to perceived threats to water, air, and property values. Financial risks may include lack of markets for biogas and/or residues and failure to receive adequate quantities of materials to ensure needed economies of scale.	Volume reduction is projected up to 75% assuming the pre-processing of the feedstock to remove non-organics and the beneficial reuse of digestate (i.e., solid residues). Without beneficial use of the digestate, the potential is projected to be approximately 60%.

Kaua‘i County ISWMP
Alternative Solid Waste Reduction Technologies Matrix

Technology	Applicability to Kaua‘i Waste Stream	Commercial Status	Risks (i.e., technology, environmental, financial)	Waste Diversion Potential
Waste-to-Energy	Based on the 2006 waste characterization analysis, the overall waste stream is composed of approximately 85% combustible materials by weight. The moisture content analysis reflects ___ and the average BTU content is ___.	MSW combustion is a fully commercialized processing technology with nearly 90 WTE projects (mass burn and RDF) operating in the U.S. alone. Many others are operating throughout the world. Most of the facilities in the U.S. are sized to process, on average, approximately 1000 tons per day. Some smaller WTE facilities of less than 250 TPD (i.e. limited economies of scale) are operating in the U.S, but in many instances struggle to remain economically competitive with landfill disposal options. Many of these smaller WTE facilities have had to be retrofit for additional air pollution control equipment in the last decade, which has dramatically increased overall costs.	Technology risks may include inefficient energy production due to waste variability, as well as excessive unscheduled maintenance. Environmental risks may include odor at tipping floor/pre-processing stage, exceedance of air emissions limits, metals in ash, and inability to site a facility due to perceived threats to water, air, and property values. Financial risks may include high operating costs and variability in energy sales.	Volume reduction for mass burn WTE facilities is projected up to 90% with limited pre-processing to remove bulky items. Volume reduction for refuse-derived fuel facilities is up to 75% assuming pre-processing of the materials to remove the non-combustible wastes.

Kaua‘i County ISWMP
Alternative Solid Waste Reduction Technologies Matrix

Technology	Applicability to Kaua‘i Waste Stream	Commercial Status	Risks (i.e., technology, environmental, financial)	Waste Diversion Potential
Pyrolysis/Gasification	This technology process converts the carbon-based portion of the waste stream into a syngas that can be used to generate electricity or fuels. The carbon content of the waste stream has not been specifically measured. However, the organic content which is carbon- based composes approximately 70% of the waste stream. The carbon content of the overall waste stream would exceed this value.	There are a handful of commercially-operating gasification plants operating worldwide using MSW as feedstock. A small number of pilot facilities reportedly are operating or have operated in the U.S. using pre-processed MSW as feedstock to produce syngas. Operating data is very limited for the application of this technology to MSW and thus this technology is not considered fully commercialized. The technology has been used for other types of feedstock such as coal and uniform types of biomass. Plasma arc thermal gasification, a variation of conventional gasification, is reportedly planned for commercial use in Japan to manage pre-processed MSW and other types of homogeneous solid wastes, such as auto shredder fluff.	Technology risks may include inadequate materials processing because of underperforming gasification process due to lack of uniform feedstock and/or issues associated with scaling up demonstration projects. Environmental risks may include odor at the pre-processing stage, exceedance of air emissions when using the syngas as a fuel in a boiler, disposal or residues (i.e., char, silica, slag, and ash), and inability to site a facility due to perceived threats to water, air, and property values. Financial risks may include lack of markets for sales of syngas and uncertain capital and operating costs due to lack of full-scale projects with MSW as the feedstock.	Volume reduction for pyrolysis/gasification can theoretically reach up to 90% with limited pre-processing. However, limited operating data using MSW as feedstock exits to confirm this projection.

Kaua‘i County ISWMP
Alternative Solid Waste Reduction Technologies Matrix

Technology	Applicability to Kaua‘i Waste Stream	Commercial Status	Risks (i.e., technology, environmental, financial)	Waste Diversion Potential
MSW Composting	The overall waste stream has a disproportionately large quantity of compostable materials as compared to most other U.S. communities and their MSW streams. Food wastes, yard wastes and compostable paper alone compose nearly 30% of the waste stream. MSW aerobic composting converts the organic portion of the waste stream into a compost product that can have a beneficial reuse as a solid conditioner and/or erosion control.	MSW composting facilities were first developed in the 1960s in conjunction with the Solid Waste Disposal Act. A renewed interest in this technology emerged in the 1980s with many states passing legislation promoting landfill diversion and recycling. By the early 1990s there were more than 15 commercially- operating MSW composting facilities in the U.S. However, the overall number of MSW composting facilities has not grown over the last decade. In 2000, *BioCycle* reported 16 commercially-operating MSW composting facilities. The trend in solid waste composting over the last five years has been the development of source-separated organic composting facilities for residential and commercial organics programs in such communities as San Francisco, Oakland, San Jose, and Seattle.	Technology risks may include limited materials decomposition because of insufficient pre-processing of non-combustibles. This occurrence may result in extensive quantities of residuals needing disposal. Environmental risks may include odor from pre-processing and/or the composting process, potential for metals in the compost end-product, and inability to site a facility due to perceived threats to water, air, and property values. Financial risks may include lack of markets for the compost by-product and failure to receive adequate quantities of materials to ensure economies of scale.	Volume reduction for MSW composting is projected up to 70% assuming the pre-processing of the feedstock to remove the non-combustibles and the successful marketing of the compost by-product for beneficial reuse. The actual operating history of many MSW composting facilities over the last 10 to 15 years has generally reflected a volume reduction level less than 70%. However, the development of source-separated organics composting facilities offers an opportunity for greater volume reduction.

