Appendixes

Integrated Resources and Solid Waste Management Plan
The Path to Zero Waste

A Chronology for Waste Reduction Technology for Hawai`i County
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E Considerations for Siting a New Landfill in East Hawai`i
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H Energy Balance

Prepared for

County of Hawai`i

Final, December 2009

CH2MHILL

12/21/2009

APPENDIX A

Chronology for Waste Reduction Technology for Hawai`i County

EXHIBIT A-1

Chronology for Waste Reduction Technology for Hawai`i County

Date	Event/Document
1995	
3/19/1995	Notice to Proposers for RFP S-3227 (RFP #1)
1996	
12/16/1996	Letters notifying RFP S-3227 proposers of non-selection
12/16/1996	Letter to Norton Environmental notifying them of selection
2000	
8/6/2000	Notice to Proposers for Solid Waste RFP (RFP #2)
11/30/2000	Administration Recommendation to Council
2001	
1/1/2001	Department of Environmental Management established
1/2/2001	Administration Recommendation Withdrawal to Council
5/15/2001	Contracted with Harding ESE, Inc. to update the County's Integrated Resources and Solid Waste Management Plan (IRSWMP)
5/23/2001	Environmental Management Commission first meeting; meetings held monthly until May 2004, bi-monthly thereafter.
7/3/2001	First Solid Waste Advisory Committee (SWAC) meeting; meetings were held monthly through February 27, 2002
2002	
1/23/2002	East Hawai`i Regional Transfer Station drawings submitted to Council
4/30/2002	Regional Transfer Station update provided to Council Parks and Environmental Management Committee
5/20/2002	Draft of IRSWMP submitted to Council
8/19/2002	Public Meeting held in Kona regarding IRSWMP
8/20/2002	Public Meeting held in Waimea regarding IRSWMP
8/20/2002	Public Meeting held in Hilo regarding IRSWMP
10/15/2002	Two-day waste technology Vendor presentations to Council at Parks and Environmental Management Committee
11/6/2002	Final Draft of the Integrated Resources and Solid Waste Management Plan submitted to Council
11/20/2002	Council Resolution 238-02 to adopt Update to IRSWMP
11/29/2002	State released $1M CIP For East Hawai‘i Regional Sort Station and waste diversion planning
12/30/2002	Tipping Fee Increase request submitted to Council

EXHIBIT A-1

Chronology for Waste Reduction Technology for Hawai`i County

Date	Event/Document
2003	
1/8/2003	Two-day Comprehensive Planning & Visioning meeting for Solid Waste Division (1/8/2003-1/10/2003)
1/22/2003	Council Resolution 28-03. Setting landfill diversion goals with low-tech & high tech
3/3/2003	Two-day planning meeting Discussion: identifying major issues and articulating possible solution; decision made to procure Sort station independent of waste reduction technology.
3/19/2003	2003 GO Bonds authorizes $4M for Sort Station construction
4/15/2003	Executed Contract for design and EIS for Sort Station
4/23/2003	EIS Preparation Notice
6/30/2003	Design Forum for Recycling Services at EHRSS
9/22/2003	Sort Station Draft EIS published
10/9/2003	EMC and public tour of Oahu Solid Waste facilities, including Hpower
6/4/2003-12/17/2003	Public meetings held regarding Sort Station EIS
2004	
1/22/2004	Two-day Solid Waste Vision meeting (1/22/2004-23/2004)
2/23/2004	Final Environmental Impact Statement (EIS) for the East Hawai`i Regional Sort Station published by OEQC
5/2/2004	Notice of Request for Information for Solid Waste Reduction Technology
5/5/2004	Council Resolution 180-04 adopted
6/30/2004	RFI responses received
8/4/2004	Council approves Resolution that supports solid waste landfill diversion through waste reduction technology (WRT) with procurement criteria that matches Hawai‘i County policies, needs and waste stream, and delineates next actions.
8/4/2004	Award of CDBG Grant to upgrade certain transfer stations
10/13/2004	EMC and public tour of Oahu Solid Waste facilities, including Hpower
10/28/2004	First RFP evaluation committee meeting
10/29/2004	Notice to Offerors published for RFP 2146 (RFP #3)
12/7/2004	RFP for Waste Reduction Technology Hilo Landfill Site Tour & pre-proposal conference

EXHIBIT A-1

Chronology for Waste Reduction Technology for Hawai`i County

Date	Event/Document
12/10/2004	RFP 2146, Addendum No. 1
12/30/2004	RFP 2146, Addendum No. 2
2005	
1/21/2005	Response deadline for RFP 2146; Received Pacific Waste Proposal
1/26/2005	RFP evaluation committee meeting
2/4/2005	RFP evaluation committee meeting
2/16/2005	Additional questions and comments sent to proposers
3/10/2005	Pacific Waste response received to 2/16/05 questions
4/1/2005	RFP evaluation committee meeting
4/12/2005	RFP evaluation committee meeting
4/20/2005	County Council Executive Session
4/22/2005	Evaluation committee request to Purchasing Agent to cancel RFP and notify responders
4/28/2005	RFP 2146 solicitation cancelled by Purchasing Agent
4/29/2005	Letter from DEM to Council Chair requesting Executive Session
4/29/2005	Letter from Council Chair Higa to Council members transmitting 4/28/05, 4/7/05 and 4/26/05 communications from County and Barlow relating to RFP No. 2146.
5/3/2005	Letter from DEM to Isbell submitting requested C&C of Honolulu's RFP dated 2/14/03.
5/5/2005	Letter from Council member Jacobson to Stacy Higa, Council Chair, regarding open discussion of RFP process for Waste Reduction Technology, and Resolution 218-04.
5/9/2005	Council member Jacobson submitted a press release regarding the Waste Reduction Technology RFP
5/11/2005	Article regarding Solid Waste Reduction, West Hawai'i Today
5/16/2005	Letter from Mayor to Council relating to RFP cancellation and legal restrictions in the Procurement Code
12/28/2005	Issuance of Stage 1 Proposals - RFP#2210 (RFP #4)
2006	
3/20/2006	Received responses & transmitted to Evaluation Committee
5/1/2006	Issuance of Short List to receive Stage 2 RFP
5/8/2006	EISPN published in State OEQC Bulletin

EXHIBIT A-1

Chronology for Waste Reduction Technology for Hawai`i County

Date	Event/Document
6/7/2006	End of EISPN Public Comment Period
10/6/2006	Issuance of Stage 2 Proposals - RFP#2210
4/16/2007	Received responses & transmitted to Evaluation Committee
2/25/2008	Received and reviewed Wheelabrator's BAFO
3/4/2008	Awarded Contract to Wheelabrator Technologies
4/21/2008	Finance Committee forwarded Resolution 551-08 (authorizing payment for a multi-year contract for a WTE Facility) to Council with negative recommendation
3/25/2008- 4/15/2008	Public hearings held around the island
5/7/2008	Council votes 5-3 not to approve Resolution 551-08

APPENDIX B

Waste Composition Study County of Hawai`i

Final

Waste Composition Study
County of Hawai`i

Prepared by

CH2MHILL

In Association with
Sky Valley Associates

September 2008

Contents

SECTION 1

Introduction

The County of Hawai`i is updating its Integrated Solid Waste Management Plan. The plan will examine waste management options in the County. To aid in the evaluation of these options, CH2M HILL conducted this waste composition study to provide statistically valid data on the types and quantities of waste currently being disposed of at the West Hawai`i (Pu`uanahulu) Landfill. The field work for this study was performed by Sky Valley Associates.

This report presents the results of the waste composition study, which include composition estimates, both for the overall waste stream and for the transfer station, commercial, and self-haul wastes disposed at the landfill. The results are based on samples taken during May of 2008. A similar study was performed at the South Hilo Landfill in 2001[1]. We have used the results of that study to represent the composition of waste that enters the East Hawai`i landfill. The results are combined to provide waste composition estimates for total County disposal.

There are four major sections of this report. Section 1 briefly summarizes the project, including a description of the sources of disposed waste and the project methodology. Sections two through four provide sampling results for the overall waste stream; results for the transfer station, commercial, and self-haul substreams; and substream estimates for West Hawai`i and East Hawai`i.

Following the main body of the report are attachments that included detailed sampling results (Attachments A and B), descriptions of waste components (Attachment C), descriptions of the sampling methodology and calculations (Attachment D), and field sampling forms (Attachment E).

1.1 Sources of Disposed Waste

For analysis and planning purposes, landfill disposal quantities can be divided into substreams. A waste substream is defined according to its source of generation, its means of collection and transport to the disposal facility, or both[2]. For the purposes of this study, the waste disposed at the West Hawai`i Landfill was divided into the following three substream categories:

1. Transfer Station – This is waste hauled from one of nine transfer stations on the west side of the Island. It is transported to the West Hawai`i Landfill in transfer station compactor boxes. Transfer station loads are composed primarily of residential waste.

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[1] Cascadia Consulting Group, 2001. *Waste Composition Study, South Hilo Landfill, County of Hawai`i.*

[2] It should be noted that this study estimates the composition of waste disposed, not waste generated. Waste generation is equal to the sum of both the disposed and recycled amounts.

2. Commercial – This is waste hauled by commercial hauling companies. Commercial haulers use a variety of vehicles to transport this waste to the West Hawai`i Landfill, including packer trucks (garbage trucks), roll-offs (primarily open boxes), and other vehicles (e.g. flatbeds, pickups, etc.). This waste is collected both from residences and businesses.

3. Self-Haul – This is waste that residents, contractors, businesses, and public entities haul directly to the West Hawai`i Landfill. These loads are transported either in small vehicles (e.g. autos, pick-ups, etc.) or large vehicles (e.g. dump trucks, flatbeds, etc). As with waste in the commercial substream, self-haul waste comes from both residences and businesses. Waste from public agencies (such as the County of Hawai`i Parks Department) is also included in this category.

The waste stream was broken down further in the transfer station and commercial substreams as follows:

- During field sampling, samples taken from the transfer station substream were also recorded by station so that information about the waste composition at individual stations could be recorded. Note, however, the relatively few number of samples taken at any individual station make any resulting composition estimates highly uncertain: the results should be viewed accordingly.
- Samples from the commercial substream were divided among the three main vehicle types (packers, rolloffs, and other).

Each of the three substreams contributed a portion of the approximately 128,500 total tons of waste disposed at the West Hawai`i Landfill from July 2007-June 2008 (FY 2008). About 32 percent (or about 41,700 tons) of this waste was hauled from transfer stations. Commercial hauling companies disposed of nearly 63 percent (81,000 tons), and the remaining 5,900 tons (approximately 5 percent) were transported to the landfill by self-haulers.

1.2 Methodology

This section presents a summary of the sampling and calculation procedures used in this study. The complete sampling methodology including descriptions of the main calculations can be found in Attachment C. The procedures summarized in this section were used during the recent sampling event at the West Hawai`i Landfill. Sky Valley Associates conducted both the recent sampling event at the West Hawai`i Landfill and the 2001 sampling event at the South Hilo Landfill; the same procedures were used during both events.

1.2.1 Sampling Procedures

A sampling plan was developed to produce statistically valid composition data for the three substreams described above. A total of 100 samples were captured and sorted at the West Hawai`i Landfill on May 15, 16, and 19 through 21, 2008[3]. The allocation of these samples among the three substreams was determined according to each substream's contribution to

[3] Because all sampling occurred during May of 2008, these results do not account for any seasonal variation.

the total waste stream, with one exception. There is relatively little mixed self-haul material delivered to the West Hawai`i Landfill (1,200 of 128,000 tons in FY 2008, or less than 1 percent). Therefore, it was decided that overall sampling accuracy would be improved by using self-haul sampling results from the 2001 study to represent the composition of mixed self-haul loads in West Hawai`i, and assigning samples that would have been obtained from the self-haul stream to the other two substreams. The composition profile of mixed self-haul loads from the 2001 study was used to estimate the mixed self-haul composition for the West Hawai`i Landfill.

In addition to the mixed self-haul loads delivered to the West Hawai`i Landfill, there were about 4,700 tons of pure loads i.e., loads that could be assigned to a single waste component such as confidential documents or tires (or in the case of construction and demolition debris, assigned to a subset of the waste stream). The 2001 composition profile was applied only to the mixed self-haul loads: the pure loads were added to the mixed load profile resulting in a total self-haul profile.

Finally, adjustments were made so that a sufficient number of samples were taken from each substream and vehicle type to assure that sample data are representative of composition. The commercial substream was oversampled to account for the increased variability typically encountered in that substream.

Exhibit 1-1 presents the number of samples taken per day.

EXHIBIT 1-1
Samples per Day by Substream and Vehicle Type

	Number of Samples				
	Transfer Station	Commercial Packer	Commercial Rolloff	Commercial Other	Total
May 15, 2008	6	5	6	3	20
May 16, 2008	6	8	5	1	20
May 19, 2008	6	7	6	1	20
May 20, 2008	6	4	9	1	20
May 21, 2008	6	6	4	4	20
Total	30	30	30	10	100

All loads were systematically selected for sampling[4]. From each selected load, a 200- to 300-pound representative sample was hand-sorted into 58 prescribed component material categories, which were then weighed and recorded. Evidence of explosive or hard-to-process items was noted for each load. A listing and description of the component material categories is included in Attachment C. Exhibit 1-2 summarizes the number of samples and the total and average sample weight.

[4] Systematic sampling is outlined in more detail in Attachment B. In short, this procedure assures that the correct number of samples is taken randomly and throughout the day by selecting every “nth” vehicle from each substream (i.e. every 4th commercial packer truck).

EXHIBIT 1-2
Number of Samples, Total and Average Sample Weight

		Sample Weights (in pounds)	
	Sample Count	Total for All Samples	Average
Transfer Station	30	6,986	232.9
Commercial Packer	30	6,724	224.1
Commercial Drop Box	30	6,902	230.1
Commercial Other	10	2,376	237.6
Total	100	22,988	231.2

1.2.2 Calculations

A weighted averaging process was used to prepare the waste composition estimates in which composition percentages from substreams were multiplied by FY 2008 tons from that substream. The result is FY 2008 tons for each waste component in each substream.

Exhibit 1-3 presents a flow chart that summarizes the calculation process for the waste composition estimates. For West Hawai`i, composition estimates were calculated for the sample groups, the three substreams, and the overall waste stream using the linked procedure shown. For the transfer station substream, composition percentages were calculated for each of the nine transfer stations. Sample loads that came from each of the nine stations determined these composition percentages. The percentages were weighted according to the tons disposed by each station during FY 2008, and then pooled to produce an overall transfer station composition[5].

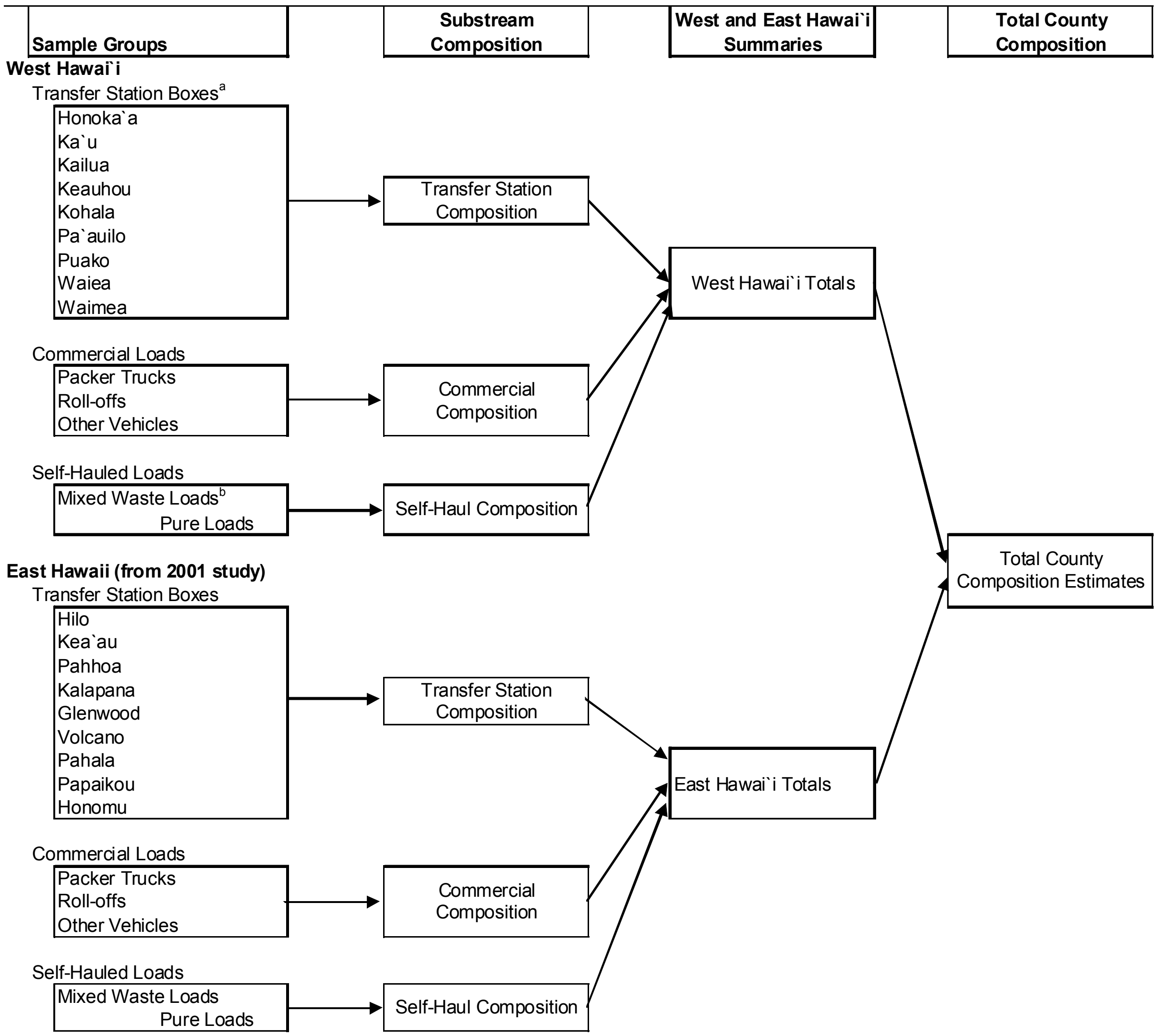
For the commercial haulers, separate composition percentages were calculated for three vehicle types: packer, roll-off, and other vehicles. These percentages were weighted according to the estimated tons disposed by each vehicle type during FY 2008. They were then combined to give composition percentages for the commercial substream.

For waste from East Hawai`i delivered to the South Hilo Landfill, the waste quantities by component were determined by multiplying the 2001 waste composition percentages by FY 2008 deliveries from each substream (transfer stations, commercial loads, and self-haul loads. As described above, pure loads delivered to the South Hilo Landfill were assigned to specific waste components.

The overall waste stream composition for West Hawai`i and East Hawai`i was calculated as an aggregate of the sample group compositions, which were weighted according to their tonnage contribution to the overall waste stream. Finally, a similar process is used to combine results from West Hawai`i and East Hawai`i into a total county waste composition profile.

[5] Tonnages from the West Hawai`i Landfill and the South Hilo Landfill provided all tonnages used to “weight” each sample group for this study. The weighting process is described in Attachment C.

EXHIBIT 1-3
Flow Diagram of Composition Calculations



[a]Not sampled because quantities were small. The 2001 composition was used for these loads.

[b]No waste was sampled from the Laupahoehoe, Miloli`i and Ke`ei stations. Tons from these stations were assigned a waste composition profile from one of the other stations.

For the West Hawai`i substreams, low and high estimates are shown that represent a 90 percent confidence level, meaning that there is a 90 percent certainty that the actual composition is within the calculated range[6]. In exhibits and charts throughout this report, the values graphed represent the mean component percentage, not the range.

[6] The low and high estimates could not be calculated for any profile that blends information from more than one East Hawai`i substream because the relative quantity of waste delivered to each substream has changed since 2001.

SECTION 2

Countywide Sampling Results

This section presents a summary of countywide composition results for the total waste stream and the three substreams (transfer stations, commercial, and self-haul), and includes data for both West and East Hawai`i. Most of this information is presented in one of the following two formats:

- A bar chart that depicts the composition by nine main waste *categories*: paper, glass, metal, plastic, organics, construction and demolition, household hazardous, special, and mixed.
- An exhibit that lists the ten largest of the 58 waste *components*, by weight.

More comprehensive exhibits that details the full composition results for the 58 component categories are presented in Attachment A (Exhibits A-1 through A-6).

2.1 Total County, West Hawai`i, and East Hawai`i Composition

Exhibits 2-1, 2-2, and 2-3 are bar charts that show the overall composition results for the nine main waste categories of waste disposed for the entire County, for West Hawai`i, and for East Hawai`i, respectively. When combined, organics and paper comprise more than half of the waste stream. Construction and demolition waste accounts for another 22% by weight. The construction and demolition category includes such components as clean lumber and gypsum scrap. The organics main waste category contains such components as food, textiles, and prunings.

The composition of waste disposed in West Hawai`i is similar to the composition of disposed waste in East Hawai`i. Two differences that merit mention include: there are more organics disposed of in West Hawai`i (35.3%) than in East Hawai`i (29.6%); and more special waste disposed of in East Hawai`i (5.2%) than in West Hawai`i (1.9%). The types of special wastes disposed most often in East Hawai`i include industrial sludge, bulky items, and tires (see Exhibit A-3 in Attachment A).

Exhibits 2-4, 2-5, and 2-6 show the ten largest waste components for the entire County, for West Hawai`i, and for East Hawai`i. In all three areas, the largest three components by weight are food, clean and treated lumber[7], and cardboard, which combined make up approximately a third of the total waste stream.

Notable differences between West Hawai`i and East Hawai`i include:

- One component in each area appears on the list in one area but not in the other: R/C metal[8] is in the top ten for West Hawai`i, and film plastic in East Hawai`i.

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7 Most of the disposed lumber in the waste stream is treated, and is not appropriate for composting.

8 The R/C components include waste that is made mostly of one component but contains significant amounts of other components, or waste that is part of a broad waste category but cannot be put into any of its component categories. Examples of R/C organic waste includes carpet and disposable diapers, while materials such as paper towels and coated milk cartons belong to R/C paper.

- Clean and treated lumber accounts for 8.8% by weight in West Hawaii versus 14.3% in East Hawaii.
- Food accounts for 17.7% by weight in West Hawai`i versus 12.8% in East Hawai`i.

Exhibit 2-7 shows a summary comparison of composition and quantities for the nine main waste categories for West Hawai`i and East Hawai`i.

2.2 Comparison of Hawai`i County Composition to U.S. Average

Exhibit 2-8 provides an aggregated comparison of the Hawai'i County disposed waste stream with the U.S. average, as compiled by the US Environmental Protection Agency (EPA). The data are shown in aggregated form because the EPA data is grouped somewhat differently and excludes construction and demolition debris. As shown, Hawaii County's disposed waste stream includes somewhat more paper, metal, and organics and somewhat less plastic and glass than U.S. averages.

2.3 Transfer Station, Commercial, and Self-Haul Substreams

Exhibits 2-9, 2-10, and 2-11 are bar charts that show the overall composition results of waste disposed countywide in the main waste categories for the transfer station, commercial, and self-haul substreams. The composition by category for transfer station and commercial substreams are similar with organics, paper, and construction and demolition waste accounting for 70-80% of the waste disposed. Construction and demolition waste is more pronounced in the commercial substream (24.0% vs. 14.4%) and organics is more pronounced in the transfer station substream (37.6% vs. 31.5%). In comparison, the self-haul substream is quite high in construction and demolition waste (45.6%) and special waste (21.6%). As shown in Attachment A (Exhibit A-6), most of the self-haul special waste consists of industrial sludge.

Exhibits 2-12, 2-13, and 2-14 show the ten largest waste components for the transfer station, commercial, and self-haul substreams. The top ten components make up 69%, 76%, and 87% of the transfer station, commercial, and self-haul substreams, respectively. Food, clean and treated lumber, and cardboard are each in the top 5 components in the transfer station and commercial substreams. The largest self-haul substream components include clean and treated lumber (20.5%), industrial sludge (15.1%), and green waste (11.4%).

It is important to note that many of the top ten components are good candidates for re-use or are potentially recyclable. For example, the estimates indicate that there is over 15,800 tons of cardboard disposed by the transfer station and commercial substreams: cardboard represents 5.9% of the transfer station substream, and 10.0% of the commercial substream.

2.4 Explosive and Hard-to-Process Items

During the process of capturing and sorting samples, the field supervisor noted loads that contained hard-to-process or potentially explosive items. Hard-to-process items include anything that would be difficult or impossible to manually sort, automatically process, or transfer by conveyor belt due to weight or size constraints. Examples of these items are appliances, mattresses, and carpet. Of the 100 loads sampled, 9 contained hard-to-process items: three with mattresses, three with bulky furniture, and one each with large-sized demolition materials, large crates, and large plastic pipe. Five of the hard-to-process items came from the transfer station substream and four came from the commercial substream.

No potentially explosive items were identified during the 2008 and 2001 sampling events.

EXHIBIT 2-1
Composition Estimates by Waste Category: Total County

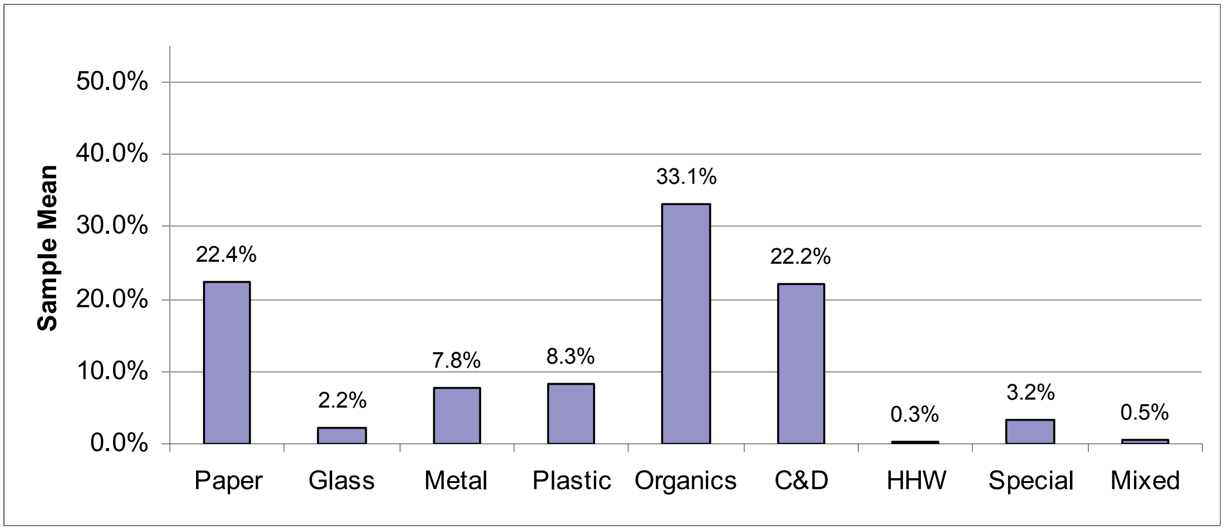


EXHIBIT 2-2
Composition Estimates by Waste Category: West Hawai`i

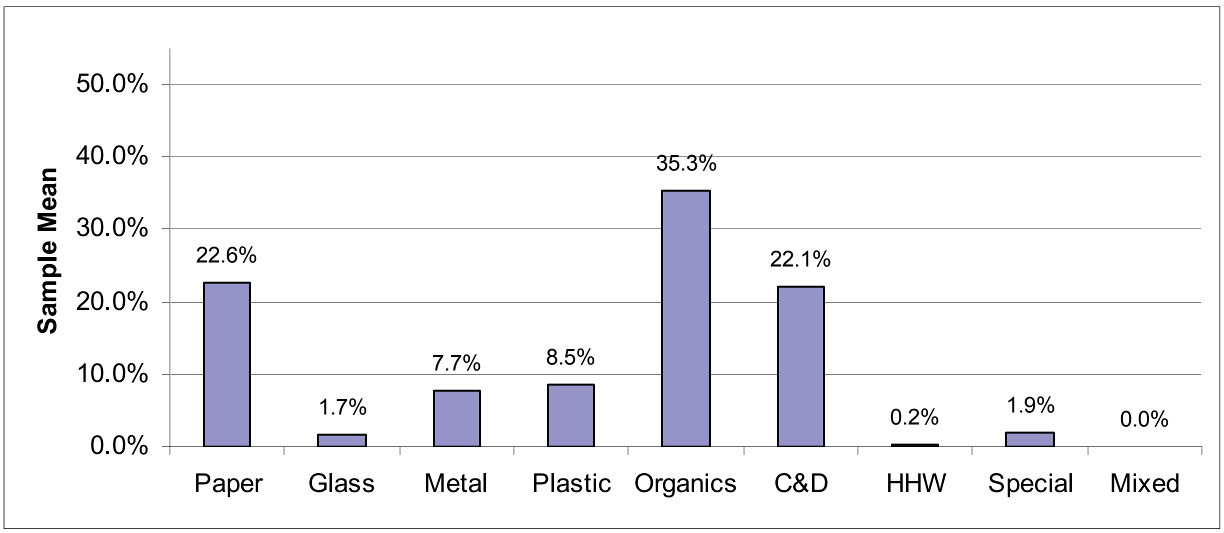


EXHIBIT 2-3
Composition Estimates by Waste Category: East Hawai`i

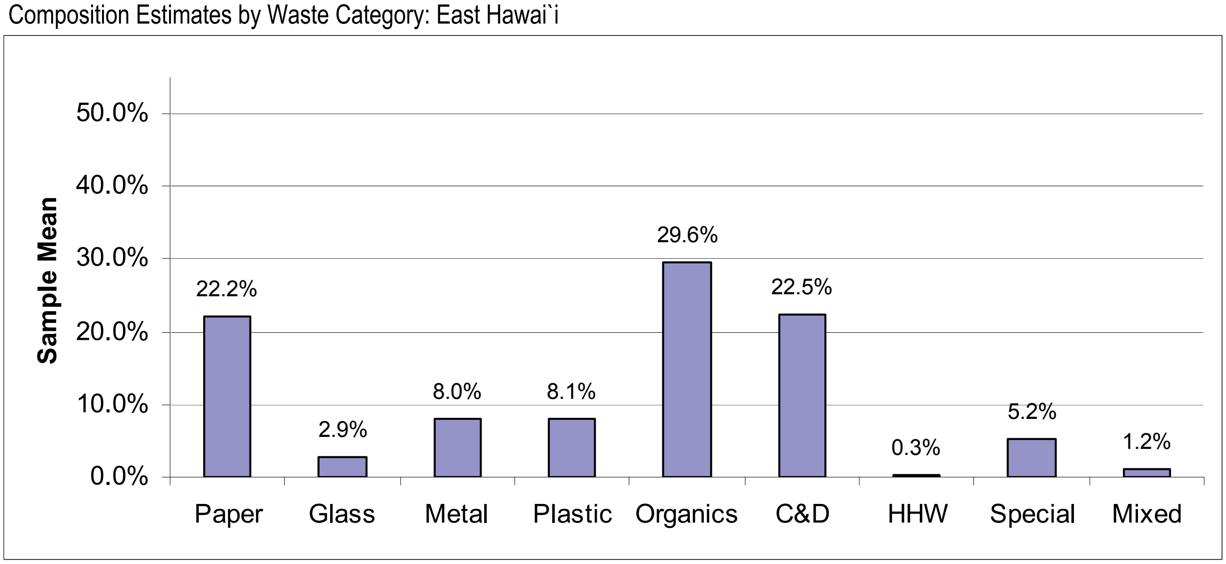


EXHIBIT 2-4
Top Ten Components: Total County

	Tons Disposed	Percent of Total	Cumulative Percent of Total
Food	34,230	16.3%	16.3%
Clean and Treated Lumber	22,984	10.9%	27.2%
Cardboard	16,182	7.7%	34.9%
Green waste	15,858	7.6%	42.5%
R/C Organic	13,875	6.6%	49.1%
R/C Demolition	12,819	6.1%	55.2%
R/C Paper	11,443	5.4%	60.7%
Miscellaneous Paper	8,634	4.1%	64.8%
Ferrous Metal	7,441	3.5%	68.3%
Film Plastic	6,170	2.9%	65.4%

EXHIBIT 2-5
Top Ten Components: West Hawai`i

	Tons Disposed	Percent of Total	Cumulative Percent of Total
Food	22,804	17.7%	17.7%
Clean and Treated Lumber	11,363	8.8%	26.6%
Cardboard	10,211	7.9%	34.5%
Green Waste	10,211	7.9%	42.5%
R/C Demolition	10,172	7.9%	50.4%
R/C Organic	8,573	6.7%	57.1%
R/C Paper	6,400	5.0%	62.0%
Miscellaneous Paper	6,233	4.8%	66.9%
Ferrous Metal	4,417	3.4%	70.3%
R/C Metal	4,169	3.2%	69.0%

EXHIBIT 2-6
Top Ten Components: East Hawai`i

	Tons Disposed	Percent of Total	Cumulative Percent of Total
Clean and Treated Lumber	11,621	14.3%	14.3%
Food	11,426	12.8%	12.8%
Cardboard	5,970	6.8%	33.8%
Green Waste	5,644	6.9%	40.8%
R/C Organic	5,302	6.0%	46.7%
R/C Paper	5,043	4.6%	51.4%
Ferrous Metal	3,025	3.3%	54.7%
R/C Demolition	2,647	3.2%	57.9%
Miscellaneous Paper	2,401	2.5%	60.5%
Film Plastic	2,157	2.3%	62.7%

Note: The abbreviation “R/C” stands for Remainder/Composite. The R/C components include waste that is made mostly of one component but contains significant amounts of other components, or waste that is part of a broad waste category but cannot be put into any of its component categories. Examples of R/C organic waste includes carpet and disposable diapers, while materials such as paper towels and coated milk cartons belong to R/C paper.

Green waste includes leaves and grass, prunings, and stumps.

EXHIBIT 2-7
Composition and Quantities for West Hawai`i and East Hawai`i Main Categories

	Percent of Total		FY 07-08 Tons	
	West Hawai`i	**East Hawai`i**	**West Hawai`i**	**East Hawai`i**
Paper	22.6%	22.2%	29,031	18,099
Glass	1.7%	2.9%	2,234	2,359
Metal	7.7%	8.0%	9,861	6,526
Plastic	8.5%	8.1%	10,895	6,588
Organics	35.3%	29.6%	45,346	24,102
Construction and Demolition	22.1%	22.5%	28,405	18,298
Household Hazardous	0.2%	0.3%	267	260
Special	1.9%	5.2%	2,504	4,259
Mixed Residue	0.0%	1.2%	1	996
	100.0%	100.0%	128,543	81,487

EXHIBIT 2-8
Comparison of Hawai`i County Composition to U.S. Average

Material Category	Hawaii County	United States[a]	Difference HI - US
Paper	28.9%	26.3%	2.6%
Glass	2.8%	6.6%	-3.8%
Metal	10.0%	7.8%	2.2%
Plastic	10.7%	17.5%	-6.8%
Organics	42.5%	37.3%	5.2%
Other	5.1%	4.5%	0.5%

[a]U.S. Environmental Protection Agency, 2006. *Municipal Solid Waste Generation, Recycling, and Disposal in the United States: facts and Figures for 2006.* Accessed at http://www.epa.gov/epaoswer/non-hw/muncpl/pubs/06data.pdf

Note: Excludes construction and demolition debris.

EXHIBIT 2-9
Composition Estimates by Waste Category: Transfer Stations

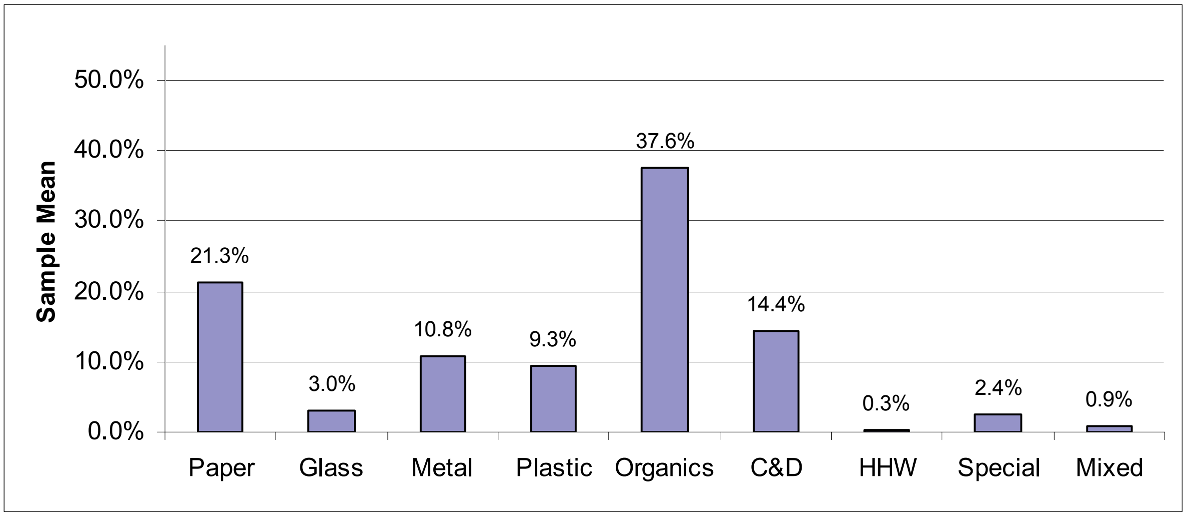


EXHIBIT 2-10
Composition Estimates by Waste Category: Commercial

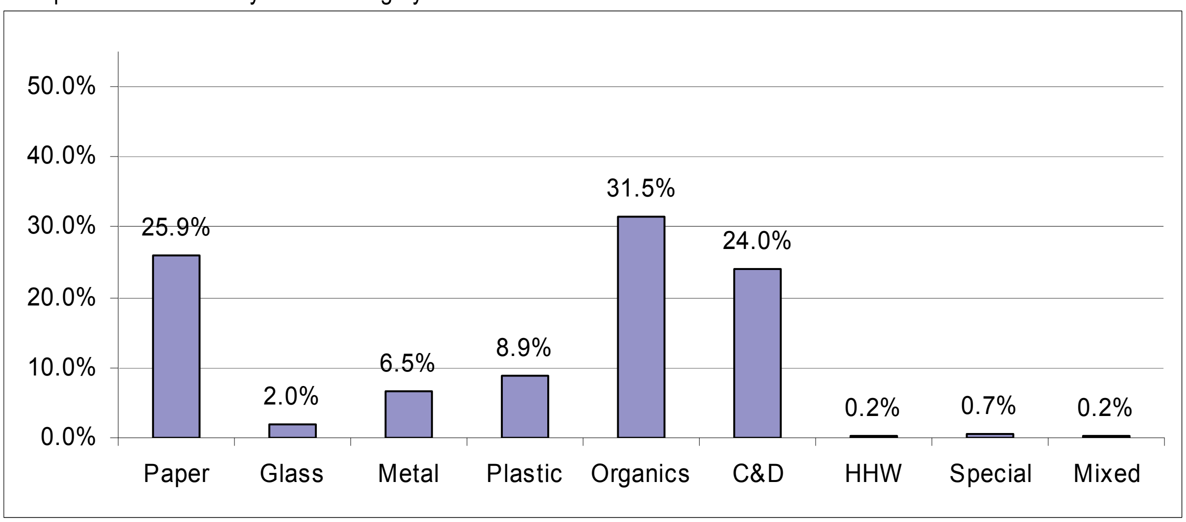


EXHIBIT 2-11
Composition Estimates by Waste Category: Self-Haul

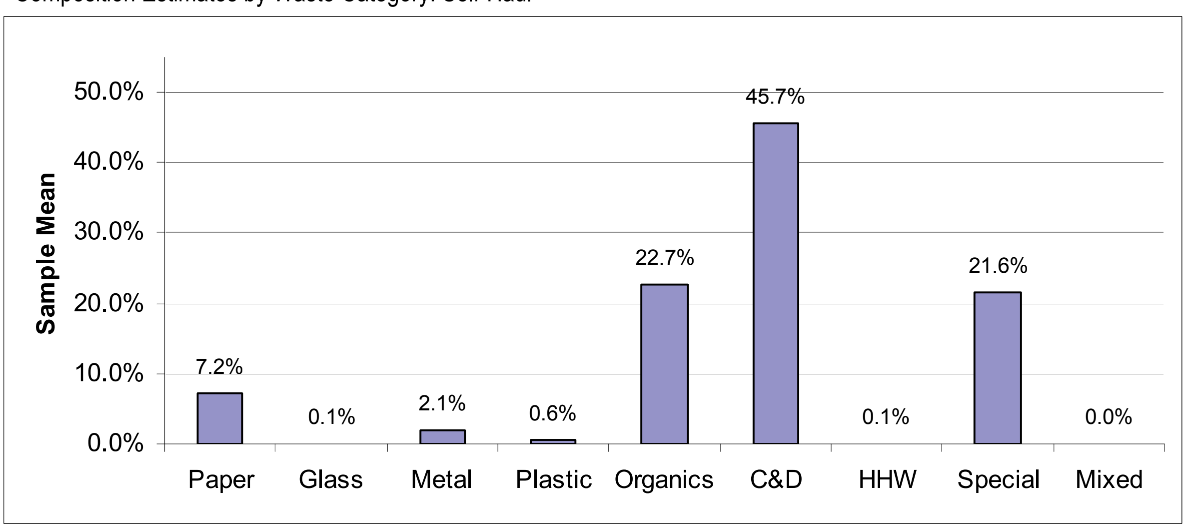


EXHIBIT 2-12

Top Ten Components: County Transfer Stations

	Tons Disposed	Percent of Total	Cumulative Percent of Total
Food	10,944	13.5%	13.5%
Green Waste	9,839	12.1%	25.6%
R/C Organic	6,711	8.3%	33.8%
Clean and Treated Lumber	5,570	6.9%	40.7%
Cardboard	4,822	5.9%	46.6%
R/C Demolition	4,014	4.9%	51.6%
Miscellaneous Paper	3,834	4.7%	56.3%
R/C Paper	3,730	4.6%	60.9%
Ferrous Metal	3,574	4.4%	65.3%
R/C Metal	3,102	3.8%	69.1%

EXHIBIT 2-13

Top Ten Components: County Commercial

	Tons Disposed	Percent of Total	Cumulative Percent of Total
Food	22,760	20.7%	20.7%
Clean and Treated Lumber	13,576	12.3%	33.0%
Cardboard	11,011	10.0%	43.0%
R/C Demo	7,422	6.7%	49.7%
R/C Paper	6,826	6.2%	55.9%
R/C Organic	5,586	5.1%	61.0%
Miscellaneous	4,764	4.3%	65.3%
Green Waste	3,886	3.5%	68.9%
Film	3,845	3.5%	72.4%
Concrete	3,696	3.4%	75.7%

EXHIBIT 2-14

Top Ten Components: County Self-Haul

	Tons Disposed	Percent of Total	Cumulative Percent of Total
Clean and Treated Lumber	3,839	20.5%	20.5%
Industrial Sludge	2,826	15.1%	35.6%
Green Waste	2,129	11.4%	47.0%
R/C Organic	1,578	8.4%	55.5%
R/C Demolition	1,383	7.4%	62.9%
Concrete	923	4.9%	67.8%
Rocks and Soil	921	4.9%	72.7%
Asphalt Paving	897	4.8%	77.5%
R/C Paper	888	4.7%	82.3%
Treated Lumber	878	4.7%	87.0%

Notes: The abbreviation “R/C” stands for Remainder/Composite. The R/C components include waste that is made mostly of one component but contains significant amounts of other components, or waste that is part of a broad waste category but cannot be put into any of its component categories. Examples of R/C organic waste includes carpet and disposable diapers, while materials such as paper towels and coated milk cartons belong to R/C paper.