Attachment B

WASTE TO ENERGY OPTION

R·W·BECK

10.1 Introduction

The Waste–To-Energy (WTE) industry emerged in the United States in the 1970s due to several factors. The Arab Oil Embargo resulted in oil and energy prices increasing substantially. There was also increasing recognition of the potential risks of groundwater contamination at existing unlined landfills. This led to new regulations requiring the construction of lined sanitary landfills, which increased solid waste landfilling costs. WTE facilities were considered viable alternatives for waste disposal and energy production. In 1980, less than 60 WTE facilities were operating. By 1993, the number of operating facilities reached a peak of approximately 150. From 1993 to present, the number of operating WTE facilities has declined to approximately 89 due to several factors, including:

- An abundance of landfill space with lower tipping fees than WTE facilities,
- The loss of ordinance-based flow control through the Carbone versus Clarkstown United States Supreme Court case decision,
- The implementation of more stringent federal air quality standards, and
- The issuance of federal guidelines for municipal combustion residue monitoring, sampling, and testing.

According to the United States Environmental Protection Agency (USEPA), WTE facilities process approximately 12 percent of all municipal solid waste generated in the United States.

Presented below is a discussion of the materials flow, technology, and planning assumptions we have made in evaluating the potential costs associated with a WTE facility to serve the County. Although many hybrids exist, three basic types of WTE facilities were developed to combust and recover energy from solid wastes. From an air emissions regulatory standpoint, the USEPA refers to these sources as “municipal waste combustors.” The basic types include: (1) mass burn waterwall, (2) mass burn modular, and (3) refuse-derived fuel-fired waterwall (RDF). Mass burn waterwall and modular facilities typically do not preprocess waste. Waste is introduced directly from a stockpile into the feed chute of the combustion chamber. RDF facilities shred and process waste into a homogeneous mixture for metering into the combustion units. Due to economies of scale, RDF processing and dedicated boiler facilities typically have larger capacities. For example, H-POWER is a 2,000-ton-per-day RDF processing and combustion facility located on O‘ahu. Due to the projected processing capacity of the WTE facility to serve Kaua‘i, the mass burn waterwall technology was

selected for this analysis. Mass burn modular technology was not selected because it does not offer long-term reliability (more than 20 years) and does not have the history of producing higher pressure steam for efficient electric generation.

It is important to note that the last "greenfield"[1] WTE facility utilizing mass burn technology was constructed in the United States from 1993 to 1995 in Montgomery County, Maryland. Since that date, many WTE vendors have exited the business (Westinghouse, Foster Wheeler, and General Electric) and with Covanta's recent acquisition of American Ref-Fuel, there are only five major companies in the United States with experience in the construction and operation of WTE facilities: Barlow Projects, Covanta Energy, Energy Answers, Montenay Power, and Wheelabrator Technologies. Barlow Projects has entered the market retrofitting several smaller WTE facilities. In the early 2000s, a number of older WTE facilities began to implement retrofits to continue operating beyond 20 years. In 2006, a complete retrofit is expected for an 800-ton-per-day (tpd) WTE facility in the City of Harrisburg, Pennsylvania. Lee County, Florida is proceeding with adding a 600-tpd unit to expand a WTE facility.

Higher energy prices have resulted in a renewed interest in new WTE projects as it is a processing option that is less impacted, in a negative manner, by rising oil prices. In fact, dependent upon: (1) the terms of a power sales agreement between the County and the electric utility purchasing the electricity produced by a WTE facility; and (2) the type of fuel used by the electric utility, increasing fuel costs may result in higher energy revenues for a WTE facility. The potential impact is often even less for those WTE facilities that are selling energy in the form of steam rather than electricity, when the price of steam is pegged to the price of an alternative fuel.

10.2 Material Flow

WTE facilities generally have two methods of waste receiving and storage as follows:

1. Tipping floor with pit for waste storage with overhead cranes to charge the furnace-boilers; and,
2. Tipping floor for waste unloading and storage with elevated conveyors to charge the furnace-boilers.

The planning period for a WTE facility is generally 20 years minimum. However, several mass burn WTE facilities in the United States have operated beyond 20 years. For purposes of this analysis, this option relied on the solid waste quantity projections provided in Table 2-2. The waste receipts in Table 2-2 reflect all of the residential and commercial waste that is projected to be annually disposed. Because the County collects less than 50 percent waste stream and "flow control" by ordinance may not be an option, the County should contract with private waste haulers to guarantee waste receipts.

The first year of operation for a new WTE facility on Kaua'i was set at 2011 to account for the projected timeframe needed for siting and project development. The

[1] Greenfield refers to land not previously developed for commercial or industrial use.

2020 disposal quantity projections were extrapolated 10 years to 2030 as shown in Table 10-1. The table uses the following assumptions:

- For the first 10 years (2011 – 2020) of operation, the two-unit WTE facility will have sufficient processing capacity;
- For the second 10 years (2021 – 2030) of operation, a third identical unit could be added to provide sufficient processing capacity;
- Initially, the size of the electric generating system will meet the capacity of the expanded WTE facility;
- The WTE facility will have a 90 percent availability factor due to scheduled and unscheduled equipment outages;
- The WTE facility will produce 15 (minimum) to 20 (maximum) percent residue by weight from waste processed;
- Minimize bypassing "unprocessable" waste from the WTE facility for disposal in the landfill;
- The WTE facility will receive all the commercial and residential waste that requires disposal on the Island; and,
- All waste will be initially delivered to a pre-processing/mixed waste processing facility that will separate and dispose approximately 10 percent of "unprocessable" waste, which will be landfilled. An additional 10 percent of the waste entering the pre-processing facility will be separated for recycling using automated and manual sorting methods. For example, aluminum cans will be automatically retrieved using an Eddy current separator, and tin cans will be recovered using magnets. Conversely, large corrugated cardboard and plastic bottles will be manually recovered through a conveyor system. R. W. Beck does not recommend trying to recover glass bottles, as much of the glass will be broken, which substantially deceases its market value and may pose an injury to workers.

The projected waste receipts, recycled, "unprocessable," and "processable" quantities, and average processing capacities required by year are provided in Table 10-1.

Table 10-1
Projected Quantities for Mass Burn Waste-to-Energy Facility with Preprocessing/Mixed Waste Recovery Facility

Year	Disposal Rate (pcd) (1)	Waste Receipts Quantity (tpy) (2)	Unprocessable Quantity (tpy) (3)	Waste Delivered to Preprocessing/ Mixed Waste Recovery Facility (tpy) (4)	Front-end Recovered Materials (tpy) (5)	Processable Quantity (tpy) (6)	Average Processing Capacity (tpd) (7)	Processed Quantity (tpy) (8)	Minimum Combustion Residue Quantity (tpy) (9)	Maximum Combustion Residue Quantity (tpy) (10)
2011	6.65	115,430	11,543	103,887	10,389	93,498	285	93,498	14,025	18,700
2012	6.84	120,670	12,067	108,603	10,860	97,743	298	97,743	14,661	19,549
2013	7.04	126,260	12,626	113,634	11,363	102,271	311	102,271	15,341	20,454
2014	7.24	132,090	13,209	118,881	11,888	106,993	326	106,993	16,049	21,399
2015	7.45	138,330	13,833	124,497	12,450	112,047	341	112,047	16,807	22,409
2016	7.68	144,940	14,494	130,446	13,045	117,401	357	117,401	17,610	23,480
2017	7.92	151,860	15,186	136,674	13,667	123,007	374	123,007	18,451	24,601
2018	8.17	159,240	15,924	143,316	14,332	128,984	393	128,984	19,348	25,797
2019	8.43	167,020	16,702	150,318	15,032	135,286	412	135,286	20,293	27,057
2020	8.69	175,210	17,521	157,689	15,769	141,920	432	141,920	21,288	28,384
2021	8.73	175,017	17,502	157,515	15,751	141,763	432	141,763	21,265	28,353
2022	8.92	180,699	18,070	162,629	16,263	146,366	446	146,366	21,955	29,273
2023	9.12	186,381	18,638	167,743	16,774	150,969	460	150,969	22,645	30,194
2024	9.32	192,063	19,206	172,857	17,286	155,571	474	155,571	23,336	31,114
2025	9.52	197,745	19,775	177,971	17,797	160,174	488	160,174	24,026	32,035
2026	9.72	203,427	20,343	183,085	18,308	164,776	502	164,776	24,716	32,955
2027	9.92	209,110	20,911	188,199	18,820	169,379	516	169,379	25,407	33,876
2028	10.12	214,792	21,479	193,313	19,331	173,981	530	173,981	26,097	34,796
2029	10.32	220,474	22,047	198,427	19,843	178,584	544	178,584	26,788	35,717
2030	10.52	226,156	22,616	203,541	20,354	183,187	558	183,187	27,478	36,637

(1) Disposal Rate in pounds per capita per day equals Disposal Quantity times 2000 lbs/ton divided by 365 days/year divided by De Facto Population.
(2) Disposal Quantity in tons per year equals Generation Quantity in Table 2-2 minus projected Diversion Quantities.
(3) Unprocessable Quantity in tons per year is 10% by weight of the Disposal Quantity.
(4) Waste Delivered to Preprocessing/Mixed Waste Recovery Facility is Disposal Quantity less Unprocessable Quantity in tons per year.
(5) Front-end Recovered Materials prior to combustion in tons per year are 10% times Waste Delivered to the Preprocessing/Mixed Waste Recovery Facility.
(6) Processable Quantity equals Disposal Quantity less Unprocessable Quantity and Front-end Recovered Materials in tons per year.
(7) Average Processing Quantity in tons per day equals Processable Quantity in tons per year divided by 365 days per year and 90% facility capacity availability.
(8) Processed Quantity is the Processable Quantity up to the rated facility processing capacity in tons per year times a 90% annual availability factor.
(9) Minimum Combustion Residue Quantity is the Processed Quantity in tons per year times 15% on a weight basis after back-end ferrous metal recovery.
(10) Maximum Combustion Residue Quantity is the Processed Quantity in tons per year times 20% on a weight basis after back-end ferrous metal recovery.

The facility and unit sizes were selected for the option analysis as follows:

1. For the first 10 years of operation, a 450-tpd WTE facility will comprise two 225-tpd processing units. The annual facility processing capacity will be approximately 147,800 tons per year.
2. For the second 10 years of operation, a 675-tpd WTE facility could comprise three 225-tpd processing units. The annual facility processing capacity will be approximately 221,700 tons per year.

If recycling diversion increases substantially or future waste generation is less than projections, the County may delay the addition of the third processing unit at the WTE facility.

10.2.1 Technology Overview

A 450-tpd mass burn WTE facility will consist of a large building, including enclosed waste receiving and storage area, furnace-boiler room, central operations control center, water treatment area, turbine-generator hall, and residue storage area. An air-cooled condenser, two independent air emissions control systems, a continuous emissions monitoring system enclosure, and single stack with multiple flues will be located outdoors behind the large building. Initially, the facility will include two 225-tpd mass burn waterwall furnace-boiler units with available space to expand the waste receiving and storage enclosure, and potentially add a third identical processing unit. The turbine hall will include a single 14-Megawatt (MW) turbine-generator rated at the anticipated maximum facility processing capacity of 675 tons per day. To conserve valuable water resources on Kaua‘i, an air-cooled condenser was selected to cool the steam turbine exhaust. The WTE facility will be situated on a minimum 8- to 10-acre site surrounded by additional buffer area. The ideal selected site should exist near a major road for ease of access, water supply source, wastewater discharge point to treat wastewater, and electrical interconnection. The design of a new WTE facility can incorporate on-site wastewater reuse.

In addition, a pre-processing facility/mixed waste recovery facility will be located adjacent to the WTE. At the first stage, “unprocessable” (i.e., large, bulky) solid waste is separated from the “processable” waste. Solid waste components that will classified as “unprocessable” include demolition/renovation/construction debris, durables, household hazardous wastes, and special wastes. County has existing program to accept the durables, household hazardous wastes, and special wastes.

Next, recyclables will be recycled from the waste stream using a combination of manual and automated recovery systems. R. W. Beck estimates that 10 percent of the waste stream will be recovered for recycling at the preprocessing/mixed waste recovery facility. Finally, ferrous metals will be recovered from the back end residue for recycling.