Green waste includes leaves and grass, prunings, and stumps.

SECTION 3

West Hawai`i Sampling Results

This section presents summary composition results for the West Hawai`i transfer station, commercial, and self-haul substreams. The information is presented using the same formats used in Section 2. More comprehensive exhibits that detail the full composition results for the 58 component categories are presented in Attachment A (Exhibits A-7, A-8, and A-9).

Exhibits 3-1, 3-2, and 3-3 show the overall composition results for waste disposed of in West Hawai`i via the three substreams. Organics, paper, and construction and demolition debris account for 77% and 83% of the transfer station and commercial substreams, respectively. More than 90% of the self-haul substream consists of three waste categories: special waste (mainly industrial sludge), construction and demolition debris, and organics.

Exhibits 3-4, 3-5, and 3-6 show the ten largest waste components in West Hawai`i for the three main substreams. Cardboard is a significant component in all three substreams: 5.1% for transfer stations, 9.8% for commercial, and 2.4% for self-haul. Other components that appear in all three substreams include food, green waste, clean and treated lumber, and R/C organic.

Green waste (14.4%) is the largest component of the West Hawai`i transfer station substream, and food (21.3%) is the largest component of the West Hawai`i commercial substream. Food, clean and treated lumber and R/C demolition are in the top 5 of both the transfer station and commercial substreams. Some components that appear in the top 10 of only one of the transfer station or commercial substreams include R/C metal, ferrous metal, and textiles, which are in the top 10 in the transfer station substream, and R/C paper, concrete, and film plastic which are in the top 10 in the commercial substream.

The self-haul substream composition differs from the transfer station and commercial substreams. The top three components of the self-haul substream are industrial sludge, clean and treated lumber, and rocks and soil.

Exhibit 3-7 shows FY 2008 tons, the number of samples taken, and composition results by category for West Hawai`i transfer stations. As discussed in Section 1, the small number of samples taken from individual stations means that there is considerable uncertainty associated with these estimates.

EXHIBIT 3-1
Composition Estimates by Waste Category: West Hawai`i Transfer Station

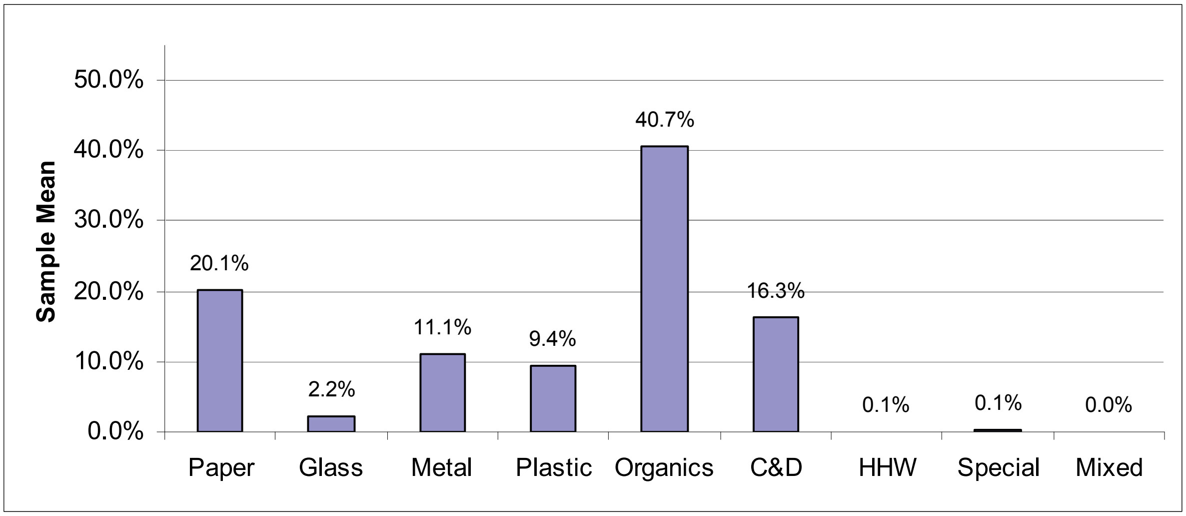


EXHIBIT 3-2
Composition Estimates by Waste Category: West Hawai`i Commercial

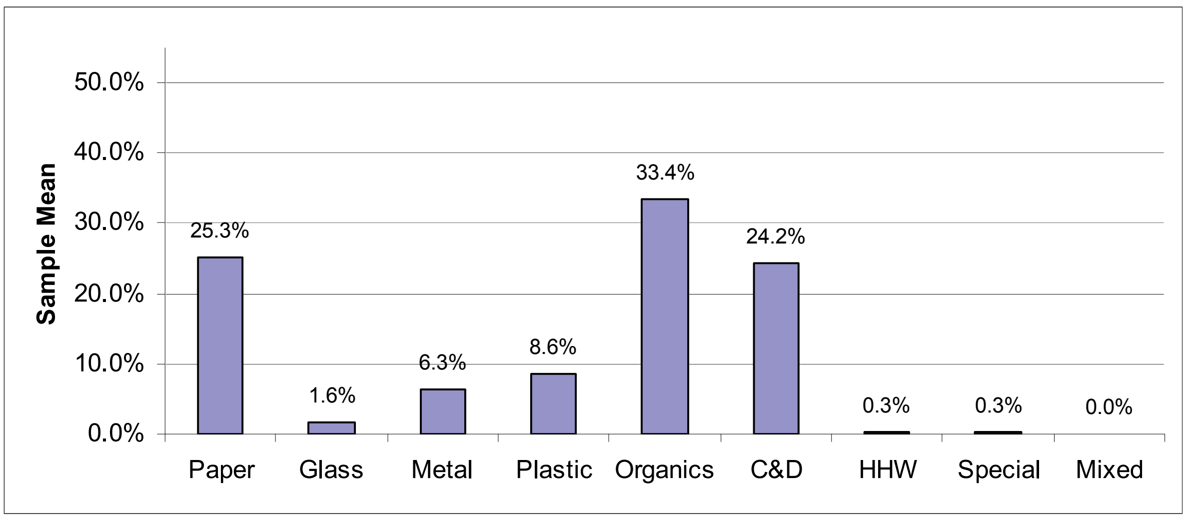


EXHIBIT 3-3
Composition Estimates by Waste Category: West Hawai`i Self-Haul

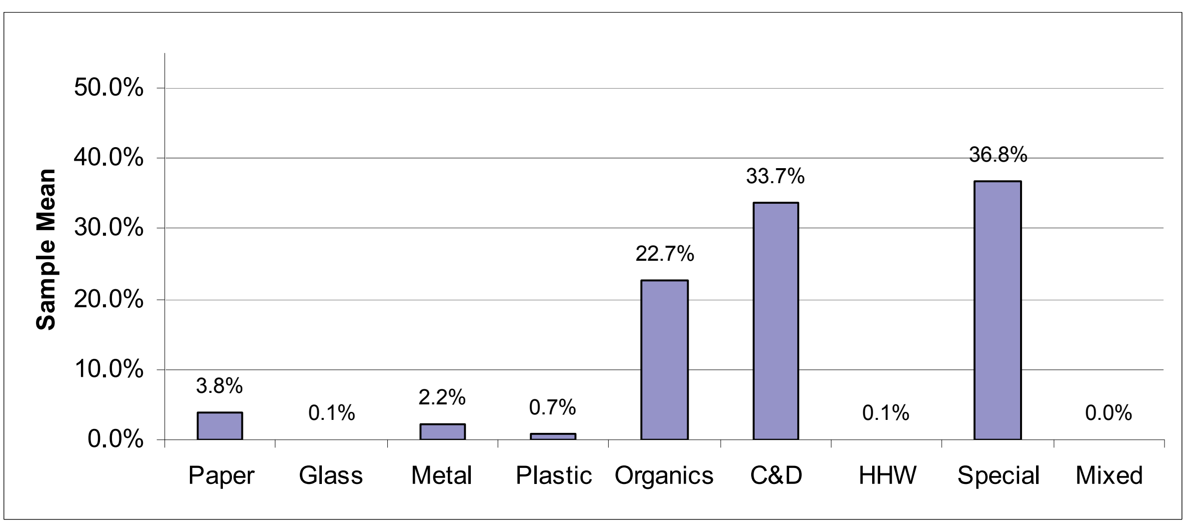


EXHIBIT 3-4
Top Ten Components: West Hawai`i Transfer Stations

	Tons Disposed	Percent of Total	Cumulative Percent of Total
Green Waste	6,007	14.4%	14.4%
Food	5,311	12.7%	27.2%
R/C Organic	3,721	8.9%	36.1%
Clean and Treated Lumber	3,334	8.0%	44.1%
R/C Demolition	2,859	6.9%	51.0%
Miscellaneous Paper	2,333	5.6%	56.6%
R/C Metal	2,230	5.4%	61.9%
Cardboard	2,125	5.1%	67.0%
Ferrous Metal	1,911	4.6%	71.6%
Textiles	1,903	4.6%	76.2%

EXHIBIT 3-5
Top Ten Components: West Hawai`i Commercial

	Tons Disposed	Percent of Total	Cumulative Percent of Total
Food	17,280	21.3%	21.3%
Cardboard	7,945	9.8%	31.1%
Clean and Treated Lumber	7,586	9.4%	40.5%
R/C Demolition	6,835	8.4%	49.0%
R/C Paper	4,936	6.1%	55.1%
R/C Organic	4,468	5.5%	60.6%
Miscellaneous	3,885	4.8%	65.4%
Concrete	3,693	4.6%	69.9%
Green Waste	3,467	4.3%	74.2%
Film Plastic	2,774	3.4%	77.6%

EXHIBIT 3-6
Top Ten Components: West Hawai`i Self-Haul

	Tons Disposed	Percent of Total	Cumulative Percent of Total
Industrial Sludge	1,585	26.8%	26.8%
Clean and Treated Lumber	921	14.5%	41.3%
Rocks and Soil	792	13.4%	54.7%
Green Waste	737	12.5%	67.2%
R/C Demolition	478	8.1%	75.3%
R/C Organic	384	6.5%	81.8%
R/C Special Waste	299	5.1%	86.9%
Food	212	3.6%	90.5%
Cardboard	141	2.4%	92.8%
Tires	116	2.0%	94.8%

Note: The abbreviation "R/C" stands for Remainder/Composite. The R/C components include waste that is made mostly of one component but contains significant amounts of other components, or waste that is part of a broad waste category but cannot be put into any of its component categories. Examples of R/C organic waste includes carpet and disposable diapers, while materials such as paper towels and coated milk cartons belong to R/C paper.

Green waste includes leaves and grass, prunings, and stumps.

EXHIBIT 3-7
Composition Estimates: West Hawai`i Individual Transfer Stations

	Honoka`a	Ka`u	Kailua	Keauhou	Kohala	Pa`auilo	Puako	Waiea	Waimea	Laupa-hoehoe	Miloli`i	Ke`ei
Tons 06-07	3,459	3,447	7,860	5,017	4,145	1,922	2,681	2,968	6,376	1,547	207	2,025
No. of Samples	2	3	6	5	4	1	2	2	5			
Station used as a proxy when calculating total transfer station waste composition										Pa`auilo	Waiea	Kohala
Percent of Total												
Paper	21.9%	24.1%	23.6%	21.9%	17.2%	21.1%	6.3%	14.4%	20.5%	Not Sampled		
Glass	0.7%	3.3%	2.2%	4.9%	0.5%	1.7%	0.1%	2.1%	1.7%			
Metal	11.3%	14.6%	7.4%	10.2%	7.9%	23.0%	16.9%	11.4%	7.7%			
Plastic	10.3%	6.9%	15.1%	10.4%	5.2%	11.3%	4.8%	5.4%	7.6%			
Organics	33.3%	40.9%	36.5%	41.0%	42.6%	25.3%	70.8%	41.8%	43.2%			
Construction and Demolition	21.8%	10.1%	15.1%	11.5%	26.5%	17.6%	1.1%	24.8%	18.3%			
Household Hazardous	0.7%	0.2%	0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	0.1%			
Special	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%			
Mixed Residue	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%			

SECTION 4

East Hawai`i Sampling Results

This section presents summary composition results for the East Hawai`i transfer station, commercial, and self-haul substreams. More comprehensive exhibits that detail the full composition results for the 58 component categories are presented in Attachment A (Exhibits A-10, A-11, and A-12). As noted in Section 1, the composition percentages for the East Hawai`i substreams were taken from the results of the 2001 study. The tons for waste components were calculated by multiplying FY 2008 tons for each substream by the 2001 study's composition percentages.

Exhibits 4-1, 4-1, and 4-3 show the overall composition results of waste disposed of in East Hawai`i via the three main substreams. Organics, paper, and construction and demolition debris account for 69%, 77% and 83% of the transfer station, commercial, and self-haul substreams, respectively. Other waste types that comprise large percentages of individual substreams include metal and plastic in the transfer station substream (10.5% and 9.2%, respectively), plastic in the commercial substream (10.0%), and special waste (14.6%) in the self-haul substream.

Exhibits 4-4, 4-5, and 4-6 show the ten largest waste components in East Hawai`i for the three main substreams. Three of the top five components are the same for the transfer station and commercial substreams (food, cardboard, and R/C paper). Cardboard comprises 6.8% of the transfer stations substream and 10.5% of the commercial substream. Several waste components appear in the top 10 of only one substream, including green waste, bulky items, and R/C plastic, which are in the top 10 in the transfer station substream, and film plastic, durable plastic, and newspaper which are in the top 10 in the commercial substream.

The self-haul substream composition differs from the transfer station and commercial substreams. The top three self-haul substream components are clean and treated lumber, green waste, and industrial sludge. The only top 10 self-haul components that are also in the top 10 in one or both of the other substreams include green waste, R/C organic, R/C paper, and clean and treated lumber.

EXHIBIT 4-1
Composition Estimates by Waste Category: East Hawai`i Transfer Stations

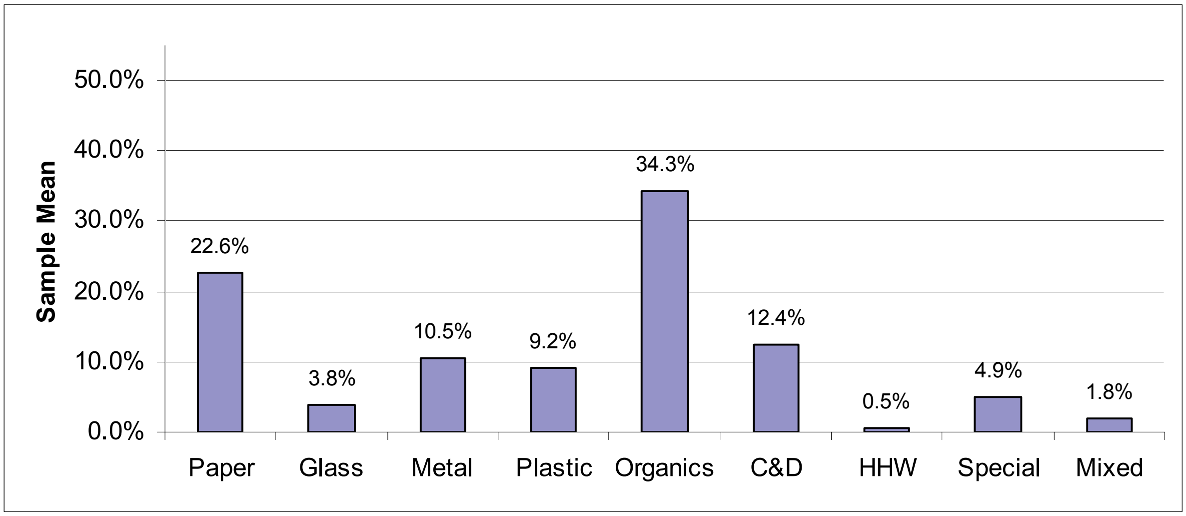


EXHIBIT 4-2
Composition Estimates by Waste Category: East Hawai`i Commercial

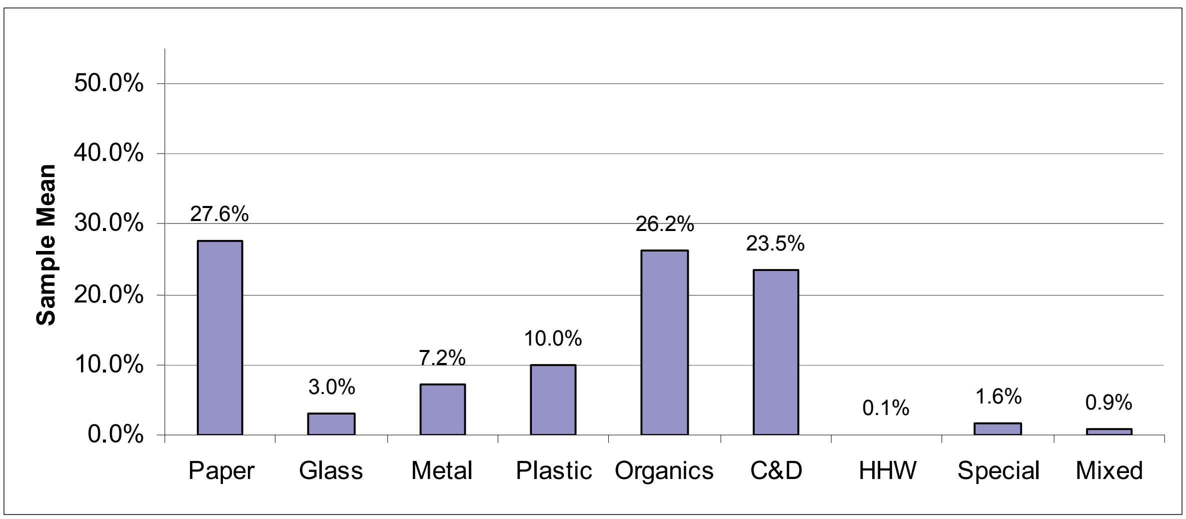


EXHIBIT 4-3
Composition Estimates by Waste Category: East Hawai`i Self-Haul

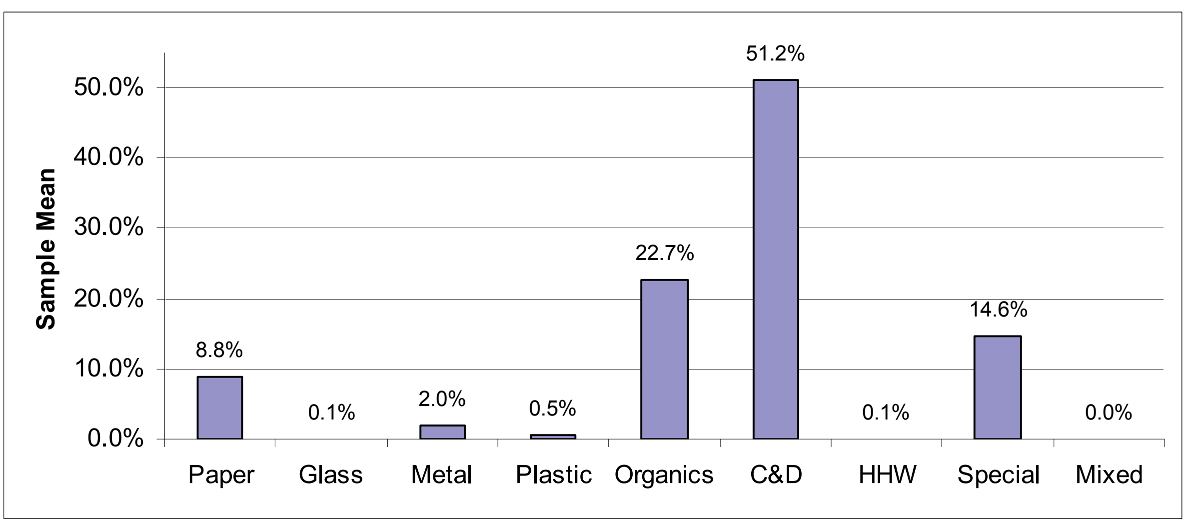


EXHIBIT 4-4
Top Ten Components: East Hawai`i Transfer Stations

	Tons Disposed	Percent of Total	Cumulative Percent of Total
Food	5,633	14.2%	14.2%
Green Waste	3,832	9.7%	23.9%
R/C Organic	2,990	7.6%	31.5%
Cardboard	2,696	6.8%	38.3%
R/C Paper	2,303	5.8%	44.1%
Clean and Treated Lumber	2,235	5.6%	49.8%
Ferrous Metal	1,663	4.2%	54.0%
Bulky Items	1,642	4.1%	58.1%
Miscellaneous Paper	1,501	3.8%	61.9%
R/C Plastic	1,291	3.3%	65.2%

EXHIBIT 4-5
Top Ten Components: East Hawai`i Commercial

	Tons Disposed	Percent of Total	Cumulative Percent of Total
Clean and Treated Lumber	5,990	20.6%	20.6%
Food	5,479	18.8%	39.4%
Cardboard	3,066	10.5%	49.9%
R/C Paper	1,889	6.5%	56.4%
Ferrous Metal	1,207	4.1%	60.5%
R/C Organic	1,118	3.8%	64.4%
Film Plastic	1,072	3.7%	68.1%
Miscellaneous Paper	879	3.0%	71.1%
Durable Plastic	815	2.8%	73.9%
Newspaper	734	2.5%	76.4%

EXHIBIT 4-6
Top Ten Components: East Hawai`i Self-Haul

	Tons Disposed	Percent of Total	Cumulative Percent of Total
Clean and Treated Lumber	1,194	18.8%	18.8%
Green Waste	1,392	10.9%	29.7%
Industrial Sludge	1,241	9.7%	39.4%
R/C Organic	1,194	9.3%	48.7%
R/C Demolition	905	7.1%	55.8%
R/C Paper	850	6.6%	62.4%
Concrete	816	6.4%	68.8%
Asphalt Paving	793	6.2%	75.0%
Tires	514	4.0%	79.0%
Gypsum Board	509	4.0%	83.0%

Note: The abbreviation "R/C" stands for Remainder/Composite. The R/C components include waste that is made mostly of one component but contains significant amounts of other components, or waste that is part of a broad waste category but cannot be put into any of its component categories. Examples of R/C organic waste includes carpet and disposable diapers, while materials such as paper towels and coated milk cartons belong to R/C paper.

Green waste includes leaves and grass, prunings, and stumps.

ATTACHMENT A

Detailed Sampling Results

EXHBIT A-1
Composition Estimates: Total County

	Tons Disposed	Percent of Total		Tons Disposed	Percent of Total
Paper	**47,130**	**22.4%**	**Construction and Demolition**	**46,702**	**22.2%**
Cardboard	16,182	7.7%	Concrete	5,128	2.4%
Bags	723	0.3%	Asphalt Paving	2,212	1.1%
Newspaper	4,193	2.0%	Asphalt Roofing	381	0.2%
White Ledger	1,540	0.7%	Clean and Treated Lumber	22,984	10.9%
Colored Ledger	280	0.1%	Gypsum Board	1,471	0.7%
Computer	92	0.0%	Rocks and Soil	1,707	0.8%
Office	1,510	0.7%	R/C Demo	12,819	6.1%
Magazines	2,424	1.2%	**Household Hazardous**	**527**	**0.3%**
Directories	109	0.1%	Paint	171	0.1%
Miscellaneous	8,634	4.1%	Vehicle Fluids	20	0.0%
R/C Paper	11,443	5.4%	Oil	54	0.0%
Glass	**4,592**	**2.2%**	Batteries	117	0.1%
Clear Containers	1,476	0.7%	R/C Hazardous	165	0.1%
Green Containers	1,296	0.6%	**Special**	**6,762**	**3.2%**
Brown Containers	1,024	0.5%	Ash	93	0.0%
Other Containers	307	0.1%	Sewage Sludge	0	0.0%
Flat Glass	160	0.1%	Industrial Sludge	2,826	1.3%
R/C Glass	329	0.2%	Treated Medical	139	0.1%
Metal	**16,388**	**7.8%**	Bulky Items	2,177	1.0%
Aluminum Cans	565	0.3%	Tires	1,124	0.5%
Tin Cans	1,525	0.7%	R/C Special	404	0.2%
Ferrous	7,441	3.5%	**Mixed**	**997**	**0.5%**
Nonferrous	504	0.2%	Mixed Residue	997	0.5%
White Goods	742	0.4%			
R/C Metal	5,611	2.7%			
Plastic	**17,482**	**8.3%**			
#1 Containers	1,067	0.5%			
#2 Containers	882	0.4%			
Other Containers	818	0.4%			
Film	6,170	2.9%			
Durable	4,002	1.9%			
R/C Plastic	4,543	2.2%			
Organics	**69,448**	**33.1%**			
Food	34,230	16.3%			
Textiles	5,485	2.6%			
Leaves and Grass	6,160	2.9%			
Prunings	7,057	3.4%			
Stumps	2,637	1.3%			
Crop Residue	3	0.0%			
Manure	0	0.0%			
R/C Organic	13,875	6.6%			
Total Tons	210,030				
Sample Count	100				

EXHBIT A-2

Composition Estimates: Total West Hawai`i

	Tons Disposed	Percent of Total		Tons Disposed	Percent of Total
Paper	**29,031**	**22.6%**	**Construction and Demolition**	**28,405**	**22.1%**
Cardboard	10,211	7.9%	Concrete	3,800	3.0%
Bags	360	0.3%	Asphalt Paving	616	0.5%
Newspaper	2,313	1.8%	Asphalt Roofing	165	0.1%
White Ledger	726	0.6%	Clean and Treated Lumber	11,363	8.8%
Colored Ledger	190	0.1%	Gypsum Board	829	0.6%
Computer	62	0.0%	Rocks and Soil	1,460	1.1%
Office	1,090	0.8%	R/C Demo	10,172	7.9%
Magazines	1,410	1.1%	**Household Hazardous**	**267**	**0.2%**
Directories	36	0.0%	Paint	117	0.1%
Miscellaneous	6,233	4.8%	Vehicle Fluids	2	0.0%
R/C Paper	6,400	5.0%	Oil	54	0.0%
Glass	**2,234**	**1.7%**	Batteries	29	0.0%
Clear Containers	590	0.5%	R/C Hazardous	65	0.1%
Green Containers	615	0.5%	**Special**	**2,504**	**1.9%**
Brown Containers	401	0.3%	Ash	93	0.1%
Other Containers	294	0.2%	Sewage Sludge	0	0.0%
Flat Glass	98	0.1%	Industrial Sludge	1,585	1.2%
R/C Glass	236	0.2%	Treated Medical	20	0.0%
Metal	**9,861**	**7.7%**	Bulky Items	392	0.3%
Aluminum Cans	224	0.2%	Tires	116	0.1%
Tin Cans	800	0.6%	R/C Special	299	0.2%
Ferrous	4,417	3.4%	**Mixed**	**1**	**0.0%**
Nonferrous	250	0.2%	Mixed Residue	1	0.0%
White Goods	1	0.0%			
R/C Metal	4,169	3.2%			
Plastic	**10,895**	**8.5%**			
#1 Containers	580	0.5%			
#2 Containers	483	0.4%			
Other Containers	566	0.4%			
Film	4,013	3.1%			
Durable	2,632	2.0%			
R/C Plastic	2,621	2.0%			
Organics	**45,346**	**35.3%**			
Food	22,804	17.7%			
Textiles	3,755	2.9%			
Leaves and Grass	4,833	3.8%			
Prunings	4,085	3.2%			
Stumps	1,293	1.0%			
Crop Residue	3	0.0%			
Manure	0	0.0%			
R/C Organic	8,573	6.7%			
Total Tons	128,543				
Sample Count	100				

EXHBIT A-3

Composition Estimates: Total East Hawai`i

	Tons Disposed	Percent of Total		Tons Disposed	Percent of Total
Paper	**18,099**	**22.2%**	**Construction and Demolition**	**18,298**	**22.5%**
Cardboard	5,970	7.3%	Concrete	1,328	1.6%
Bags	362	0.4%	Asphalt Paving	1,597	2.0%
Newspaper	1,880	2.3%	Asphalt Roofing	216	0.3%
White Ledger	814	1.0%	Clean and Treated Lumber	11,621	14.3%
Colored Ledger	90	0.1%	Gypsum Board	642	0.8%
Computer	31	0.0%	Rocks and Soil	247	0.3%
Office	420	0.5%	R/C Demo	2,647	3.2%
Magazines	1,014	1.2%	**Household Hazardous**	**260**	**0.3%**
Directories	74	0.1%	Paint	53	0.1%
Miscellaneous	2,401	2.9%	Vehicle Fluids	18	0.0%
R/C Paper	5,043	6.2%	Oil	0	0.0%
Glass	**2,359**	**2.9%**	Batteries	89	0.1%
Clear Containers	886	1.1%	R/C Hazardous	100	0.1%
Green Containers	682	0.8%	**Special**	**4,259**	**5.2%**
Brown Containers	623	0.8%	Ash	0	0.0%
Other Containers	13	0.0%	Sewage Sludge	0	0.0%
Flat Glass	62	0.1%	Industrial Sludge	1,241	1.5%
R/C Glass	92	0.1%	Treated Medical	119	0.1%
Metal	**6,526**	**8.0%**	Bulky Items	1,785	2.2%
Aluminum Cans	341	0.4%	Tires	1,008	1.2%
Tin Cans	725	0.9%	R/C Special	105	0.1%
Ferrous	3,025	3.7%	**Mixed**	**996**	**1.2%**
Nonferrous	254	0.3%	Mixed Residue	996	1.2%
White Goods	741	0.9%			
R/C Metal	1,442	1.8%			
Plastic	**6,588**	**8.1%**			
#1 Containers	487	0.6%			
#2 Containers	399	0.5%			
Other Containers	252	0.3%			
Film	2,157	2.6%			
Durable	1,370	1.7%			
R/C Plastic	1,923	2.4%			
Organics	**24,102**	**29.6%**			
Food	11,426	14.0%			
Textiles	1,730	2.1%			
Leaves and Grass	1,327	1.6%			
Prunings	2,972	3.6%			
Stumps	1,344	1.6%			
Crop Residue	0	0.0%			
Manure	0	0.0%			
R/C Organic	5,302	6.5%			
Total Tons	81,487				
Sample Count (2001 study)	100				

EXHBIT A-4
Composition Estimates: Total County Transfer Stations

	Tons Disposed	Percent of Total		Tons Disposed	Percent of Total
Paper	**17,309**	**21.3%**	**Construction and Demolition**	**11,699**	**14.4%**
Cardboard	4,822	5.9%	Concrete	509	0.6%
Bags	232	0.3%	Asphalt Paving	803	1.0%
Newspaper	2,109	2.6%	Asphalt Roofing	102	0.1%
White Ledger	503	0.6%	Clean and Treated Lumber	5,570	6.9%
Colored Ledger	69	0.1%	Gypsum Board	249	0.3%
Computer	24	0.0%	Rocks and Soil	452	0.6%
Office	826	1.0%	R/C Demo	4,014	4.9%
Magazines	1,136	1.4%	**Household Hazardous**	**258**	**0.3%**
Directories	26	0.0%	Paint	46	0.1%
Miscellaneous	3,834	4.7%	Vehicle Fluids	16	0.0%
R/C Paper	3,730	4.6%	Oil	19	0.0%
Glass	**2,407**	**3.0%**	Batteries	84	0.1%
Clear Containers	830	1.0%	R/C Hazardous	94	0.1%
Green Containers	666	0.8%	**Special**	**1,981**	**2.4%**
Brown Containers	563	0.7%	Ash	0	0.0%
Other Containers	155	0.2%	Sewage Sludge	0	0.0%
Flat Glass	43	0.1%	Industrial Sludge	0	0.0%
R/C Glass	150	0.2%	Treated Medical	0	0.0%
Metal	**8,802**	**10.8%**	Bulky Items	1,699	2.1%
Aluminum Cans	277	0.3%	Tires	221	0.3%
Tin Cans	790	1.0%	R/C Special	60	0.1%
Ferrous	3,574	4.4%	**Mixed**	**732**	**0.9%**
Nonferrous	320	0.4%	Mixed Residue	732	0.9%
White Goods	739	0.9%			
R/C Metal	3,102	3.8%			
Plastic	**7,530**	**9.3%**			
#1 Containers	481	0.6%			
#2 Containers	472	0.6%			
Other Containers	368	0.5%			
Film	2,301	2.8%			
Durable	1,752	2.2%			
R/C Plastic	2,156	2.7%			
Organics	**30,511**	**37.6%**			
Food	10,944	13.5%			
Textiles	3,017	3.7%			
Leaves and Grass	5,133	6.3%			
Prunings	4,243	5.2%			
Stumps	462	0.6%			
Crop Residue	0	0.0%			
Manure	0	0.0%			
R/C Organic	6,711	8.3%			
Total Tons	81,230				
Sample Count	70				

EXHBIT A-5
Composition Estimates: Total County Commercial

	Tons Disposed	Percent of Total
Paper	**28,471**	**25.9%**
Cardboard	11,011	10.0%
Bags	484	0.4%
Newspaper	2,019	1.8%
White Ledger	1,034	0.9%
Colored Ledger	210	0.2%
Computer	69	0.1%
Office	684	0.6%
Magazines	1,286	1.2%
Directories	84	0.1%
Miscellaneous	4,764	4.3%
R/C Paper	6,826	6.2%
Glass	**2,173**	**2.0%**
Clear Containers	642	0.6%
Green Containers	630	0.6%
Brown Containers	459	0.4%
Other Containers	152	0.1%
Flat Glass	117	0.1%
R/C Glass	173	0.2%
Metal	**7,202**	**6.5%**
Aluminum Cans	283	0.3%
Tin Cans	735	0.7%
Ferrous	3,654	3.3%
Nonferrous	181	0.2%
White Goods	0	0.0%
R/C Metal	2,348	2.1%
Plastic	**9,844**	**8.9%**
#1 Containers	583	0.5%
#2 Containers	407	0.4%
Other Containers	447	0.4%
Film	3,845	3.5%
Durable	2,242	2.0%
R/C Plastic	2,319	2.1%
Organics	**34,691**	**31.5%**
Food	22,760	20.7%
Textiles	2,460	2.2%
Leaves and Grass	985	0.9%
Prunings	2,790	2.5%
Stumps	112	0.1%
Crop Residue	0	0.0%
Manure	0	0.0%
R/C Organic	5,586	5.1%

	Tons Disposed	Percent of Total
Construction and Demolition	**26,466**	**24.0%**
Concrete	3,696	3.4%
Asphalt Paving	512	0.5%
Asphalt Roofing	279	0.3%
Clean and Treated Lumber	13,576	12.3%
Gypsum Board	646	0.6%
Rocks and Soil	335	0.3%
R/C Demo	7,422	6.7%
Household Hazardous	**253**	**0.2%**
Paint	117	0.1%
Vehicle Fluids	0	0.0%
Oil	33	0.0%
Batteries	32	0.0%
R/C Hazardous	71	0.1%
Special	**738**	**0.7%**
Ash	0	0.0%
Sewage Sludge	0	0.0%
Industrial Sludge	0	0.0%
Treated Medical	91	0.1%
Bulky Items	330	0.3%
Tires	273	0.2%
R/C Special	45	0.0%
Mixed	**262**	**0.2%**
Mixed Residue	262	0.2%

Total Tons	110,101
Sample Count	66

EXHBIT A-6
Composition Estimates: Total County Self-Haul

	Tons Disposed	Percent of Total		Tons Disposed	Percent of Total
Paper	**1,350**	**7.2%**	**Construction and Demolition**	**8,537**	**45.7%**
Cardboard	349	1.9%	Concrete	923	4.9%
Bags	6	0.0%	Asphalt Paving	897	4.8%
Newspaper	65	0.3%	Asphalt Roofing	0	0.0%
White Ledger	2	0.0%	Clean and Treated Lumber	3,839	20.5%
Colored Ledger	0	0.0%	Gypsum Board	575	3.1%
Computer	0	0.0%	Rocks and Soil	921	4.9%
Office	1	0.0%	R/C Demo	1,383	7.4%
Magazines	2	0.0%	**Household Hazardous**	**15**	**0.1%**
Directories	0	0.0%	Paint	7	0.0%
Miscellaneous	36	0.2%	Vehicle Fluids	4	0.0%
R/C Paper	888	4.7%	Oil	2	0.0%
Glass	**13**	**0.1%**	Batteries	1	0.0%
Clear Containers	5	0.0%	R/C Hazardous	0	0.0%
Green Containers	1	0.0%	**Special**	**4,043**	**21.6%**
Brown Containers	2	0.0%	Ash	93	0.5%
Other Containers	0	0.0%	Sewage Sludge	0	0.0%
Flat Glass	0	0.0%	Industrial Sludge	2,826	15.1%
R/C Glass	5	0.0%	Treated Medical	48	0.3%
Metal	**384**	**2.1%**	Bulky Items	148	0.8%
Aluminum Cans	5	0.0%	Tires	630	3.4%
Tin Cans	0	0.0%	R/C Special	299	1.6%
Ferrous	213	1.1%	**Mixed**	**3**	**0.0%**
Nonferrous	2	0.0%	Mixed Residue	3	0.0%
White Goods	3	0.0%			
R/C Metal	161	0.9%			
Plastic	**108**	**0.6%**			
#1 Containers	2	0.0%			
#2 Containers	3	0.0%			
Other Containers	2	0.0%			
Film	23	0.1%			
Durable	8	0.0%			
R/C Plastic	69	0.4%			
Organics	**4,245**	**22.7%**			
Food	526	2.8%			
Textiles	9	0.0%			
Leaves and Grass	42	0.2%			
Prunings	24	0.1%			
Stumps	2,063	11.0%			
Crop Residue	3	0.0%			
Manure	0	0.0%			
R/C Organic	1,578	8.4%			
Total Tons	18,699				
Sample Count	24				

EXHBIT A-7

Composition Estimates: West Hawai`i Transfer Stations

	Tons Disposed	Percent of Total	Low	High		Tons Disposed	Percent of Total	Low	High
Paper	**8,359**	**20.1%**			**Construction and Demolition**	**6,794**	**16.3%**		
Cardboard	2,125	5.1%	4.1%	6.1%	Concrete	0	0.0%	0.0%	0.0%
Bags	47	0.1%	0.0%	0.2%	Asphalt Paving	0	0.0%	0.0%	0.0%
Newspaper	1,001	2.4%	1.5%	3.3%	Asphalt Roofing	102	0.2%	0.0%	0.7%
White Ledger	195	0.5%	0.3%	0.7%	Clean and Treated Lumber	3,334	8.0%	5.0%	11.0%
Colored Ledger	31	0.1%	0.0%	0.1%	Gypsum Board	165	0.4%	0.0%	0.9%
Computer	21	0.1%	0.0%	0.1%	Rocks and Soil	333	0.8%	0.3%	1.3%
Office	532	1.3%	0.6%	2.0%	R/C Demo	2,859	6.9%	3.5%	10.2%
Magazines	632	1.5%	0.9%	2.1%	**Household Hazardous**	**48**	**0.1%**		
Directories	15	0.0%	0.0%	0.1%	Paint	0	0.0%	0.0%	0.0%
Miscellaneous	2,333	5.6%	4.2%	7.0%	Vehicle Fluids	0	0.0%	0.0%	0.0%
R/C Paper	1,427	3.4%	2.7%	4.1%	Oil	19	0.0%	0.0%	0.1%
Glass	**918**	**2.2%**			Batteries	15	0.0%	0.0%	0.1%
Clear Containers	309	0.7%	0.2%	1.2%	R/C Hazardous	14	0.0%	0.0%	0.1%
Green Containers	235	0.6%	0.3%	0.9%	**Special**	**58**	**0.1%**		
Brown Containers	130	0.3%	0.1%	0.5%	Ash	0	0.0%	0.0%	0.0%
Other Containers	142	0.3%	0.2%	0.5%	Sewage Sludge	0	0.0%	0.0%	0.0%
Flat Glass	14	0.0%	0.0%	0.1%	Industrial Sludge	0	0.0%	0.0%	0.0%
R/C Glass	87	0.2%	0.1%	0.3%	Treated Medical	0	0.0%	0.0%	0.0%
Metal	**4,630**	**11.1%**			Bulky Items	58	0.1%	0.0%	0.4%
Aluminum Cans	75	0.2%	0.1%	0.2%	Tires	0	0.0%	0.0%	0.0%
Tin Cans	268	0.6%	0.5%	0.8%	R/C Special	0	0.0%	0.0%	0.0%
Ferrous	1,911	4.6%	3.1%	6.0%	**Mixed**	**0**	**0.0%**		
Nonferrous	147	0.4%	0.0%	0.7%	Mixed Residue	0	0.0%	0.0%	0.0%
White Goods	0	0.0%	0.0%	0.0%					
R/C Metal	2,230	5.4%	3.1%	7.6%					
Plastic	**3,907**	**9.4%**							
#1 Containers	173	0.4%	0.3%	0.5%					
#2 Containers	222	0.5%	0.4%	0.7%					
Other Containers	217	0.5%	0.4%	0.6%					
Film	1,229	3.0%	2.5%	3.4%					
Durable	1,202	2.9%	1.6%	4.2%					
R/C Plastic	865	2.1%	1.6%	2.5%					
Organics	**16,941**	**40.7%**							
Food	5,311	12.7%	10.5%	15.0%					
Textiles	1,903	4.6%	2.5%	6.6%					
Leaves and Grass	4,016	9.6%	5.3%	14.0%					
Prunings	1,529	3.7%	1.0%	6.3%					
Stumps	462	1.1%	0.0%	2.3%					
Crop Residue	0	0.0%	0.0%	0.0%					
Manure	0	0.0%	0.0%	0.0%					
R/C Organic	3,721	8.9%	7.2%	10.7%					
Total Tons	41,655								
Sample Count	30								

Low and High are calculated at a 90% confidence interval

EXHIBIT A-8

Composition Estimates: West Hawai`i Commercial

	Tons Disposed	Percent of Total	Low	High		Tons Disposed	Percent of Total	Low	High
Paper	**20,448**	**25.3%**			**Construction and Demolition**	**19,622**	**24.2%**		
Cardboard	7,945	9.8%	6.6%	13.0%	Concrete	3,693	4.6%	1.4%	7.7%
Bags	311	0.4%	0.1%	0.7%	Asphalt Paving	512	0.6%	0.0%	1.6%
Newspaper	1,286	1.6%	0.6%	2.6%	Asphalt Roofing	63	0.1%	0.0%	0.2%
White Ledger	530	0.7%	0.2%	1.1%	Clean and Treated Lumber	7,586	9.4%	4.8%	14.0%
Colored Ledger	158	0.2%	0.0%	0.4%	Gypsum Board	598	0.7%	0.0%	1.6%
Computer	40	0.0%	0.0%	0.1%	Rocks and Soil	335	0.4%	0.0%	1.0%
Office	558	0.7%	0.3%	1.1%	R/C Demo	6,835	8.4%	3.2%	13.7%
Magazines	777	1.0%	0.3%	1.6%	**Household Hazardous**	**214**	**0.3%**		
Directories	21	0.0%	0.0%	0.1%	Paint	117	0.1%	0.0%	0.3%
Miscellaneous	3,885	4.8%	3.4%	6.2%	Vehicle Fluids	0	0.0%	0.0%	0.0%
R/C Paper	4,936	6.1%	4.1%	8.1%	Oil	33	0.0%	0.0%	0.1%
Glass	**1,311**	**1.6%**			Batteries	13	0.0%	0.0%	0.0%
Clear Containers	279	0.3%	0.1%	0.6%	R/C Hazardous	51	0.1%	0.0%	0.2%
Green Containers	379	0.5%	0.2%	0.7%	**Special**	**274**	**0.3%**		
Brown Containers	270	0.3%	0.1%	0.5%	Ash	0	0.0%	0.0%	0.0%
Other Containers	152	0.2%	0.1%	0.3%	Sewage Sludge	0	0.0%	0.0%	0.0%
Flat Glass	84	0.1%	0.0%	0.3%	Industrial Sludge	0	0.0%	0.0%	0.0%
R/C Glass	147	0.2%	0.0%	0.4%	Treated Medical	0	0.0%	0.0%	0.0%
Metal	**5,103**	**6.3%**			Bulky Items	274	0.3%	0.0%	0.9%
Aluminum Cans	147	0.2%	0.1%	0.2%	Tires	0	0.0%	0.0%	0.0%
Tin Cans	533	0.7%	0.2%	1.1%	R/C Special	0	0.0%	0.0%	0.0%
Ferrous	2,447	3.0%	0.7%	5.3%	**Mixed**	**0**	**0.0%**		
Nonferrous	102	0.1%	0.1%	0.2%	Mixed Residue	0	0.0%	0.0%	0.0%
White Goods	0	0.0%	0.0%	0.0%					
R/C Metal	1,874	2.3%	0.6%	4.1%					
Plastic	**6,944**	**8.6%**							
#1 Containers	406	0.5%	0.4%	0.6%					
#2 Containers	261	0.3%	0.2%	0.4%					
Other Containers	348	0.4%	0.3%	0.6%					
Film	2,774	3.4%	2.3%	4.6%					
Durable	1,427	1.8%	0.5%	3.0%					
R/C Plastic	1,728	2.1%	1.2%	3.0%					
Organics	**27,064**	**33.4%**							
Food	17,280	21.3%	15.1%	27.5%					
Textiles	1,849	2.3%	1.3%	3.3%					
Leaves and Grass	809	1.0%	0.0%	2.1%					
Prunings	2,546	3.1%	0.0%	6.6%					
Stumps	112	0.1%	0.0%	0.3%					
Crop Residue	0	0.0%	0.0%	0.0%					
Manure	0	0.0%	0.0%	0.0%					
R/C Organic	4,468	5.5%	2.6%	8.5%					
Total Tons	80,981								
Sample Count	30								

EXHBIT A-9

Composition Estimates: West Hawai`i Self-Haul

	Tons Disposed	Percent of Total		Tons Disposed	Percent of Total
Paper	**224**	**3.8%**	**Construction and Demolition**	**1,989**	**33.7%**
Cardboard	141	2.4%	Concrete	106	1.8%
Bags	3	0.0%	Asphalt Paving	103	1.8%
Newspaper	26	0.4%	Asphalt Roofing	0	0.0%
White Ledger	1	0.0%	Clean and Treated Lumber	443	7.5%
Colored Ledger	0	0.0%	Gypsum Board	66	1.1%
Computer	0	0.0%	Rocks and Soil	792	13.4%
Office	0	0.0%	R/C Demo	478	8.1%
Magazines	1	0.0%	**Household Hazardous**	**5**	**0.1%**
Directories	0	0.0%	Paint	0	0.0%
Miscellaneous	14	0.2%	Vehicle Fluids	2	0.0%
R/C Paper	37	0.6%	Oil	2	0.0%
Glass	**5**	**0.1%**	Batteries	1	0.0%
Clear Containers	2	0.0%	R/C Hazardous	0	0.0%
Green Containers	0	0.0%	**Special**	**2,172**	**36.8%**
Brown Containers	1	0.0%	Ash	93	1.6%
Other Containers	0	0.0%	Sewage Sludge	0	0.0%
Flat Glass	0	0.0%	Industrial Sludge	1,585	26.8%
R/C Glass	2	0.0%	Treated Medical	20	0.3%
Metal	**128**	**2.2%**	Bulky Items	60	1.0%
Aluminum Cans	2	0.0%	Tires	116	2.0%
Tin Cans	0	0.0%	R/C Special	299	5.1%
Ferrous	59	1.0%	**Mixed**	**1**	**0.0%**
Nonferrous	1	0.0%	Mixed Residue	1	0.0%
White Goods	1	0.0%			
R/C Metal	65	1.1%			
Plastic	**44**	**0.7%**			
#1 Containers	1	0.0%			
#2 Containers	1	0.0%			
Other Containers	1	0.0%			
Film	9	0.2%			
Durable	3	0.1%			
R/C Plastic	28	0.5%			
Organics	**1,341**	**22.7%**			
Food	212	3.6%			
Textiles	3	0.1%			
Leaves and Grass	9	0.1%			
Prunings	10	0.2%			
Stumps	719	12.2%			
Crop Residue	3	0.1%			
Manure	0	0.0%			
R/C Organic	384	6.5%			
Total Tons	5,907				
Sample Count	0				

Notes:

Waste composition percent for mixed loads from 2001 study at South Hilo Landfill.