10.2.2 Applicability to the Waste Stream

“Unprocessable” (i.e., large, bulky) solid waste is separated in the waste receiving area for recycling or landfill disposal. Based on the 2005 solid waste composition

presented in Table 2-8, for purposes of this analysis, a WTE facility could not process approximately 10 percent by weight of the solid waste generated on the island. The

Based on previous experience and reviewing the compositional data, the anticipated energy content (higher heating value) of the "processable" solid waste will range from 5,000 to 5,200 Btu per pound. Food waste is the highest moisture laden component with the lowest energy value and the least desirable of the potential "processable" waste components for the WTE facility. Therefore, the County should target food waste for diversion. Because food waste is over 14 percent of the waste stream, diversion programs should be instituted before the facility is designed as they may impact processing requirements.

10.2.3 Environmental Considerations

USEPA's maximum achievable control technology (MACT) requirements mandated that WTE facilities with large units (i.e., >250 tpd) comply with new Clean Air standards on or before December 19, 2000. Small unit facilities (i.e., 35 tpd to < 250 tpd) had to meet less stringent MACT rules no later than November 6, 2005. On April 28, 2006, the USEPA issued a more stringent rule that large unit facilities must satisfy within three years. The USEPA would consider the proposed units for the Kaua'i WTE facility as small units. Commercially available technologies can satisfy the stringent requirements for air emission control.

In addition, the WTE facility would have to meet the State's air quality requirements of Chapter 11-60.1 Hawai'i Administrative Rules (HAR), Subchapter 5 – Covered Sources. Relating to the State's solid waste regulations, the WTE facility must comply with HAR Section 11-58.1-20. The WTE facility will require obtaining air quality and solid waste permits to construct and operate.

Odor control is accomplished by drawing combustion air from the tipping area, and the odor-causing compounds are destroyed in the furnace-boiler units. Industry standard combustion practices will minimize formation of organics (i.e., dioxins and furans). The air emission control system will reduce emissions of nitrogen oxides ($NO_{x)}$, mercury, acid gases, organics, and particulate matter) using:

- Aqueous ammonia or urea injection for selective non-catalytic reduction SNCR, reducing NO_x emissions;
- Activated carbon injection to adsorb vaporized mercury and organics;
- Lime spray dryer to absorb acid gases, such as sulfur dioxide (SO_2) and hydrochloric acid (HCl); and,
- Fabric filter, for removal of particulate matter, including fly ash and reaction products from the spray dryer.

A continuous emissions monitoring system will record the major emissions from the WTE facility. The State Department of Health will require annual stack testing for all regulated emissions. In addition, the agency will require periodic sampling and lab analysis of the residue.

10.3 Residuals

For purposes of this analysis, a WTE facility with a pre-processing/mixed waste recovery facility that captures "unprocessable" and recyclable waste on the front-end would process approximately 80 percent by weight of the solid waste.

Generally, the bottom ash from the furnace grate and fly ash from the air emissions control system are combined. Based on the 2005 solid waste composition presented in Table 2-8, for purposes of this analysis, the potential feedstock for a WTE facility has a 3 percent ferrous content by weight. A back-end ferrous recovery system will remove metal from the combustion residue to reduce landfill disposal cost and increase diversion. Ferrous recovery will vary between 50 to 70 percent by weight. Depending on the inert content of the feedstock, the WTE facility will produce combined residue that is 15 to 20 percent by weight of the material processed. Table 10-1 presents minimum and maximum annual quantities of processing residue by weight produced by the WTE facility.

Combustion residue from H-Power on O‘ahu is disposed of in a monofill cell at the Waimanalo Gulch landfill. For this option, Kaua‘i would likely need to develop a monofill cell at the Kekaha Landfill to dispose of combustion residue from the proposed WTE facility. Using combustion residue as alternative daily cover would require approval from the State Department of Health. [Some states in the mainland US allow use of combustion residue as ADC. We are not aware that Oahu has sought approval for this reuse.]

10.3.1 Planning Level Cost Estimate

The data in this document represent planning level cost estimates to determine a range of first-year tipping fees for the WTE facility. This data is not intended for project financing and is intended for comparison to other alternative technologies. If the County decides to move forward with the development of the proposed WTE facility, a more detailed analysis would need to be completed. For planning purposes, the implementation time required for the proposed facility is approximately five years.

- Pre-Processing/Mixed Waste Recovery Facility
  - 10 percent of the incoming material would be considered "unprocessable" and disposed;
  - 10 percent of the incoming material would be recycled;
  - The facility would be initially sized to process 450-tpd of waste. Long-term the facility could require expansion.
  - In 2011, the facility will process approximately 115,400 tons of material
- WTE Processing Capacity
  - Approximately-80 percent of the waste that is received for processing;
  - 90 percent annual facility availability factor;

- At the 450-tpd rated capacity, the WTE facility will process a maximum of 147,800 tons per year with the assumed availability factor;
- In 2011, the WTE facility will process approximately 94,000 tons;

- WTE Capital Cost. The estimated capital cost includes provision for the construction of the WTE facility excluding electrical interconnection. The 450-tpd facility would consist of two furnace-boilers. The estimate assumed the following components:
  - No direct costs for land for facility site
  - Waste Receiving and Storage – three days enclosed waste storage
  - Waterwall Furnace-Boilers – grate, low NO_X units, SNCR systems, flue gas recirculation, auxiliary fuel burners, and economizers
  - Air Pollution Control Equipment – spray dryers, baghouses, carbon injection, continuous emissions monitoring system, and stack
  - Balance of Plant – operations control center, metals recovery from residue, 14-MW turbine-generator, air-cooled condenser, and water treatment system
  - Pre-processing/Mixed Waste Recovery Facility Capital "Hard" Cost - $25,000 to $30,000 per tpd of installed capacity for 450 tpd (2011 dollars) which is equivalent to $11.3 to $13.5 million.
  - WTE Capital "Hard" Cost – $170,000 to $190,000 per tpd of installed capacity for 450-tpd (2011 dollars), which is equivalent to approximately $76.5 to $85.5 million.
  - Pre-processing/Mixed Waste Recovery Facility Project Development "Soft" Cost – 15 percent of the Capital Cost includes engineering, permitting, financing, air emission offsets, spare parts, start-up, and contingency, which is equivalent to $1.7 to $2.0 million.
  - WTE Project Development "Soft" Cost – 15 percent of the Capital Cost includes engineering, permitting, financing, air emission offsets, spare parts, start-up, and contingency, which is equivalent to $11.5 to $12.8 million.
- Annual Debt Service Requirements
  - Financing costs of 2 percent of the principal amount of the bond issue
  - Interest rate on the bonds of 5 percent
  - Revenue bonds with 20 years of operation and a principal repayment period of 20 years
  - Level debt service payments for 20 years
- Operating & Maintenance (O&M) Expenses
  - The O&M expenses include provision for labor, parts and supplies, extraordinary renewals and replacements, general and administration, operator profit, electricity, fuel, and "normal" pass throughs such as

chemicals, insurance, and utilities. This does not include property taxes, host fees, or residue disposal.

  - Pre-processing/Mixed Waste Recovery Facility O&M Expenses - $30 to $35 per ton of solid waste processed.
  - WTE Facility O&M Expenses – $60 to $70 per ton of solid waste processed at 450 tpd (2011 dollars).

- Pre-processing Waste Generation and Disposal
  - For planning purposes, R. W. Beck estimates that all of the "unprocessable" waste will require landfill disposal at $70 per ton.
- Post-Processing Combustion Residue Generation and Disposal
  - 15-20 percent (on a weight basis) of the solid waste processed will require landfill disposal as combustion residue. In 2011, the facility will generate approximately 14,000 to 18,700 tons of residue [The quantities vary each year per Table 10-1].
  - In 2011, Kaua'i County will dispose of the residue at a monofill cell in the landfill for $70 per ton if the material can not be used as daily cover.
- Electricity Production Capability and Revenues
  - Net electrical generation will range from 475-525 kWh per ton of waste processed, assuming solid waste with a higher heating value ("HHV") of 5,000-5,200 Btu per pound.
  - In 2011, the facility will deliver the excess power to Kaua'i Island Utility Cooperative (KIUC) at the energy charge of $0.131 per kWh. This value was obtained from the *Renewable Energy Technology Assessments* report issued by KIUC in 2005. In future years, KIUC will likely begin paying a capacity charge as well.
- Pre-Processing/Mixed Waste Recovery Facility Revenues
  - For this analysis, it was conservatively estimated that the County would not receive revenue from materials recovered at the pre-processing/mixed waste recovery facility.
- Post-Processing Revenues
  - R. W. Beck conservatively estimates no revenues being generated from the sale of ferrous metals.
- Schedule
  - Two years to obtain permits, site facility, select a vendor, and obtain financing
  - Three years to construct and acceptance test the facility

Table 10-2 presents the planning level cost analysis for the first-year operation of the 450-tpd WTE facility in 2011 that includes a pre-processing/mixed waste recovery facility. For comparison to other technology options, the first-year cost analysis offers

sufficient detail. The selected technology option may warrant a more in-depth life cycle analysis. The anticipated tipping fees ranges from approximately $111 to $131 per ton of solid waste received. To expand the facility to 675-tpd by 2020 or later, Kaua‘i County would need to issue additional bonds for adding the third 225-tpd processing unit.

Table 10-2
450-tpd Waste-To-Energy Facility with Preprocessing/Mixed Waste Recovery Facility
2011 First -Year Planning Level Operating Cost Analysis
($ Million)

Expense	Low	High
Debt Service	$8.2	$9.2
O&M Cost	$8.7	$10.2
Unprocessable Waste Disposal	$0.8	$0.8
Combustion Residue Disposal	$1.0	$1.3
Total Expenses	$18.7	$21.5
Revenue		
Electricity Sales (1)	$5.8	$6.4
Total Revenues	$5.8	$6.4
Net Cost ($)	$12.9	$15.1
Tipping Fee ($/ton) (2)	$111	$131

Note: Totals may not add due to rounding.
(1) Electricity Sales include an energy charge payment but not a capacity charge payment.
(2) Tipping Fee was calculated using the 115,430 tons of solid waste received in 2011.

Attachment C

ANAEROBIC DIGESTION OPTION

R·W·BECK

10.1 Introduction

Anaerobic Digestion (AD) in the broadest sense is a process to degrade organic material in the absence of oxygen. Therefore, AD breaks down the organic fraction of waste. This includes paper, yard waste, food waste, and other organic wastes. The process of AD can be accelerated in landfills through the implementation of a bioreactor. However, this section focuses on "in vessel" AD. The following discussion will examine organic feedstocks, processes, products/byproducts, environmental issues, current facilities, and applicability to Kauai's waste stream.

Methane is emitted from anthropogenic sources such as agriculture (rice fields, animal breeding and fattening), combustion, and landfills. AD not only provides pollution prevention opportunities, but also produces reusable byproducts methane (i.e., medium Btu biogas) and digestate (i.e., fibrous byproduct and water). The process requires thermal energy to heat the digesters and electricity to operate the ancillary equipment, while engine-generators combust the biogas cogenerating electricity and thermal energy. Overall, AD is a net energy producer. The potential also exists for the reuse of the residual fiber as compost. The technology has been applied extensively to the management of biosolids. As the application of the technology continues to mature, AD is becoming a viable method for promoting waste reduction, energy recovery of biomass, and useable byproducts.

Worldwide, more than 130 large AD plants operate that digest the organic fraction of the municipal solid waste (OFMSW) stream and/or organic industrial wastes. All but approximately five of these installations are located in Europe. Various AD technologies are operational, including wet and dry digestion processes with single and multiple stages. No commercial-scale AD facilities are presently operating in the United States that use municipal solid waste or OFMSW as feedstocks.