Pure loads at the West Hawaii Landfill added to the mixed load composition.

EXHBIT A-10

Composition Estimates: East Hawai`i Transfer Stations

	Tons Disposed	Percent of Total	Low	High		Tons Disposed	Percent of Total	Low	High
Paper	**8,950**	**22.6%**			**Construction and Demolition**	**4,905**	**12.4%**		
Cardboard	2,696	6.8%	5.5%	8.2%	Concrete	509	1.3%	0.3%	2.3%
Bags	185	0.5%	0.3%	0.6%	Asphalt Paving	803	2.0%	0.0%	5.2%
Newspaper	1,108	2.8%	0.2%	3.6%	Asphalt Roofing	0	0.0%	0.0%	0.0%
White Ledger	308	0.8%	0.5%	1.0%	Clean and Treated Lumber	2,235	5.6%	3.7%	7.5%
Colored Ledger	37	0.1%	0.1%	0.1%	Gypsum Board	85	0.2%	0.0%	0.4%
Computer	2	0.0%	0.0%	0.0%	Rocks and Soil	119	0.3%	0.0%	0.7%
Office	294	0.7%	0.1%	1.3%	R/C Demo	1,154	2.9%	0.3%	5.6%
Magazines	503	1.3%	0.8%	1.7%	**Household Hazardous**	**210**	**0.5%**		
Directories	11	0.0%	0.0%	0.1%	Paint	46	0.1%	0.0%	0.3%
Miscellaneous	1,501	3.8%	3.0%	4.6%	Vehicle Fluids	16	0.0%	0.0%	0.1%
R/C Paper	2,303	5.8%	4.5%	7.1%	Oil	0	0.0%	0.0%	0.0%
Glass	**1,489**	**3.8%**			Batteries	69	0.2%	0.1%	0.3%
Clear Containers	520	1.3%	0.9%	1.7%	R/C Hazardous	80	0.2%	0.0%	0.4%
Green Containers	431	1.1%	0.8%	1.4%	**Special**	**1,923**	**4.9%**		
Brown Containers	433	1.1%	0.7%	1.5%	Ash	0	0.0%	0.0%	0.0%
Other Containers	13	0.0%	0.0%	0.1%	Sewage Sludge	0	0.0%	0.0%	0.0%
Flat Glass	29	0.1%	0.0%	0.2%	Industrial Sludge	0	0.0%	0.0%	0.0%
R/C Glass	63	0.2%	0.1%	0.2%	Treated Medical	0	0.0%	0.0%	0.0%
Metal	**4,172**	**10.5%**			Bulky Items	1,642	4.1%	1.5%	6.8%
Aluminum Cans	202	0.5%	0.4%	0.6%	Tires	221	0.6%	0.0%	1.1%
Tin Cans	523	1.3%	1.0%	1.7%	R/C Special	60	0.2%	0.0%	0.4%
Ferrous	1,663	4.2%	2.2%	6.2%	**Mixed**	**732**	**1.8%**		
Nonferrous	173	0.4%	0.3%	0.6%	Mixed Residue	732	1.8%	0.9%	2.8%
White Goods	739	1.9%	0.0%	4.7%					
R/C Metal	872	2.2%	0.8%	3.6%					
Plastic	**3,623**	**9.2%**							
#1 Containers	308	0.8%	0.5%	1.0%					
#2 Containers	250	0.6%	0.5%	0.8%					
Other Containers	151	0.4%	0.3%	0.5%					
Film	1,072	2.7%	2.2%	3.2%					
Durable	550	1.4%	0.9%	1.9%					
R/C Plastic	1,291	3.3%	2.4%	4.2%					
Organics	**13,570**	**34.3%**							
Food	5,633	14.2%	11.2%	17.3%					
Textiles	1,114	2.8%	1.9%	3.8%					
Leaves and Grass	1,118	2.8%	1.2%	4.4%					
Prunings	2,714	6.9%	3.4%	10.3%					
Stumps	0	0.0%	0.0%	0.0%					
Crop Residue	0	0.0%	0.0%	0.0%					
Manure	0	0.0%	0.0%	0.0%					
R/C Organic	2,990	7.6%	4.3%	10.8%					
Total Tons	39,575								
Sample Count (2001 study)	40								

Low and High are calculated at a 90% confidence interval

EXHBIT A-11
Composition Estimates: East Hawai'i Commercial

	Tons Disposed	Percent of Total	Low	High		Tons Disposed	Percent of Total	Low	High
Paper	**8,023**	**27.6%**			**Construction and Demolition**	**6,844**	**23.5%**		
Cardboard	3,066	10.5%	7.4%	13.7%	Concrete	2	0.0%	0.0%	0.0%
Bags	174	0.6%	0.4%	0.8%	Asphalt Paving	0	0.0%	0.0%	0.0%
Newspaper	734	2.5%	1.5%	3.5%	Asphalt Roofing	216	0.7%	0.0%	2.0%
White Ledger	504	1.7%	0.9%	2.6%	Clean and Treated Lumber	5,990	20.6%	12.5%	28.7%
Colored Ledger	52	0.2%	0.1%	0.2%	Gypsum Board	48	0.2%	0.0%	0.4%
Computer	28	0.1%	0.0%	0.2%	Rocks and Soil	0	0.0%	0.0%	0.0%
Office	125	0.4%	0.3%	0.6%	R/C Demo	587	2.0%	0.0%	4.6%
Magazines	509	1.7%	0.8%	2.7%	**Household Hazardous**	**39**	**0.1%**		
Directories	63	0.2%	0.0%	0.5%	Paint	0	0.0%	0.0%	0.0%
Miscellaneous	879	3.0%	2.4%	3.7%	Vehicle Fluids	0	0.0%	0.0%	0.0%
R/C Paper	1,889	6.5%	4.5%	8.5%	Oil	0	0.0%	0.0%	0.0%
Glass	**861**	**3.0%**			Batteries	19	0.1%	0.0%	0.2%
Clear Containers	363	1.2%	0.8%	1.7%	R/C Hazardous	20	0.1%	0.0%	0.2%
Green Containers	250	0.9%	0.4%	1.3%	**Special**	**464**	**1.6%**		
Brown Containers	189	0.6%	0.3%	1.0%	Ash	0	0.0%	0.0%	0.0%
Other Containers	0	0.0%	0.0%	0.0%	Sewage Sludge	0	0.0%	0.0%	0.0%
Flat Glass	33	0.1%	0.0%	0.3%	Industrial Sludge	0	0.0%	0.0%	0.0%
R/C Glass	26	0.1%	0.0%	0.2%	Treated Medical	91	0.3%	0.0%	0.7%
Metal	**2,098**	**7.2%**			Bulky Items	56	0.2%	0.0%	0.5%
Aluminum Cans	136	0.5%	0.3%	0.6%	Tires	273	0.9%	0.0%	2.1%
Tin Cans	202	0.7%	0.5%	0.9%	R/C Special	45	0.2%	0.0%	0.3%
Ferrous	1,207	4.1%	0.3%	8.0%	**Mixed**	**262**	**0.9%**		
Nonferrous	79	0.3%	0.1%	0.4%	Mixed Residue	262	0.9%	0.5%	1.3%
White Goods	0	0.0%	0.0%	0.0%					
R/C Metal	474	1.6%	0.4%	2.9%					
Plastic	**2,900**	**10.0%**							
#1 Containers	177	0.6%	0.3%	0.9%					
#2 Containers	146	0.5%	0.3%	0.7%					
Other Containers	99	0.3%	0.2%	0.4%					
Film	1,072	3.7%	2.8%	4.5%					
Durable	815	2.8%	0.3%	5.2%					
R/C Plastic	591	2.0%	1.0%	3.0%					
Organics	**7,627**	**26.2%**							
Food	5,479	18.8%	13.7%	24.0%					
Textiles	611	2.1%	0.4%	3.8%					
Leaves and Grass	176	0.6%	0.2%	1.1%					
Prunings	243	0.8%	0.3%	1.4%					
Stumps	0	0.0%	0.0%	0.0%					
Crop Residue	0	0.0%	0.0%	0.0%					
Manure	0	0.0%	0.0%	0.0%					
R/C Organic	1,118	3.8%	1.5%	6.1%					

Total Tons	29,119
Sample Count (2001 study)	36

Low and High are calculated at a 90% confidence interval

EXHBIT A-12
Composition Estimates: East Hawai`i Self-Haul

	Tons Disposed	Percent of Total		Tons Disposed	Percent of Total
Paper	**1,126**	**8.8%**	**Construction and Demolition**	**6,549**	**51.2%**
Cardboard	208	1.6%	Concrete	816	6.4%
Bags	4	0.0%	Asphalt Paving	793	6.2%
Newspaper	39	0.3%	Asphalt Roofing	0	0.0%
White Ledger	1	0.0%	Clean and Treated Lumber	2,619	20.5%
Colored Ledger	0	0.0%	Treated Lumber	776	6.1%
Computer	0	0.0%	Gypsum Board	509	4.0%
Office	1	0.0%	Rocks and Soil	129	1.0%
Magazines	1	0.0%	R/C Demo	905	7.1%
Directories	0	0.0%	**Household Hazardous**	**11**	**0.1%**
Miscellaneous	21	0.2%	Paint	7	0.1%
R/C Paper	850	6.6%	Vehicle Fluids	3	0.0%
Glass	**8**	**0.1%**	Oil	0	0.0%
Clear Containers	3	0.0%	Batteries	1	0.0%
Green Containers	1	0.0%	R/C Hazardous	0	0.0%
Brown Containers	1	0.0%	**Special**	**1,871**	**14.6%**
Other Containers	0	0.0%	Ash	0	0.0%
Flat Glass	0	0.0%	Sewage Sludge	0	0.0%
R/C Glass	4	0.0%	Industrial Sludge	1,241	9.7%
Metal	**256**	**2.0%**	Treated Medical	28	0.2%
Aluminum Cans	3	0.0%	Bulky Items	88	0.7%
Tin Cans	0	0.0%	Tires	514	4.0%
Ferrous	154	1.2%	R/C Special	0	0.0%
Nonferrous	1	0.0%	**Mixed**	**2**	**0.0%**
White Goods	2	0.0%	Mixed Residue	2	0.0%
R/C Metal	96	0.7%			
Plastic	**65**	**0.5%**			
#1 Containers	1	0.0%			
#2 Containers	2	0.0%			
Other Containers	1	0.0%			
Film	14	0.1%			
Durable	5	0.0%			
R/C Plastic	41	0.3%			
Organics	**2,905**	**22.7%**			
Food	314	2.5%			
Textiles	5	0.0%			
Leaves and Grass	33	0.3%			
Prunings	15	0.1%			
Stumps	1,344	10.5%			
Crop Residue	0	0.0%			
Manure	0	0.0%			
R/C Organic	1,194	9.3%			
Total Tons	12,792				
Sample Count (2001 study)	24				

ATTACHMENT B

Detailed West Hawai`i Commercial Substream Results

EXHIBIT B-1

Composition Estimates: West Hawai`i Commercial Packer Trucks

bb	Tons Disposed	Percent of Total	Low	High
Paper	**12,382**	**31.5%**		
Cardboard	3,260	8.3%	6.8%	9.8%
Bags	146	0.4%	0.2%	0.6%
Newspaper	765	1.9%	1.3%	2.5%
White Ledger	466	1.2%	0.3%	2.0%
Colored Ledger	153	0.4%	0.0%	0.8%
Computer	5	0.0%	0.0%	0.0%
Office	540	1.4%	0.6%	2.2%
Magazines	605	1.5%	0.5%	2.6%
Directories	21	0.1%	0.0%	0.1%
Miscellaneous	3,148	8.0%	6.1%	9.9%
R/C Paper	3,274	8.3%	6.3%	10.4%
Glass	**712**	**1.8%**		
Clear Containers	144	0.4%	0.2%	0.5%
Green Containers	274	0.7%	0.4%	1.0%
Brown Containers	170	0.4%	0.2%	0.7%
Other Containers	111	0.3%	0.2%	0.4%
Flat Glass	0	0.0%	0.0%	0.0%
R/C Glass	12	0.0%	0.0%	0.1%
Metal	**2,400**	**6.1%**		
Aluminum Cans	114	0.3%	0.2%	0.4%
Tin Cans	253	0.6%	0.5%	0.8%
Ferrous	907	2.3%	0.3%	4.3%
Nonferrous	97	0.2%	0.2%	0.3%
White Goods	0	0.0%	0.0%	0.0%
R/C Metal	1,029	2.6%	1.3%	4.0%
Plastic	**3,941**	**10.0%**		
#1 Containers	312	0.8%	0.6%	1.0%
#2 Containers	204	0.5%	0.4%	0.7%
Other Containers	254	0.6%	0.5%	0.8%
Film	1,803	4.6%	3.8%	5.4%
Durable	372	0.9%	0.6%	1.3%
R/C Plastic	996	2.5%	2.0%	3.1%
Organics	**16,599**	**42.2%**		
Food	10,880	27.7%	22.6%	32.7%
Textiles	1,677	4.3%	2.5%	6.0%
Leaves and Grass	699	1.8%	0.0%	3.7%
Prunings	807	2.1%	0.6%	3.5%
Stumps	0	0.0%	0.0%	0.0%
Crop Residue	0	0.0%	0.0%	0.0%
Manure	0	0.0%	0.0%	0.0%
R/C Organic	2,537	6.5%	4.3%	8.6%

	Tons Disposed	Percent of Total	Low	High
Construction and Demolition	**2,904**	**7.4%**		
Concrete	0	0.0%	0.0%	0.0%
Asphalt Paving	512	1.3%	0.0%	3.4%
Asphalt Roofing	0	0.0%	0.0%	0.0%
Clean and Treated Lumber	713	1.8%	1.3%	2.3%
Gypsum Board	112	0.3%	0.0%	0.7%
Rocks and Soil	94	0.2%	0.0%	0.6%
R/C Demo	1,473	3.7%	1.2%	6.3%
Household Hazardous	**97**	**0.2%**		
Paint	0	0.0%	0.0%	0.0%
Vehicle Fluids	0	0.0%	0.0%	0.0%
Oil	33	0.1%	0.0%	0.2%
Batteries	13	0.0%	0.0%	0.1%
R/C Hazardous	51	0.1%	0.0%	0.3%
Special	**274**	**0.7%**		
Ash	0	0.0%	0.0%	0.0%
Sewage Sludge	0	0.0%	0.0%	0.0%
Industrial Sludge	0	0.0%	0.0%	0.0%
Treated Medical	0	0.0%	0.0%	0.0%
Bulky Items	274	0.7%	0.0%	1.8%
Tires	0	0.0%	0.0%	0.0%
R/C Special	0	0.0%	0.0%	0.0%
Mixed	**0**	**0.0%**		
Mixed Residue	0	0.0%	0.0%	0.0%

Total Tons	39,309
Sample Count	30

Low and High are calculated at a 90% confidence interval

EXHIBIT B-2

Composition Estimates: West Hawai`i Commercial Drop Boxes

	Tons Disposed	Percent of Total	Low	High		Tons Disposed	Percent of Total	Low	High
Paper	**7,737**	**21.1%**			**Construction and Demolition**	**13,562**	**37.0%**		
Cardboard	4,443	12.1%	7.3%	16.9%	Concrete	3,652	10.0%	3.2%	16.7%
Bags	135	0.4%	0.0%	0.7%	Asphalt Paving	0	0.0%	0.0%	0.0%
Newspaper	514	1.4%	0.0%	2.9%	Asphalt Roofing	4	0.0%	0.0%	0.0%
White Ledger	57	0.2%	0.1%	0.3%	Clean and Treated Lumber	5,818	15.9%	8.3%	23.4%
Colored Ledger	6	0.0%	0.0%	0.0%	Gypsum Board	371	1.0%	0.0%	2.1%
Computer	36	0.1%	0.0%	0.3%	Rocks and Soil	0	0.0%	0.0%	0.0%
Office	16	0.0%	0.0%	0.1%	R/C Demo	3,718	10.1%	3.5%	16.7%
Magazines	167	0.5%	0.1%	0.8%	**Household Hazardous**	**117**	**0.3%**		
Directories	0	0.0%	0.0%	0.0%	Paint	117	0.3%	0.0%	0.7%
Miscellaneous	715	2.0%	1.0%	2.9%	Vehicle Fluids	0	0.0%	0.0%	0.0%
R/C Paper	1,648	4.5%	2.2%	6.8%	Oil	0	0.0%	0.0%	0.0%
Glass	**587**	**1.6%**			Batteries	0	0.0%	0.0%	0.0%
Clear Containers	134	0.4%	0.0%	0.7%	R/C Hazardous	0	0.0%	0.0%	0.0%
Green Containers	98	0.3%	0.1%	0.5%	**Special**	**0**	**0.0%**		
Brown Containers	100	0.3%	0.1%	0.5%	Ash	0	0.0%	0.0%	0.0%
Other Containers	40	0.1%	0.0%	0.2%	Sewage Sludge	0	0.0%	0.0%	0.0%
Flat Glass	84	0.2%	0.0%	0.6%	Industrial Sludge	0	0.0%	0.0%	0.0%
R/C Glass	131	0.4%	0.0%	0.8%	Treated Medical	0	0.0%	0.0%	0.0%
Metal	**2,422**	**6.6%**			Bulky Items	0	0.0%	0.0%	0.0%
Aluminum Cans	32	0.1%	0.0%	0.1%	Tires	0	0.0%	0.0%	0.0%
Tin Cans	142	0.4%	0.2%	0.6%	R/C Special	0	0.0%	0.0%	0.0%
Ferrous	1,495	4.1%	1.3%	6.9%	**Mixed**	**0**	**0.0%**		
Nonferrous	4	0.0%	0.0%	0.0%	Mixed Residue	0	0.0%	0.0%	0.0%
White Goods	0	0.0%	0.0%	0.0%					
R/C Metal	749	2.0%	0.0%	4.3%					
Plastic	**2,857**	**7.8%**							
#1 Containers	92	0.3%	0.1%	0.4%					
#2 Containers	56	0.2%	0.1%	0.3%					
Other Containers	94	0.3%	0.1%	0.4%					
Film	886	2.4%	0.9%	3.9%					
Durable	1,048	2.9%	0.5%	5.2%					
R/C Plastic	681	1.9%	0.6%	3.1%					
Organics	**9,389**	**25.6%**							
Food	6,380	17.4%	9.2%	25.6%					
Textiles	164	0.4%	0.2%	0.7%					
Leaves and Grass	29	0.1%	0.0%	0.2%					
Prunings	962	2.6%	0.0%	6.5%					
Stumps	0	0.0%	0.0%	0.0%					
Crop Residue	0	0.0%	0.0%	0.0%					
Manure	0	0.0%	0.0%	0.0%					
R/C Organic	1,854	5.1%	1.2%	8.9%					
Total Tons	36,671								
Sample Count	30								

Low and High are calculated at a 90% confidence interval

EXHIBIT B-3
Composition Estimates: West Hawai`i Commercial Other

	Tons Disposed	Percent of Total	Low	High		Tons Disposed	Percent of Total	Low	High
Paper	**330**	**6.6%**			**Construction and Demolition**	**3,156**	**63.1%**		
Cardboard	242	4.8%	0.6%	9.1%	Concrete	42	0.8%	0.0%	1.8%
Bags	29	0.6%	0.0%	1.3%	Asphalt Paving	0	0.0%	0.0%	0.0%
Newspaper	7	0.1%	0.0%	0.4%	Asphalt Roofing	59	1.2%	0.0%	3.0%
White Ledger	7	0.1%	0.0%	0.3%	Clean and Treated Lumber	1,055	21.1%	9.2%	33.0%
Colored Ledger	0	0.0%	0.0%	0.0%	Gypsum Board	115	2.3%	0.4%	4.2%
Computer	0	0.0%	0.0%	0.0%	Rocks and Soil	241	4.8%	0.0%	11.7%
Office	2	0.0%	0.0%	0.1%	R/C Demo	1,644	32.9%	16.3%	49.5%
Magazines	6	0.1%	0.0%	0.3%	**Household Hazardous**	**0**	**0.0%**		
Directories	0	0.0%	0.0%	0.0%	Paint	0	0.0%	0.0%	0.0%
Miscellaneous	22	0.4%	0.0%	1.0%	Vehicle Fluids	0	0.0%	0.0%	0.0%
R/C Paper	15	0.3%	0.0%	0.6%	Oil	0	0.0%	0.0%	0.0%
Glass	**13**	**0.3%**			Batteries	0	0.0%	0.0%	0.0%
Clear Containers	0	0.0%	0.0%	0.0%	R/C Hazardous	0	0.0%	0.0%	0.0%
Green Containers	7	0.1%	0.0%	0.4%	**Special**	**0**	**0.0%**		
Brown Containers	0	0.0%	0.0%	0.0%	Ash	0	0.0%	0.0%	0.0%
Other Containers	1	0.0%	0.0%	0.0%	Sewage Sludge	0	0.0%	0.0%	0.0%
Flat Glass	0	0.0%	0.0%	0.0%	Industrial Sludge	0	0.0%	0.0%	0.0%
R/C Glass	4	0.1%	0.0%	0.2%	Treated Medical	0	0.0%	0.0%	0.0%
Metal	**281**	**5.6%**			Bulky Items	0	0.0%	0.0%	0.0%
Aluminum Cans	2	0.0%	0.0%	0.1%	Tires	0	0.0%	0.0%	0.0%
Tin Cans	138	2.8%	0.0%	6.9%	R/C Special	0	0.0%	0.0%	0.0%
Ferrous	45	0.9%	0.2%	1.6%	**Mixed**	**0**	**0.0%**		
Nonferrous	0	0.0%	0.0%	0.0%	Mixed Residue	0	0.0%	0.0%	0.0%
White Goods	0	0.0%	0.0%	0.0%					
R/C Metal	96	1.9%	0.4%	3.4%					
Plastic	**145**	**2.9%**							
#1 Containers	1	0.0%	0.0%	0.1%					
#2 Containers	1	0.0%	0.0%	0.0%					
Other Containers	0	0.0%	0.0%	0.0%					
Film	85	1.7%	0.2%	3.2%					
Durable	7	0.1%	0.0%	0.3%					
R/C Plastic	51	1.0%	0.0%	2.2%					
Organics	**1,076**	**21.5%**							
Food	20	0.4%	0.0%	1.1%					
Textiles	8	0.2%	0.0%	0.4%					
Leaves and Grass	81	1.6%	0.0%	3.3%					
Prunings	777	15.5%	0.0%	31.7%					
Stumps	112	2.2%	0.0%	5.3%					
Crop Residue	0	0.0%	0.0%	0.0%					
Manure	0	0.0%	0.0%	0.0%					
R/C Organic	77	1.5%	0.0%	3.9%					
Total Tons	5,000								
Sample Count	10								

Low and High are calculated at a 90% confidence interval

ATTACHMENT C

Waste Component Definitions

ATTACHMENT C

Waste Component Definitions

The list and definitions of the Standard Material Categories were drawn from the California Integrated Waste Management Board's Uniform Waste Disposal Characterization Method. The component category "treated lumber" was added during the design of this study. Definitions of the component materials used in this report follow.

Paper

(1) **Uncoated Corrugated Cardboard** usually has three layers. The center wavy layer is sandwiched between the two outer layers. It does not have any wax coating on the inside or outside. Examples: This component includes entire cardboard containers, such as shipping and moving boxes, computer packaging cartons, and sheets and pieces of boxes and cartons. This component does not include chipboard.

(2) **Paper Bags** means bags and sheets made from kraft paper. Examples: This component includes paper grocery bags, fast food bags, department store bags, and heavyweight sheets of kraft packing paper.

(3) **Newspaper** means paper used in newspapers. Examples: This component includes newspaper and glossy inserts, and all items made from newsprint, such as free advertising guides, election guides, and tax instruction booklets.

(4) **White Ledger** means uncolored bond, rag, or stationary grade paper. It may have colored ink on it. When the paper is torn, the fibers are white. Examples: This component includes white photocopy, white laser print, and letter paper.

(5) **Colored Ledger** means colored bond, rag, or stationery grade paper. When the paper is torn, the fibers are colored throughout. Examples: This component includes colored photocopy and letter paper. This component does not include fluorescent dyed paper or deep-tone dyed paper such as goldenrod colored paper.

(6) **Computer Paper** means paper used for computer printouts. This component usually has a strip of form feed holes along two edges. If there are no holes, then the edges show tear marks. This component can be white or striped. Examples: This component includes computer paper and printouts from continuous feed printers. This component does not include "white ledger" used in laser or impact printers, nor computer paper containing groundwood.

(7) **Other Office Paper** means other kinds of paper used in offices. Examples: This component includes manila folders, manila envelopes, index cards, white envelopes, white window envelopes, notebook paper, and carbonless forms. This component does not include "white ledger," "colored ledger," or "computer paper".

(8) **Magazines and Catalogs** means items made of glossy coated paper. This paper is usually slick, smooth to the touch, and reflects light. Examples: This component includes glossy magazines, catalogs, brochures and pamphlets.

(9) **Phone Books and Directories** means thin paper between coated covers. These items are bound along the spine with glue. Examples: This component includes whole or damaged telephone books, "yellow pages," real estate listings, and some non-glossy mail order catalogs.

(10) **Other Miscellaneous Paper** means items made mostly of paper that do not fit into any of the above components. Paper may be combined with minor amounts of other materials such as wax or glues. This component includes items made of chipboard, groundwood paper, and deep-toned or fluorescent dyed paper. Examples: This component includes cereal and cracker boxes, unused paper plates and cups, goldenrod colored paper, and hardcover and softcover books.

(11) **Remainder/Composite Paper** means items made mostly of paper but combined with large amounts of other materials such as wax, plastic, glues, foil, food, and moisture. Examples: This component includes waxed corrugated cardboard, aseptic packages, wax coated milk cartons, waxed paper, tissue, paper towels, blueprints, sepia, onionskin, fast food wrappers, carbon paper, self-adhesive notes, and photographs.

Glass

(12) **Clear Glass Bottles and Containers** means clear glass beverage and food containers with or without a CRV label. Examples: This component includes whole or broken clear soda and beer bottles, fruit juice bottles, peanut butter jars, and mayonnaise jars.

(13) **Green Glass Bottles and Containers** means green-colored glass containers with or without a CRV label. Examples: This component includes whole or broken green soda and beer bottles, and whole or broken green wine bottles.

(14) **Brown Glass Bottles and Containers** means brown-colored glass containers with or without a CRV label. Examples: This component includes whole or broken brown soda and beer bottles, and whole or broken brown wine bottles.

(15) **Other Colored Glass Bottles and Containers** means colored glass containers and bottles other than green or brown with or without a CRV label. Examples: This component includes whole or broken blue or other colored bottles and containers.

(16) **Flat Glass** means clear or tinted glass that is flat. Examples: This component includes glass windowpanes, doors, and tabletops, flat automotive window glass (side windows), safety glass, and architectural glass. This component does not include windshields, laminated glass, or any curved glass.

(17) **Remainder/Composite Glass** means glass that cannot be put in any other component category. It includes items made mostly of glass but combined with other materials. Examples: This component includes Pyrex, Corningware, crystal and other glass tableware, mirrors, and auto windshields.

Metal

(18) **Tin/Steel Cans** means rigid containers made mainly of steel. These items will stick to a magnet and may be tin-coated. This component is used to store food, beverages, paint, and a variety of other household and consumer products. Examples: This component includes canned food and beverage containers, empty metal paint cans, empty spray paint and other aerosol containers, and bimetal containers with steel sides and aluminum ends.

(19) **Major Appliances** means discarded major appliances of any color. These items are often enamel-coated. Examples: This component includes washing machines, clothes dryers, hot water heaters, stoves, and refrigerators. This component does not include electronics, such as televisions and stereos.

(20) **Other Ferrous** means any iron or steel that is magnetic or any stainless steel item. This component does not include "tin/steel cans". Examples: This component includes structural steel beams, metal clothes hangers, metal pipes, stainless steel cookware, security bars, and scrap ferrous items.

(21) **Aluminum Cans** means any food or beverage container made mainly of aluminum. Examples: This component includes aluminum soda or beer cans, and some pet food cans. This component does not include bimetal containers with steel sides and aluminum ends.

(22) **Other Non-Ferrous** means any metal item, other than aluminum cans, that is not stainless steel and that is not magnetic. These items may be made of aluminum, copper, brass, bronze, lead, zinc, or other metals. Examples: This component includes aluminum window frames, aluminum siding, copper wire, shell casings, brass pipe, and aluminum foil.

(23) **Remainder/Composite Metal** means metal that cannot be put in any other component category. This component includes items made mostly of metal but combined with other materials and items made of both ferrous metals and non-ferrous metal combined. Examples: This component includes brown goods (electronics and other small appliances), computers, televisions, radios, and electronic parts.

Plastic

(24) **HDPE Containers** means natural and colored HDPE containers. This plastic is usually either cloudy white, allowing light to pass through it (natural) or a solid color, preventing light from passing through it (colored). When marked for identification, it bears the number "2" in the triangular recycling symbol. Examples: This component includes milk jugs, water jugs, detergent bottles, some haircare bottles, empty motor oil, empty antifreeze, and other empty vehicle and equipment fluid containers.

(25) **PETE Containers** means clear or colored PETE containers. When marked for identification, it bears the number "1" in the center of the triangular recycling symbol and may also bear the letters "PETE" or "PET". The color is usually transparent green or clear. A PETE container usually has a small dot left from the manufacturing process, not a seam. It does not turn white when bent. Examples: This component includes soft drink and water bottles, some liquor bottles, cooking oil containers, and aspirin bottles.

(26) **Miscellaneous Plastic Containers** means plastic containers made of types of plastic other than HDPE or PETE. Items may be made of PVC, PP, or PS. When marked for identification, these items may bear the number "3," "4," "5," "6," or "7" in the triangular recycling symbol. Examples: This component includes food containers such as bottles for salad dressings and vegetable oils, flexible and brittle yogurt cups and lids, syrup bottles, margarine tubs, microwave food trays, and clamshell-shaped fast food containers. This component also includes some shampoo containers and vitamin bottles.

(27) **Film Plastic** means flexible plastic sheeting. It is made from a variety of plastic resins including HDPE and LDPE. It can be easily contoured around an object by hand pressure. Examples: This component includes plastic garbage bags, food bags, dry cleaning bags, grocery store bags, packaging wrap, and food wrap. This component does not include rigid bubble packaging.

(28) **Durable Plastic Items** means plastic objects other than containers and film plastic. This component also includes plastic objects other than containers or film that bear the numbers "1" through "7" in the triangular recycling symbol. These items are usually made to last for more than one use. Examples: This component includes plastic outdoor furniture, plastic toys and sporting goods, and plastic housewares, such as mop buckets, dishes, cups, and cutlery. This component also includes building materials such as house siding, window sashes and frames, housings for electronics such as computers, televisions and stereos, and plastic pipes and fittings.

(29) **Remainder and Composite Plastic** means plastic that cannot be put in any other component category. This component includes items made mostly of plastic but combined with other materials. Examples: This component includes auto parts made of plastic attached to metal, plastic bubble packaging, drinking straws, foam drinking cups, produce trays, egg cartons, foam packing blocks, packing peanuts, and cookie and muffin trays.

Other Organic

(30) **Food** means food material resulting from the processing, storage, preparation, cooking, handling or consumption of food. This component includes material from industrial, commercial or residential sources. Examples: This component includes discarded meat scraps, dairy products, eggshells, fruit or vegetable peels, and other food items from homes, stores, and restaurants. This component includes grape pomace and other processed residues or material from canneries, wineries, or other industrial sources.

(31) **Leaves and Grass** means plant material, except woody material, from any public or private landscapes. Examples: This component includes leaves, grass clippings, and plants. This component does not include woody material or material from agricultural sources.

(32) **Prunings and Trimmings** means woody plant material up to 4 inches in diameter from any public or private landscape. Examples: This component includes prunings, shrubs, and small branches with branch diameters that do not exceed 4 inches. This component does not include stumps, tree trunks, or branches exceeding 4 inches in diameter. This component does not include material from agricultural sources.

(33) **Branches and Stumps** means woody plant material, branches and stumps that exceed 4 inches in diameter from any public or private landscape.

(34) **Agricultural Crop Residues** means plant material from agricultural sources. Examples: This component includes orchard and vineyard prunings, vegetable by-products from farming, residual fruits, vegetables, and other crop remains after usable crop is harvested. This component does not include processed residues from canneries, wineries, or other industrial sources.

(35) **Manures** means manure and soiled bedding materials from domestic, farm, or ranch animals. Examples: This component includes manure and soiled bedding from animal production operations, racetracks, riding stables, animal hospitals, and other sources.

(36) **Textiles** means items made of thread, yarn, fabric, or cloth. Examples: This component includes clothes, fabric trimmings, draperies, and all natural and synthetic cloth fibers. This component does not include cloth-covered furniture, mattresses, leather shoes, leather bags, or leather belts.

(37) **Remainder/Composite Organic** means organic material that cannot be put in any other component category. This component includes items made mostly of organic materials but combined with other materials. Examples: This component includes leather items, carpets, disposable diapers, cork, hemp rope, garden hoses, rubber items, hair, and carpet padding.

Construction and Demolition

(38) **Concrete** means a hard material made from sand, gravel, aggregate, cement mix and water. Examples: This component includes pieces of building foundations, concrete paving, and cinder blocks.

(39) **Asphalt Paving** means a black or brown, tar-like material mixed with aggregate used as a paving material.

(40) **Asphalt Roofing** means composite shingles and other roofing material made with asphalt. Examples: This component includes asphalt shingles and attached roofing tar and tarpaper.

(41) **Clean Lumber** means processed wood for building, manufacturing, landscaping, packaging, and processed wood from demolition. Examples: This component includes untreated dimensional lumber, lumber cutoffs, engineered wood such as plywood and particleboard, wood scraps, pallets, wood fencing, wood shake roofing, and wood siding. Note that County of Hawai`i building codes require the use of treated lumber for home construction, thus there is relatively little clean lumber in the waste stream.

(42) **Treated Lumber** means new and used lumber that has been treated with any chemical preservative. Examples: This component includes railroad ties, marine timbers and pilings, some landscape timbers, and telephone poles.

(43) **Gypsum Board** means interior wall covering made of a sheet of gypsum sandwiched between paper layers. Examples: This component includes used or unused, broken or whole

sheets of sheetrock, drywall, gypsum board, plasterboard, gypboard, gyproc, and wallboard.

(44) **Rock, Soil and Fines** means rock pieces of any size and soil, dirt, and other matter. Examples: This component includes rock, stones, and sand, clay, soil and other fines. This component also includes non-hazardous contaminated soil.

(45) **Remainder/Composite Construction and Demolition** means construction and demolition material that cannot be put in any other component category. This component may include items from different components combined, which would be very hard to separate. Examples: This component includes brick, ceramics, tiles, toilets, sinks, and fiberglass insulation. This component may also include demolition debris that is a mixture of items such as plate glass, wood, tiles, gypsum board, and aluminum scrap.

Household Hazardous Waste

(46) **Paint** means containers with paint in them. Examples: This component includes latex paint, oil-based paint, and tubes of pigment or fine art paint. This component does not include dried paint, empty paint cans, or empty aerosol containers.

47) **Vehicle and Equipment Fluids** means containers with fluids used in vehicles or engines, except used oil. Examples: This component includes used antifreeze and brake fluid. This component does not include empty vehicle and equipment fluid containers.

(48) **Used Oil** means the same as defined in Health and Safety Code section 25250.1(a). Examples: This component includes spent lubricating oil such as crankcase and transmission oil, gear oil, and hydraulic oil.

(49) **Batteries** means any type of battery including both dry cell and lead acid. Examples: This component includes car, flashlight, small appliance, watch and hearing aid batteries.

(50) **Remainder/Composite Household Hazardous** means household hazardous material that cannot be put in the "Paint", "Automotive Fluids", "Used Oil", or "Batteries" component categories. This component also includes household hazardous material that is mixed. Examples: This component includes household hazardous waste which if improperly put in the solid waste stream may present handling problems or other hazards.

Special Waste

(51) **Ash** means a residue from the combustion of any solid or liquid material. Examples: This component includes ash from fireplaces, incinerators, biomass facilities, waste-to-energy facilities, and barbecues. This component also includes ash and burned debris from structure fires.

(52) **Sewage Solids** means residual solids and semi-solids from the treatment of domestic wastewater or sewage. Examples: This component includes biosolids, sludge, grit, screenings, and septage. This component does not include sewage or waste water discharged from the sewage treatment process.

(53) **Industrial Sludge** means sludge from factories, manufacturing facilities, and refineries. Examples: This component includes paper pulp sludge, and water treatment filter cake sludge.

(54) **Treated Medical Waste** has the same meaning as treated medical waste in Section 25023.5 of the Health and Safety Code.

(55) **Bulky Items** means large, hard-to-handle items that are not defined separately, including furniture, mattresses, and other large items. Examples: This component includes all sizes and types of furniture, mattresses, box springs, and base components.