Presented below is a discussion of the materials flow, technology, and planning assumptions we have made in evaluating the potential costs associated with an AD facility to serve the County. A wide variety of engineered systems have been specifically developed for the rapid "in vessel" digestion of the OFMSW and other types of organic wastes. Most systems operate in the thermophilic (122°F-131°F) state to accelerate performance. Each has its own special benefits and constraints. Although many hybrids exist, six basic types of AD systems reduce volume and recover energy from solid wastes. The basic types include: (1) wet single-step, (2) wet multi-step, (3) dry continuous, (4) dry sequencing batch, (5) dry one-step, and (6) percolation (dry two-step). Anaerobic digestion is operational at over 130 locations throughout Europe primarily to manage OFMSW, yard wastes, food wastes, organic

industrial wastes, sludges, and manures. The primary applications of the wet single-step systems are to co-digest source-separated OFMSW with a liquid substrate such as manure or sewage sludge. This system is not typically used for the AD of the full OFMSW stream. Generally, wet digestion is only economically feasible when the residual liquids can be reused. Contrastingly, the dry one- and two-step systems can usually manage OFMSW effectively. Considering the characteristics of the organic feedstock available in Kaua‘i, the dry one-step system with mechanical treatment was selected for this analysis due to the lower moisture content of the feedstock.

10.2 Material Flow

AD facilities generally use enclosed tipping floors to stockpile the OFMSW prior to processing. The life expectancy for AD facilities is generally 15 to 20 years. For purposes of this analysis, this option relied on the residential and commercial solid waste quantity projections through 2020 provided in Tables 4-5 and 4-15 in Section 4.3.B and adjusted the generation quantities based on the amount of each waste stream that the facility may receive[1]. The first year of operation for a new AD facility on Kaua‘i was set at 2011 to account for the projected timeframe needed for siting and project development. The analysis in Table 10-1.B uses the following assumptions:

- For the first 10 years (2011 – 2020) of operation, the multiple units of the AD facility will have sufficient processing capacity;
- For the second 10 years (2021 – 2030) of operation, potentially expand the AD facility to provide sufficient processing capacity;
- The AD facility will have a 90 percent availability factor due to scheduled and unscheduled equipment outages;
- The mechanical preprocessing system will mechanically remove 5 percent as unacceptable materials by weight for landfill disposal;
- After biological post-processing, the AD facility will produce 10 (minimum) to 20 (maximum) percent residue by weight from waste processed; and,
- The AD facility will minimize bypassing processable waste to the landfill for disposal.

The projected processable quantities and average daily processing capacities required by year are provided in Table 10-1.B

R. W. Beck selected facility sizes for the option analysis as follows:

1. For the first 10 years of operation, a 110-tpd AD facility will comprise multiple processing units. The annual facility processing capacity will be approximately 36,100 tons per year in 2011.

[1] R. W. Beck estimated that the facility would receive 90 percent of the residential green wastes generated and 50 percent of the residential food waste and non-recyclable, but compostable paper.

Table 10-1
Projected Quantities for Anaerobic Digestion Facility

Year	Green Waste Diverted (tpy) (1)	Residential Food Waste Diverted (tpy) (2)	Commercial Food Waste Diverted (tpy) (2)	Non-Recyclable Paper Diverted (tpy) (2)	Biosolids Diverted (tpy) (2)	Total Organic Fraction Received (tpy) (3)	Processable Quantity (tpy) (4)	Preprocess-ing Residue (tpy) (5)	Average Processing Capacity (tpd) (6)	Processed Quantity (tpy) (7)	Minimum Residue Quantity (tpy) (8)	Maximum Residue Quantity (tpy) (9)
2011	12,910	3,825	4,144	4,386	1,790	27,055	25,702	1,353	78	25,702	2,570	5,140
2012	13,130	3,998	4,331	4,579	1,869	27,906	26,511	1,395	81	26,511	2,651	5,302
2013	13,340	4,177	4,525	4,778	1,950	28,770	27,332	1,439	83	27,332	2,733	5,466
2014	13,580	4,367	4,731	4,990	2,037	29,705	28,219	1,485	86	28,219	2,822	5,644
2015	13,800	4,565	4,945	5,210	2,127	30,646	29,114	1,532	89	29,114	2,911	5,823
2016	14,040	4,770	5,167	5,438	2,220	31,634	30,052	1,582	91	30,052	3,005	6,010
2017	14,270	4,982	5,397	5,674	2,316	32,640	31,008	1,632	94	31,008	3,101	6,202
2018	14,500	5,203	5,636	5,919	2,416	33,674	31,990	1,684	97	31,990	3,199	6,398
2019	14,740	5,436	5,890	6,179	2,522	34,767	33,029	1,738	101	33,029	3,303	6,606
2020	15,000	5,684	6,158	6,455	2,635	35,932	34,135	1,797	104	34,135	3,414	6,827
2021	15,163	5,722	6,199	6,498	2,653	36,234	34,423	1,812	105	34,423	3,442	6,885
2022	15,385	5,905	6,397	6,702	2,736	37,125	35,269	1,856	107	35,269	3,527	7,054
2023	15,608	6,088	6,595	6,905	2,819	38,015	36,115	1,901	110	36,115	3,611	7,223
2024	15,831	6,270	6,793	7,109	2,902	38,906	36,960	1,945	113	36,960	3,696	7,392
2025	16,054	6,453	6,991	7,313	2,985	39,796	37,806	1,990	115	37,806	3,781	7,561
2026	16,277	6,636	7,189	7,516	3,068	40,687	38,652	2,034	118	38,652	3,865	7,730
2027	16,500	6,819	7,387	7,720	3,151	41,577	39,498	2,079	120	39,498	3,950	7,900
2028	16,723	7,002	7,585	7,924	3,235	42,468	40,344	2,123	123	40,344	4,034	8,069
2029	16,945	7,185	7,783	8,127	3,318	43,358	41,190	2,168	125	41,190	4,119	8,238
2030	17,168	7,367	7,981	8,331	3,401	44,249	42,036	2,212	128	42,036	4,204	8,407