(56) **Tires** means vehicle tires. Examples: This component includes tires from trucks, automobiles, motorcycles, heavy equipments, and bicycles.

(57) **Remainder/Composite Special Waste** means special waste that cannot be put in any other component category. Examples: This component includes asbestos-containing materials, such as certain types of pipe insulation and floor tiles, auto fluff, auto-bodies, trucks, trailers, truck cabs, and artificial fireplace logs.

Mixed Residue

(58) **Mixed Residue** means material that cannot be put in any other component categories. This component includes mixed residue that cannot be further sorted. Examples: This component includes residual material from a materials recovery facility or other sorting process that cannot be put in any of the previous remainder/composite component categories.

ATTACHMENT D

Sampling Methodology and Calculations

ATTACHMENT D

Sampling Methodology and Calculations

Sampling Methodology

Objective

This study was intended to produce statistically valid data on the types and quantities of waste disposed at the West Hawai`i Landfill during FY 2008. The results of this study were combined with the results of the 2001 study conducted at the South Hilo Landfill resulting in a waste composition profile for the entire County.

Substream Definition

The waste hauled to the West Hawai`i Landfill can be divided into the following three categories (called **substreams**):

1. **Transfer Station** – is composed of waste hauled from nine transfer stations on the west side of the island. It is transported to the West Hawai`i Landfill in transfer station compactor boxes. Transfer station loads are made up primarily of residential waste.

2. **Commercial** – is composed of waste hauled by commercial hauling companies. Commercial haulers use a variety of vehicles to transport this waste to the West Hawai`i Landfill, including: packer trucks (garbage trucks), roll-offs (primarily open boxes), and other vehicles (e.g. flatbeds, pickups, etc.). This waste is collected from both residences and businesses. Commercial samples were allocated to each of these three vehicle types.

3. **Self-Haul** – is composed of waste that residents, contractors, businesses, and public entities haul directly to the West Hawai`i Landfill. These loads are transported either in small vehicles (e.g. autos, pick-ups, etc.) or large vehicles (e.g. dump trucks, flatbeds, etc). As with waste in the commercial substream, self-haul waste comes from both residences and businesses.

Sample Allocation

The total number of samples allocated to each substream and sampled on each day of the study is provided in Exhibit D-1. Note that no samples were allocated to the self-haul substream. There is relatively little mixed self-haul material delivered to the West Hawai`i Landfill (1,200 of 128,000 tons in FY 2008, or less than 1 percent). Therefore, it was decided that overall sampling accuracy would be improved by using self-haul sampling results from the 2001 study to represent the composition of mixed self-haul loads in West Hawai`i, and assigning samples that would have been obtained from the self-haul stream to the other two substreams. The composition profile of mixed self-haul loads from the 2001 study was used to estimate the mixed self-haul composition for the West Hawai`i Landfill.

The project budget allowed for a total of 100 total loads to be sampled. The allocation of samples between the substreams was determined according to each substream's

EXHIBIT D-1
Samples per Day by Substream

	Number of Samples				
	Transfer Station	Commercial Packer	Commercial Rolloff	Commercial Other	Total
May 15, 2008	6	5	6	3	20
May 16, 2008	6	8	5	1	20
May 19, 2008	6	7	6	1	20
May 20, 2008	6	4	9	1	20
May 21, 2008	6	6	4	4	20
Total	30	30	30	10	100

contribution to the total waste stream. Adjustments were made so that a sufficient number of samples were taken from each substream to ensure a representative composition. Thus, the commercial substream was slightly over sampled, and the transfer station substream was slightly under sampled.

Vehicle Selection

Sampling intervals for each substream and vehicle type were determined by dividing the day's expected number of arriving loads by the number of samples needed on that day. For example, if 20 commercial packer trucks were expected to arrive at the West Hawai`i Landfill on a sampling day, and a total of 5 samples were needed, every 4th commercial packer truck would be selected for sampling. Prior to each sampling day, the Field Supervisor was given a sheet outlining specific sampling intervals per substream and vehicle type. Attachment E contains an example of the vehicle selection sheet used in this study.

Field Procedures

On each sampling day, the Field Supervisor identified sample loads as they arrived at the West Hawai`i Landfill. The Supervisor assigned each selected load a unique sample identification number. Then, the Supervisor surveyed the driver of each vehicle to obtain "header information" which was recorded on that sample's waste sort sheet. The following information was collected for each sample load:

1. Load type

a. Commercially hauled loads only - the hauler name

b. Transfer station loads only - name of transfer station the load came from

2. Generator type

a. Commercially hauled loads only

i. Loads that were 80% or more residential waste were recorded as "residential"

ii. Loads that were 80% or more commercial waste were recorded as "commercial"

iii. Otherwise, the generator type was recorded as "mixed"

b. Transfer station loads only - always marked as "mixed"

3. Vehicle type

a. Commercially hauled loads only - recorded as "packer," "roll-off," or "other vehicle" (e.g. flatbeds, dump trucks, pickups).

b. Transfer station loads only - were always recorded as "transfer station box."

As the load was emptied at the West Hawai`i Landfill, the Field Supervisor observed the load for evidence of hard-to-process or potentially explosive items. Details regarding these items were noted on the sample's waste sort sheet. Hard-to-process items included anything that would be difficult or impossible to manually sort, automatically process, or transfer by conveyor belt due to weight or size, such as: appliances, mattresses, cabinets, carpet, asphalt or concrete, and large pieces of scrap metal or lumber.

Next, the selected load was visually divided into an imaginary 16-cell grid. The supervisor then identified the randomly selected cell and approximately 200 to 300 pounds of waste was removed from that cell with a loader and placed on a tarpaulin. Samples were then tagged with a sample identifier labeled with their unique sample number and the date.

Once the total weight of a sample was recorded, the material was sorted by hand into the 58 prescribed components, placed in plastic laundry baskets, weighed, and recorded. (See Attachment C for a list and definitions of the components.)

Each sample was sorted by hand to the greatest reasonable level of detail, until no more than a small amount of homogeneous fines (less than 1 square inch) remained. The goal was to sort each sample completely into component categories. However, if fines did remain after sorting, they were weighed and the Supervisor classified them as "mixed residue."

As the final step in collecting field data, the Supervisor reviewed, completed and organized the forms from each day's sampling activity. The Supervisor also prepared data summary sheets and sampling checklists at the end of each day. Completed data forms were then transmitted to the Project Manager at CH2M HILL for review and quality control prior to data entry.

Waste Composition Calculations

The composition estimates represent the **ratio of the components' weight to the total waste** for each noted substream. They are derived by summing each component's weight across all of the selected records and dividing by the sum of the total weight of waste, as shown in the following equation:

$$r_j = \frac{\sum_i c_{ij}}{\sum_i w_i}$$

where:

c = weight of particular component

w = sum of all component weights

for i 1 to n

where n = number of selected samples

for j 1 to m

where m = number of components

The low and high, or confidence interval, for this estimate is derived from a nonparametric statistical technique called the Bootstrap (Efron, B. 1982. *The Jackknife, the Bootstrap, and other Resampling Plans*. Society for Industrial and Applied Mathematics). Standard methods of calculating sample statistics are generally not applicable to waste composition results because each substream consists of multiple waste components that must sum to one for each substream. The distribution of these components is a multinomial with unknown properties. As such, sample statistics other than the sample mean proportions cannot be calculated using standard parametric techniques without making unappealing assumptions that would invalidate the results.

The Bootstrap method is a simulation technique that allows the calculation of the variance and other statistics of a parameter with unknown distributional properties. In this study, the Bootstrap method was used to calculate the square root of the Bootstrap variance estimates of each sample mean (henceforth referred to as the standard error). The mean and standard error were then used to calculate confidence intervals about sample mean estimates.

The upper and lower confidence limits provide the boundaries of an interval within which we are 90 percent confident that the true mean proportion of a waste type will lie. They represent the high and low estimates shown in this study.

Upper and lower confidence limits were calculated as follows:

$$CI_u = \overline{SM_g} + (1.645 * SE_g)$$

$$CI_l = \overline{SM_g} - (1.645 * SE_g)$$

where: CI_u = upper confidence limit

CI_l = lower confidence limit

$\overline{SM_g}$ = sample mean proportion for waste component g

1.645 = standard normal deviate (two-tailed) at a 0.05 level

SE_g = standard error for waste component g

The overall waste composition estimates were calculated by performing a weighted average across the relevant sampling groups. For the transfer station substream, the estimates were calculated by performing a weighted average based on the tonnage disposed by each transfer station. For the commercial substream, the estimates were calculated by performing a weighted average based on the tonnage hauled by each vehicle type. For the self-haul substream, the estimates were calculated by multiplying total self-haul mixed loads by the waste component percentages from mixed loads from the 2001 sampling study. To that was added the tonnages disposed by 18 pure loads. Component percentages were then calculated based on the tons of mixed material and pure loads for each component.

The weighting percentages that were used to perform the composition calculations are listed in Exhibit D-2. This information was obtained from scale records at the West Hawai`i Landfill for FY 2008. The composition estimates for both the overall waste stream and each substream were applied to the relevant tonnages to estimate the amount of waste disposed for each component category.

The **weighted average for an overall composition estimate** is performed as follows:

$$O_j = (p_1 * r_{j1}) + (p_2 * r_{j2}) + (p_3 * r_{j3}) +$$

where:

Oj = overall composition estimate for component j

p = the production of tonnage contributed by the noted sample group

r = ratio of component weight to total waste weight in the noted sample group

for j = 1 to m

where m = number of components

EXHIBIT D-2
Weighting Percentages

Transfer Stations	Tons Disposed	Percent of Total
Kailua	7,860	6.1%
Keauhou	5,017	3.9%
Keei / Napoopoo	2,025	1.6%
Waiea	2,968	2.3%
Milolii	207	0.2%
Waiohinu / Ka'u	3,447	2.7%
Waimea	6,376	5.0%
Puako	2,681	2.1%
Kohala	4,145	3.2%
Honoka'a	3,459	2.7%
Pa'auilo	1,922	1.5%
Laupahoehoe	1,547	1.2%
Commercial		
Packers	39,309	30.6%
Rolloff	36,671	28.5%
Other Commercial	5,000	3.9%
Self-Haul		
Ash	93	0.1%
Crop residue	3	0.0%
Industrial Sludge	1,585	1.2%
Oil	2	0.0%
R/C Demo	765	0.6%
R/C Organic	294	0.2%
R/C Paper	2	0.0%
R/C Special	299	0.2%
Rocks and Soil	786	0.6%
Stumps	719	0.6%
Tires	116	0.1%
Treated Medical	20	0.0%
Mixed waste Loads	1,224	1.0%
Total	128,543	100.0%

Waste was not sampled from the Laupahoehoe, Miloli`i, and Ke`ei transfer stations. When calculating composite results for the transfer station substream, the tons from those stations were assumed to have the composition profile of the following stations: Pa`auilo, Waiea, and Kohala, respectively.

ATTACHMENT E

Field Sampling Forms

ATTACHMENT E

Field Sampling Forms

Two sampling forms were used in the field during the sampling event:

- Vehicle Selection Sheet
- Waste Sort Sheet

Examples of those forms follow.

COUNTY OF HAWAI`I WASTE CHARACTERIZATION STUDY

Vehicle Selection Form

Site: Pu`uanahulu Landfill

Date: **Thursday, May 15, 2008**

Cross off one number for each type of vehicle entering the landfill.

Continue for each block, beginning at #1, on the next line until the required number of vehicles is sampled.

TRANSFER STATION BOXES:		NEED 6 TOTAL – SAMPLE EVERY 2nd VEHICLE
1	2	
1	2	
1	2	
1	2	
1	2	
1	2	

COMMERCIAL PACKERS:			NEED 5 TOTAL – SAMPLE EVERY 3rd VEHICLE
1	2	3	
1	2	3	
1	2	3	
1	2	3	
1	2	3	

COMMERCIAL ROLL-OFFS:					NEED 6 TOTAL – SAMPLE EVERY 5th VEHICLE
1	2	3	4	5	
1	2	3	4	5	
1	2	3	4	5	
1	2	3	4	5	
1	2	3	4	5	
1	2	3	4	5	

NEED 3 TOTAL – SAMPLE FIRST VEHICLE AFTER TIME INDICATED
After 9:00 am
After 11:00 am
After 2:00 pm

Pu`uanahulu Landfill Sampling Form

Sample ID: _____

Date: _____

Load Type: ☐ TS ☐ Com

Generator: ☐ Res ☐ Com ☐ Mix R/C ☐ Const ☐ GW

Vehicle Type: ☐ Packer ☐ Roll Off ☐ Other Com ☐ TS Box

(Commercial Loads Only)
Hauler: _____
Route: _____

(TS Boxes Only)

Site/Origin: _____

PAPER

Cardboard			
Bags			
Newspaper			
White Ledger			
Colored Ledger			
Computer			
Office			
Magazines			
Directories			
Miscellaneous			
R/C Paper			

GLASS

Clear Containers			
Green Containers			
Brown Containers			
Other Containers			
Flat Glass			
R/C Glass			

METAL

Aluminum Cans			
Tin Cans			
Ferrous			
Nonferrous			
White Goods			
R/C Metal			

SPECIAL

Ash			
Sewage Sludge			
Industrial Sludge			
Treated Medical			
Bulky Items			
Tires			
R/C Special			

Mixed Residue			

ORGANIC

Food			
Textiles			
Leaves and Grass			
Prunings			
Stumps			
Crop Residue			
Manure			
R/C Organic			

PLASTIC

#1 Containers			
#2 Containers			
Other Containers			
Film			
Durable			
R/C Plastic			

C & D

Concrete			
Asphalt Paving			
Asphalt Roofing			
Clean Lumber			
Treated Lumber			
Gypsum Board			
Rocks and Soil			
R/C Demo			

HHW

Paint			
Vehicle Fluids			
Oil			
Batteries			
R/C Hazardous			

Evidence of Explosive/Hard –to-Process Items in Load:

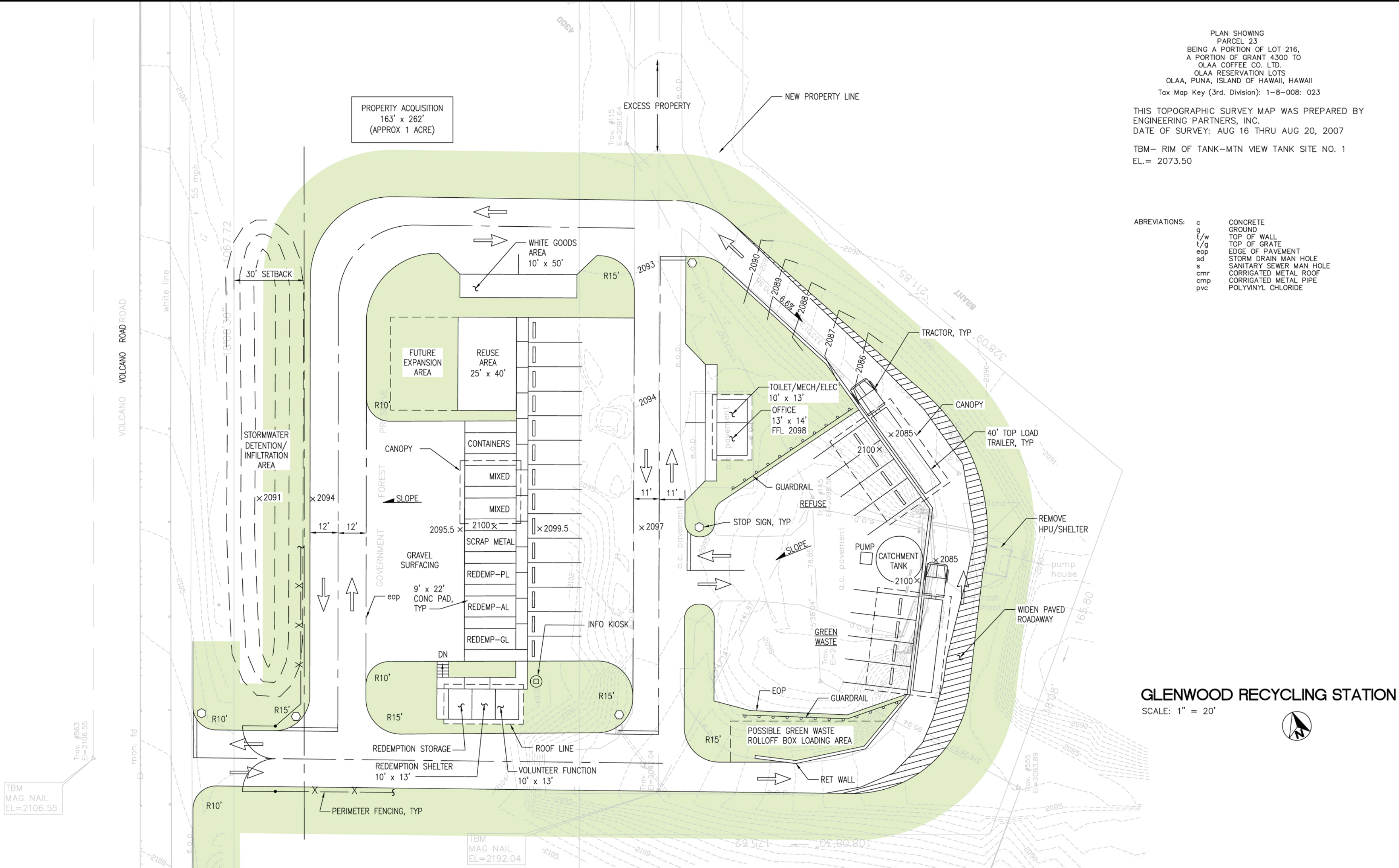
Yes ☐` No ☐

Explosives:
(e.g., propane tanks) ____________________

Hard-to-Process Items: ____________________

APPENDIX C

Recycling and Transfer Station Reconstruction Concepts

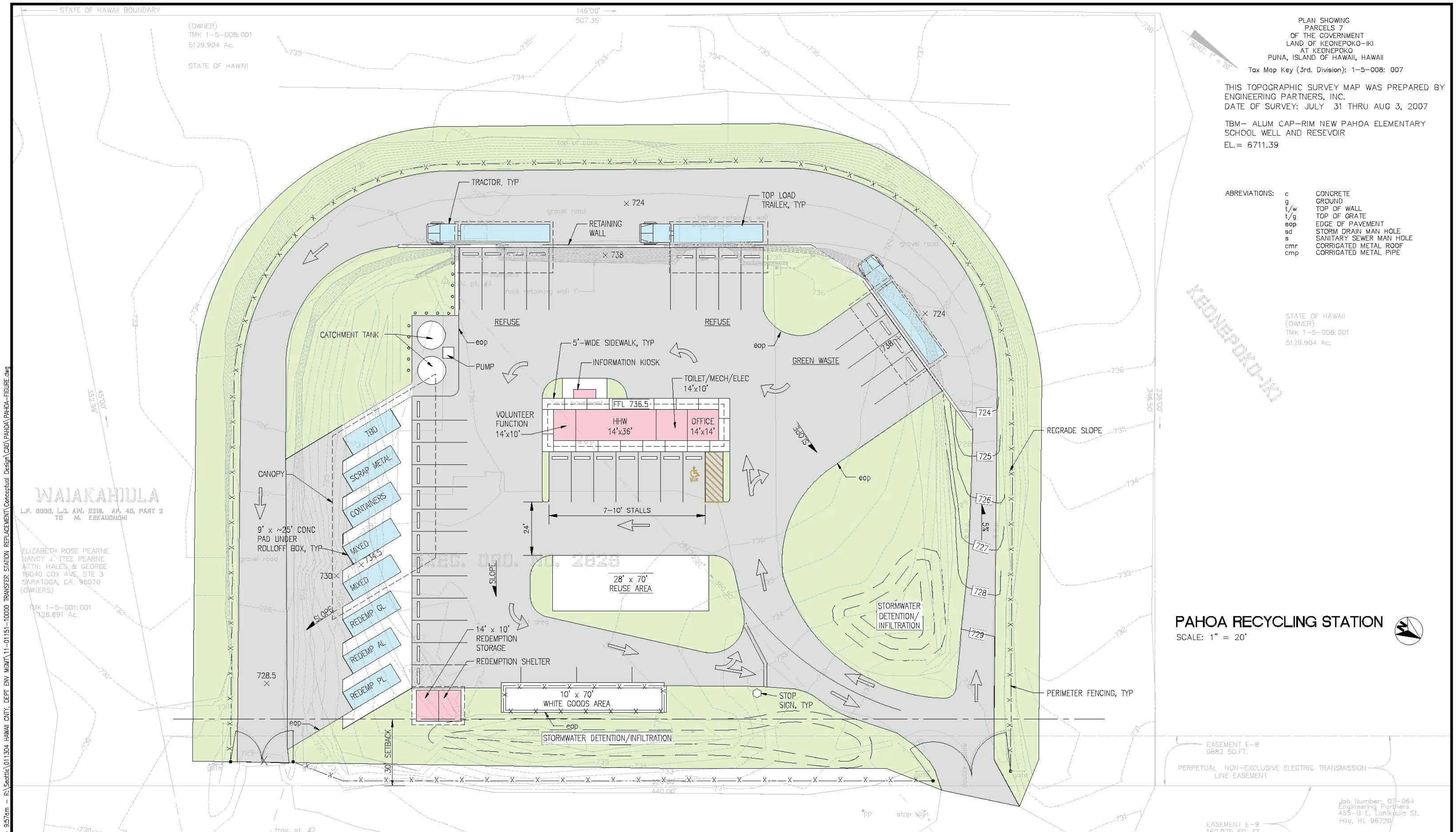


DESIGNED					
DRAWN					
VERIFY SCALE BAR IS ONE INCH ON ANSI "D" DRAWING 0 — 1"	B	9/17/07			REVISED PER COUNTY COMMENTS
	REV	DATE	CHK'D	APP'D	REVISION DESCRIPTION

R·W·BECK
R.W. Beck, Inc.
1001 Fourth Avenue, Suite 2500
Seattle, WA 98154-1004
(206) 695-4700

COUNTY OF HAWAII
EXHIBIT 8-5
GLENWOOD RECYCLING STATION

PROJECT NUMBER: 11-010
SHT. OF: 1
DRAWING NUMBER:

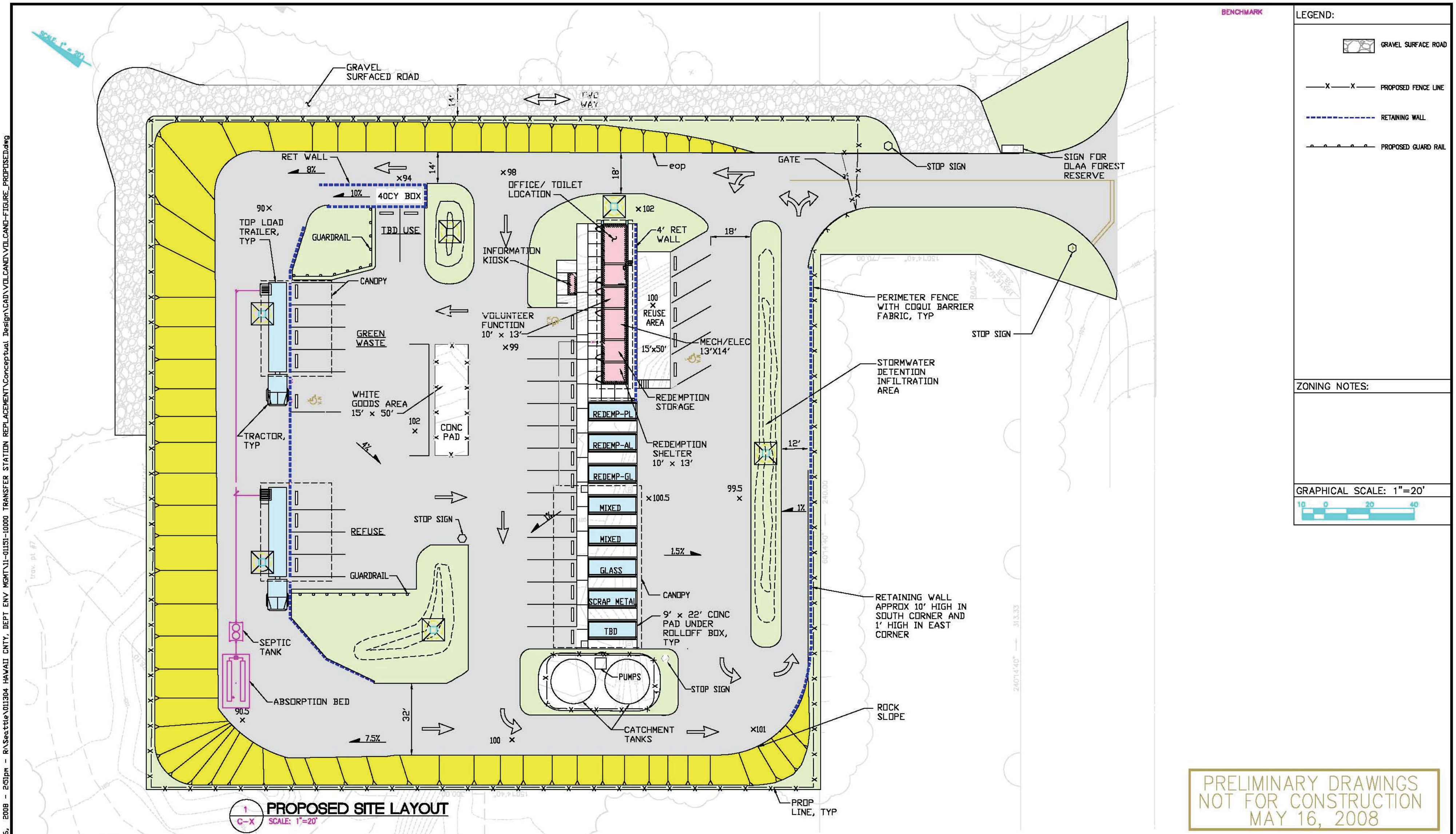


DESIGNED	DRAWN	REV	DATE	CHK'D	APP'D	REVISION DESCRIPTION
	VERIFY SCALE BAR IS ONE INCH ON ANSI "D" DRAWING 0 — 1"					

R.W. Beck, Inc.
1001 Fourth Avenue, Suite 2500
Seattle, WA 98154-1004
(206) 695-4700

COUNTY OF HAWAII
EXHIBIT 8-6
PAHOA RECYCLING STATION

PROJECT NUMBER: 11-010
SHT. OF: 1
DRAWING NUMBER:



DESIGNED	DRAWN	REV	DATE	CHK'D APP'D	REVISION DESCRIPTION

VERIFY SCALE
BAR IS ONE INCH ON ANSI "D" DRAWING

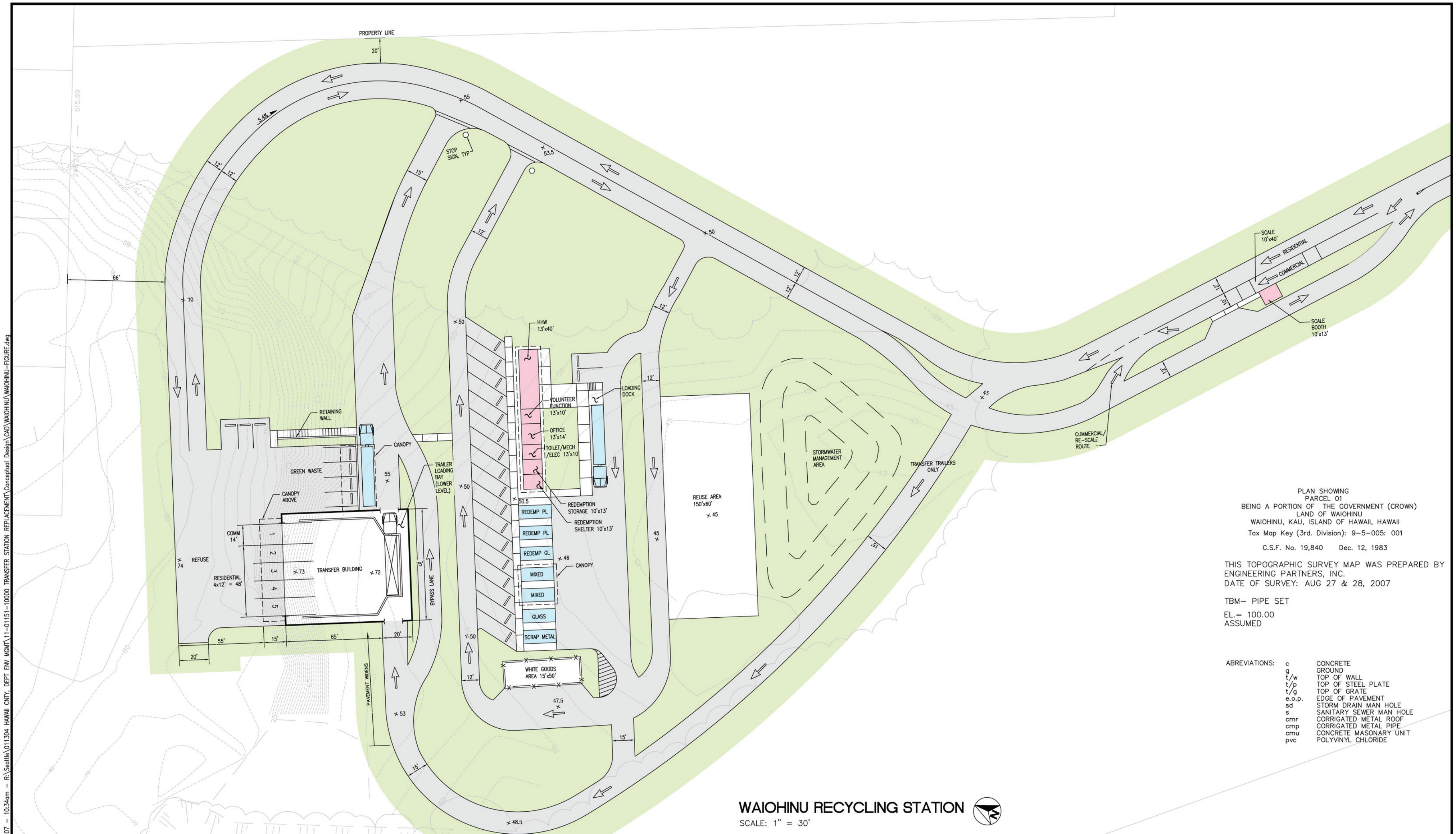
R.W. Beck, Inc.
1001 Fourth Avenue, Suite 2500
Seattle, WA 98154-1004
(206) 695-4700

COUNTY OF HAWAII

EXHIBIT 8-7

VOLCANO RECYCLING STATION

PROJECT NUMBER: 11-010
SHT. 1 OF:
DRAWING NUMBER:



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COUNTY OF HAWAII
EXHIBIT 8-8
WAIOHINU RECYCLING STATION

PROJECT NUMBER: 11-010
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APPENDIX D

Hawai`i County Mechanical-Biological Treatment Facility Conceptual Design

Hawai`i County Mechanical-Biological Treatment Facility Conceptual Design

PREPARED FOR: Mike Dworsky, Solid Waste Division Chief, County of Hawai`i

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DATE: May 12, 2009

PROJECT NUMBER: 374128.11.01

Introduction

As outlined in the draft Residuals Management Chapter of the County of Hawai`i Integrated Resources and Solid Waste Management Plan (IRSWMP) Update, there is enough operating history within Europe and North America for the County of Hawai`i to evaluate the potential for developing one or more mechanical-biological treatment (MBT) facilities to process solid wastes generated by island residents and businesses.

This memorandum assumes that two MBT facilities would be developed: one in East Hawai`i at the South Hilo Sanitary Landfill (SHSL) site, and a second facility at the West Hawai`i Sanitary Landfill (WHSL) site. Conceptually, both facilities would accept and process municipal solid waste (MSW) from the existing transfer station network and from commercial sources on the island.

In response to discussions and the need for further analyses around how mechanical-biological treatment of MSW could be integrated into the IRSWMP, CH2M HILL has prepared this conceptual design report for the two-facility concept. The purpose of the conceptual design report is to:

- Provide a summary of the current and estimated future waste tonnages available for diversion through the facilities.
- Outline the performance and functional requirements for the two facilities including the identification of the appropriate processing technology and equipment requirements, environmental protection measures, nuisance controls, product quality, and product market issues.
- Develop conceptual layouts for each facility.
- Develop order-of-magnitude capital cost estimates for each facility.

Mechanical-Biological Treatment Overview

As outlined in the draft Residuals Management chapter of the IRSWMP Update, mechanical-biological treatment generally refers to the integration of MSW treatment processes normally found in material recycling facilities (MRF), refuse derived fuel (RDF) plants, and composting plants. A key feature of MBT facilities is the use of mechanical separation to remove and recover non-organic components of the MSW stream, and biological treatment to stabilize the organic fraction of the MSW stream.

MBT facilities involve waste input and control, mechanical preparation, biological treatment, and product conditioning. Waste input and control normally consists of manually removing oversized and hazardous materials. Mechanical processing can include minimal separation or shredding, or sophisticated sorting of the inbound waste into biodegradable material, recyclables, and contaminant streams. Sorting is usually done with dry processes but it can also involve wet processes, such as flotation and hydro-pulping. Hand-sorting systems have also been implemented at some facilities, but this increases health and safety requirements for staff. Depending on the quality and market demand, the recyclables are typically sold, but paper fibers, textiles, rubber, plastics, and residual organics can also be used as RDF.

In the IRSWMP update, MBT systems were classified into three groups:

- Biological treatment used to produce RDF for combustion
- Anaerobic digestion to recover energy
- Composting to stabilize organic wastes or to produce a soil amendment

Use of biological treatment to produce an RDF product for combustion is a popular approach in Europe, but is much less common in North America.

The anaerobic digestion (AD) process is used to break down organic materials in an anaerobic (i.e., without oxygen) environment and allows the recovery of the energy from the organic materials in the form of "biogas". In addition to biogas, the AD process results in liquid and solid byproducts, some of which may have a high nutrient value, making the byproducts suitable for beneficial reuse as a soil amendment. Liquids may include high levels of chemical oxygen demand (COD) requiring further treatment. In some cases, byproducts can be applied directly to land, although there is an increasing trend towards some type of further processing (e.g., composting or drying) prior to land-application. If composting or drying is the selected secondary processing technology, these processes are typically integrated into the process and facility designs.

The biogas that is collected from the AD process can be further processed and refined into a fuel source for use in industrial engines, vehicles or in a generator to create electricity for local use or distribution to through an electrical grid.

Anaerobic digestion is well established in North America as a means of treating wastewater treatment plant residuals, dairy manures, and other sources of relatively homogenous organic material. The application of AD to source-separated organics and MSW is a more recent development and one that has become popular in Europe during the past decade as a result of bans on disposal of organics in landfills. However, while there is significant interest in applying AD to organic solid wastes in North America, there are relatively few operating facilities.

Using composting as the biological treatment component is the most common approach at MBT plants currently operating in North America. Composting is a controlled aerobic biological process in which a succession of bacteria and other microbial populations decompose organic material, converting it into a biologically stable product. If implemented in its entirety, the composting process results in the production of "compost" which is stabilized enough to use as a soil supplement. However, at some facilities the composting process is cut short, and instead of being used to create compost, is used only to stabilize organic wastes prior to disposal.

Mixed municipal solid waste (MMSW) composting is a type of MBT facility that has been implemented in nearly a dozen jurisdictions in the United States and Canada. The first generation of these MMSW composting facilities were developed in the 1980s and early 1990s, and involved short-term (i.e., 1 to 3 days) biological treatment in a large rotating drum similar to a cement kiln, following by composting.

Data from operating MMSW facilities indicates that, relative to facilities that compost source-separated organic wastes, they are subject to higher costs, more frequent equipment breakdowns, and require a steady market for the compost end-products. For example, the latest MMSW composting plant built in North America (Edmonton, Alberta) has faced a number of challenges related to equipment failures and maintenance since it opened in 2000[1]. Over the past five years, the City of Edmonton, which owns the facility, has implemented several modifications and is considering additional changes to improve the economics of the plant.

The quality of the compost produced from an MBT or MMSW composting facility depends on the specific processes used, the quality of the feedstock, and the ability to separate metals, plastics, glass fragments, and toxic materials from the organic fraction. In general, the quality of the compost produced at an MBT facility is lower than that produced at a composting facility that processes source-separated organic material such as green waste or food waste. In some cases the product is not saleable. On the other hand, soil conditions, and the lack of soil cover in some areas on the island of Hawai`i could create many potential uses for composts of varying quality. Issues associated with compost marketing are discussed below.

A final important concern at MBT facilities is the management of odors both from waste handling and from the biological treatment process. Experience within the organic waste industry during the past 20 years has more than adequately demonstrated the need to monitor and manage potentially offensive odors. Management and control of nuisance odors can significantly effect construction and operating costs for a facility. For example, bio filters are effected methods of mitigating odors, but add significantly to operational costs.

MBT Management Issues

Odor Management

Odor is perhaps the most common problem associated with both anaerobic digestion and composting facilities. Failure to sufficiently address odor issues has led to unpleasant relationships with neighbors and, in several instances, litigation or closure of anaerobic digestion and composting facilities. For example, a manure and organic waste composting facility (former Unisyn Biowaste Technologies facility) located on O`ahu was closed after

[1] Gamble, S, "Five Years of Composting in Edmonton" Biocycle Vol 46, No 10

neighbors complained about odors emanating from the facility. There are many other examples of facilities that have been shut down over the years in North America because of odor complaints. Proper siting is important to reduce impacts to users and adjacent property owners.

Although a well-constructed and well-operated organic waste facility will not be odor-free, it should not produce offensive odors. Some odor control techniques, such as good housekeeping and eliminating sources of odor like wet feedstocks and/or stagnant water, cost very little and can be extremely effective in preventing odor production. Sound management practices, careful site selection, and communication with neighbours may be the best and least expensive means of preventing odor complaints.

Every facility operator should know and understand the sources of odor at their facility, and develop proactive strategies to manage them. This would include understanding the types of odors the facility could potentially produce, site and environmental conditions which lead to odor release, engineering controls and operating practices that reduce odor potential, and the potential impacts fugitive odors may have on neighboring land uses.

Because most anaerobic digestion and composting facilities have experienced odor problems at some point in their history, one of the most effective ways of developing a strategy is to incorporate lessons learned based on experience at similar facilities. The exchange of verified technical information on emissions before and after process modifications is valuable in identifying and selecting control methods. Casually observed odor control results that are not backed by supportive technical data should not be used as the sole basis for justifying corrective actions.

Generally, enclosed or in-vessel systems have a much greater ability to capture odorous emissions and treat them prior to release. There are a number of available methods to treat odors from composting facilities including wet scrubbers, biofiltration, and carbon adsorption. The choice of which treatment methods are appropriate is dependent on process air volumes, types of odor compounds generated, and airborne gas concentrations both on site and at properties adjacent to the facility.

“Fugitive odors” is a term that is used to describe airborne gas emissions (odors) that escape from point sources at a facility and migrate to surrounding areas. They can include odors from leachate spills, stagnant water, and leakage of odorous process air from tanks and vessels, from feedstock stockpiles, and from open or faulty overhead doors. Because they tend to be smaller in volume and concentration, and more dispersed throughout a facility, it is often more difficult to manage these fugitive odors than to collect and manage odorous process gases.

Maintenance

Within the composting industry, MBT facilities are known as having technically challenging working environments. One of the primary technical challenges is corrosion resulting from sustained exposure of equipment and infrastructure to humidity and process gases, and biological corrosion processes. Concrete and stainless steel buildings have been demonstrated to be the most durable types of structures for this type of corrosive environment. However, the initial capital costs associated with these types of structures are not acceptable to some Owners. For steel or other metal structures, a range of coating types (e.g., galvanizing, epoxy, foam) and building liner systems have been tried with moderate success. As a compromise between initial capital cost and long-term durability, many newer facilities combine negative aeration and extensive source capture or heating, ventilation, and air conditioning (HVAC) systems with coatings and liners.

Humidity and dust within an enclosed composting facility generally result in high maintenance costs for both fixed and mobile equipment. To mitigate the resulting negative effects on equipment, preventative or predictive maintenance is required which typically includes:

- More frequent greasing of bearings
- Replacing worn parts on a more frequent schedule
- Increased frequency of fluid and filter changes
- Flushing of aeration and leachate pipes
- Particulate removal from HVAC ducting
- Changing odor control system media
- General cleaning and housekeeping

The required maintenance and the associated costs required to operate an MBT facility is similar to what is required at food processing or manufacturing facilities, chemical manufacturing plants, and wastewater treatment plants. Owners new to the composting industry, and even those who have been involved with outdoor composting operations, may be familiar with these types of mitigation measures, and may not be prepared for the resources and costs required to sustain operations. In some cases these requirements have been underestimated during the feasibility study or during the project budgeting processes, resulting in insufficient allocation of funds and resources. Experience at other MBT facilities has demonstrated that the failure to allocate proper resources for facility maintenance has had significant impacts on the lifespan of the asset. For municipal facilities, inadequate maintenance and the resulting issues (higher than anticipated operating costs, fugitive emissions, etc.) can also have an impact on public or political support for the project.

Product Marketing

There are a number of value-added compost products that can be produced from organic waste feedstocks. Traditional uses for these products include compost for general horticultural and agricultural use, top dressing (finer texture), mulch, and for use in manufactured top soils. Over the past five years, several new uses have emerged for compost products including incorporation into specialty growing media, use in erosion control applications (where the product is pneumatically applied either on its own or as a mixture with seed or fertilizer), use in storm water filtration products, and in retaining wall applications (e.g., Filtrexx's Living Wall ™ and Greenloxx ™).

Historically, many compost programs have been set up with little thought given to the needs of the end users that will buy the product, or based on the assumption that all of the compost products will be sold to homeowners. While the homeowner market is important, it is certainly not the only market, and typically producers do not sell large volumes of product directly to homeowners. More often homeowners purchase bulk compost from landscape or garden supply centers, or in bagged form through larger retail outlets (e.g., Home Depot, Lowes). Depending on local availability of similar products, both of these markets can potentially be difficult to penetrate. In the case of retail "bag" markets, the investment required in equipment and quality assurance/quality control (QA/QC) is also significant, and the return on investment is generally low unless a large volume of bags can be packaged and sold.

A key to a sustainable program is having a well thought out marketing plan, as opposed to a “sales plans” which simply outlines the specific strategies used to sell a product to the consumer (i.e., lead generation, cold calls, literature, samples). A true marketing plan includes a much broader scope, and outlines a range of activities that are undertaken from the initial concept development to the point at which there are consistent return sales. It includes product research and development, market research and needs analysis, planning and positioning, distribution, promotion, and sales. Available data from the composting industry indicates that the time required to implement and realize consistent results from a marketing plan typically takes from 2 to 5 years. For MBT facilities, the timeline tends towards the higher end of this range (e.g., 4 to 5 years).

It is rare that the financial returns (i.e., sales revenue) from product sales are sufficient to offset all of the costs associated with compost production, even with a successful marketing program in place. In many of the mainland States, wholesale pricing for screened bulk compost ranges from $5 to $15 per cubic yard, with MMSW compost being at the lower end of this range. Most often, these revenues are only sufficient to offset marketing and sales costs, product quality control (analytical laboratory testing) costs, and perhaps some portion of product refining cost.

Waste Characteristics

An extensive review and summary of solid waste quantities and characteristics has been prepared as part of the overall solid waste planning process for Hawai`i. This information was analyzed in conjunction with population and other data to develop an understanding of the geographic distribution of waste on the island, generation rates and estimated future quantities of solid waste.

A summary of the estimated solid waste quantities generated by residential and commercial sources in the County during FY 2008 are presented in Exhibit 1. This summary provided the baseline for analyses of MBT options and conceptual facility designs.

Estimates of the relative amounts of organic and non-organic components in the waste stream are provided in Exhibit 2. These estimates are taken from the waste composition study prepared in support of the IRSWMP Update[2].

EXHIBIT 1
Solid Waste Quantities, FY2008

	West Hawai`i	East Hawai`i	Total
Disposal	128,543	81,847	210,030
Transfer Station	41,655	39,575	81,239
Commercial	86,888	41,912	128,800
Diverted	N/A	N/A	86,443
Total			296,473

2 CH2M HILL. *Waste Composition Study, County of Hawai`i*. 2008.

EXHIBIT 2
Solid Waste Components

Waste Component	West Hawai'i		East Hawai'i	
	Tons Disposed	Percent of Total	Tons Disposed	Percent of Total
Paper	**29,031**	**22.6%**	**18,099**	**22.2%**
Cardboard	10,211	7.9%	5,970	7.3%
Bags	360	0.3%	362	0.4%
Newspaper	2,313	1.8%	1,880	2.3%
White Ledger	726	0.6%	814	1.0%
Colored Ledger	190	0.1%	90	0.1%
Computer	62	0.0%	31	0.0%
Office	1,090	0.8%	420	0.5%
Magazines	1,410	1.1%	1,014	1.2%
Directories	36	0.0%	74	0.1%
Miscellaneous	6,233	4.8%	2,401	2.9%
R/C Paper	6,400	5.0%	5,043	6.2%
Glass	**2,234**	**1.7%**	**2,359**	**2.9%**
Containers	1,900	1.5%	2,204	2.7%
Flat Glass	98	0.1%	62	0.1%
R/C Glass	236	0.2%	92	0.1%
Metal	**9,861**	**7.7%**	**6,526**	**8.0%**
Aluminum Cans	224	0.2%	341	0.4%
Tin Cans	800	0.6%	725	0.9%
Ferrous	4,417	3.4%	3,025	3.7%
Nonferrous	250	0.2%	254	0.3%
White Goods	1	0.0%	741	0.9%
R/C Metal	4,169	3.2%	1,442	1.8%
Plastic	**10,895**	**8.5%**	**6,588**	**8.1%**
Containers	1,629	1.3%	1,138	1.4%
Film	4,013	3.1%	2,157	2.6%
Durable	2,632	2.0%	1,370	1.7%
R/C Plastic	2,621	2.0%	1,923	2.4%
Organics	**45,346**	**35.3%**	**24,102**	**29.6%**
Food	22,804	17.7%	11,426	14.0%
Textiles	3,755	2.9%	1,730	2.1%
Leaves and Grass	4,833	3.8%	1,327	1.6%
Prunings	4,085	3.2%	2,972	3.6%
Stumps	1,293	1.0%	1,344	1.6%
Crop Residue	3	0.0%	0	0.0%
R/C Organic	8,573	6.7%	5,302	6.5%
Construction and Demolition	**28,405**	**22.1%**	**18,298**	**22.5%**
Concrete	3,800	3.0%	1,328	1.6%
Asphalt Paving	616	0.5%	1,597	2.0%
Asphalt Roofing	165	0.1%	216	0.3%
Clean and Treated Lumber	11,363	8.8%	11,621	14.3%
Gypsum Board	829	0.6%	642	0.8%
Rocks and Soil	1,460	1.1%	247	0.3%
R/C Demo	10,172	7.9%	2,647	3.2%
Household Hazardous	**267**	**0.2%**	**260**	**0.3%**
Special	**2,504**	**1.9%**	**4,259**	**5.2%**
Ash	93	0.1%	0	0.0%
Sewage Sludge	0	0.0%	0	0.0%
Industrial Sludge	1,585	1.2%	1,241	1.5%
Treated Medical	20	0.0%	119	0.1%
Bulky Items	392	0.3%	1,785	2.2%
Tires	116	0.1%	1,008	1.2%
R/C Special	299	0.2%	105	0.1%
Mixed Residue	**1**	**0.0%**	**996**	**1.2%**
Totals	128,543	100%	81,487	100%

Conceptual Design Basis

Design and performance criteria are specific measurable parameters that provide guidance for the design of a facility. The design and performance criteria contained in this section have been developed based on experience at other MBT and organic waste processing facilities in North America, as well as industry "best management practices".

In addition to the criteria, a set of functional requirements have also been developed for the two MBT facilities. These are intended to identify specific facility components that will be required, the role of each, and any associated design requirements.

Design and Performance Criteria

Design Life

Based on the current and projected quantities of these feedstocks and the rate at which solid waste management technologies are advancing, a minimum design life of twenty years is recommended for the major components of the facilities, including buildings.

Secondary components, including mobile equipment and some mechanical pre- and post-processing equipment, will have a shorter lifespan and will require replacement during the twenty year period. For example, mobile equipment used in MBT plants can be expected to have a lifespan of 5 to 7 years, and processing equipment from 5 to 10 years. The lifespan of equipment in Hawai`i County will also be affected by volcanic emissions (sulfuric acid rain), particularly with the high rainfall experienced in East Hawai`i (approximately 135 inches per year).

Feedstocks

The two facilities would be expected to accept and process MMSW from both residential and commercial sources. This feedstock will contain a mixture of organic and non-organic materials, and separation of these materials within the facility by various mechanical processes would be required. It is expected that materials would be received in loose form as well as contained in non-biodegradable plastic bags.

In addition to the MMSW stream, it has been assumed that the facilities would accept and process green waste that is currently being mulched or composted through other operations on the island.

The facilities would not be designed to accept and process white goods, construction and demolition wastes, household hazardous waste or special wastes. These would be addressed by other waste programs implemented by the County or through Extended Producer Responsibility programs.

Biosolids from wastewater treatment plants could also be mixed with MSW and processed at the MBT plants. The biosolids provide a convenient source of both nutrients and moisture which will aid the biological degradation process, and reduce the amount of moisture that needs to be added to the feedstocks.

Amendments

It is a normal practice in composting and MBT facilities to recycle a portion of the oversized material screened from the finished compost back into the initial feedstock mix. In addition to inoculating the bacterial population, this practice can be used to help adjust moisture levels, nutrient requirements, and porosity. The amount of oversized material recycled back into the mixture depends on a number of factors, including particle size, moisture of incoming feedstocks, and amount of non-organic materials present in the oversized materials.

Facility Capacity

The two MBT facilities are intended to process MMSW collected through recycling and transfer stations, and MMSW delivered direct to the facility by collection trucks. The waste stream quantities provided previously in this technical memorandum serve as the basis for determining the required capacity of each facility.

It is proposed that the facilities be developed in two stages. The first stage would include development of facilities with a capacity sufficient to handle annual waste tonnages during an initial ten year period. A second phase of development would be initiated in Year 7 based on a reassessment of waste quantities, and also an assessment of the performance of the Phase 1 facilities. This phased approach has the advantage of lowering the required initial capital investment, allows for the potential success of zero waste programs, and allows for future advancements of technology in this field.

Initial design capacities of the two facilities, which are based on projections of overall waste tonnages for the year 2022, and the composition of the waste stream, are as follows:

- West Hawai`i MMSW facility: 134,000 tons per year (515 tons per day based on 5-day week).
- East Hawai`i MMSW facility: 82,000 tons per year (315 tons per day based on 5-day week).

A breakdown of the waste tonnages which form the basis of the facility capacities is provided in Exhibit 3[3].

Feedstock Receiving

It is expected that MMSW would be delivered to the facilities directly from recycling and transfer stations, and from collection vehicles operated by private sector collection firms. As a result, the facilities would be required to accommodate a range of waste collection vehicles, including rear and side load trucks, front-end trucks, roll-off trucks, and walking floor trucks.

Materials that are obviously not compatible with the MBT process (e.g., concrete and asphalt, treated wood waste, segregated household hazardous waste) will bypass the facility and be sent directly to the appropriate handling or disposal facility.

Since material would be received throughout the year, maintaining year-round access to the facilities for feedstock deliveries is required.

[3] These tonnages are based on initial forecasts made during development of the IRSWMP Update. The final forecasts are lower than shown above, thus, 10-year plant capacity needs and capital costs would be lower than shown in this document.

EXHIBIT 3
Basis of Design – Initial Facility Capacity

Waste Component	West Hawai'i (tons per year)			East Hawai'i (tons per year)		
	Transfer Stations	Commerical	Total	Transfer Stations	Commerical	Total
Paper	**13,607**	**26,413**	**40,020**	**11,594**	**13,611**	**25,205**
Cardboard	4,786	9,290	14,076	3,825	4,490	8,314
Bags	169	328	497	232	273	505
Newspaper	1,084	2,104	3,188	1,205	1,414	2,619
White Ledger	340	660	1,000	522	612	1,134
Colored Ledger	89	173	262	58	68	125
Computer	29	56	85	20	23	43
Office	511	992	1,503	269	316	585
Magazines	661	1,283	1,944	649	762	1,412
Directories	17	33	49	47	55	102
Miscellaneous	2,921	5,671	8,592	1,538	1,806	3,344
R/C Paper	3,000	5,823	8,823	3,230	3,792	7,022
Glass	**1,047**	**2,032**	**3,079**	**1,511**	**1,774**	**3,285**
Containers	890	1,729	2,619	1,412	1,657	3,069
Flat Glass	46	89	135	40	47	86
R/C Glass	111	215	326	59	70	129
Metal	**4,622**	**8,972**	**13,594**	**4,181**	**4,908**	**9,088**
Aluminum Cans	105	204	309	218	256	474
Tin Cans	375	728	1,103	464	545	1,009
Ferrous	2,070	4,018	6,088	1,938	2,275	4,212
Nonferrous	117	227	345	162	191	353
White Goods	0.5	1.1	1.6	475	557	1,032
R/C Metal	1,954	3,793	5,747	924	1,084	2,008
Plastic	**5,106**	**9,912**	**15,019**	**4,220**	**4,954**	**9,174**
Containers	764	1,482	2,246	729	855	1,584
Film	1,881	3,651	5,532	1,382	1,622	3,004
Durable	1,234	2,395	3,628	878	1,031	1,908
R/C Plastic	1,228	2,384	3,613	1,232	1,446	2,677
Organics	**21,254**	**41,257**	**62,511**	**15,440**	**18,125**	**33,565**
Food	10,688	20,747	31,436	7,320	8,593	15,912
Textiles	1,760	3,417	5,177	1,108	1,301	2,409
Leaves and Grass	2,265	4,397	6,663	850	998	1,848
Prunings	1,915	3,717	5,631	1,904	2,235	4,139
Stumps	606	1,176	1,782	861	1,011	1,872
Crop Residue	1.5	2.9	4.3	0	0	0
R/C Organic	4,018	7,800	11,819	3,396	3,987	7,383
Mixed Residue	**1**	**1**	**2**	**638**	**749**	**1,387**
Totals	**45,637**	**88,589**	**134,225**	**37,584**	**44,120**	**81,704**

Product Quality Requirements

The State of Hawai`i Department of Agriculture does not regulate the sale of fertilizers and soil amendments. This means that products do not need to be registered with the State before sale, and related fees are not assessed or collected. It also means that at this time there are no quality standards put in place by the State for this type of product. It is required, however, to submit a sample of the compost (soil amendment) to an independent laboratory and then submit a copy of the report to the State Plant Quarantine Branch. This is a requirement for soil amendments that are imported.

The Hawai`i Department of Health's Solid and Hazardous Waste Branch regulates only the production of specific compost products; there are currently no regulations for selling or marketing compost in Hawai`i. However, compost produced from sewage sludge must comply with the federal EPA 503 regulations. These regulations require that the pathogen and heavy metal limits outlined in Exhibits 4 and 5 be met.

In many States, the 503 regulations are used as a default for the regulation of MMSW compost. In most cases the MMSW composts meet these regulatory standards. In some jurisdictions, the 503 limits are adopted in combination with a content limit for inert materials and a stability standard. Inert materials are defined as man-made materials such as glass or plastic, while stability measures the level of biological activity in the compost. For MSW compost products, individual State numerical standards can be more difficult to meet.

EXHIBIT 4
US EPA Sewage Sludge (Biosolids) 503 Regulations, Trace Element Limits

Pollutant	Pollutant Concentration Limits for Exceptional Quality Biosolids (mg/kg)
Arsenic	41
Cadmium	39
Copper	1,500
Lead	300
Mercury	17
Molybdenum	--
Nickel	420
Selenium	36
Zinc	2,800

EXHIBIT 5
US EPA Sewage Sludge (Biosolids) Regulations, Pathogen Limits

Pathogens	Limit
Salmonella	< 3 MPN/4 grams of total solids
Fecal Coliform	<1000 MPN/gram of total solids

State and federal regulations dealing with compost product quality tend to focus on protection of human and environmental health, and not on agronomic factors. These agronomic factors are generally defined by the marketplace, and include such things as pH, electrical conductivity, organic matter content, particle size, and water holding capacity. Agronomic factors often dictate the best use for a particular type of compost.

Assuming that MMSW compost products produced in Hawai`i County could meet applicable State and Federal requirements, it likely that sale and distribution would be more significantly affected by the agronomic standards of the marketplace. Although acceptable commercial and agricultural grade composts have been produced from MMSW, experience has shown that retail grade products are very difficult to produce from this feedstock. This is primarily because it is difficult to remove all of the man-made inert materials from the end product. Therefore, a MMSW compost product is typically less visually attractive than a more uniform yard trimmings or biosolids-based compost that does not contain fragments of inert materials.

MMSW composts are also unable to be listed as a product for use in certified organic farming because of the feedstock materials it contains and the variety of feedstock sources.

To increase consumer confidence in the product and improve marketability, the MMSW compost could be certified through the US Composting Council's Seal of Testing Assurance Program, with the appropriate analytical testing performed by certified laboratories. Two other Hawaiian composters (EKO systems in Maui, and Hawaiian Earth Products in Kapolei) already participating in this program.

Design for Operability and Maintenance

MBT facilities generally tend to have operating environments in which equipment is subject to a higher degree of wear and breakdown than in transfer stations and material recovery facilities. Flexibility and redundancy should therefore be incorporated into the layout and design of the facilities to allow operators to adjust for planned and unplanned maintenance, and unexpected surges in waste quantities. Flexibility and redundancy can be achieved through such features as the following:

- Use of equipment with proven reliability.
- Use of equipment which can be readily serviced locally.
- Use of parallel processing lines to provide processing redundancy.
- Cleaning the tipping floors daily.
- "Decoupling" of pre-processing, processing, and post-processing operations where possible to allow for each process to operate independently and on different schedules.
- Minimizing use of equipment that can not be replaced with relative ease and speed or for which parts are not locally available.

Equipment should also be situated to conserve floor space and accommodate efficient vehicle access routes, personnel walkways, access stairs, and service platforms. Access and service platforms should be incorporated into equipment arrangements so that moving parts are readily accessible for inspection, maintenance, repair and/or replacement.

Health and safety measures should be incorporated into the design to mitigate operator fatigue and recordable injuries, and downtime due to human-error related incidents.

Corrosion Protection

Experience at several MBT and organic waste processing facilities over the past 15 years has highlighted the corrosive nature of the sorting and conversion processes when these processes are conducted in enclosed buildings or vessels. Therefore, all buildings and major equipment that will be come into contact with the organic material, process off-gasses, or other corrosive environments at the facilities should be designed and constructed using suitable materials or protective coatings to minimize corrosion. Site-specific environmental conditions (rainfall and volcanic emissions) should be taken into consideration when designing corrosion mitigation measures.

Storm Water Management

Storm water that has come in contact with feedstocks, or which has been contaminated by run-off from receiving, processing and product storage areas can be high in biochemical oxygen demand (BOD), suspended solids and/or nutrients. Storm water runoff and related regulatory compliance issues were a major factor contributing to the eventual shut down of the Unisyn facility on O`ahu.

In order to minimize the potential for contamination of surface waters (which in turn increases leachate management requirements), storm water from areas outside of the facility should be diverted around or away from the facilities through ditches, swales, berms or other conveyance methods. Similarly, drainage from building roofs should be controlled so that it does not enter or impede access to processing areas and buildings.

All drainage controls and conveyances should be designed such that the potential for erosion and sediment transport is minimized. Use of filter berms, bioswales and erosion blankets constructed from compost should also be incorporated into drainage controls as necessary. Appropriate regulatory compliance plans for storm water and process water should be prepared for each facility.

Process Water and Wastewater Management

To control the impacts that could potentially result from the releases of contaminated surface water, run-off generated within each facility's receiving, processing, and curing areas should be collected and managed as leachate.

Working surfaces in these areas should be constructed to withstanding expected wear and tear from site equipment and customer vehicles, and should be underlain by an impermeable layer to prevent downward and lateral migration of leachate into groundwater.

Surplus process water that can not be recycled and reused within the process should be subjected to analytical testing, and could likely be managed in conjunction with leachate from the landfill operations.

Fire Protection

Due to the nature of the materials that will be processed at the facilities, features that will minimize the risk of fires starting and spreading should be incorporated into their design and operation. These include the following:

- Operating areas of the facilities should be designated as non-smoking areas.
- Stationary and mobile equipment should be blown down using compressed air on a regular basis to prevent accumulation of dust and other debris in and around engine compartments and exhaust systems.
- Amendment and product stockpiles, and biological conversion and product curing areas should be monitored regularly to prevent development of conditions that could lead to spontaneous combustion.
- Storage piles of dry amendment should be limited to 15 feet in height.
- Aisles should be maintained between amendment and product storage piles to allow for equipment or fire truck access in the event that a fire occurs.
- Necessary firefighting equipment, including portable pumps, hoses and mobile equipment, should be stored at strategic locations onsite and be regularly maintained to ensure they are in good working condition.

Nuisance Control

Nuisance controls are required to manage dust, litter, and vectors, and to prevent the attraction of animals and birds. Nuisance conditions are managed primarily through engineering controls and the implementation of good operating practices. However, design features such as hard-surface roadways, permanent litter fences, and enclosures should be incorporated into the design of the facilities to complement operational practices.

Functional Requirements

Feedstock Receiving, Storage and Pre-processing Area

Due to the potential for attraction of birds and wildlife and the potential for odors, the two facilities should include enclosed receiving and storage areas for MSW deliveries. Areas where pre-processing of feedstocks is undertaken, should also be enclosed for the above reasons as well as for litter control.

The feedstock receiving and storage areas should be sized to accommodate the efficient receipt and storage of MSW, while still providing access to stored material on a “first-in, first-out” basis for processing. Storage piles should not exceed 15 feet in height.

A sufficient number of overhead doors should be provided in the waste receiving buildings to minimize waiting times for waste delivery vehicles and also to allow for continued service in the event that one or more doors malfunction (door malfunctions at transfer stations and other waste handling facilities is a relatively common occurrence).

Interior floors within the feedstock receiving and storage areas should be sloped such that any leachate or other liquid escaping from feedstocks is contained within the building. Floor surfaces should also be suitably reinforced, coated, or otherwise constructed to withstand the normal wear and tear from vehicle traffic and scraping from wear edges of wheel-loader buckets.

Building components (including but not limited to HVAC units and associated ducting, light fixtures, cable trays, electrical cables and conduits, water lines, natural gas lines, and sprinkler systems) should be situated in a manner and location that does not interfere with the unloading of delivery vehicles and the use of mobile equipment in the building.

Processing Areas

The composting process is generally broken down into three stages: primary, secondary, and curing.

The primary composting stage typically takes several weeks and is typified by high temperatures, rapid decomposition of feedstocks, and objectionable odors. It is recommended that the processing areas at the two facilities be enclosed to prevent attraction of birds and wildlife, and to control odors and leachate generated by the composting process.

The secondary composting stage typically involves a slower degradation rate and slightly lower process temperatures. Because much of the initial breakdown of feedstocks has occurred during primary composting process, feedstocks are for the most part no longer recognizable and do not attract birds and animals. However, there is still a high potential for odor generation. In light of these considerations, as well as the island climate, it is recommended that the secondary composting stage be enclosed and that active aeration be employed as a process and odor management tool.

The curing stage typically involves low temperatures and does not generate objectionable odors provided proper operating practices are followed. After the secondary composting stage, the product resembles soil and it is less likely to attract wildlife and birds. It is accepted practice in the industry to cure materials outdoors. However, given the amount of rainfall on in the eastern portion of the County (i.e., in excess of 100 inches per year), there is a real potential that outdoor curing piles could become saturated, which could lead to anaerobic conditions and odors. As a result, it is recommended that curing at the East Hawai`i facility be done using some form of covered composting system (e.g., Poly-flex’s Ag-bag system, or windrows covered with Compostex or similar tarp-like fabric).

Odor Control Systems

Odorous emissions are a byproduct of the MSW handling and biological degradation process that occurs at MBT facilities. However, if the facility is properly designed and operated, these emissions should not be excessive or become a nuisance either onsite or at neighbouring properties.

Emissions control and treatment systems must be included for all material receiving and processing buildings to prevent release of fugitive odors and dusts. This is typically achieved through building ventilation systems and process aeration systems that maintain negative atmospheric pressure in the buildings.

For material receiving and processing buildings, a ventilation air flow rate of six air changes per hour or greater, combined with source capture of emissions from specific processing equipment, is typically used as a design basis. Different processing areas within the facility should be segregated with walls to discourage transfer of large volumes of airflow and migration of odors and dust between individual areas. Treatment of odorous air through biofiltration is generally sufficient to render odors to an acceptable level. An additional level of treatment can be achieved by using enclosed "engineered" biofilters with a secondary activated carbon "polishing" cell.

In outdoor operating areas, the degree of control that the design has over odors is limited relative to enclosed operating areas. Odor control in outdoor areas is achieved primarily through the implementation and maintenance of good operating practices.

The following features should be incorporated into the design of outdoor areas of each facility:

- Working surfaces should be sloped at a minimum of 0.5 percent grade to promote drainage and prevent standing water which can become an odor source and attract vectors.
- Working surfaces should be designed to provide all-weather access for site equipment, and to resist rutting and settlement which can lead to standing water.
- Windrows and stockpiles should be oriented parallel to the slope of working surfaces to promote drainage and prevent the base of windrows from becoming saturated.

Residuals Storage

Experience in other jurisdictions indicates that as much as 50 percent of the material processed through MBT facilities is non-recoverable and becomes a residual. These residuals are normally removed from the facility at various points during the pre-processing, processing and post-processing stages. Depending upon the point at which they are removed from the process and their characteristics, it may be possible to re-introduce and re-process a portion of these residuals, or use them in secondary application (e.g., landfill daily cover). Generally, the residuals are not suitable for use as soil amendments.

Once residuals are removed, they must be stored and handled in a manner that does not result in objectionable odors or litter being generated. Typically, residuals are stored in roll-off waste containers, long-haul transfer trailers, or in an enclosed building until sufficient volumes accumulate to warrant transporting them offsite. Similar to feedstocks, residuals should be managed on a "first in-first out" basis. It is also recommended that residuals be stored for a maximum of three days.

Product Storage and Distribution

The inventory of finished compost must be stored in a manner that preserves the product's quality (e.g., prevents weed propagation and pathogen reintroduction). This generally means that product stockpiles are stored on prepared surfaces which are kept free of vegetation.

There must also be sufficient area at the site to store product produced during months when product sales or shipments are low. Typically, a storage capacity large enough to accommodate 3 to 6 months of product is necessary once markets are fully developed. During the initial 2 to 4 years of a facility's operation (before markets are fully developed) a larger storage capacity may be necessary.

Stockpiling finished compost in 20 to 30 foot high piles with a "stacking conveyor" is a common practice for storing inventory in a small area.

Exterior Roadways and Working Surfaces

The design of exterior roadways and access lanes (e.g., lane widths, turning radii, maneuvering areas) must be able to safely accommodate waste collection vehicles including roll-off trucks, side and rear load residential collection trucks, and long-haul transfer trucks. Adequate setback is required for perimeter roadways in order to meet zoning and building code requirements.

Roadways and working surfaces should be constructed of asphalt, concrete or equivalent materials that are capable of withstanding the weight of vehicles and site equipment. Hard surfaces are also recommended to help prevent dust generation, and because hard surfaces are generally easier to clean.

Weigh Scales

All vehicles delivering feedstocks should be weighed prior to unloading at the facilities. Since the two facilities would conceptually be located adjacent to the WHSL and SHSL operations, it has been assumed that vehicles would use existing scale systems.

Additional Requirements

In addition to those outlined previously, the facility should also include the following components:

- A staff break room and suitably sized washrooms, locker rooms, and shower facilities for the facility's expected staff requirements
- A dedicated Control Room
- A laboratory that is appropriately sized and equipped to complete analysis of samples for process control purposes (e.g., moisture content, pH, weighing, particle size, and sample inspection/sorting).

Conceptual Facility Design

Pre-processing Equipment Selection

The recovery of MSW components through manual and mechanical separation, and the subsequent preparation of feedstocks for composting, requires careful consideration and design.

While many of the MSW components (e.g., ferrous and non-ferrous metals, paper fibre, plastic[4]) can be recovered, the quality of the materials may not be acceptable for some markets. Materials recovered from mixed MSW streams are often wet or coated with organic matter (e.g., green waste or food waste) and can not be recycled through traditional markets. The materials may also have smaller particles of foreign matter clinging to them (e.g., stones, bottle caps) that make them unacceptable at recycling facilities.

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[4] Glass is typically not recovered at MBT facilities because it is often broken into smaller particles during the waste collection and transfer process, and recovery of small glass particles is very difficult.

Removal of some components, or failure to remove others, may also affect the quality of the compost product produced by the MBT plant. For example, removing too much of the paper fraction may result in a moisture or carbon imbalance that can affect the biological breakdown processes. Failure to remove special wastes (e.g., household hazardous wastes, car batteries) may also negatively affect the chemical content of the finished product and make it unsuitable for certain applications.

Mixed MSW often contains bulky items such as tires, fire extinguishers, propane tanks and cylinders, mattresses, carpet and furniture, or long "stringy" items such as rope, chains, or hoses. These items must be removed prior to or during pre-processing to prevent clogging or damage to equipment.

Finally, processing of MSW feedstocks poses many health and safety concerns including exposure to dust and bioaerosols, and the risk of cuts and puncture wounds from sharp objects (which can lead to infection and/or diseases such as tetanus, hepatitis, and HIV). Typically, there is a higher reliance on mechanical sorting (versus manual sorting) at mixed MSW facilities when compared to traditional MRF's. Also, the HVAC systems at mixed MSW handling facilities generally require more complicated designs to maintain an acceptable working environment for staff in areas where manual sorting is implemented.

Pre-processing equipment commonly used at mixed MSW facilities includes:

- Bag-openers
- Disc or finger screens for separation of materials based on size [5]
- Slow speed shredders for size reduction
- Air classifiers or suction devices for removal of film plastics
- Over-head and/or head-pulley magnets on conveyor belts for ferrous metal removal
- Eddy current separators for removal of larger non-ferrous items (e.g., soda cans)
- Sorting conveyors with "picker stations" where targeted materials can be removed by hand

MSW materials are typically handled and transferred between processing stages using a combination of wheel loaders, grapple cranes, and conveyor belts.

Experience gained at other MBT plants in North America, in particular those at Edmonton (Alberta), Cobb County (Georgia) and Sumpter County (Florida), indicate that there are advantages to using simplified pre-processing lines that rely primarily on mechanical methods (and to a lesser extent on manual sorting). Based on this experience and the nature of the waste streams anticipated for Hawai`i County, the following pre-processing system for the two MBT facilities has been developed.

- Initial removal of bulky items, and loading of materials onto the processing line using a grapple crane.
- Opening of plastic garbage bags with a rotary drum bag opener.
- Use of two finger screens in series to separate materials into three size fractions (less than 4 inches, 4 to 12 inches, and greater than 12 inches).

[5] Trommel screens can also be used for size separation, but have a tendency to become clogged if the moisture content of the MSW is high or if there is a high amount of textiles, ropes

- Manual inspection and removal of contaminants from the mid and large sized fractions at the finger screen.
- Magnetic removal of ferrous metals from all three fractions.
- Shredding of the large fraction.
- Recombination and mixing of three fractions using a continuous-flow pug-mill mixer.

Rather than a single processing system at each facility that handles all materials delivered, the processing systems would be constructed with parallel lines (two at East Hawai`i and three at West Hawai`i), each sized for a throughput of 40,000 to 45,000 tons per year. This provides internal redundancy within each facility in the event of a breakdown. It also allows all five of the processing lines to use the same type and size of equipment, providing a second layer of redundancy between the two facilities and reducing the overall inventory of spare parts that is required.

The splitting of processing systems into smaller parallel lines also allows for operation of a single processing line when waste deliveries are lower than peak values, and for one line to be run on an evening or weekend shift to reprocess materials if needed.

A schematic layout of the pre-processing system is provided in Exhibit 6.

Composting Technology Selection

Selection of a composting technology is a site-specific exercise. Each technology has advantages and disadvantages which make it more or less appropriate for a particular situation. A summary of general advantages and disadvantages of the more common composting technologies is provided in Exhibit 7.

Utilizing a combination of technologies in series is becoming more common at composting facilities in North America. This approach allows for technologies with a higher level of odor and nuisance control (but higher cost) to be used at the start of the process, and lower cost technologies to be used in the latter stages where nuisance risks are lower.

The various technologies summarized in Exhibit 7 were considered in terms of their appropriateness for use as a primary or secondary processing method, or as a means of curing compost at the two MMSW facilities. The results of the screening level evaluation of technologies are summarized in Exhibit 8.

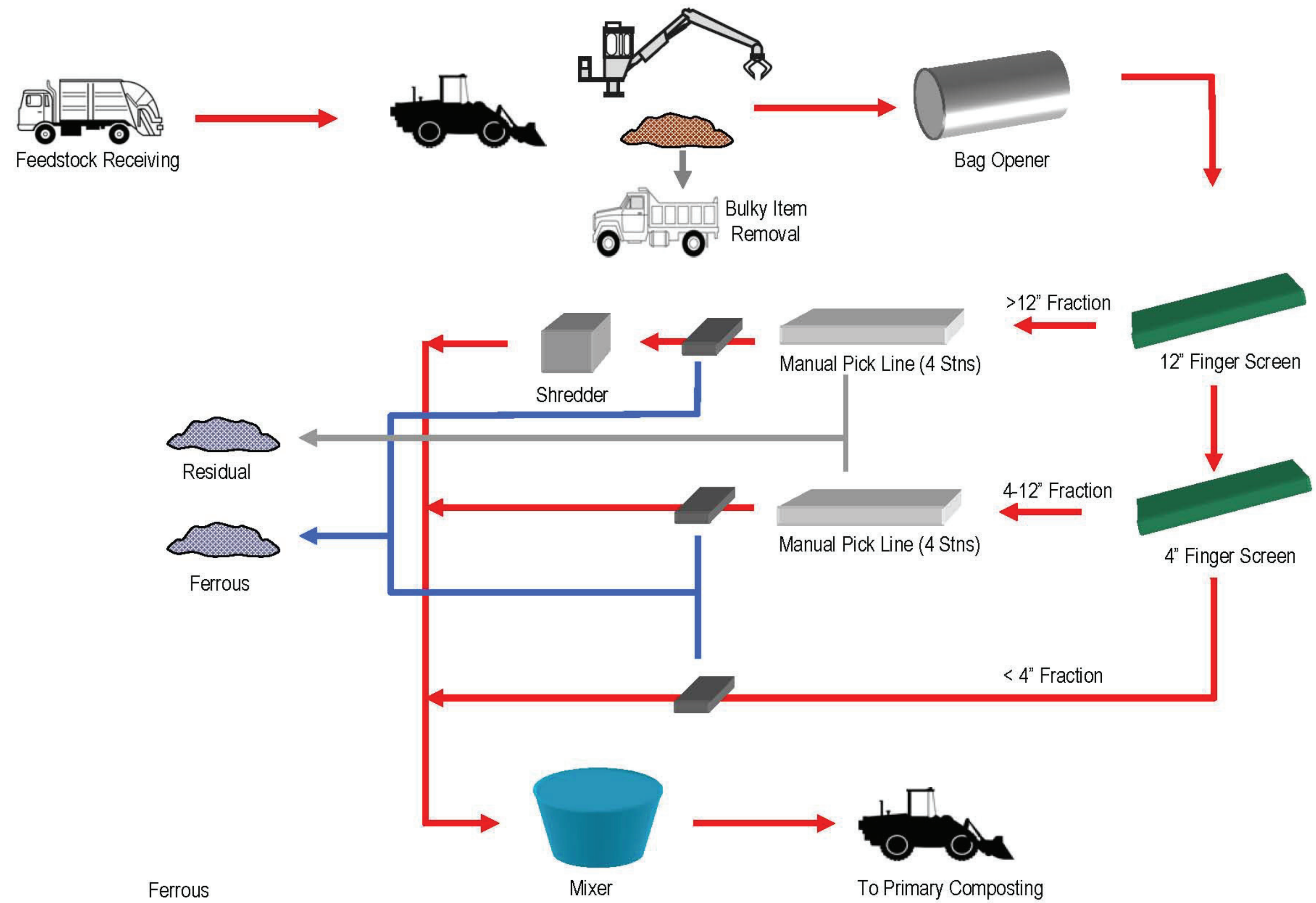

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Exhibit 6
Pre-Processing System Schematic Diagram

EXHIBIT 7
Composting Technology Advantages and Disadvantages

Technology	Advantages	Disadvantages
Static Pile	• Low capital and operating cost • Piles do not require frequent turning (low equipment and manpower requirements) • Works best when feedstock contains large amounts of woodchip or bark. • No electric power needed	• Large area required • No means of controlling odors, which may drive a need for larger buffer areas around the site • Lower ability to manage pile moisture • Spontaneous combustion is more likely • Slow decomposition rate • Exposure to rain, wind and cold, can be problematic
Passively Aerated Pile	• As per static pile technology	• As per static pile technology • Piles can be awkward to construct
Windrow	• Can handle feedstocks with lower C:N ratios or porosity than static piles • Relatively-low capital costs and low technology requirements (window turners front-end loaders or farm equipment will suffice) • Relatively low operating costs. • No electric power needed	• Large area required • More labor-intensive than static piles, particularly for feedstocks with low C:N ratio or porosity • No odor control which may require larger buffer area between site and neighbors • More challenges to overcome if food waste or biosolids are included • Exposure to rain, wind and cold, can be problematic
Aerated Static Pile	• Forced aeration reduces land requirements • Use of negative aeration can help avoid odor problems • Smaller overall surface area (relative to windrows) reduces impacts of cold weather and infiltration of precipitation • Lower operating costs and shorter process • Material handling requirements are less than windrow system (no turning required) • Lower risk of spontaneous combustion	• Slightly higher capital cost for forced aeration equipment • Over-aeration can remove moisture • Feedstock pre-processing requires a higher degree of care. Feedstocks must be well mixed and properly sized and moistened • More operator skill required to manage aeration systems • Aeration systems generally require 3-phase electrical supply
Mass Bed	• Excellent weather protection • Efficient use of available space • Efficient material handling • Forced aeration can be used to further reduce processing time requirements and avoid odor problems	• Specialized windrow turner has higher capital cost than towed and straddle type turners. • Capital cost is increased if forced aeration system is used • Can remove moisture from the piles
Aerated Static Pile (enclosed)	• Moderate capital and operating costs • Usually in buildings, so better odor control • Lower space requirements than windrow systems • Contained system which reduces potential for odor emissions and contaminated storm water	• Potential steam or dust issues inside the enclosure • Indoor air must be managed in odor control system prior to release • Operating and maintenance expertise required
Channel and Agitated Bed (enclosed)	• Moderate capital and operating costs • Usually in buildings, so better odor control • Lower space requirements than windrow	• Lacks flexibility in dealing with variable feedstock volumes • Large volume of air to be managed in odor control system • Operating/maintenance expertise required • Higher capital/operating costs than windrow
Tunnel	• Design of tunnel system leads to small headspace and high degree of odor control	• Moderate to high capital costs • Generally suitable for primary composting only. Secondary composting typically done using alternative method/technology.
In-vessel	• High degree of odor control • Low space requirements	• Operating and maintenance expertise required • Higher capital and operating costs.

EXHIBIT 8
Composting Technology Suitability

Technology	Primary	Secondary	Curing
Static Pile			✓
Passively Aerated Static Pile			✓
Windrow			✓
Aerated Static Pile (outdoor)			✓
Aerated Static Pile (enclosed)		✓	
Mass Bed (outdoor)			✓
Mass Bed (enclosed)		✓	
Channel / Agitated Bed (enclosed)		✓	
Tunnel	✓		
Rotary Drum	✓		
In-vessel	✓		

Based on the criteria, all outdoor technologies were eliminated from consideration as primary and secondary processing methods, primarily due to climatic considerations and their potential to attract wildlife and birds. Enclosed technologies were the only ones deemed appropriate for primary and secondary composting.

Following the initial screening, further review and consideration was given to specific technologies and vendor systems that could be used for primary and secondary composting. Based on the review and the experiences at other MBT and MMSW composting facilities, a combination of tunnels for primary composting and enclosed mass bed composting on an aerated floor are recommended for use in the two Hawai`i facilities:

Although rotary drum systems have been used extensively at other MBT plants in North America, they are not recommended for use in Hawai`i. This is based on the experience from other facilities where there have been several drum system failures resulting in temporary or permanent decommissioning of individual drums. Drum systems also require a high degree of specialized maintenance (i.e., gearbox refurbishment, oil changes, drum alignments) and stocking of lubricants and spare parts. It is also possible that the environmental conditions in Hawai`i would increase maintenance requirements and make their implementation less practical.

Provided a suitable residence time (i.e., 4 to 6 weeks) and optimal process conditions are provided in the primary and secondary composting stages, the use of outdoor technologies would be appropriate for the curing stage. For curing, lower-tech outdoor technologies such as turned windrows are the most suitable approach. Due to the longer degradation and curing times required for MMSW compost (relative to food waste or biosolids compost), curing in static piles is generally not an efficient use of curing space.

Siting

Access, site layouts, material handling, and odor/nuisance controls contained in the conceptual designs have been developed based on the assumption that the facilities would be located at the WHLF and EHLF.

While use of the two landfills as host sites appears logical, a more thorough analysis of transportation logistics, environmental factors, and socio-economic considerations would be necessary to confirm this assumption.

Process Flow Diagram

A conceptual process flow diagram for the two MBT facilities is provided in Exhibit 9. It has been assumed that the two facilities would be identical in terms of processing steps and equipment, and that only the facility capacities would vary.

Facility Layout

Conceptual sizing and layout of the two composting facilities was completed based on the recommended technology and design capacity of each site. The conceptual designs also incorporate the following assumptions:

- Pre-processing will consist of visual inspection, contaminant removal, and mixing as outlined in Exhibit 6.
- Primary composting would be completed in concrete tunnels with a residence time of one to two weeks.
- Secondary composting would be completed using an indoor mass bed system on an aerated floor, with a residence time of four weeks.
- Materials would be screened between the secondary composting and curing stages. Oversized materials from the screening process would be discarded as residuals.
- Compost would be cured outdoors using a mass bed system for a period of approximately four to six months to meet maturity criteria. At the West Hawai`i facility, curing would be done outdoors. However, at the East Hawai`i facility the curing area would be covered due to high rainfall.
- Final screening would be done using portable equipment or following curing.
- The oversized fraction from the finished product screening would be further composted and re-screened, or recycled back into the process at the discretion of operations staff.

Site plans showing layouts of the two facilities that incorporate the key design features outlined are provided in Exhibits 10 and 11.