(1) Green Waste Diverted in tons per year (tpy) is from Table 4-5 in Section 4B.
(2) Assumes 50% of Food Waste (Residential and Commercial), Non-Recyclable Paper, and Biosolids Diverted (wastewater treatment sludge) in tons per year per Table 4-15 in Section 4B. From Table 4-14, the Residential Food Waste and Commercial Food Waste Diverted are 48% and 52% of the total food waste by weight diverted.
(3) Total Organic Fraction Received is the sum of Green Waste, Residential Food Waste, Commercial Food Waste, Non-recyclable Paper, and Biosolids Diverted in tons per year.
(4) Processable Quantity in tons per year equals Total Organic Fraction Diverted less 5% Preprocessing Residue.
(5) Preprocessing Residue in tons per year is the Total Organic Fraction Received times 5%.
(6) Average Processing Capacity in tons per day equals Processable Quantity in tons per year divided by 365 days per year and 90% facility capacity availability.
(7) Processed Quantity is the Processable Quantity up to the rated facility processing capacity in tons per year times a 90% annual availability factor.
(8) Minimum Residue Quantity is the Processed Quantity in tons per year times 10%.
(9) Maximum Residue Quantity is the Processed Quantity in tons per year times 20%.

2. For the second 10 years of operation, the AD facility could add another processing unit. The annual facility processing capacity will be approximately 55,800 tons per year by 2021.

If the diversion of the OFMSW is less than projections, the County may delay the addition of another processing unit at the AD facility.

10.2.1 Technology Overview

A 110-tpd AD facility will consist of a medium size building, including an enclosed waste receiving and storage area (includes adequate ventilation to address odors), digester area and ancillary equipment room, operations control center, utilities service area, biogas engine-generator area, and residue storage area. Windrow composting of the AD process residue will occur on a large concrete pad outdoors with storm water control. Odor control measures will be implemented such as a biofilter. The composted residue will require an on-site storage area for curing. Initially, the facility will include multiple digesters with available space to expand the waste receiving and storage enclosure, and potentially add another identical processing unit and biogas engine-generator.

The AD facility will be situated on a minimum 12- to 15-acre site surrounded by additional buffer area. The ideal selected site should exist near a major road for ease of access, water supply source, wastewater discharge point to treat wastewater, and electrical interconnection.

10.2.2 Applicability to the Waste Stream

Section 4B identified the following components as possible organic components for feedstock to the AD facility:

- Green waste
- Residential food waste
- Non-Recyclable, but compostable paper
- Biosolids (wastewater sludge)

In addition, commercial waste sources are expected to divert approximately 60 percent of their food waste to the AD facility.

Program experience in Europe and the United States has shown that comprehensive source separation of organics provides the best quality feedstock for either composting or AD, with a minimum of heavy metal and plastic contamination. Where source separation has been mandated in Europe, the results have been encouraging. The experience of some European communities indicates that 30-50 percent of the total OFMSW can be successfully collected and managed separately.

The most applicable characteristics of AD feedstock are used when the organic fraction can be collected at the source of generation, (e.g., food processing industries, pulp and paper mills, etc.). In addition to minimal contamination, the waste

composition using this approach is more consistent over time for achieving steady biogas production. This is optimal for conversion into a useful energy byproduct.

As proposed in Section 4B, the County would provide wet-dry collection service to the residents. The haulers will deliver the wet or OFMSW to the AD facility. The facility will process the organic fraction with mechanical treatment to remove contaminants for landfill disposal. For purposes of this analysis, the AD facility will remove 5 percent contaminants by weight through mechanical preprocessing for landfill disposal. Even with source separation by waste generators. Some preprocessing will continue to be necessary.

10.2.3 Volume Reduction and Diversion Potential

AD facilities can result in an 80-90 percent volume reduction of the organic solid waste received. Potentially, mixed municipal solid waste could be received at AD facility and a "dirty" materials recovery facility (MRF) could be integrated into the facility to process the non-organics. However, this approach creates greater risks as it relates to the quality of the feedstock, directly impacts biogas production, increases the capital investment, and increases the quantities of residue. As a result, as an alternative, the proposed approach for Kauai County includes separation of these materials at the source. The "processable" quantities shown in Table 10.1.B reflect the latter approach, where organics would be separated at the source.

10.2.4 Environmental Considerations

As with other solid waste processes, the AD facility may emit fugitive dust (particulate matter) and odors associated with the materials handling components of the process. Depending on the extent of potential fugitive dust, proper industrial ventilation design and control with a baghouse may be required. Organic emissions and odors in material handling areas may also require local ventilation and control with activated carbon systems. Assuming that the process vents are completely leak-free, no air emissions or odor nuisances will occur from the AD process since it is fully enclosed. A scrubber will remove hydrogen sulfide and moisture directing the cleaned biogas (composed primarily of methane) to a low NO_x reciprocating engine to cogenerate electricity and thermal energy to heat the digesters. Combustion of the biogas will result in emissions of nitrogen oxides (NO_x), carbon monoxide (CO), volatile organic compounds (VOC), particulate matter, and sulfur dioxide (SO_2).

The AD facility would have to meet the State's air quality requirements of Chapter 11-60.1 Hawai'i Administrative Rules (HAR), Subchapter 5 – Covered Sources. Relating to the State's solid waste regulations, the AD facility must comply with HAR Sections 11-58.1-32 Recycling and Materials Recovery Facilities and 11-58.1-41 Composting Facilities. The AD facility will require obtaining air quality and solid waste permits to construct and operate.

The AD process will produce some wastewater, which would need treatment and disposal. Proper process design and moisture management can minimize this byproduct to a negligible level or eliminate this stream. In some instances, the

moisture resulting from the process has been treated and used for irrigation or reintroduced into the composting process for the residue.

10.3 Residuals

The coproducts of the AD process are a medium Btu content biogas and a slurry called digestate. The biogas contains approximately 50-70 percent methane and is water saturated. The balance of the biogas mixture is carbon dioxide, and some parts per million (ppm) of hydrogen sulfide. The digestate consists of undigested solids, cell mass, soluble nutrients, other inert materials, and water.

As previously discussed, for purposes of this analysis, an AD facility would process approximately 95 percent of the diverted organic wastes received by weight. The preprocessing system mechanically separates unacceptable material, which is disposed of at the landfill. The system would employ bag breaking and screening. Depending on the volatile content and quality of the feedstock, the AD facility will produce combined residue that is 10 to 20 percent by weight of the material processed. After the digestion process, the post-processing of the resulting residue will occur. The post-processing system includes mechanical dewatering followed by biological treatment by windrow composting outdoors for 10-15 days. The final product will be sold as soil conditioner. Table 10-1.B presents annual quantities of preprocessing and post-processing (minimum and maximum) residues by weight produced by the AD facility.

10.3.1 Planning Level Cost Estimate

The data in this document represent planning level cost estimates to determine a range of first-year tipping fees for the AD facility. This data is not intended for project financing and is intended for comparison to other alternative technologies. If the County decides to move forward with the development of the proposed AD facility, a more detailed analysis would need to be completed. For planning purposes, the implementation time required for the proposed facility is approximately five years.

The planning level cost estimate for the AD system uses the following assumptions:

- Waste Processing Capacity
  - 90 percent annual facility availability factor;
  - At 110 tpd rated capacity, the facility will process a maximum of 36,100 tons per year with the assumed availability factor;
  - In 2011, the facility will receive approximately 27,100 tons of materials and process approximately 25,700 tons of the OFMSW; and,
  - The approximate difference (1,400 tons) between OFMSW received and OFMSW processed will be landfill disposed at $70 per ton.
- Capital Cost. The estimated capital cost includes provision for the construction of the facility, excluding electrical interconnection. The 110-tpd facility would consist of multiple digesters. The estimate assumed the following components:

- No direct costs for land for the facility site
- Waste receiving and storage – three days enclosed waste storage with odor control
- Preprocessing – minimal mechanical separation to remove unacceptable materials
- Digesters – operations control center, pumps, heaters, and other ancillary equipment
- Post-processing – mechanical dewatering, outdoor windrow composting on concrete pad, and storm water controls
- Biogas engine-generators – gas scrubbers, low NO_X units, switchgear, auxiliary fuel oil handling and storage system, continuous monitoring system, and stack
- Capital "Hard" Cost – $320 to $390 per annual ton of installed capacity for approximately 40,200 tons (2011 dollars), which is equivalent to $12.8 to $15.7 million
- Project Development "Soft" Cost – 15 percent of the capital cost includes engineering, permitting, financing, air emission offsets, spare parts, start-up, and contingency, which is equivalent to $1.9 to $2.3 million

- Annual Debt Service Requirements
  - Financing costs of 2 percent of the principal amount of the bond issue
  - Interest rate on the bonds of 5 percent
  - Revenue bonds with 20 years of operation and a principal repayment period of 20 years
  - Level debt service payments for 20 years
- Operating & Maintenance (O&M) Expenses
  - The O&M expenses include provision for labor, parts and supplies, extraordinary renewals and replacements, general and administration, operator profit, electricity, fuel, and "normal" pass throughs such as chemicals, insurance, and utilities. This does not include property taxes, and host fees.
  - O&M Expenses – $40 to $45 per ton of solid waste processed (2011 dollars)
- Residue Disposal Expenses and Reuse Re
  - A mechanical preprocessing system will remove 5 percent residue (on a weight basis) of the solid waste received for landfill disposal. In 2011, the preprocessing system will remove approximately 1,400 tons of residue.
  - A biological post-processing system will produce 10-20 percent residue (on a weight basis) of the solid waste processed. Seventy-five percent of the compost may potentially sell as a soil conditioner at $10 per ton. The unsold

material is used as alternative daily cover at the landfill. In 2011, the facility will generate approximately 2,600 to 5,100 tons of process residue.

- Electricity Production Capability and Revenues
  - Net electrical generation will range from 120-150 kWh per ton of waste processed.
  - In 2011, the facility will deliver the excess power to Kaua‘i Island Utility Cooperative (KIUC) at the energy charge of $0.131 per kWh. This value was obtained from the *Renewable Energy Technology Assessments* report issued by KIUC in 2005. In future years, KIUC will likely begin paying a capacity charge as well.
- Schedule
  - Two years to obtain permits, site facility, select a vendor, and obtain financing.
  - Three years to construct and acceptance test the facility.

Table 10-2.B presents the planning level cost analysis for the first-year operation of the 110-tpd AD facility in 2011. For comparison to other technology options, the first-year cost analysis offers sufficient detail. The selected technology option may warrant a more in-depth life cycle analysis. The anticipated tipping fees range from approximately $72 to $82 per ton of solid waste processed. R. W. Beck estimates approximately $2,300,300[2] in annual operating and container costs to provide separate collection for 27,055 tons of residential and commercial organics. This yields an additional system cost of per ton of $85 per ton that should be considered when evaluating this system.

[2] Based on 2005 costs

Table 10-2.B
110-tpd Anaerobic Digestion Facility
2011 First -Year Planning Level Operating Cost Analysis
($ Million)

Expense		Low	High
Debt Service		$1.2	$1.5
O&M Cost		$1.1	$1.2
Preprocessing Residue Disposal		$0.1	$0.1
Total Expenses		$2.4	$2.8
Revenue			
Electricity Sale [1]		$0.4	$0.5
Compost Sale [2]		$0.02	$0.04
Total Revenues		$0.4	$0.5
Tipping Fee	($)	$1.9	$2.2
	($/ton) [3]	$72	$82

Note: Totals may not add due to rounding.
[1] Electricity Sale includes an energy charge payment but not a capacity charge payment.
[2] Compost Sale is 75% of the compost may potentially sell as a soil conditioner at $10 per ton on-site. The unsold material is used as alternative daily cover at the landfill.
[3] Tipping Fee was calculated using the 27,055 tons of solid waste received for processing in 2011.