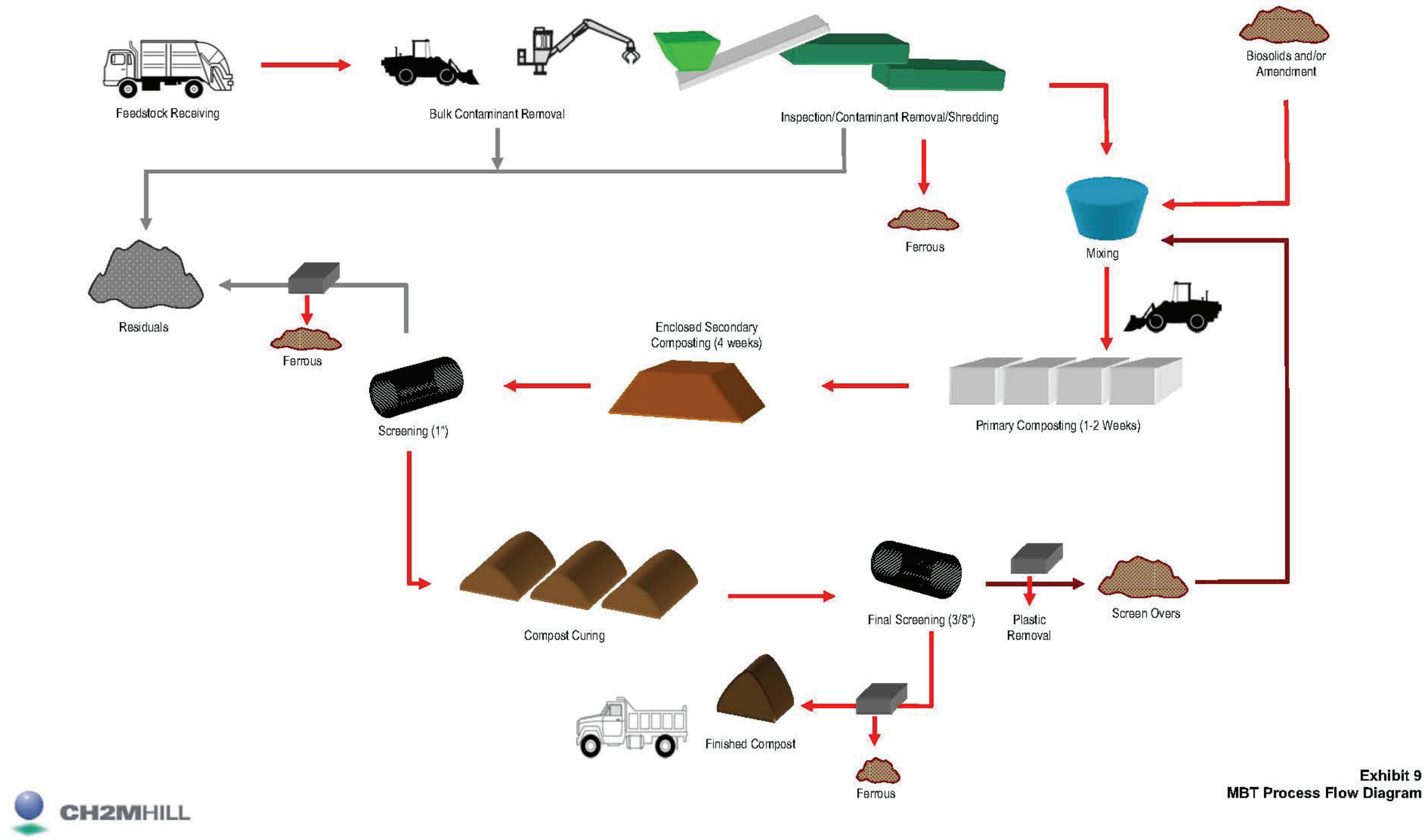

Exhibit 9
MBT Process Flow Diagram

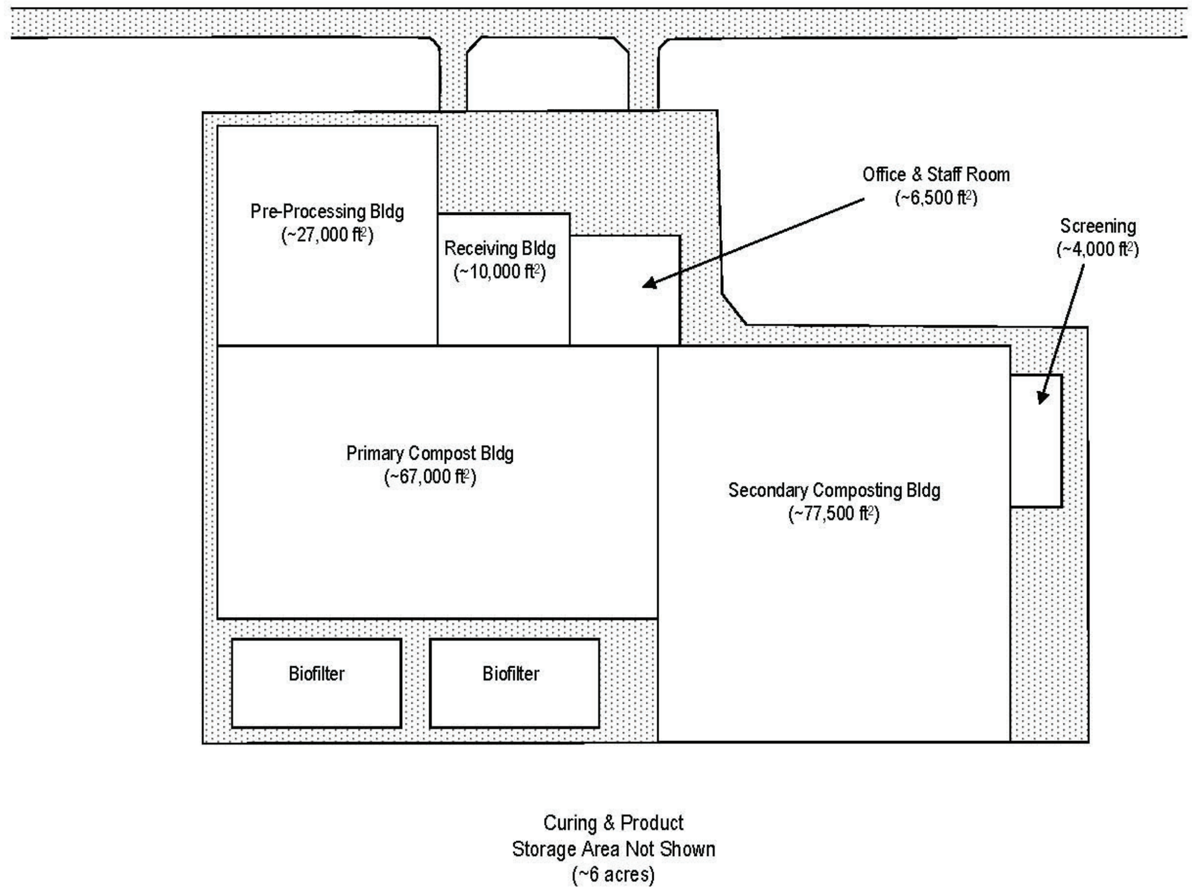

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Exhibit 10
West Hawai'i Conceptual Site Layout
N.T.S.

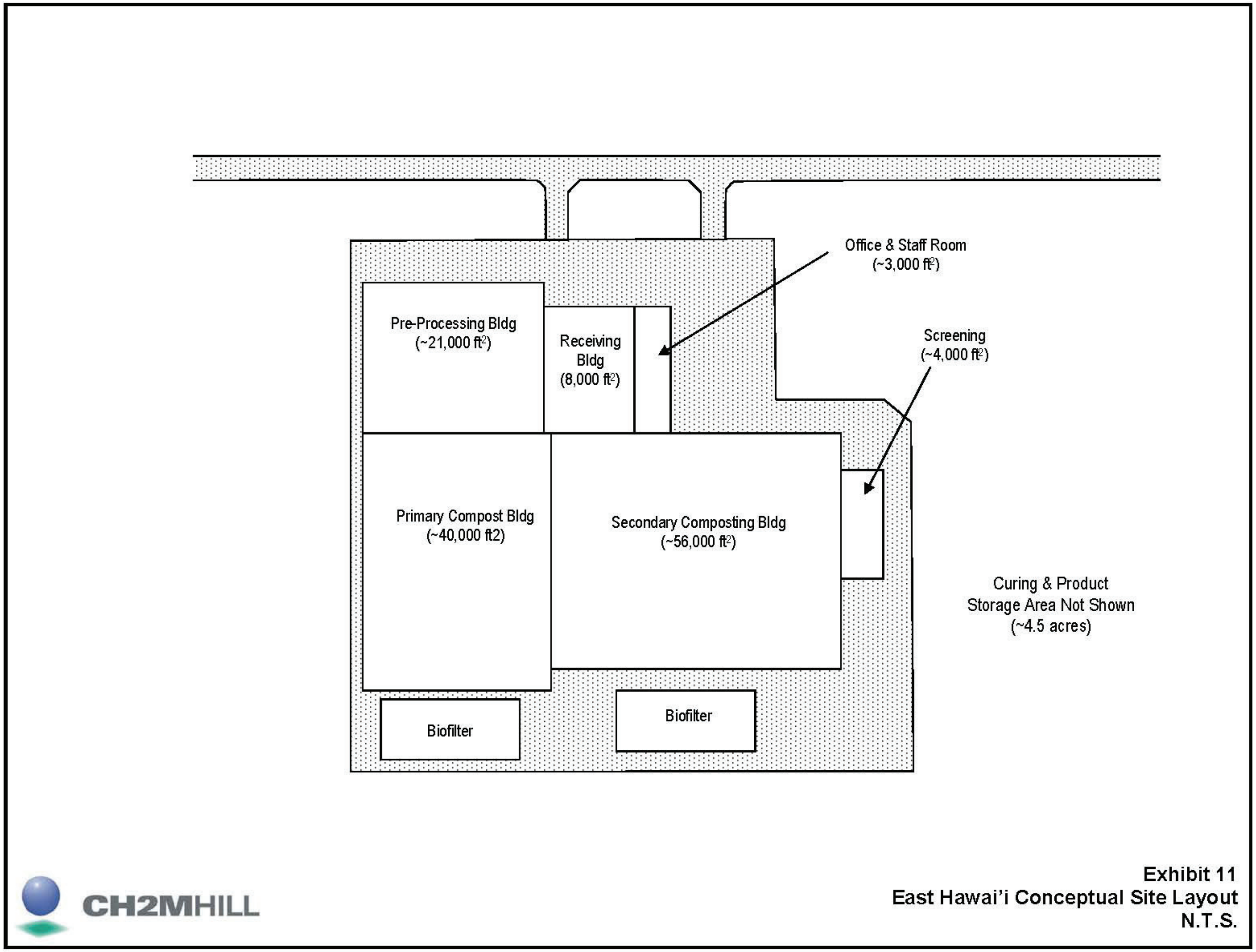


Exhibit 11
East Hawai'i Conceptual Site Layout
N.T.S.

Staffing Requirements

The following staffing requirements have been developed for each facility.

EXHIBIT 12
Staffing Requirements

Staff Position	West Hawai`i Facility	East Hawai`i Facility	Shared Positions
Operation Manager	1 FTE	1 FTE	
Administrative Support	1 FTE	1 FTE	
Purchasing Support			1 FTE
Product Sales			1 FTE
Shift Supervisors	2 FTE	2 FTE	
Process/Lab Technologist	2 FTE	1 FTE	
Equipment Operators/Truck Driver	6 FTE	5 FTE	
Sort Line Laborer	12-18 FTE	8-12 FTE	
General Laborer	2 FTE	1 FTE	
Maintenance Coordinator			1 FTE
Millwright	2 FTE	1 FTE	
Electrician	1 FTE	1 FTE	
Instrumentation			1 FTE
Total	29 – 35 FTE	21 - 25 FTE	4 FTE

Mobile Equipment Requirements

The conceptual design of the MBT facilities is based on use of enclosed composting technology, but does not involve a high level of automation. Therefore the following mobile equipment will be required to support each operation.

Compost Markets and End Uses

Based on the facility design and experience elsewhere in North America, it is assumed that the compost produced at the two Hawai`i MBT plants would meet the 503 regulations, and will be mature enough for uses as a soil amendment. It is also anticipated the product will be relatively free of large inert materials (i.e., >3/8"), but will contain a noticeable number of small glass and hard plastic particles. With that in mind, the product would likely be sold to the agriculture and reclamation sectors, and to a lesser extent to commercial landscapers, and land developers. Aside from the product's characteristics, the demographics of the target market also affect to which markets the compost can be sold.

EXHIBIT 13
Mobile Equipment Requirements

Equipment Type	West Hawai`i Facility	East Hawai`i Facility
Wheel Loader (JD624 or equivalent)	3	3
Vermeer 1010 Compost Turner	2	2
Portable Trommel for finished product screening	2	1
Portable hard hose reel for water addition during curing stage	1	1
60 ft stacking conveyor for creating finished product stockpiles	1	1
Walking Floor Trailer	2	2
Tractor Unit	1	1

Demographics

Hawai`i County has a relatively small, but growing diversified agricultural industry in Hawai`i. Macadamia nuts, papaya, flowers, tropical and temperate vegetables, and coffee are all important crops.

Hawai`i County is now host to more than 20 certified organic farms and production facilities. All of Hawai`i's major agricultural crops can be grown according to organic standards and the County now produces organically grown coffee, avocado, ginger, banana, taro, pineapple, citrus, and a large variety of salad greens and vegetables. Based on 1996 Department of Agricultural figures, diversified agriculture provided for over 2,550 direct employment jobs, $300 million in annual revenue and supplied over 50 percent of the Big Island's fresh fruits and vegetables for consumers.

Hawai`i County's $20 million foliage industry is the fastest growing of the island's major agricultural crops. Landscape plants are produced for sale locally and to neighbor islands, and in some cases are shipped to the mainland U.S., Hawai`i County is the primary producer of landscape plants in the state.

The landscape/nursery industry often plays a key role in composting marketing plans. The general business demographics of the County's modestly sized landscape/nursery industry are shown in Exhibit 14. This industry serves a population base of over 200,000.

EXHIBIT 14
Landscape and Nursery Industry Demographics

Landscape Designers	Landscape Contractors	Retail/Wholesale Nurseries	Golf Courses		Bulk Materials			Garden Centers
			Private	Public	Landscape Suppliers	Topsoil Dealers	Mulches	
12	60	51	7	14	11	10	0	1

Realistic Markets

Before developing a facility of this size, additional market and reuse research needs to be completed. The geographic remoteness of the island, and limited local Hawai`i market, indicates that the majority of the compost would probably have to be used in Hawai`i County Internal utilization, as well as the marketing of the product would need to be considered. Therefore, lower value markets (which are typically large in acreage size) may need to be investigated. Based on the anticipated characteristics of the MSW compost, a variety of potential end use applications and market segments can be considered. The more popular uses and markets for MMSW compost are summarized in Exhibit 15.

EXHIBIT 15
MMSW Compost Markets

Primary Market segments	Potential uses
Land Reclamation	
Topsoil blender /supplier	Soil amendment – landscape/turf
In-county (Parks, Landfill)	Soil amendment – reclamation
Landscape/turf	Soil amendment - agriculture
Agriculture	Topsoil blending component
Nurseries/greenhouses	Landfill closure
Land Developers	Landfill alternative daily cover
Golf Courses	Subsoil alternative

Challenges / Opportunities

The greatest challenge to developing markets for the proposed MMSW compost is the relative size of the facility compared to size of the existing marketplace (as based on current demographic data). Of course, additional research is required to evaluate market potential before any definitive conclusions could be made. Completing actual market research on both known higher and lower value markets, and high and lower volume markets will be imperative. Further, it will important to better understand the characteristics of the product which could be produced. Certainly, opportunities will need to be investigated within known MMSW compost markets, including landfill cover, agriculture, topsoil blending and erosion control.

Facility Cost Estimates

Order of magnitude capital cost estimates were developed for each of the conceptual facility designs. These estimates were pro-rated from recent quoted construction costs for similar facilities. A summary of the capital and equipment cost estimates are provided in Exhibits 16 and 17. Costs are annualized assuming conservative useful life estimates for facilities and equipment and an annual interest rate of 5.0 percent. Annualized capital costs are estimated to be $96 per ton for East Hawai`i and $90 per ton for West Hawai`i.

Annual operating and maintenance costs, including labor and utilities, for the two MBT facilities are expected to be approximately $48 per tonne. As the facilities age, this operating cost can be expected to increase as maintenance requirements increase.

With an MBT plant, not all materials currently disposed of in the County would be recycled or made into compost. Construction materials such as most treated wood, concrete, asphalt, and other hard to process materials would be recycled to the extent possible, and then sent directly to landfill. There would also be residuals at the back end of the process. It is estimated that the MBT system would divert an additional 62 percent of material, resulting in approximately, 38 percent of current disposal being sent to landfill. Assuming disposal of this material at $70 per ton, the total cost of the MBT system plus landfill disposal is estimated to be approximately $160 per ton.

EXHIBIT 16
Order of Magnitude Cost Estimate – East Hawai`i

	Quantity	Unit	Unit Rate	Total	Useful Life	Annual Cost
Site Preparation			Allowance	$500,000	15	$48,000
Receiving Building						
Building	8,000	ft2	$208	$1,664,000	15	$160,000
Fixed Equipment	N/A	LS		N/A		
Pre-Processing Equipment						
Building	21,000	ft2	$208	$4,368,000	15	$421,000
Fixed Equipment	1	LS		$3,900,000	12	$440,000
Primary Composting System						
Building	40,000	ft2	$208	$8,320,000	15	$802,000
Fixed Equipment	1	LS		$7,800,000	12	$880,000
Secondary Composting Equipment						
Building	56,000	ft2	$260	$14,560,000	15	$1,403,000
Fixed Equipment	1	LS		$3,250,000	12	$367,000
Screening Building						
Building	4,000	ft2	$208	$832,000	15	$80,000
Fixed Equipment	1	LS		$650,000	12	$73,000
Curing Pad						
Working Surface	5	acres	$130,000	$585,000	15	$56,000
Subtotal				$46,429,000		$4,730,000
Mobilization/General Conditions	10%			$4,642,900		$473,000
Contingency	30%			$13,928,700		$1,419,000
Construction Total (Rounded)				$65,000,000		$6,600,000
Engineering and Design	15%			$9,750,000		$993,000
Construction Management	5%			$3,250,000		$331,000
Mobile Equipment	1	LS		$3,250,000	7	$562,000
Project Total				$78,000,000		$7,900,000
Construction Cost Multiplier			1.3			
Interest Rate			5.0%			
Tons per year						82,000
Capital cost per ton						$96

Note:
These cost opinions are in first quarter 2009 dollars. They do not include future escalation or unusual material cost increases. No potential hazardous material mitigation is included.

The cost opinions shown have been prepared for guidance in project evaluation from the information available at the time of preparation. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope, final project schedule and other variable factors. As a result, the final project costs will vary from the cost presented above. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

EXHIBIT 17
Order of Magnitude Cost Estimate – West Hawai`i

	Quantity	Unit	Unit Rate	Total	Useful Life	Annual Cost
Site Preparation			Allowance	$500,000	15	$48,000
Receiving Building						
Building	10,000	ft2	$208	$2,080,000	15	$200,000
Fixed Equipment	N/A	LS		N/A		
Pre-Processing Equipment						
Building	27,000	ft2	$208	$5,616,000	15	$541,000
Fixed Equipment	1	LS		$5,200,000	12	$587,000
Primary Composting System						
Building	67,000	ft2	$208	$13,936,000	15	$1,343,000
Fixed Equipment	1	LS		$15,600,000	12	$1,760,000
Secondary Composting Equipment						
Building	77,500	ft2	$260	$20,150,000	15	$1,941,000
Fixed Equipment	1	LS		$4,550,000	12	$513,000
Screening Building						
Building	4,000	ft2	$208	$832,000	15	$80,000
Fixed Equipment	1	LS		$650,000	12	$73,000
Curing Pad						
Working Surface	6	acres	$130,000	$780,000	15	$75,000
Subtotal				$69,894,000		$7,161,000
Mobilization/General Conditions	10%			$6,989,400		$716,000
Contingency	30%			$20,968,200		$2,148,000
Construction Total (Rounded)				$97,900,000		$10,000,000
Engineering and Design	15%			$14,685,000		$1,505,000
Construction Management	5%			$4,895,000		$502,000
Mobile Equipment	1	LS		$3,900,000	7	$674,000
Project Total				$117,500,000		$12,000,000
Hawai`i County Construction Cost Multiplier			1.3			
Interest Rate			5.0%			
Tons per year						134,000
Capital cost per ton						$90

Note:
These cost opinions are in first quarter 2009 dollars. They do not include future escalation or unusual material cost increases. No potential hazardous material mitigation is included.

The cost opinions shown have been prepared for guidance in project evaluation from the information available at the time of preparation. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope, final project schedule and other variable factors. As a result, the final project costs will vary from the cost presented above. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

APPENDIX E

Considerations for Siting a New Landfill in East Hawai`i

Considerations for Siting a New Landfill in East Hawai‘i

Prepared by Geometrician Associates for:

CH2M Hill Inc.

and

County of Hawai‘i, Department of Environmental Management

December 2008

1. Introduction

This report is intended to accompany the ongoing update to the County of Hawaiʻi *Integrated Solid Waste Management Plan* (ISWMP). The current version of the ISWMP was adopted in 2002 using a Solid Waste Advisory Committee (SWAC) of public and private individuals to set priorities for the County's solid waste management system (Hawaiʻi County DEM 2002). The ISWMP specifically advised against building any new landfill in East Hawaiʻi, and instead emphasized the recovery of recyclable materials at the planned East Hawaiʻi Sort Station; establishing a County recycling program with a long list of elements that could significantly increase waste diversion; and procuring a waste reduction facility for the East Hawaiʻi waste stream using either waste-to-energy, thermal gasification, or anaerobic digestion technology. It was expected that by 2008 the South Hilo Sanitary Landfill (SHSL) would be closed and that East Hawaiʻi solid waste would either be trucked to the West Hawaiʻi Sanitary Landfill (WHSL) or be powering a waste-to-energy plant. Neither of these options has come to pass, and through engineering adjustments and some success with recycling, the SHSL has managed to stay open, although its capacity beyond the next four to five years is unknown. DEM is currently revising the ISWMP, and given the current realities, a reconsideration of an SHSL expansion or an alternative site somewhere in East Hawaiʻi is being explored as part of normal due diligence.

The County of Hawaiʻi's 2004 Environmental Impact Statement (EIS) for East Hawaiʻi Regional Sort Station EIS considered the issue of a new East Hawaiʻi landfill in depth in the context of an alternative to the Sort Station. That EIS still provides a valuable and relevant analysis that serves as the basis for some of the discussion in this document, updated as appropriate.

2. Existing Conditions

The South Hilo Sanitary Landfill (SHSL) serves roughly the eastern half of the island (Figure 1). The SHSL is located just outside the eastern edge or urban Hilo, in an area of industrial, airport, and farm lot use (Figures 2a and 2b). The landfill is accessed from Leilani Street and an unnamed access road. The County of Hawaiʻi owns and operates the SHSL, and the Department of Environment Management estimates that the landfill has been in operation since the 1960s. The landfill is unlined and encompasses approximately 40 acres, the majority of which is used for municipal solid waste disposal. According the *SHSL Proposed Expansion Feasibility and Capital Cost Report* prepared by SWT Engineering in 2008, the established refuse footprint includes approximately 910,000 cubic yards of airspace capacity. The SHSL has an estimated 5 years of life remaining at current recycling rates (or through 2013).

Figure 1
Disposal at Hawai‘i County Transfer Stations and Landfills, FY 2008

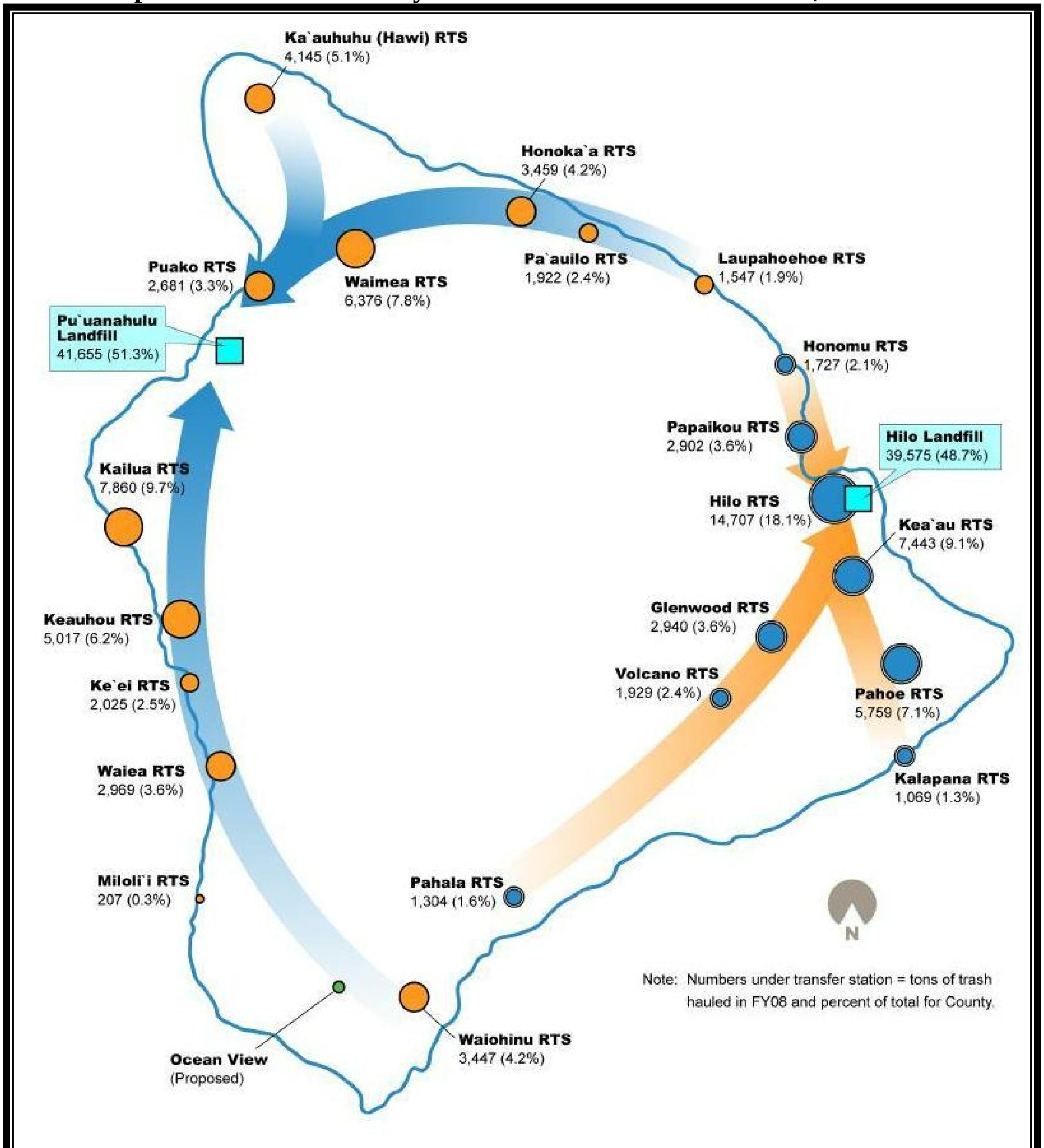


Figure 2 Location Map of South Hilo Sanitary Landfill

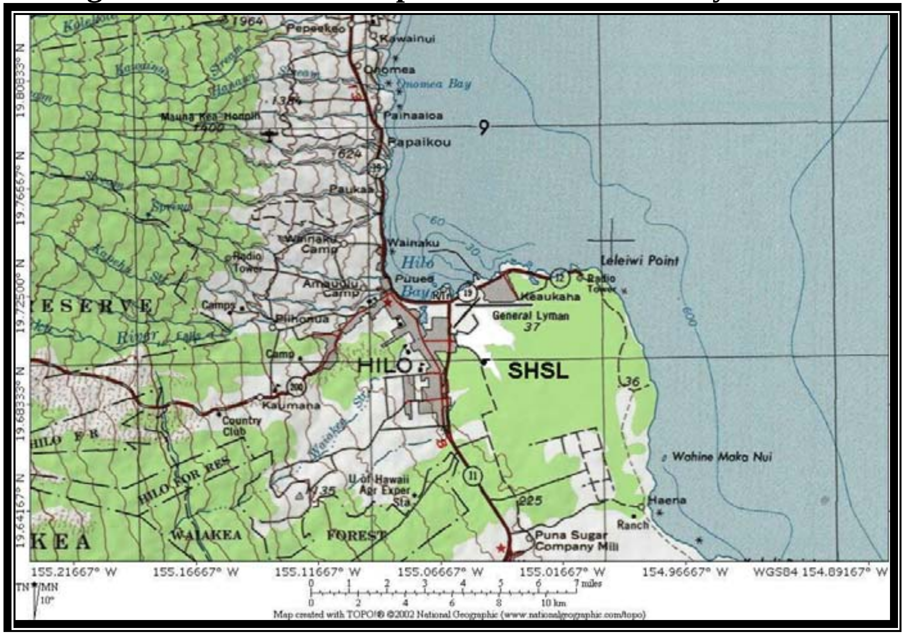
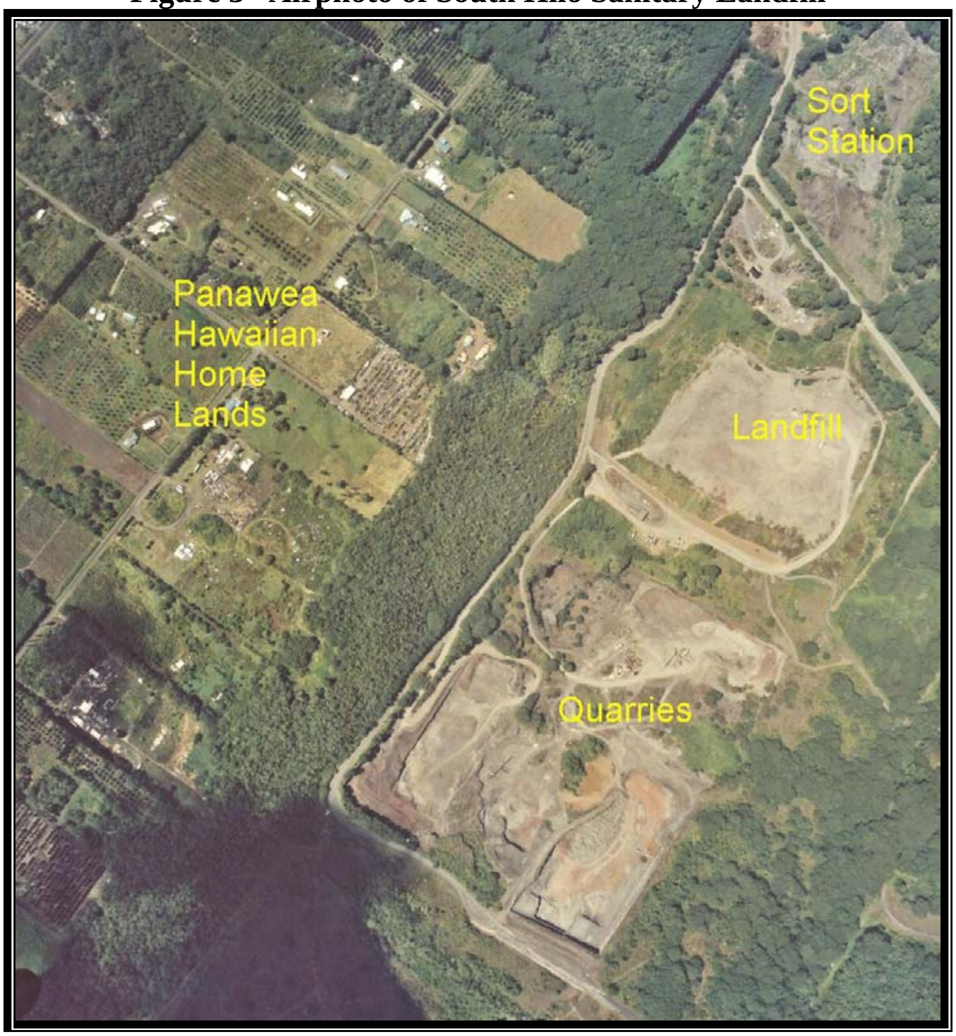


Figure 3 Airphoto of South Hilo Sanitary Landfill



3. Siting Considerations

Specific landfill siting criteria for East Hawai‘i are briefly discussed below.

Ownership and Property Size. Approximately 300 acres are needed for landfilling, support and buffer areas. Large properties under the control of one owner are best suited for a landfill location, as they require no or negligible property consolidation and minimum owner negotiation. Most suitable are properties owned by the County or State, where land for public purposes can be obtained without payment or at a reduced cost. Agricultural land values in Puna, based on County records from 2004, are approximately $4,000 per acre, meaning that more than $1,000,000 could be required for acquisition of a private property with agricultural zoning. Urban zoned properties would have far higher value, but very few large existing urban tracts are available.

Zoning. Landfills are explicitly permitted uses only in the State Land Use (SLU) Urban District with County industrial zoning in an area identified on the General Plan’s Land Use Pattern Allocation Guide Map (LUPAG) for Industrial uses. However, property with all these existing designations is scarce. Various land use permits and approvals can be obtained to allow landfills in other areas. The WHSL and a portion of the SHSL are both within the Agricultural District. These facilities were both required to obtain Special Permits from the County Planning Commission and the State Land Use Commission. It may also be possible to obtain a Conservation District Use Permit to construct a landfill in the State Land Use Conservation District. Although such permits are possible, they are time-consuming, potentially controversial, discretionary, and may include conditions that are expensive or difficult to fulfill. If urban land were not available it would thus be preferable for the County to undertake a Land Use Boundary Amendment to reclassify Agricultural or Conservation land to the Urban District, amend the General Plan LUPAG map, and then rezone to the appropriate County zone.

Topography and Soils. Landfills can be developed in many types of topography and soil conditions. The topography for a landfill site can be flat, rolling, or a depression, as long as the overall site gradient is not too steep. Desirable soils include clays for liners, fine grained, a reasonable distance (6 feet plus) to bedrock, well draining soils for cover material and road building, and an absence of rocks that would hinder operations. It is rare for a site to have all of these desirable characteristics and landfills can be operated quite effectively with on-site soils supplemented with synthetic fabrics for liners or covers.

Traffic and Transportation. Landfills involve substantial truck traffic during both construction and operation. Access roads should avoid residential neighborhoods and should otherwise be appropriate for travel by heavy garbage trucks (speed limits, pavement, shoulder widths, sight lines).

Population Centrality. Landfills are ideally located in relative proximity to the geographic centroid of waste generation in order to reduce hauling costs and maximize convenience to users. Access to labor and related services may also be a consideration.

Utilities and Services. Landfills generally require electricity, water (not necessarily potable) and landfill cover material (in Hawaiʻi, crushed rock).

Biological Considerations. Aside from water quality issues discussed below, landfills use or affect large tracts of land and should avoid threatened or endangered species and direct or indirect impacts to rare or valuable ecosystems such as wetlands. Hawaiʻi is known as the endangered species capital of the world; the most sensitive locations are generally near the shoreline and/or within lands designated within the Conservation District, which occupies a very large proportion of land on the island of Hawaiʻi. Landfills must formally coordinate with nearby airports to determine if pest birds attracted to landfills could pose a hazard to aircraft.

Social and Cultural Impacts. Solid waste facilities by their nature often involve certain proximity impacts or nuisances including litter, odors, noise, and vermin. Despite mitigation, any new landfill would almost certainly meet substantial community resistance if it were not located at least a half-mile away from existing residences.

Geologic Hazards. The entire Big Island is subject to geologic hazards, especially lava flows and earthquakes. Volcanic hazard on the Island of Hawaiʻi has been assessed by the U.S. Geological Survey on a scale of ascending risk of 9 to 1. Based on the presence of the volcanoes Kilauea and Mauna Loa, the large majority of East Hawaiʻi is within Lava Flow Hazard Zone 1, 2 or 3. During the past 750 years, lava flows have covered about 15 to 20% of Zone 3 on Mauna Loa and 75% on Kilauea. As a landfill represents a fairly long term commitment, it is seen as imprudent to locate one in an area with greater hazard than this, i.e., Zones 1 or 2. In terms of seismic risk, the entire Island of Hawaiʻi is rated Zone 4 Seismic Hazard (*Uniform Building Code, 1997 Edition*, Figure 16-2). Zone 4 areas are at risk from major earthquake damage, especially to structures that are poorly designed or built, as the 6.7-magnitude quake of October 15, 2006 demonstrated. A landfill sited anywhere on the island of Hawaiʻi needs to design for this seismic setting. Areas near known faults or subject to mass wasting may be inappropriate locations.

Water Quality, Rainfall and UIC: The State Department of Health (DOH) establishes and monitors land use in areas that lie above sensitive drinking water sources in order to minimize contamination. DOH places restrictions on Underground Injection Wells, which inject water or other fluids into a groundwater aquifer. The restrictions differ depending on whether the area is inland (mauka) or seaward (makai) of the Underground Injection Control (UIC) line. Although landfills do not inject fluids into the ground, by nature they generate fluids called leachate that include decomposition products from the waste contained within them. All new landfills and lateral expansions must have a low-permeability bottom liner and leachate management system that minimize the water quality effects. Bottom liners and leachate collection systems minimize the quantity of leachate that enters the soil, but do not totally eliminate the potential for leachate intrusion into groundwater. For this reason, all new landfills built since the 1960s in Hawai‘i have been located seaward of the UIC line so that sources of drinking water are protected. The DOH has seen some applications proposing to site landfills above the UIC line. These applicants have established a precedent for modifying these mauka landfills to contain two bottom liners, as is required for hazardous waste landfills. Although there are no regulations that either prevent landfills from being sited above the UIC line or specify conditions if allowed mauka of the UIC line, it is almost certain that DOH would require the double bottom liner.

Because of the difficulty of dealing with large quantities of leachate, most landfills are built in areas with low average annual rainfall. A review for the Sort Station EIS of mainland landfills in 2004 found the wettest landfill on the U.S. Mainland to be east of Seattle, WA., which receives between 50 and 60 inches of annual precipitation. In Hawai‘i, the rainfall at landfills varies from 9 inches at Pu‘uanahulu to 22 inches in Lana‘i; the exception to dry locations is Hilo, with over 126 inches per year.

4. Identification of Potential Sites

It should be noted that as part of alternative analysis for the 2003 Sort Station EIS and the 2006 Waste Reduction Technology Facility (WRTF) planning documents, DEM has identified a site adjacent to the existing SHSL as a potentially viable site for a landfill or landfill extension. The site consists of quarries leased from the State by the County and subleased to Jas W. Glover to provide daily cover for the landfill and rock for other destinations. The site has been excavated to approximately 60 feet below ground surface and has vertical walls on three of its four sides, with additional quarry space on the three parcels to the south. The existing excavation would facilitate construction of a landfill.

This location would have a number of advantages including being in an existing, excavated quarry, proximity to needed services, utilities, and roads, and potentially appropriate land use designations, among others. Land acquisition time and expense would be virtually eliminated, and infrastructure development costs would be minimized. Visual, social and proximity impacts of landfill siting would also be minimal because of the history of solid waste management at the site and industrial nature of the surrounding areas. The Sort Station EIS and WRTF planning studies identified the key deficiency of the site, which it shares with any wet location in East Hawai‘i, which is the cost of treating leachate. Since the time of these studies several years ago, DEM has been studying how to reduce the generation of leachate through portable, impermeable covers and treating leachate in constructed wetlands. Elsewhere in the ISWMP, a study of leachate treatment using constructed wetlands prepared by CH2M HILL for SWT Engineering predicted that leachate concentrations from the proposed lateral expansion can be treated using constructed wetlands, and the initial, conceptual cost estimate for this approach showed the approach would not be cost prohibitive. Because the site adjacent to the SHSL has been extensively studied and has other advantages, it serves in this assessment as a benchmark by which other potential landfill sites may be compared.

Environmental Constraints on Landfill Location

There are obvious and significant constraints for locating a landfill over large portions of East Hawai‘i. Figures 3a-e are thematic maps of East Hawai‘i depicting some of the major constraints capable of being mapped.

Environmental Constraints: Population Centers

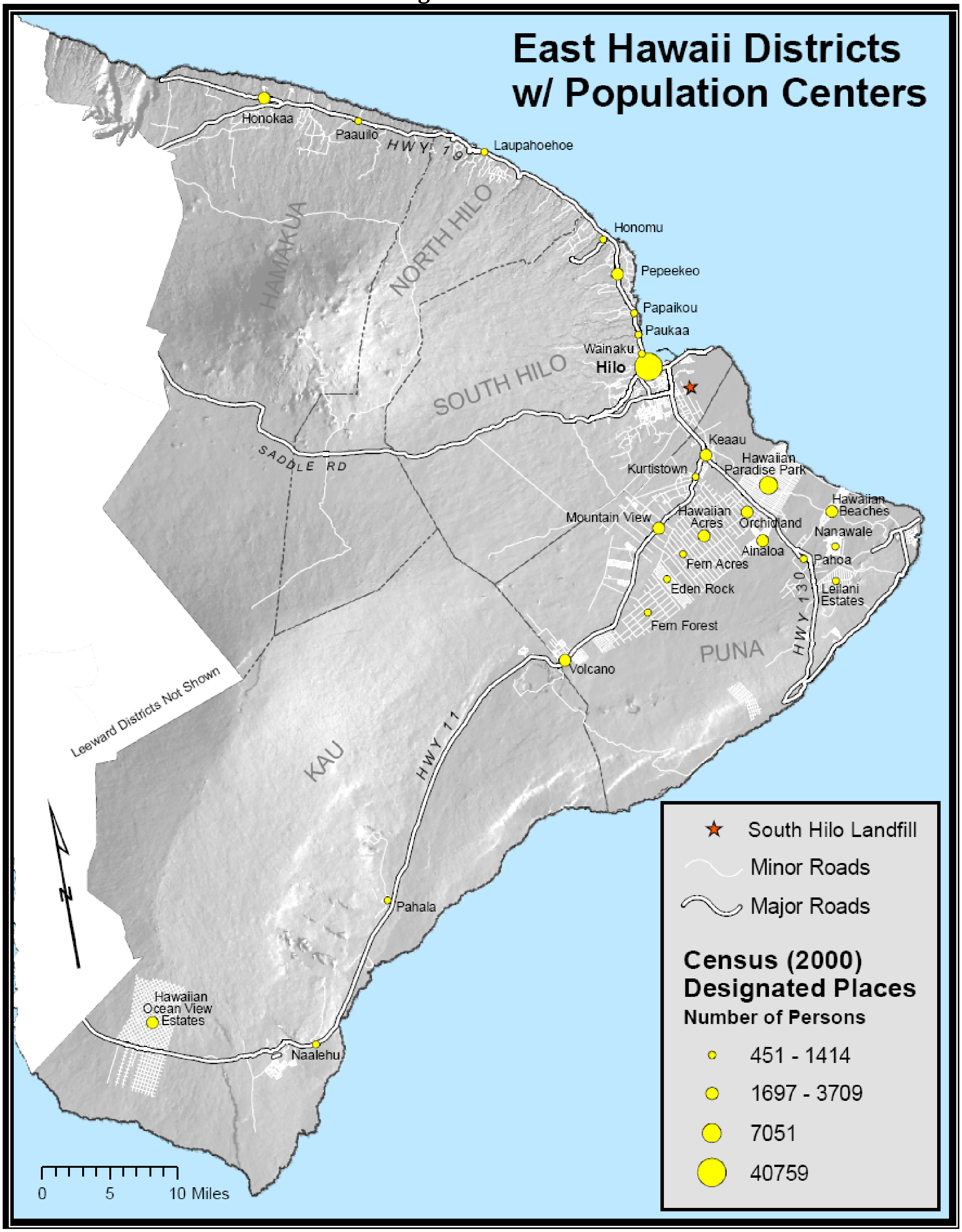
As shown in Figure 3a, population in East Hawai‘i is strongly clustered around Hilo. A secondary population center is in Puna, where population is scattered but weakly focused on an axis along Highway 130 that links the towns of Kea‘au and Pahoa and the subdivisions of Hawaiian Paradise Park, Orchidland, and Ainaloa. Smaller population centers – minor sources of labor and generators of solid waste –are widely scattered in other locations from Honokaa to Ocean View. In terms of efficiency of the collection of solid waste and the availability of labor and services, the most favorable location for a new East Hawai‘i landfill would be in or near Hilo.

Environmental Constraints: Land Use Designations and Ownership

Figure 3b shows State Land Use (SLU) Districts, critical County Land Use Pattern Allocation Guide Map (LUPAG) classifications, and State or County land ownership (Figure 3c is a close-up of the South Hilo area). Very little urban zoned and/or LUPAG Industrial land is available, and most of it is concentrated in Hilo. There is an especially extensive area of appropriate land use designation near the existing landfill, which, as discussed above, has been considered. Other areas with at least some Urban/LUPAG industrial land include Kea‘au, Pahala, and O‘okala (a community too small to be mapped but located between Laupahoehoe and Pa‘auilo on Hamakua coast). While Conservation district land dominates East Hawai‘i, there are very large areas of Agricultural district lands with some potential for a landfill.

There are large tracts of State land, scattered throughout East Hawai‘i, much of it either Conservation District land or under the administration of Department of Hawaiian Home Lands and for all practical purposes not available. County landholdings are generally small and located within commercial and residential areas inappropriate for landfills. The exceptions are on the Hamakua coast, where some large properties were acquired in lieu of delinquent property taxes after the failure of a large sugar plantation.

Figure 3a


East Hawaii Districts
w/ Population Centers
Honokaa
Paauilo
HWY 19
Laupahoehoe
Honomu
Pepeekeo
Papaikou
Paukaa
Wainaku
Hilo
HAMAKUA
NORTH HILO
SOUTH HILO
SADDLE RD
Keaau
Hawaiian Paradise Park
Kurtistown
Hawaiian Beaches
Mountain View
Hawaiian Acres
Orchidland
Nanawale
Ainaloa
Fern Acres
Pahoa
Eden Rock
Leilani Estates
Fern Forest
HWY 130
PUNA
Volcano
Leeward Districts Not Shown
KAU
HWY 11
Pahala
Hawaiian Ocean View Estates
Naalehu
N
0
5
10 Miles
South Hilo Landfill
Minor Roads
Major Roads
Census (2000) Designated Places
Number of Persons
451 - 1414
1697 - 3709
7051
40759

Environmental Constraints: Rainfall, Aquifer Protection, and Volcanic Hazard

Figure 3d maps rainfall, the UIC line, and volcanic hazards. Generally the UIC line is within less than a mile of the coast. The UIC line is expanded well inland in the area surrounding Hilo International Airport and the SHSL southerly to the South Hilo/Puna district boundary, where it returns to the coastline. Minor exceptions to the shoreline proximity are also found near Pahala, Kapoho, Pepe'ekeo, Honokaa, and the southern tip of the island. Kapoho is an environmentally sensitive area near sea level with very high volcanic hazard. Pepe'ekeo has residential subdivisions in this area and lacks suitable areas for landfill development. The southern tip of the island in this area is mostly DHHL land and thus not available; where land ownership is otherwise, access is severely limited.

Although most environmental and socioeconomic factors clearly favor a location near Hilo, rainfall in and around Hilo presents challenges for landfill operations. Any location that receives average annual rainfall in excess of 2000 mm (roughly 80 inches) would generate a large volume of leachate that would be difficult to deal with (and would not be appreciably better than the quarries adjacent to the existing SHSL). As indicated by the map, virtually of northeast Hawai'i, including the Hamakua, North and South Hilo, and Puna Districts outside of the National Park or Mauna Kea, receive greater than 2000 mm of rain. Dry areas exist in the higher elevations on the southwest slope of Mauna Loa and south of the Highway 11 near South Point. A relatively dry area exists along the Saddle Road beginning near the Mauna Kea Access Road intersection. Dry regions are located in the higher elevations above O'okala and Honokaa and may be accessible from the Mana Road.

A landfill within a high rainfall area is of course possible, but expensive, requiring either extensive onsite wastewater treatment (e.g., a specialized plant and/or constructed wetlands) or transport of leachate via pipeline or truck to an existing wastewater treatment plant (WWTP). Constructed wetlands would add significantly to the acreage requirement, while transferring wastewater to an existing WWTP would be expensive and may result in capacity or loading challenges at the County's WWTP.

Areas of high volcanic hazard in East Hawai'i are concentrated along and downslope of the East Rift of Kilauea; along, near and downslope of the southwest rift of Mauna Loa; and along and around the upper slopes of the northeast rift of Mauna Loa. The least volcanic hazard is present in Hamakua.

Prelim Figure 3b

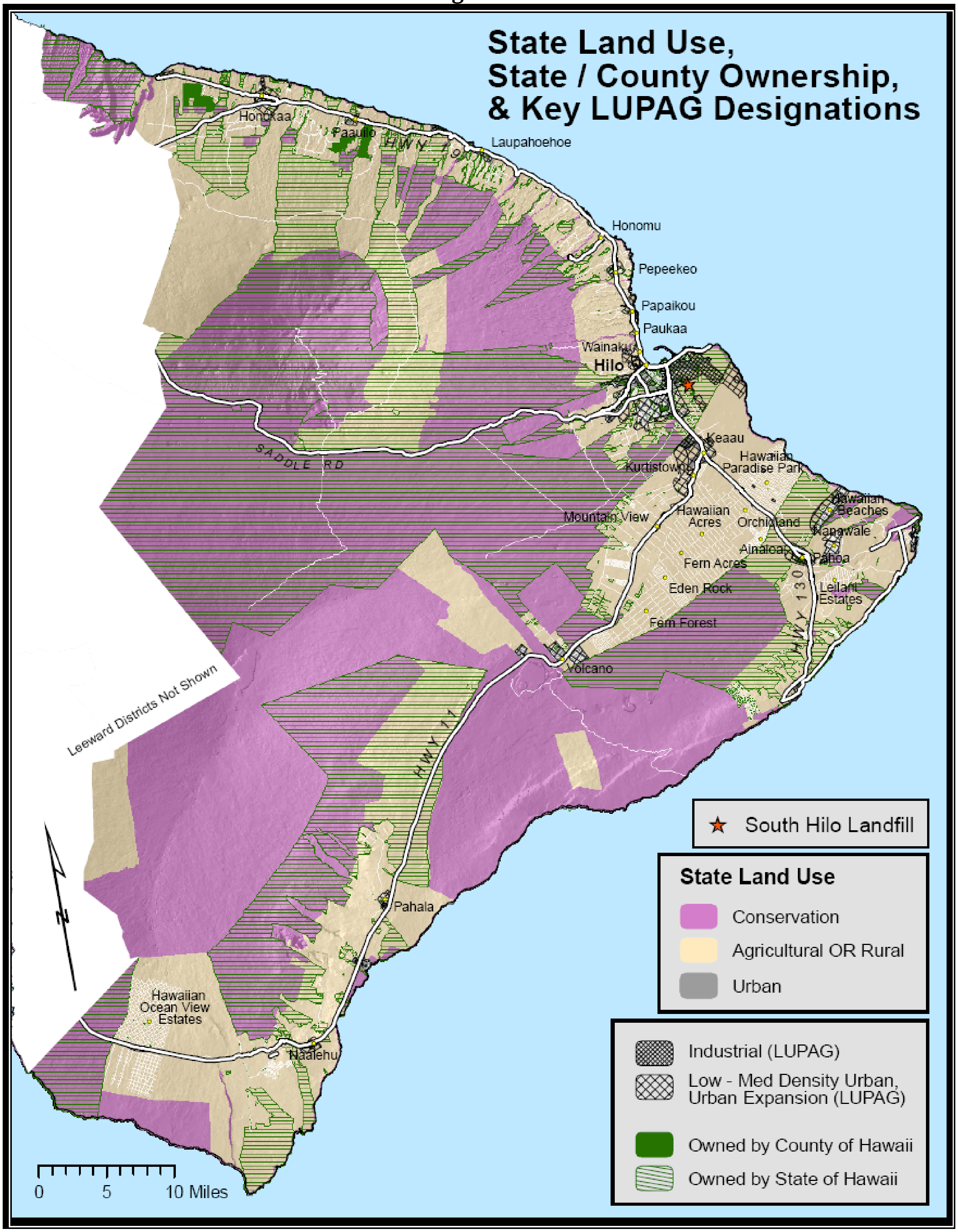
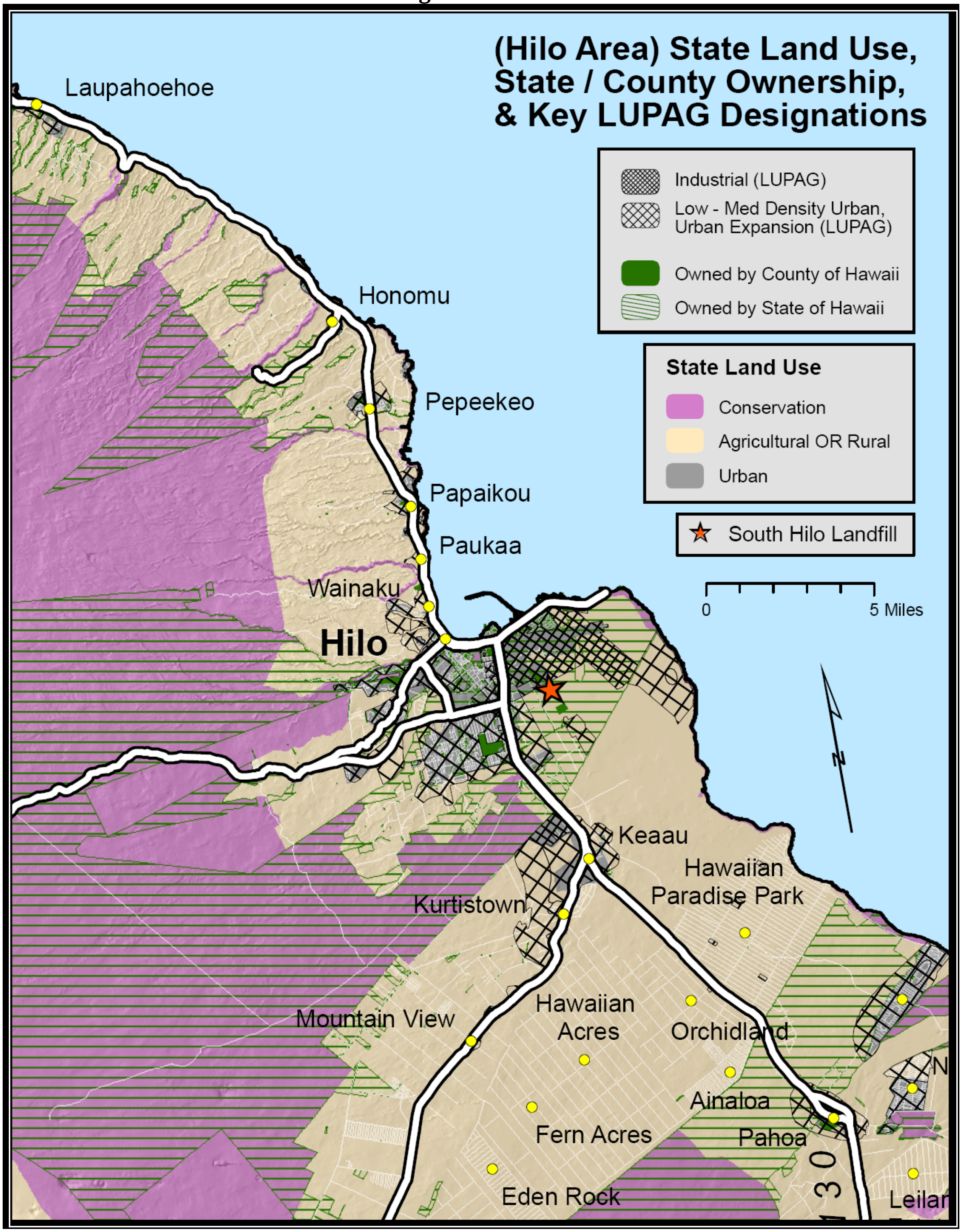
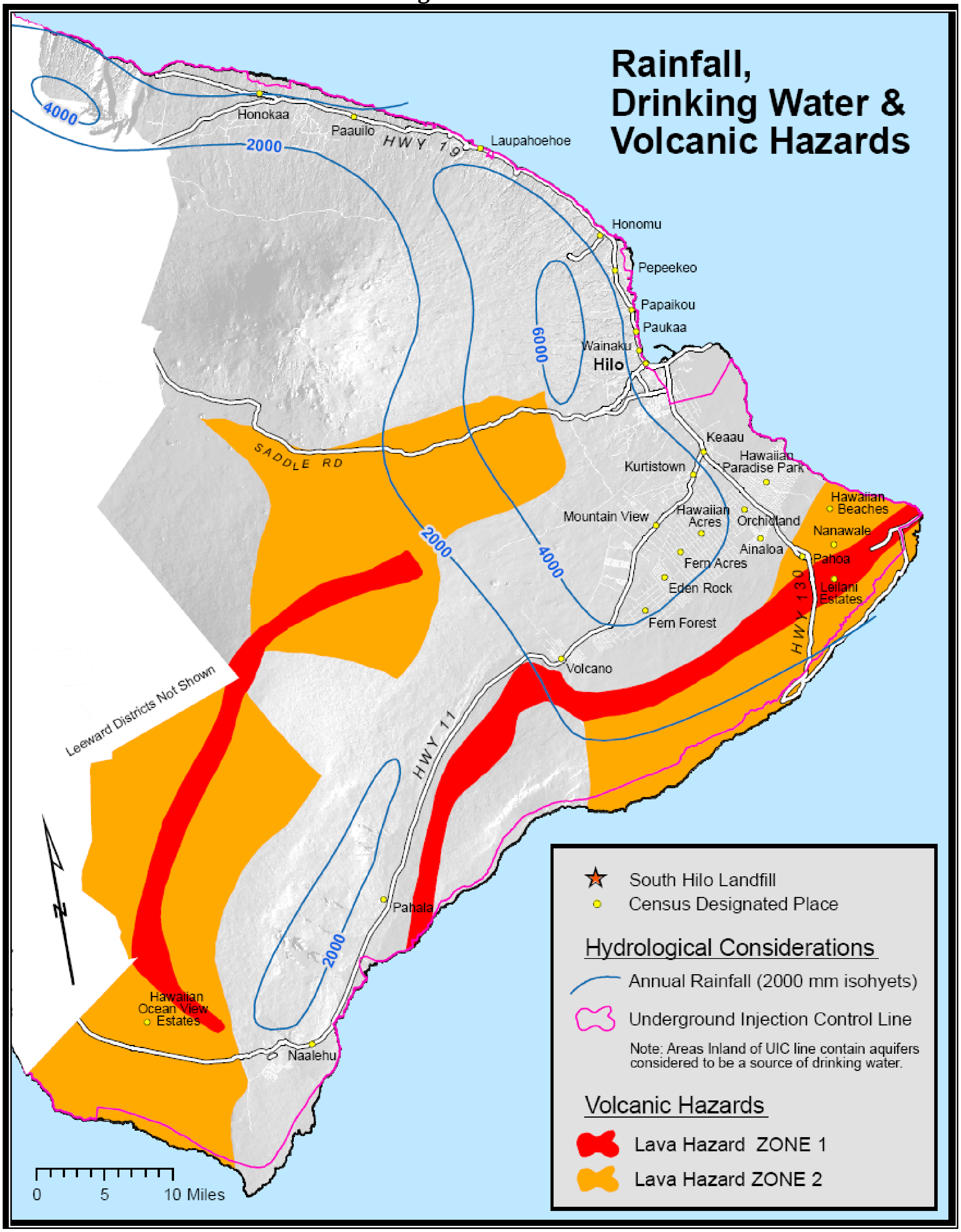


Figure 3c



(Hilo Area) State Land Use, State / County Ownership, & Key LUPAG Designations
Industrial (LUPAG)
Low - Med Density Urban, Urban Expansion (LUPAG)
Owned by County of Hawaii
Owned by State of Hawaii
State Land Use
Conservation
Agricultural OR Rural
Urban
South Hilo Landfill
0
5 Miles
Laupahoehoe
Honomu
Pepeekeo
Papaikou
Paukaa
Wainaku
Hilo
Keaau
Hawaiian Paradise Park
Kurtistown
Mountain View
Hawaiian Acres
Orchidland
Ainaloa
Fern Acres
Pahoa
Eden Rock

Figure 3d


Rainfall, Drinking Water & Volcanic Hazards
4000
2000
6000
4000
2000
4000
2000
Honokaa
Paauilo
HWY 19
Laupahoehoe
Honomu
Pepeekeo
Papaikou
Paukaa
Wainaku
Hilo
Keaau
Hawaiian Paradise Park
Kurtistown
Hawaiian Beaches
Mountain View
Hawaiian Acres
Orchidland
Nanawale
Ainaloa
Pahoa
Fern Acres
Eden Rock
Leilani Estates
Fern Forest
HWY 130
Volcano
SADDLE RD
HWY 11
Leeward Districts Not Shown
Pahala
Hawaiian Ocean View Estates
Naalehu
N
0
5
10 Miles
South Hilo Landfill
Census Designated Place
Hydrological Considerations
Annual Rainfall (2000 mm isohyets)
Underground Injection Control Line
Note: Areas Inland of UIC line contain aquifers considered to be a source of drinking water.
Volcanic Hazards
Lava Hazard ZONE 1
Lava Hazard ZONE 2

Environmental Constraints: Overall Evaluation

Figure 3e provides an overview of all the factors and allows an assessment of how well, or poorly, various areas meet the critical criteria: near population centers, lowest possible rainfall, seaward of the UIC line, existing or likely easily obtainable appropriate land use designations, and medium volcanic hazard.

Table 1 identifies a number of potential locations shown on the map and evaluates how they rate on multiple criteria. Although no weighting has been assigned to the factors, and there are other factors that are not considered, the table provides another valuable comparison tool.

It is important to point out that neither the map nor table includes factors that are impractical to map at reasonable scales (e.g., single-family residences). Perhaps more important are factors that are not amenable to mapping, particularly community perception. Opposition would likely be greatest for locations for which a landfill would represent a entirely new land use pattern, rather than a continuation of an existing one. As such, the map and table serve as rough guides only to the potential suitability of various locations for a landfill.

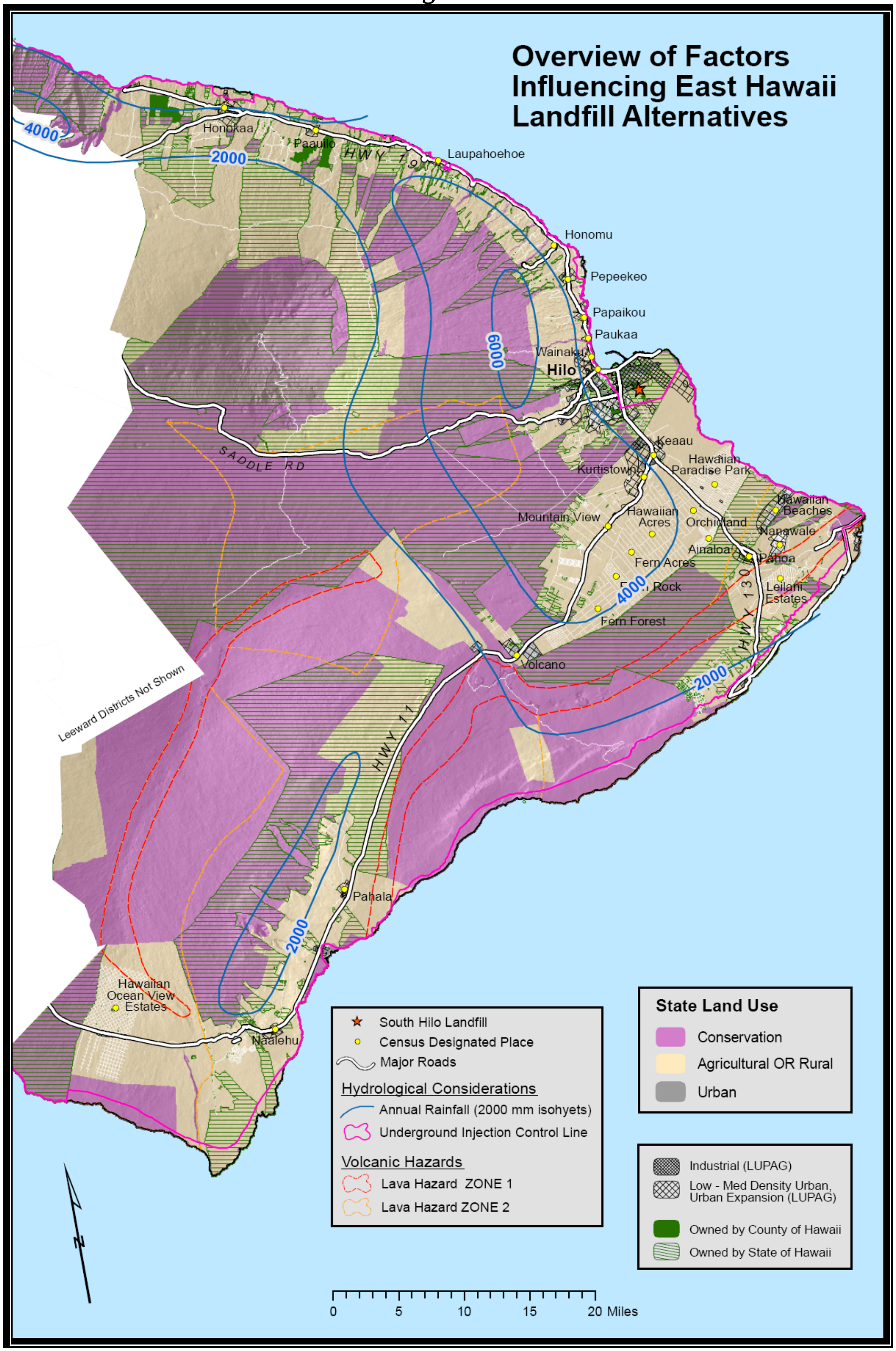
Table 1
East Hawai‘i Locations Rated on Selected Landfill Criteria

Factor/ Location	Rain-fall	Volcanic Hazard	Seaward of UIC Line	State or County Land (3)	State Land Use (4) District	Large Tracts Avail.	At or Near LUPAG Industr.	Serves Pop Center	Overall
Near SHSL	▼	▶	▲	▲	▲	▲	▲	▲	▲
Kea‘au	▼	▶	▼	▼	▲	▲	▲	▲	▶
Mid-Low Puna	▼	▶	▼	▼	▶	▲	▶	▶	▼
Kalapana	▶	▼	▲	▲	▶	▲	▼	▼	▶
Kapoho	▶	▼	▲	▼	▼	▲	▼	▼	▼
Mt. View	▼	▶	▼	▲	▶	▲	▶	▶	▼
Volcano	▶	▶	▼	▲	▲	▼	▶	▼	▼
Pahala	▲	▶	▼	▲	▲	▲	▲	▼	▶
Naalehu	▲	▶	▼	▲	▶	▲	▶	▼	▶
South Point	▲	▶	▲	▼	▶	▶	▼	▼	▼
Ocean View	▲	▼	▼	▼	▶	▲	▶	▼	▼
Saddle (1)	▲	▼	▼	▼	▼	▲	▼	▼	▼
Pepe‘ekeo (2)	▼	▲	▲	▼	▲	▲	▲	▶	▼
O‘okala	▶	▲	▼	▲	▲	▲	▲	▼	▶
Honokaa (2)	▶	▲	▲	▲	▲	▲	▲	▼	▶

Key: ▲ most favorable ▶ medium ▼ least favorable

Notes: (1) Near Mauna Kea Access Road; (2) Near coast; (3) Areas near State land that is mostly Conservation District or DHHL are rated least favorable; (4) At least some Urban land is available in the most favorable category;

Figure 3e



Overview of Factors Influencing East Hawaii Landfill Alternatives
Honokaa
Paauilo
HWY 19
Laupahoehoe
Honomu
Pepeekeo
Papaikou
Paukaa
Wainaku
Hilo
Keaau
Hawaiian Paradise Park
Kurtistown
Mountain View
Hawaiian Acres
Orchidland
Hawaiian Beaches
Nanawale
Ainaloa
Pahoa
Fern Acres
Leilani Estates
Fern Forest
HWY 130
Volcano
SADDLE RD
HWY 11
Pahala
Hawaiian Ocean View Estates
Naalehu
Leeward Districts Not Shown
4000
2000
6000
South Hilo Landfill
Census Designated Place
Major Roads
Hydrological Considerations
Annual Rainfall (2000 mm isohyets)
Underground Injection Control Line
Volcanic Hazards
Lava Hazard ZONE 1
Lava Hazard ZONE 2
State Land Use
Conservation
Agricultural OR Rural
Urban
Industrial (LUPAG)
Low - Med Density Urban, Urban Expansion (LUPAG)
Owned by County of Hawaii
Owned by State of Hawaii
N
0
5
10
15
20 Miles

Evaluation of Selected Individual Locations

It is apparent there is no location in East Hawaiʻi that meets all desirable criteria for landfill siting, and that any location would have to be a compromise that would involve considerable time and money to permit. Below is a brief discussion of individual sites:

Keaʻau has advantages in its population centrality, large tracts of land available, SLU Urban designations and LUPAG Industrial at least nearby. It has the disadvantage of being as rainy as Hilo and mauka of the UIC, with several wells in the makai area.

Mid-Lower Puna (along the Highway 130 corridor between Keaʻau and Pahoa) is generally unsuitable for the same reasons as Keaʻau, but with additional problems of virtually no land designated as SLU Urban or LUPAG Industrial, a large number of private wells, and fewer large tracts of land. The greatest traffic congestion problem in East Hawaiʻi is within this section of Highway 130, and a landfill would face stiff opposition on traffic issues alone.

Kalapana (the most southwest populated area of Puna) has only half the rainfall of Hilo, has sufficient land makai of the UIC to at least consider a landfill location, and has tracts of State land in the SLU Agricultural district. However, it is distant from population centers, located in a high volcanic hazard zone (as recently as 1990, lava flows destroyed most of the village of Kalapana), and lacks any urban land use designations. Just as with Mid-Lower Puna, congestion on Highway 130 would be an issue.

The characteristics of *Kapoho* are very similar to those of Kalapana, with additional constraints related to Conservation District lands and extensive tidepools and anchialine ponds that make the area ecologically sensitive.

Mt. View is situated reasonably close to the East Hawaiʻi population center. Some large parcels are available, but there is relatively little State land outside of the Conservation District. Rainfall is significantly greater than Hilo and it is mauka of the UIC line, above a number of wells.

Volcano is environmentally sensitive, and most land in the area is within the National Park or classified within the Conservation District. About 15 miles farther from the population center than Mt. View, it is mauka of the UIC line.

Pahala's principal disadvantage is its distance from population centers. Large parcels of agriculturally zoned lands are present, and some Urban/Industrial land is available in the center of town around the old sugar mill, although this would not be a suitable location. The UIC is close to the coast but no wells are present, and it might be possible to revise the line or obtain permission to build above the UIC. The only feasible area would be makai of the highway, between the minor resort of Punaluʻu and the conservation areas that lie to the south and the National Park and the conservation areas south of it, which the Park has expressed interest in acquiring.

The *South Point* area is both low in rainfall and seaward of the UIC line. However, aside from being very distant from the population center, South Point is poorly served by infrastructure (critically, water and roads), and the most accessible locations are under the control of the Department of Hawaiian Home Lands, which is prevented by law from allowing such general public benefit uses of its lands.

Although Ocean View itself is completely subdivided into small lots inappropriate for consideration of a landfill, large private, federal and State properties surround it. The government properties consist of a National Park and a State Natural Area Reserve. Some portions of the private properties might theoretically be suitable for a landfill, but there have been a number of plans to develop the area for a resort. Like South Point, the makai lands in Ocean View area are poorly served by infrastructure.

Naalehu is similar to Pahala in many respects but lacks significant urban land. Concerning any location in Ka‘u, including Pahala, Naalehu, South Point, and Ocean View, it is noteworthy that over the last 30 years Ka‘u has experienced a number of contentious battles over proposed developments from coastal resorts to private missile launching facilities, and no new development has been approved in that time.

The *Saddle* between Mauna Loa and Mauna Kea is a high elevation area with moderate to low rainfall. A modern State highway is being built in the Saddle to link East and West Hawai‘i. It entirely consists of State of Hawai‘i properties, but they are all within the Conservation District and/or within the control of Hawaiian Home Lands. Furthermore, the Saddle is mauka of the UIC line, with many wells below, and is among the most biologically rich and sensitive parts of the island, and within an area of high volcanic hazard.

Although just as rainy as Hilo, *Pepe‘ekeo* has advantages in its relatively central location, large tracts of land available, and some areas of SLU Urban designations and LUPAG Industrial in an area makai of the UIC line. Several hundred residences are also nearby in this growing area, which is experiencing controversy over plans to use the former sugar mill area for biomass energy production. Because of the rich soil, rainfall, and proximity to Hilo, much of the farmland in this area is being intensively cropped.

O‘okala has some Urban and Industrial land but with very similar characteristics to Pepe‘ekeo, with residences – although a smaller number – nearby. Large agricultural tracts dedicated to eucalyptus are available nearby, but it is rainy and fairly distant from the population center.

Honokaa is distant from East Hawai‘i population centers, and is actually closer to West Hawai‘i’s landfill than Hilo’s. Like Pepe‘ekeo and Ookala, it has some small areas of Urban and Industrial land that are not suitable for a landfill. There are several thousand acres of low use agricultural land makai of the UIC line here.

Summary of Evaluation of Selected Individual Locations

The location adjacent to the South Hilo Sanitary Landfill is the most central in terms of population. Though not without traffic problems, is relatively well served by roads. Critically, it is makai of the UIC line. The quarry site is ready-made for a landfill, another key advantage. Unencumbered State land is available, although within the Agricultural District (a separate DEM project may attempt to urbanize this area to bring the current landfill into conformance with its Special Permit conditions). LUPAG and County zoning would require amendment. Its principal disadvantage is 126 inches of rainfall, which would require extra steps to minimize and treat leachate. Overall, this location rates highest on this selection of objective factors.

5. Schedule

The following permits and approvals could be required for permitting a landfill in East Hawaiʻi depending on the existing State Land Use District and County LUPAG and zone.

- State Land Use Boundary Amendment to reclassify Agricultural or Conservation land to the Urban District (includes EIS): (2-3 years)
- Amendment of General Plan LUPAG map (includes EIS) (1 year)
- Change of zone to Industrial (1 year)
- Subdivision/consolidation (6 months)

Add to this time for County policy makers to approve initiation of the landfill development process, obtaining Department of Health approvals, then constructing the landfill, and a period of between 6-10 years would be probably be required to develop a new landfill, depending on the land use context. This schedule does not include extensive contested cases at the Land Use Commission or legal challenges to the EIS approval, which could lengthen the time necessary.

APPENDIX: GIS DATA SOURCES

Underground Injection Control Line (UIC)
Department of Health, Safe Drinking Water Branch (Current)

Volcanic Hazards – (only Zones 1 and 2 are shown)
U.S. Dept. of Interior / Geological Survey, 1991

Rainfall Data – (generalized to 2000 mm isohyets)
Giambelluca, T.W., Nullet, M.A., Schroeder, T.A., 1986
Digitized in early 1990s by DLNR.

State Land Use Designations
State Land Use Commission, 2006

LUPAG data (Several categories omitted to key in on suitable categories. Also, low density urban, medium density urban and urban expansion combined for map simplification).
Hawaiʻi County General Plan, Planning Department, 2005

State and County Land ownership - Parcels owned by State or County were queried from:
Hawaiʻi County Tax Assessor Parcel Data, updated 2007

Population data - Census Designated Places (CDP) from the decennial U.S. census, 2000. Categorized using 'natural breaks' method on the subset of data relevant to the geographic extent of the maps.
U.S. Census Bureau, 2000 http://factfinder.census.gov, (2008)

All GIS layers shown in **Projection**: UTM Zone 5 North
Datum: North American Datum, 1983

GIS Analysis and Cartography by **Creative Mapping Solutions, 2008**

APPENDIX F

Planning-Level Cost Estimates for Landfill Options

Planning-Level Cost Estimates for Landfill Options

TO: Mike Dworsky, County of Hawai`i

COPIES: Mark Dexter, HNL

FROM: Dan Pitzler
Cory Hinds

DATE: March 27, 2009

This memorandum provides background for planning-level cost estimates of two landfill options: 1) transfer waste from East Hawai`i to the West Hawai`i Sanitary Landfill (WHSL) and 2) expanding the South Hilo Sanitary Landfill (SHSL) in two phases, with the first phase consisting of a 7-acre lateral expansion of the existing landfill, and the second phase consisting of expanding the landfill into quarries adjacent to the SHSL site. It is intended to outline the rationale and assumptions for each option and assist the County in decision making about long-term disposal options.

The cost estimates are shown on a per-ton basis for managing the waste currently disposed of at the County's SHSL. An analysis of the County's budget resulted in an estimated per-ton cost of landfilling at the SHSL of $57.64 per ton in 2007-08. The estimated per-ton disposal cost of each landfill option follows, with a high-low cost range shown for the new landfill development options.

	Per-ton Cost (2009$)	
Landfill Options	**Low**	**High**
Transfer waste from East Hawai`i to the WHSL	$82	
7-acre lateral expansion of SHSL	$82	$94
Expand SHSL into Quarries	$69	$73

1. Transfer Waste from East Hawai`i to the WHSL

As shown in Exhibit 1, the estimated cost of transferring waste from East Hawai`i for disposal at the WHSL is $82 per ton.

EXHIBIT 1
Cost Summary – Transfer Waste from East Hawai`i to the WHSL

Cost Element	2009 Dollars per ton
Transfer Station Operations	$11.00
Transportation	$24.00
Landfill Cost	$47.00
Total	$82.00

For comparison, Table 3.2 of the 2004 Sort Station EIS[1] estimated the per-ton cost of transfer, transport, and disposal at $7.21, $18.83 and $34.83, respectively, for a per-ton total of $58.86. Escalating those costs from 2003 to 2008 using Engineering News Record's Construction Cost Index, would increase that estimate by 29 percent to $75.93 per ton, or about 7 percent less than the estimate shown in Exhibit 1.

Planning-level operating costs for a transfer operation at the SHSL Sort Station are presented in Exhibit 2. These costs include an estimate of the labor (FTEs) and equipment necessary to operate the station.

The estimated cost of transporting waste from the Sort Station to the WHSL is shown in Exhibit 3. These estimates are based on a trucking cost model used by CH2M HILL on recent similar projects, with input parameters adjusted to reflect specific conditions that apply in Hawai`i County. The estimate also includes an adjustment to account for the assumption that waste would be hauled directly from the Pahoa Recycling and Transfer Station to the WHSL instead of to the SHSL for transfer; this cost adjustment is based on the County's 2007-08 actual per-mile trucking cost. Exhibit 4 presents the assumptions used to estimate the number of tractor trailers needed for the trucking operation.

The estimated variable per-ton cost for landfilling at the WHSL is calculated based on actual 2007-08 costs as shown in Exhibit 5. It was assumed that no additional County staff would be needed at the WHSL to accommodate the increase in waste from East Hawai`i. Should additional workers be required, the unit costs would be higher than shown.

Other cost considerations relevant to this option that are not included in these cost estimates include:

- No costs have been included for environmental review, transportation improvements or mitigation. Depending on the transportation route selected from the Sort Station to the WHSL, and the number and types of permits and studies required, it's possible that additional costs would be incurred to address these considerations.
- Landfilling waste from East Hawai`i at the WHSL will shorten the life of that landfill. Long-term disposal forecasts (that take into account population and employment growth and the effect of planned diversion programs) are that the WHSL has an additional 38 years of capacity remaining[2]. If waste from East Hawai`i is added starting in 2013-14 (the time when the SHSL is likely to close if it is not expanded), the WHSL's capacity would be exhausted in 27 years, or 11 years sooner.

[1] County of Hawai`i. 2004. *Final Environmental Impact Statement, Construction and Operation of the East Hawai`i Regional Sort Station.*

[2] The County is currently investigating options to extend the years of remaining capacity at the WSHL. These options would be evaluated as part of the WHSL master plan proposed for implementation as part of this ISWMP Update.

EXHIBIT 2
Transfer Station Operating Cost

				Notes
Typical Annual Tonnage	80,000			
TS Operating hours				
per year	3,801			10.5 hours per day
per week	73			
Days per year	362			
tons per day	221			Annual tons / 362
Peak hour tons	44			Conceptual "rule of thumb" - 20 percent in peak hour
Peak hour trailers	2			Assumes 18 tons per trailer
Blended Labor rate				
Site attendants	$49,885			2008-09 cost times 36 percent benefits (percent estimated from actuals)
Equipment operator	$62,206			2008-09 cost times 36 percent benefits (percent estimated from actuals)
Staffing				CH2M HILL Estimates
Trailer Shuttle	1	$62,206	$62,206	
Dozer	1	$62,206	$62,206	
Site attendant at main building	2	$49,885	$99,770	
Scale attendant	1	$62,206	$62,206	
Extra FTE for illness/vacation	0.4		$22,030	
Total Staff	5.4		$308,419	
Multiplier for >40 hours per wk	1.8			
Total FTEs	10.0		$563,606	
Annual staffing			$563,606	
Non-labor percent			60 percent	CH2M HILL estimate for this type of facility
Non-labor cost			$338,163	Equipment replacement and operations, fuel, insurance, utilities, general site maintenance
Total			$900,000	
$/ton disposed			$11.25	Total / tons per year
Staff per operating hour			5.5	Avg number of staff on-site at one time

EXHIBIT 3

Trucking Cost Estimate

Operating Assumptions		**Equipment Cost**	
Origin Location	SHSL	Tractor (truck) Make and Model	County Actuals
Destination	WHSL	Number of Tractors in the Fleet	7.0
Miles (one way)	77.5	Annual Lease	$24,000
Average Miles per Hour	40	Total Tractor Cost	$168,000
Workdays per Week	7		
Annual Workdays	362	Trailer Make and Model	Tri-axle Trailer
Monthly Tons through the T/S	6,682	Number of Trailers in the Fleet	14
Annual Trips	4,455	Annual Lease	$11,000
Average Tons per Trip	18	Total Trailer Financed Cost	$154,000
Compacted / Uncompacted Loads	Uncompacted		
Average Loading Time	20	Total Tractor and Trailer Lease	$322,000
Average Unloading Time	20		
Average Roundtrip Time	3.88	Required Tractor Quantity	7.0
Total Time per Trip	4.54	Required Trailer Quantity	14
Loads per day	12		
		Licenses & Taxes	
Labor Assumptions		State Highway Use Tax	n.a.
Non-driving percent	0 percent	State	Hawai`i
Driver hours per day	56	Rate per mile	n.a.
Hostler hours per day	0	State An. Registration (per truck)	n.a.
Total hours per day	56		
Driver Annual Wage	$45,740	Federal Hwy Use Tax (per truck)	$550
Loaded Driver Percentage	36 percent	Insurance (per truck per year)	$1,000
		Annual Insurance	$7,000
Fuel Cost			
Fuel MPG	5.0	**Operational Assumptions**	
Diesel Cost per Gallon	$4.00	SG&A Overhead Percentage	0 percent
		(SG&A is Sales / Mgmt / Admin / Dispatch)	
Repair & Maintenance		Profit Margin Percentage	0 percent
Truck Cost per Mile	$0.30	Interest Rate	5.00 percent
Trailer Cost per Mile	$0.22		

	Annual Cost per Truck	**Annual Trucking Costs**	**Cost per Ton**	**Cost per Mile**
Truck	$24,000	$168,000	$2.10	$0.49
Trailer	$11,000	$154,000	$1.92	$0.45
Labor		$605,060	$7.55	$1.75
Fuel		$552,374	$6.89	$1.60
R&M		$359,043	$4.48	$1.04
Insurance		$14,000	$0.17	$0.04
License & Fees		$0	$0.00	$0.00
G&A		$0	$0.00	$0.00
Profit		$0	$0.00	$0.00
Total		$1,852,478	$23.10	$5.37
Direct haul from Pahoa TS to WHSL		$106,000		
Total tons			81,487	
Total per ton cost			$24.03	

EXHIBIT 4
Estimated Number of Tractors Needed to Haul to WHSL

Origin Location	SHSL
Destination	WHSL
Miles (one way)	77.5
Average speed (miles per hour)	40
Workdays per week	7
Annual workdays	362
Monthly tons throughput	6,682
Average tons per trip	18
Compacted / Uncompacted Loads	Uncompacted
Average loading time (mins.)	20
Average unloading time (mins.)	20
Average roundtrip driving time	3.9
Total time per trip (hrs.)	4.54
Hrs per day of tractor operations	10
Trips per truck/day	2.20
Spare	1.0
No. of tractors needed per shift	6.6

EXHIBIT 5
Estimated Variable Landfilling Cost at the WHSL

	$ per ton
Contract costs	$42.97
Contract escalation	$0.97
Fuel	$1.59
Parts	$1.73
Total variable cost	$47.26

2. SHSL Expansion

The cost of expanding the South Hilo Sanitary Landfill is less certain than the cost of transporting waste to the WHSL. Thus discussion of this option is based upon certain assumptions regarding feasibility, and the cost estimates as presented have some degree of uncertainty. Additional analysis would be needed to further refine the cost estimates and confirm the feasibility of this option.

Expansion of the SHSL could potentially be accomplished in two separate phases: first, a 7-acre lateral expansion to the northwest; and second, a larger-scale expansion into rock quarries located adjacent to the southeast perimeter of the site. A discussion of the two possible expansion areas follows.

Seven-Acre Lateral Expansion to the Northwest

It is assumed that the initial expansion would occur on a 7-acre vacant land parcel which borders the SHSL to the northwest. It was initially assumed that expansion into this area would also allow the County to increase the elevation of a portion of the existing landfill, and an initial estimate of the capacity that would be added by this expansion is just less than 2 million cubic yards[3]. At 2007-08 fill rates (about 250,000 cubic yards per year), this would have provided about 8 years of added capacity. However, the County recently received an unfavorable opinion from the Federal Aviation Administration that would limit the extent to which the SHSL could be expanded vertically. Thus, it is now anticipated that the lined expansion on this parcel would provide only an additional 4 years of capacity.

State and federal regulations (Hawai'i Administrative Rules [HAR], Title 11, Chapter 58.1 and 40 CFR 258.48) require that all new landfills be constructed with a waste containment system consisting of a bottom liner with leachate collection and recovery system. The liner system would consist of two layers of heavy duty plastic geomembrane, placed above and below a geosynthetic clay liner. The bottom of the new landfill cell would also have an engineered drainage layer. In addition, an expansion of the County's existing groundwater monitoring program would probably be required.

Estimated Capital Cost

The estimated construction cost for the 7-acre lined cell is $3.2 million[4]. To this estimate must be added the cost of a leachate collection and treatment system, a landfill gas collection system, and added groundwater monitoring. In regions with high annual precipitation rates higher volumes of leachate are produced and must be managed. In response, Hawai`i County should consider taking steps to actively reduce the volume of leachate generated in the lined expansion by maintaining a system of plastic membranes and tarps to cover the waste. When the waste is covered by membranes or tarps, infiltration of precipitation can be mitigated and runoff can be managed as storm water.

Even with the use of membrane and tarp covers, leachate will be generated that requires treatment. Leachate that collects on the landfill liner would be pumped out of the cell, and then treated prior to discharge. Treatment options include treatment at the local wastewater treatment plant (WWTP) near the Hilo Airport, and treatment using constructed wetlands. Treating leachate at the WWTP would be costly because it would involve either constructing a lengthy pipeline or trucking leachate to the WWTP. Further, the County wastewater division prefers that other options be considered for leachate treatment: thus, the County investigated the feasibility of wetlands treatment. An initial feasibility evaluation indicated that wetlands treatment could effectively treat the leachate[5]. Additional assessment has been completed since the initial evaluation, resulting in a range of cost estimates for the use of constructed wetlands for leachate treatment. Estimated costs for leachate treatment using constructed wetlands for leachate treatment for four scenarios are presented in Exhibit 6.

[3] "South Hilo Sanitary Landfill Proposed Expansion Feasibility and Capital Cost Estimate". 2008. SWT Engineers.

[4] ibid. plus 10 percent engineering and 8 percent permitting.

[5] CH2M HILL. 2008. *South Hilo Sanitary Landfill Leachate Quality Improvement Using Treatment Wetlands – High Level Sizing and Cost Opinion*. Technical Memorandum to SWT Engineering.

EXHIBIT 6
Estimated Capital Cost of Constructed Wetland Leachate Treatment at SHSL

					Surface Flow Wetland		Vertical Subsurface Flow Wetland	
Scenario	Cover Scenario	Fill Plan	Design Flows	Equalization Tank (gallons)	Wetland Size (acres)	Capital Cost	Wetland Size (acres)	Capital Cost
1	Aggressive: 60 percent cover	Three 15-foot lifts	Avg annual - 5.5 gpm	60,000	1.2	$1,610,000	0.2	$1,801,000
2	Moderate: 35 percent cover	Three 15-foot lifts	Avg annual - 8.9 gpm	60,000	1.5	$1,983,000	0.3	$1,956,000
3	No cover	One 15-foot lift	Avg annual - 13.5 gpm	60,000	2.3	$2,261,000	0.6	$2,398,000
4	No cover	One 15-foot lift	Peak monthly - 82 gpm	300,000	10	$6,677,000	1.8	$4,847,000

Source: CH2M HILL, 2009.

As shown in Exhibit 6, at this level of analysis there are a number of uncertainties about the sizing and cost of using constructed wetlands for leachate treatment. Wetland sizing depends on contaminant and hydraulic loading rates. Contaminant loading rates for the short-term expansion into the 7-acre parcel are unknown, but were assumed using a combination of data from "wet" landfills in Oregon and Alaska and existing data from a landfill on Oahu[6]. Based on data from a high-rainfall landfill in Unalaska, Alaska, contaminant loading rates were decreased by 50 percent during peak flows to account for dilution. The contaminant loading used in this analysis is likely to be conservative because actual dilution from rainfall at the SHSL may be higher. Because the exact data for contaminant loading is unknown, it is not certain at this stage whether smaller size wetlands would provide sufficient residence time for treatment.

Hydraulic loading refers to the rate of leachate generation in the landfill liner. Leachate flow rate depends on liner area, climate inputs (e.g., rainfall and evaporation), cover used during operations to divert storm water, and thickness of in-place waste. The design flows for the scenarios shown in Exhibit 6 were estimated using the EPA HELP model[7]. Application of more membrane and tarps to divert storm water has the potential to decrease leachate generation and require a smaller wetland footprint for treatment. The most conservative estimate for wetland sizing and cost is Scenario 4 with no cover to divert storm water, a single 15-foot lift of waste in place over the entire cell, an equalization tank sized to accommodate the 10-year peak daily flow, and wetlands sized to accommodate peak monthly precipitation yielding a high leachate flow rate of 82 gpm. Less conservative scenarios assume more cover and the associated diversion of storm water, less generation of leachate, a smaller equalization tank, and smaller wetland sizing and the associated costs.

[6] County of Hawai`i. 2004. *Final Environmental Impact Statement, Construction and Operation of the East Hawai`i Regional Sort Station.*

[7] CH2M HILL. 2008. *Estimate of Leachate Generation Rate for Proposed Lined Lateral Expansion of Hawai`i County's Hilo Landfill.* Technical Memorandum to SWT Engineering.

Wetland sizing also depends on regulatory endpoints and compliance frequency. More stringent regulatory requirements typically require higher residence time in the treatment wetlands and larger size and cost. The wetlands treatment option assumes surface discharge of treated leachate and subsequent infiltration and migration to groundwater. Testing of treated effluent would be conducted to confirm regulatory requirements prior to discharge, and groundwater monitoring would be conducted to confirm that leachate discharge is not negatively impacting the shallow aquifer.

For planning purposes it was assumed that leachate discharged from wetlands would contain lower concentrations of contaminants than are presently discharged in leachate infiltrating the subsurface from the existing unlined landfill. Leachate discharge regulatory criteria assumed for the current sizing are as follows: less than 200 milligrams per liter (mg/L) biological oxygen demand (BOD5), less than 25 mg/L total suspended solids (TSS), and less than 10 mg/L ammonia-nitrogen (NH4-N) and nitrate+nitrite- nitrogen (NOx-N). If actual regulatory endpoints are stricter than this, then required wetland size and cost would increase. Similarly, if monthly average compliance is permitted, then required size and cost would be smaller than if daily compliance is mandated.

Potential additional steps to evaluate regulatory compliance issues, and how they affect wetland size and design would include the following:

- Conduct a more thorough evaluation of contaminant loading for the potential lined expansions of the SHSL.
- Conduct modeling of specific treatment wetland processes to select minimum size treatment area.
- Meet with staff from the State of Hawai`i Department of Health Environmental Management Division, Clean Water Branch to evaluate regulatory requirements and discharge criteria for wetlands leachate treatment.

The lined expansion would require a system to collect and manage landfill gas. The type of system, active or passive, would depend on the landfill gas system selected for the unlined portion of the landfill and a series of other factors. Thus, Exhibit 7 includes a passive control system as a low estimate, and an active control system as a high estimate. The estimate is only for the 7-acre expansion to the northwest of the existing landfill.

Operations and Maintenance Costs

In is anticipated that County staff levels for day-to-day operations would be similar to its current operations. O&M costs expected to increase include costs associated with diverting rainfall from waste, managing leachate, and additional monitoring and regulatory compliance.

In Scenario 2 of Exhibit 6, it is assumed that capital costs to procure tarping, and labor costs for one extra FTE would be required. In Scenario 4, it is assumed that no extra effort would be made to divert rainfall from waste.

EXHIBIT 7
Landfill Gas Cost Estimates

328,000	Tons from 7-acre expansion
0.46	Tons per cubic meter
150,464	Cubic meters from 7-acre expansion
0.00047	SCFM per cubic meter
70.95901	SCFM
Low - Passive System	
$0.31	$ per cubic meter (escalated for Hawai`i with 10 percent engineering)
$47,000	Landfill gas cost for 7-acre expansion
$4,700	Annual O&M (10 percent of capital)
High - Active System	
Collection system	
$0.60	$ per cubic meter (escalated for Hawai`i with 10 percent engineering)
$90,000	Landfill gas collection system cost for 7-acre expansion
Flare system	
$600,000	$ per 1,000 scfm
$123,000	Flare system capital cost for 7-acre expansion
Total Active System	
$213,000	Sum of collection system and flare system costs
$21,000	Annual O&M (10 percent of capital)

Source: CH2M HILL, 2009.

Estimated additional annual costs for pumping leachate, groundwater monitoring, and a weekly walk through of the wetlands treatment system are $100,000 in Scenario 2 and $200,000 for Scenario 4.

Periodic major maintenance of the wetland treatment system would be required, which could include replacing the equalization tank, reconstruction or cleanout of wetland cells, and/or development of a new infiltration basin. These costs are estimated to occur approximately every 6 years at a cost of $250,000 for Scenario 2 and about $900,000 for Scenario 4.

Finally, it is estimated that three new monitoring wells would be constructed at a cost of $15,000 per well. Based on current County monitoring costs, it is assumed that it would cost an additional $7,500 per well annually, for a total of $22,500 per year in additional groundwater monitoring costs.

Closure and Post-Closure Costs

The SWT report (Table 3) estimates the added closure cost for the 7-acre extension of $1,156,000. Post-closure cost estimates are shown in Exhibit 8: the low estimate assumes passive landfill gas collection, and the high estimate assumes active landfill gas collection. When the extension is closed, it is assumed that any residual leachate would be treated along with leachate from the expansion into the quarries, with the costs included as part of that expansion.

EXHIBIT 8
Post-closure Cost Estimates for 7-Acre Expansion

Item	Qty	Unit	Unit cost	Annual cost Low	Annual cost High
Inspections	7	acre	$260	$2,000	$2,000
Final cover	7	acre	$1,300	$9,000	$9,000
Surface water management	7	acre	$1,300	$9,000	$9,000
Vegetation	7	acre	$390	$3,000	$3,000
Gas management				$5,000	$21,000
Environmental monitoring					
groundwater	3	wells	$7,500	$23,000	$23,000
landfill gas	7	acre	$780	$5,000	$5,000
leachate	7	acre	$260	$2,000	$2,000
stormwater	7	acre	$260	$2,000	$2,000
Inspections	7	acre	$260	$2,000	$2,000
Total				$55,000	$71,000

Source: CH2M HILL, 2009.

Per ton costs of 7-Acre Expansion

A low and high range of per-ton costs for the 7-acre expansion is shown in Exhibit 9. As shown, the costs are expected to range from between $82 and $94 per ton for approximately 4 years of added capacity.

EXHIBIT 9
Per-Ton Costs of 7-Acre Expansion (2009$)

	Low	High
Capital Costs (7-acre cell only)		
Expansion - construction	$3,200,160	$3,200,160
Leachate treatment system (wetlands) construction	$1,956,000	$4,847,000
Landfill gas collection	$47,000	$213,000
Groundwater wells	$45,000	$45,000
Closure	$1,156,000	$1,156,000
Total Capital Cost	$6,404,160	$9,461,160
O&M Costs (7-acre cell only)		
Landfill stormwater management	$60,000	$0
Leachate O&M	$100,000	$200,000
Leachate treatment upgrades (annual)	$42,000	$103,000
Added groundwater monitoring	$23,000	$23,000
Annual post closure care[a]	$277,000	$333,000
Total O&M Cost	$502,000	$659,000
Total capacity of expansion (tons)	328,000	328,000
Added per ton costs		
Capital	$19.52	$28.85
O&M	$6.12	$8.04
Total	$25.65	$36.88
Current (2007-08) per ton cost	$56.74	$56.74
Estimated per-ton cost of SH Lateral Expansion	$82.39	$93.62

[a]Assumes all funds are collected up front prior to closure and invested in a fund that is drawn down to zero over a 30-year period (i.e., a sinking fund).

The estimates assume that all funds for post-closure are collected up front in a sinking fund where the funds collect interest, and are then paid out during the 30-year post-closure period. While the County would probably fund post-closure differently, this approach is conservative. The costs shown are conservative because it is assumed that all costs would be spent at once, whereas the costs of post-closure (and the landfill gas system) would not be spent until the expansion is at capacity. In other words, the County could set aside a smaller sum into an interest-bearing account, and then spend them when needed.

Expansion into the Quarries at the SHSL Site

If constructed, the 7-acre expansion to the northwest of the current SHSL would provide capacity until approximately 2016-17. At that time, the County would need new landfill capacity for residuals from East Hawai`i. Hawai`i County owns several parcels of land currently used for quarry operations southeast of the existing landfill. The 75-acre quarry site is slightly larger than the existing landfill footprint. Preliminary estimates are that development of this quarry site for future landfill operations would provide 47 years of capacity beginning in 2017-18 when the 7-acre expansion is full[8].

This larger expansion area would be constructed and operated using the same assumptions noted above for the 7-acre northwest expansion (i.e., it assumes a liner system, constructed wetlands for leachate treatment, additional groundwater monitoring wells, an active landfill gas management, active stormwater management to minimize leachate production, and final closure and post-closure monitoring).

It is assumed that the landfill would be operated as a series of 7-acre cells. When each cell is at capacity, it would be closed on an interim basis to minimize leachate generation. Thus, it is assumed that the constructed wetlands developed for the 7-acre northwest expansion would be of sufficient size to accommodate leachate generated from the larger expansion to the southeast. It is assumed that the existing groundwater monitoring network would provide adequate coverage in the downgradient direction from the quarry expansion area, and that new monitoring wells would be needed along the east and west perimeter and upgradient edges of the new cells. It is assumed that the landfill would eventually have an active landfill gas management system. Operations are assumed to be similar to what was assumed for Scenario 2 (Exhibit 6) for the 7-acre expansion (i.e., active steps would be taken to minimize leachate generation).

It should be noted that no engineering analysis has yet been conducted for the quarry site. Thus, contingencies of 15 percent for the low estimate and 30 percent for the high estimate have been added to the capital costs to account for unknown conditions that could result in cost increases. In addition, expanding to the southeast into the quarry site would require a successful outcome of the State Land Use Boundary Amendment and County Zoning processes, completion of an Environmental Impact Statement, and resolution of Department of Health permitting issues.

The estimated costs of landfilling in the quarry site are shown in Exhibit 10.

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[8] This estimate accounts for growth in population and employment and assumes planned diversion programs in this ISWMP Update are implemented. The life of the landfill would increase if additional diversion programs are implemented in future ISWMP updates.

EXHIBIT 10
Per-ton Costs of Landfilling in Quarry Site (2009$)

Capital Costs	**Low**	**High**
Expansion – construction	$34,287,000	$34,287,000
Leachate treatment system expansion	$450,000	$700,000
Landfill gas collection	$11,212,000	$11,212,000
Groundwater wells	$135,000	$135,000
Closure	$12,386,000	$12,386,000
Add contingency (15 percent/30 percent)	$6,825,000	$13,650,000
Total Capital Cost[a]	$65,362,000	$72,580,000
O&M Costs		
Landfill stormwater management	$60,000	$0
Leachate O&M	$100,000	$200,000
Leachate treatment upgrades (annual)	$42,000	$103,000
Added groundwater monitoring[b]	$34,000	$34,000
Annual post closure care[c]	$99,000	$99,000
Total O&M Cost	$335,000	$436,000
Total capacity of expansion (tons)	7,905,700	7,905,700
Added per ton costs		
Capital	$8.27	$11.22
O&M	$4.09	$5.32
Total	$12.35	$16.54
Current (2007-08) per ton cost	$56.74	$56.74
Estimated per-ton cost of SH Lateral Expansion	$69.03	$73.28

[a]Costs would be spent over the life of the facility as new cells are opened; closure costs would be spent once the landfill is at capacity.

[b]Midpoint of annual costs over life of landfill as wells are progressively installed.

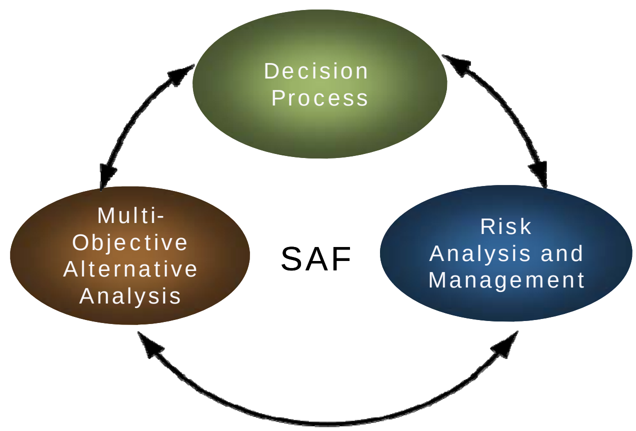
[c]Assumes all funds are collected up front prior to closure (sinking fund).

APPENDIX G

Value Model and Risk Analysis of Residuals Management Options

Value Model and Risk Analysis of Residuals Management Options

This memorandum provides draft objectives hierarchy and performance scales for analyzing site and treatment alternatives for the County of Hawai`i Integrated Solid Waste Management Plan. This information will be used to help the County decide on a residuals management option that best meets its economic, social, and environmental objectives while considering key risks and uncertainties.



Our approach to helping the County make this decision is part of the sustainability assessment framework (SAF) used by CH2M HILL on complex, public infrastructure projects. This process started by exploring the objectives that may be important to making this decision at the December 2008 and February 2009 solid waste advisory committee (SWAC) meeting. The approach taken in this analysis for assessing multiple objectives is called value modeling[1]. Value modeling is a quantitative technique for making decisions that involve multiple financial, environmental, and social objectives that is based on the principles of multi-attribute utility theory[2].

Value Modeling

Value modeling proceeds through a series of defined steps. To clarify the discussion of steps in this introduction, a simple example is developed. The steps, illustrated in Exhibit 1, are:

Establish the decision goal

Identify and specify fundamental objectives

Develop performance measures to assess project performance against objectives

Add technical detail to the performance measures, and assign scores to the performance measures

Assign weights to the objectives

Score alternatives

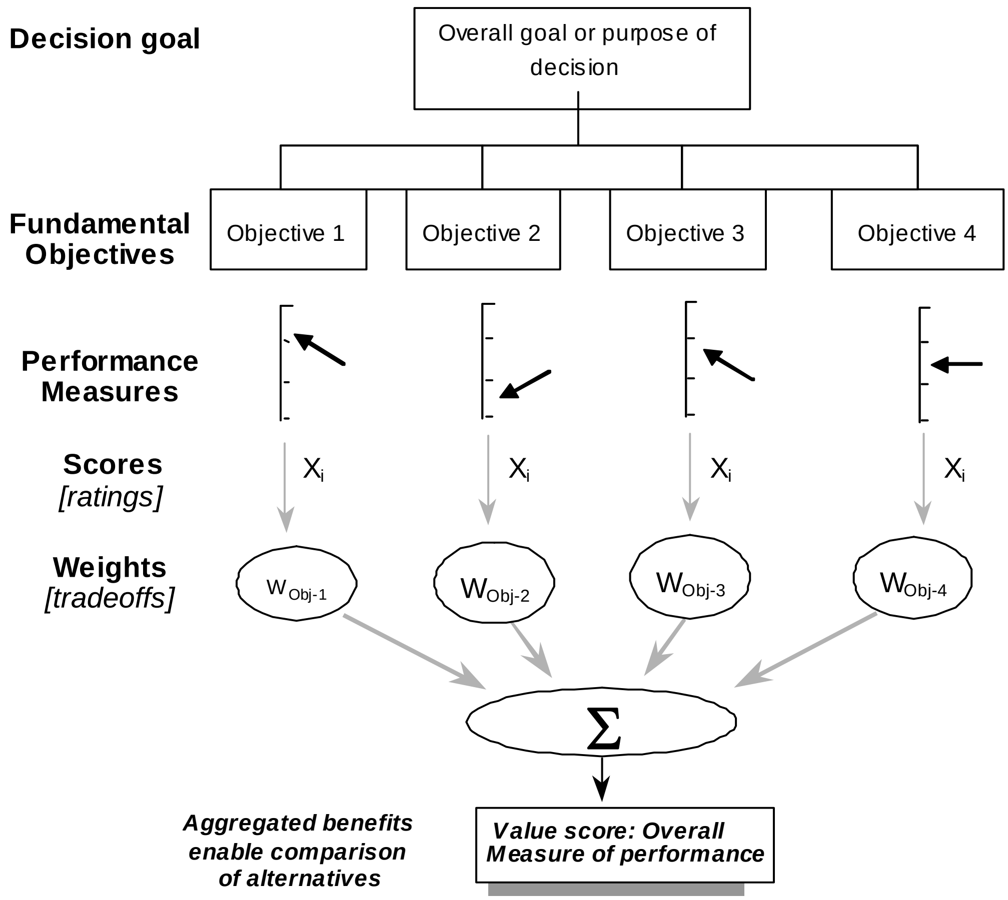
[1] Also known as multi-criteria decision analysis. The specific technique used is called SMARTS, the Simple Multi-Attribute Rating Technique with Swings.

[2] Keeney, Ralph L. and Raiffa, Howard. Decisions with Multiple Objective. Cambridge University Press. 1976.

Calculate total value scores and conduct a sensitivity analysis

These steps are discussed in detail in the following sections.

EXHIBIT 1
Generalized Representation of Value Modeling
See text for discussion of the figure. X_i represents the score of alternative "i" on the given objective. Weights are the relative importance assigned to each objective. $\sum$ is the rule for aggregating scores.



Decision Goal

The decision goal is the overall purpose of the evaluation, or what is to be accomplished by making a decision. It should clarify what is included and excluded from the scope of the evaluation. In this analysis, the decision goal is to: "select the preferred method for managing residuals after reduction, reuse, and recycling both in the short-term and in the long-term."

Objectives, and Criteria

Objectives are the important aspects of a decision that are arrived at through careful thinking about issues. Fundamental objectives are the most basic elements in the model. They are also referred to as evaluation criteria and may be further characterized by the development of sub-criteria, which ultimately produces an objectives hierarchy.

Performance Measures

Once the objectives are fully developed and the decision-maker(s) agree that they fully represent the important issues in the problem, performance measures are required to determine how well alternatives perform against the objectives. Performance measures may be quantitative or qualitative, depending upon the objective and the availability of data for each measure. The objectives hierarchy and performance measures for this analysis are shown in Exhibit 2.

EXHIBIT 2
Objectives Hierarchy and Performance Scales

Decision Context: Select the preferred method for managing residuals after reduction, reuse, and recycling both in the short-term and in the long-term

Key Assumptions

- All options are operated in compliance with applicable laws and regulations
- All options have the same level of up-front reduction, reuse, and recycling

Objectives Hierarchy			**Performance Measure**
1.	Minimize long-run life-cycle cost		System average per-ton cost in FY 2008
2.	Protect public health and the environment		
	A.	Minimize greenhouse gas production (from process and/or vehicles)	Change in annual MTons Carbon Equivalent
	B.	Minimize other harmful air emissions (from process and/or vehicles)	1-5 Scale
	C.	Minimize water pollution	1-5 Scale
	D.	Promote worker and public safety	1-5 Scale
3.	Minimize social impacts		
	A.	Minimize proximity impacts (e.g., traffic, noise, odor)	1-5 Scale
	B.	Provide local jobs	Added jobs
	C.	Promote environmental justice	1-5 Scale
4.	Accommodates future reductions in residuals and changes in composition (i.e., no put-or-pay)		1-5 Scale

Note that the costs measured are "system average per-ton cost in FY 2008". This includes the cost of disposal and any added transportation costs beyond current conditions. It does not include costs for administration and recycling, which are assumed to be fixed for the purposes of this analysis. The costs also reflect the system average so that if costs are varied for East Hawai`i, the effect on total system costs, which include costs for West Hawai`i will be less than if only East Hawai`i costs were reported. In this way, a valid comparison of the costs of alternatives can be presented. It should be noted that the costs shown are planning-level, conceptual costs. Actual costs would vary depending on many factors.

Greenhouse gas production was estimated as the change in annual metric tons of carbon from current conditions. These were estimated using the US EPA WARM model, adjusted for changes in transportation from County transfer stations to the recovery or disposal facility. Jobs are an approximation of changes in the number of full-time equivalent employees that would be needed to operate the alternative compared to the existing system. All other performance measures were constructed scales where the worst possible outcome was given a score of one, and the best possible outcome a score of five. Note that this doesn't mean that there will always be one alternative with a score of one and one with a score of five: some objectives do not vary appreciably and thus have scores clustered around the midpoint of the range (i.e., a score of three).

Alternatives

Alternatives are the actions that may be taken to accomplish objectives. A well-considered value model includes a complete set of alternatives. Care must be taken not to exclude or overlook alternatives that might meet the stated objectives. For this analysis, a series of alternatives were developed from the options presented in the draft Residuals Management section of the ISWRP Update. The following seven alternatives are investigated in this analysis:

1. Waste-to-Energy Facility for East Hawai`i; Ash and Bypass Materials to SHSL
2. Waste-to-Energy Facility for all County Residuals; Ash and Bypass Materials to WHSL
3. One or More Modular Waste-to-Energy Facilities in Rural Areas; Ash and Bypass Waste to SHSL and WHSL
4. Develop Mechanical-Biological Treatment (MBT) Facility at the SHSL and/or WHSL Sites
5. Expand SHSL for East Hawai`i residuals, and use WHSL for West Hawai`i residuals
6. Close SHSL and landfill all County Waste at the WHSL
7. Bale and Barge East Hawai`i Waste and utilize WHSL for West Hawai`i residuals

Weighting Objectives

Some objectives may be more or less important than other objectives. Different stakeholders faced with the same problem may have different underlying value systems, and, therefore, may have a different sense of what's most important in the given problem.

This leads to the concept of "weighting" objectives. Assigning weights to objectives is a subjective exercise based on the values of the stakeholder(s). This was accomplished during the February 2009 SWAC meeting, where a trained facilitator led SWAC members through an exercise to think clearly about the relative importance of different values. Weighting was done after the performance measures have been developed, so SWAC members could include in their consideration the extent to which the full set of alternatives vary in performance. Technically, the weight assigned to an objective is a measure of its relative contribution to the decision goal as it is varied from the lower end of its measurement scale to the upper end of that scale.

Weights were assigned by first rank ordering each objective in a particular level of the hierarchy from "most important" to "least important". Then weights were assigned that reflect the relative importance of each objective. These weights were then converted to a 0-1 scale regardless of the method used to obtain weights. The weights developed for the objectives are shown in Exhibit 3.

Because the weights are inherently subjective, SWAC members had different opinions about the relative important of objectives. For a few objectives, consensus was difficult to achieve, thus the sensitivity of results to changes in weights was explored for costs, greenhouse gas emissions, and worker safety.

EXHIBIT 3
Weights

Decision Context: Select the preferred method for managing residuals after reduction, reuse, and recycling both in the short-term and in the long-term

Objectives Hierarchy			Weights	Percent
1.	Minimize long-run life-cycle cost		85	23.0%
2.	Protect public health and the environment		100	
	A.	Minimize greenhouse gas production (from process and/or vehicles)	90	6.8%
	B.	Minimize other harmful air emissions (from process and/or vehicles)	80	6.0%
	C.	Minimize water pollution	90	6.8%
	D.	Promote worker and public safety	100	7.5%
3.	Minimize social impacts		90	
	A.	Minimize proximity impacts (e.g., traffic, noise, odor)	85	8.1%
	B.	Provide local jobs	80	7.6%
	C.	Promote environmental justice	90	8.6%
4.	Accommodates future reductions in residuals and changes in composition (i.e., no put-or-pay)		95	25.7%
Total				**100.0%**

Scoring Alternatives

Rating or scoring alternatives is the process by which the performance measurement scales are applied to the alternatives. Each alternative is scored to determine the extent to which that alternative meets each objective.

The scores and the rationale for each constructed scale are shown in Exhibit 4. After scoring, each performance measure is arithmetically transformed to a scale of zero-to-one. For example, if a cost scale ranging from $1,000 to $2,000 were converted to a zero-to-one scale, then $1,000 would rate a “one” on the new scale; $2,000 would rate a “zero;” and $1,500 would rate a 0.5. This zero-to-one scale described above implies a linear relationship between cost and value. This means that increasing cost from $1,000 to $1,500 is as important as increasing cost from $1,500 to $2,000. The two incremental changes are of equivalent value. Scales can also be nonlinear when changes along the scale have different degrees of importance.

EXHIBIT 4
Scores and Scoring Rationale for Residuals Management Alternatives

Decision Context: Select the preferred method for managing residuals after reduction, reuse, and recycling both in the short-term and in the long-term.

Key Assumptions
- All options are operated in compliance with applicable laws and regulations
- All options have the same level of up-front reduction, reuse, and recycling

			Scores						
	Objectives Hierarchy	Performance Measures	1. Waste-to-Energy Facility for East Hawai`i; Ash and Bypass Materials to SHSL	2. Waste-to-Energy Facility for all County Residuals; Ash and Bypass Materials to WHSL	3. One or More Modular Waste-to-Energy Facilities in Rural Areas; Ash and Bypass Waste to SHSL and WHSL	4. Develop Mechanical-Biological Treatment (MBT) Facility at the SHSL and/or WHSL Sites	5. Expand SHSL for East Hawai`i residuals, and use WHSL for West Hawai`i residuals	6. Close SHSL and landfill all County Waste at the WHSL	7. Bale and Barge East Hawai`i Waste and utilize WHSL for West Hawai`i residuals
1.	Minimize long-run life-cycle cost (per-ton disposal cost 2008 net of any changes to transfer station or trucking operations)	System average per-ton cost in FY 2008	$87	$100	$65	$185	$64	$69	$83
2.	Protect public health and the environment								
A.	Minimize greenhouse gas production (from process and/or vehicles, change from existing disposal system)	Change in annual MTons Carbon Equivalent	-22,887	-59,759	-1,596	-120,006	0	244	31,265
B.	Minimize other harmful air emissions (from process and/or vehicles)	1-5 Scale	2.0	1.0	2.5	5.0	3.0	2.5	4.0
C.	Minimize water pollution	1-5 Scale	2.5	4.5	2	3.5	1	3	4
D.	Promote worker and public safety	1-5 Scale	1.5	1	1.5	1	3	2	2
3.	Minimize social impacts								
A.	Minimize proximity impacts (e.g., traffic, noise, odor)	1-5 Scale	3.5	3.5	2	1	3	2	4
B.	Provide local jobs	Added jobs	15	23	-5	43	5	0	0
C.	Promote environmental justice	1-5 Scale	3.5	2.5	2	3.5	3	2	3.5
4.	Accommodates future reductions in residuals and changes in composition (i.e., no put-or-pay)	1-5 Scale	1.5	2	2.5	2.5	5	5	4

EXHIBIT 4 (CONTINUED)
Scores and Scoring Rationale for Residuals Management Alternatives

		Rationale						
	Objectives Hierarchy	**1. Waste-to-Energy Facility for East Hawai`i; Ash and Bypass Materials to SHSL**	**2. Waste-to-Energy Facility for all County Residuals; Ash and Bypass Materials to WHSL**	**3. One or More Modular Waste-to-Energy Facilities in Rural Areas; Ash and Bypass Waste to SHSL and WHSL**	**4. Develop Mechanical-Biological Treatment (MBT) Facility at the SHSL and/or WHSL Sites**	**5. Expand SHSL for East Hawai`i residuals, and use WHSL for West Hawai`i residuals**	**6. Close SHSL and landfill all County Waste at the WHSL**	**7. Bale and Barge East Hawai`i Waste and utilize WHSL for West Hawai`i residuals**
1.	Minimize long-run life-cycle cost (per-ton disposal cost 2008 net of any changes to transfer station or trucking operations)	Estimated cost	Estimated cost	Estimated cost	Estimated cost	Estimated cost	Estimated cost	Estimated cost
2.	Protect public health and the environment							
A.	Minimize greenhouse gas production (from process and/or vehicles, change from existing disposal system)	Estimated emissions	Estimated emissions	Estimated emissions	Estimated emissions	Estimated emissions	Estimated emissions	Estimated emissions
B.	Minimize other harmful air emissions (from process and/or vehicles)	Truck fuel use similar to today; some air process air emissions	About 24,000 additional gallons of fuel (if sited at one of the landfills); Highest air process emissions	About 13,000 gallons less truck fuel use; some air process emissions (least of all WTE options)	Truck fuel use similar to today; relatively little harmful process air emissions	Truck fuel use similar to today; Some volatile organic compounds from landfilling	About 24,000 additional gallons of fuel; Some volatile organic compounds from landfilling	About 7,000 additional gallons of fuel use; fewest landfill emissions
C.	Minimize water pollution	Reduced reliance on landfilling in East Hawai`i	Reduced reliance on landfilling in both East and West Hawai`i	Small reduction in landfilling	Reduced reliance on landfilling in both East and West Hawai`I; Stormwater and process water must be controlled	Highest reliance on landfilling	Reduced reliance on landfilling in East Hawai`i	Reduced reliance on landfilling in East Hawai`i
D.	Promote worker and public safety	Some added risk to worker safety from boilers and process equipment	Some added risk to worker safety from boilers and process equipment	Some added risk to worker safety from boilers and process equipment	Some added risk from process equipment	Similar to today	Slight reduction of risk from consolidating operations at landfill with less rainfall	Slight reduction in risk from bale and barge versus in-county landfill
3.	Minimize social impacts							
A.	Minimize proximity impacts (e.g., traffic, noise, odor)	Reduced proximity effects assuming sited at SHSL site	Reduced proximity effects assuming sited at the SHSL or WHSL site	Added proximity effects associated with modular facility	High risk of noise and odor regardless of where sited	Similar to today	Added trucking through communities already opposed to waste transportation	Fewer proximity impacts than current system
B.	Provide local jobs	About 15 more jobs than today	About 23 more jobs than today	About 5 fewer jobs than today (less trucking)	About 43 more jobs than today	About 5 more jobs than today	Similar to today	Similar to today
C.	Promote environmental justice	Slightly better than today because less material to landfill; Assumes plant is sited at SHSL	Potentially worse depending on location of the new facility	Potentially worse depending on location of the new facility; Definitely would have a facility in a new location	Somewhat better than today because less material to landfill; assumes facilities are located at existing landfill sites	Similar to today	Potentially worse than today because of added trucking	Possibly better than today because less waste landfilled in the County
4.	Accommodates future reductions in residuals and changes in composition (i.e., no put-or-pay)	Poor. Relatively poor economies of scale with facility sized for East Hawai`i would make aggressive waste reduction extra expensive	Poor. Maybe not as bad as East Hawai`i WTE because facility could be sized larger and still be compatible with relatively aggressive waste reduction	Somewhat poor—plant sizing would make aggressive waste reduction a problem in areas in vicinity of the WTE facilities	Somewhat poor—significant capital expense, and more contaminated recyclables	Good. Relatively low capital, thus compatible with aggressive reduction in waste requiring disposal	Good. Relatively low capital, thus compatible with aggressive reduction in waste requiring disposal	Relatively good assuming contract can be developed without a "put or pay" provision

Calculating Total Value Scores and Sensitivity Analysis

The total value score for each alternative is calculated as a weighted averaging process in which the scores are weighted by the value weights and summed for each alternative. Sensitivity analysis is then conducted to test the sensitivity of the results to changes in weights. The results of the analysis are shown in Exhibits 5 through 10, which show the results in the following ways:

Exhibit 5: Summary scores in total and by main objective

Exhibit 6: A bar chart showing the summary scores

Exhibit 7: A bar chart showing the detailed scoring of protecting public health and the environment

Exhibit 8: A bar chart showing the detailed scoring of minimizing social impacts

Exhibit 9: A scatter diagram plotting non-cost value versus cost

Exhibit 10: Sensitivity analysis of the results to changes in weights

As shown, the following three alternatives are rated significantly higher than the other four alternatives:

Alternative 5: Expand SHSL for East Hawai`i residuals, and use WHSL for West Hawai`i residuals

Alternative 7: Bale and Barge East Hawai`i Waste and utilize WHSL for West Hawai`i residuals

Alternative 6: Close SHSL and landfill all County Waste at the WHSL

Further, in most of the sensitivity analysis, the alternatives also ranked in the order shown, i.e., Alternative 5, expanding the SHSL, was the highest rated alternative followed by Alternatives 7 and 6.

Interpreting Results

The results of any value modeling analysis are best regarded and applied as *decision aids*. Results should inform rather than dictate the decision. The analysis provides a way of organizing and comparing complex information. To the extent the decision-maker(s) believe that the objectives hierarchy represents the important issues, the weights and performance measures are appropriate, and the scores are accurate, they may be confident in the results.

Also, sensitivity analysis often provides insights. If the results of the model do not change unless there are substantial changes in weights, then the decision-maker(s) may be confident in the results. If the results do change, further reflection about scales, weights, and objectives will help illuminate the tradeoffs faced by decision makers.

EXHIBIT 5
Value Scores for Residuals Management Alternatives

Objectives Hierarchy	Value Scores						
	1. Waste-to-Energy Facility for East Hawai`i; Ash and Bypass Materials to SHSL	**2. Waste-to-Energy Facility for all County Residuals; Ash and Bypass Materials to WHSL**	**3. One or More Modular Waste-to-Energy Facilities in Rural Areas; Ash and Bypass Waste to SHSL and WHSL**	**4. Develop Mechanical-Biological Treatment (MBT) Facility at the SHSL and/or WHSL Sites**	**5. Expand SHSL for East Hawai`i residuals, and use WHSL for West Hawai`i residuals**	**6. Close SHSL and landfill all County Waste at the WHSL**	**7. Bale and Barge East Hawai`i Waste and utilize WHSL for West Hawai`i residuals**
Total Score	**43.3**	**44.3**	**43.0**	**42.1**	**66.7**	**61.7**	**62.7**
1. Minimize long-run life-cycle cost	19.1	15.2	22.8	2.5	23.0	22.1	19.8
2. Protect public health and the environment	7.4	10.0	6.3	17.0	8.2	8.9	11.4
3. Minimize social impacts	13.6	12.7	4.2	13.0	9.9	5.0	12.2
4. Accommodates future reductions in residuals and changes in composition (i.e., no put-or-pay)	3.2	6.4	9.6	9.6	25.7	25.7	19.3

EXHIBIT 6
Total Value Scores

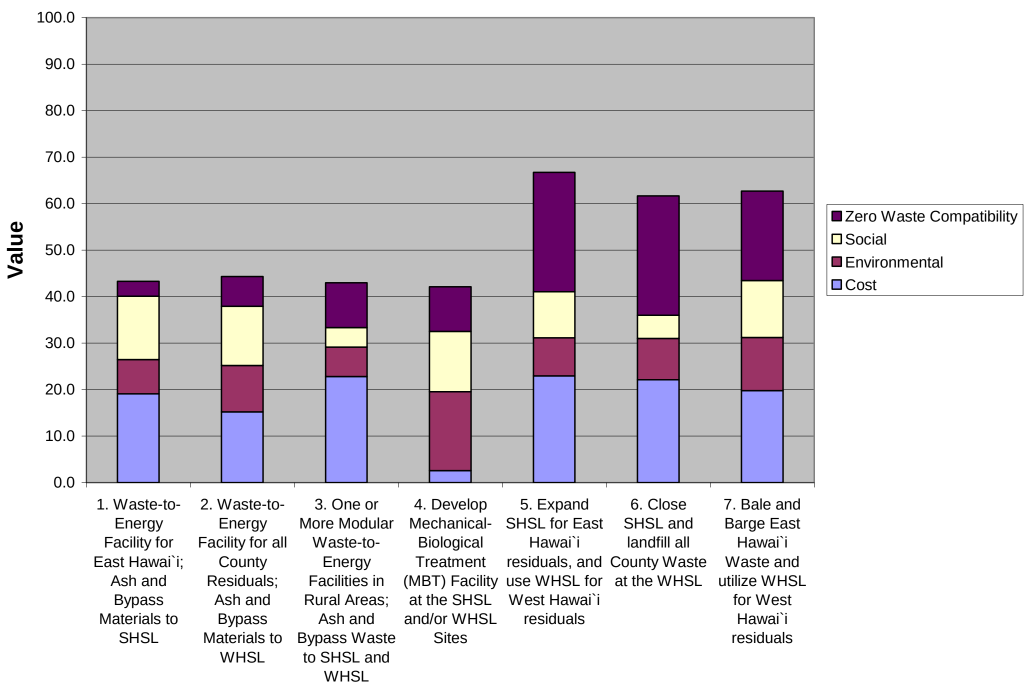


EXHIBIT 7
Value Scores for Public Health and the Environment

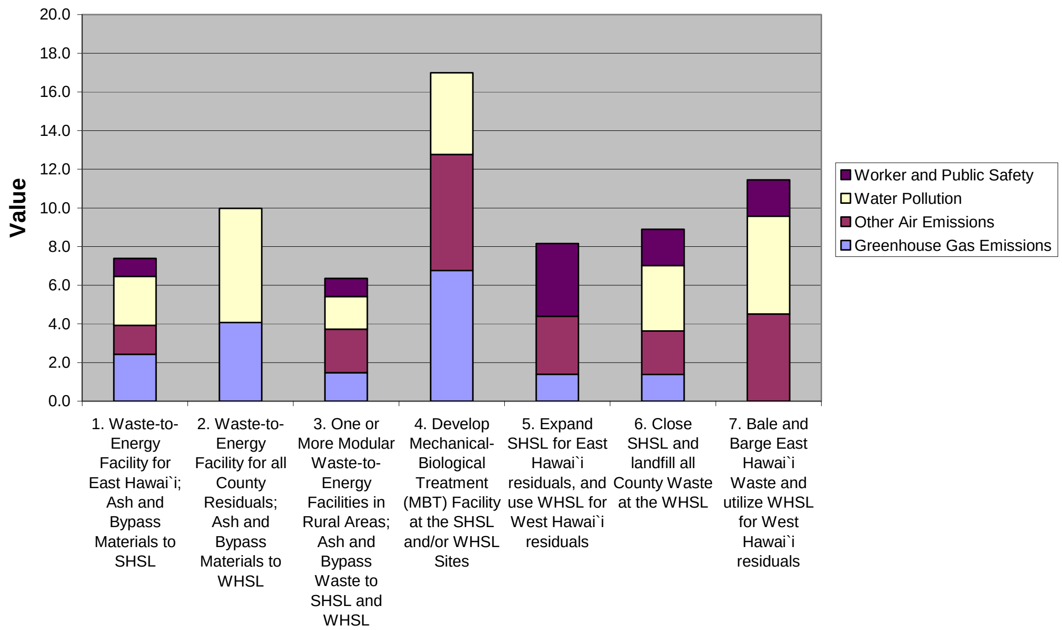


EXHIBIT 8
Value Scores for Social Impacts

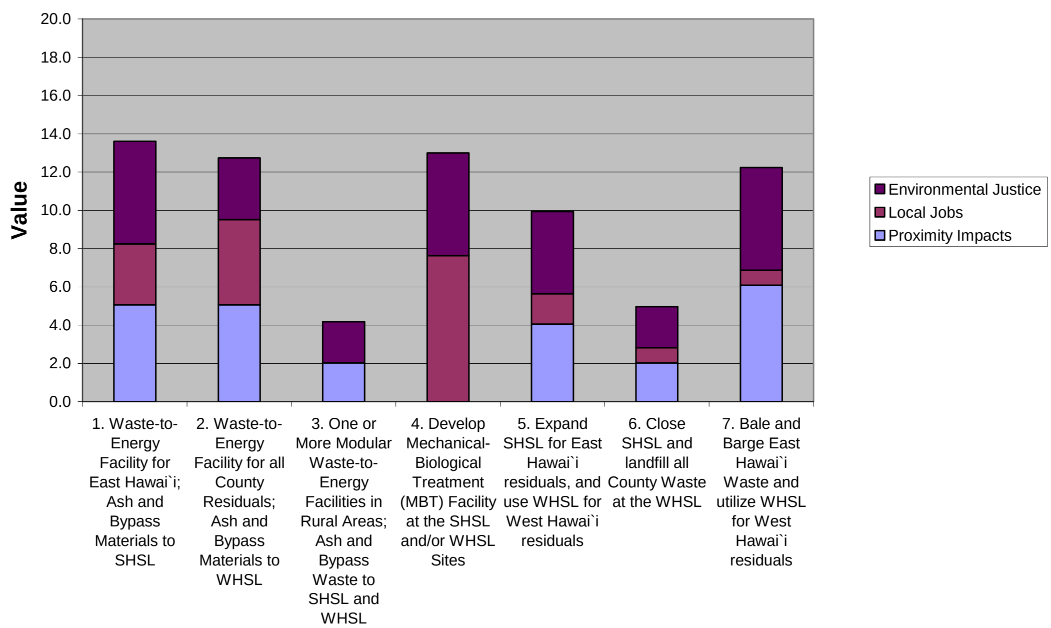


EXHIBIT 9
Value Excluding Cost

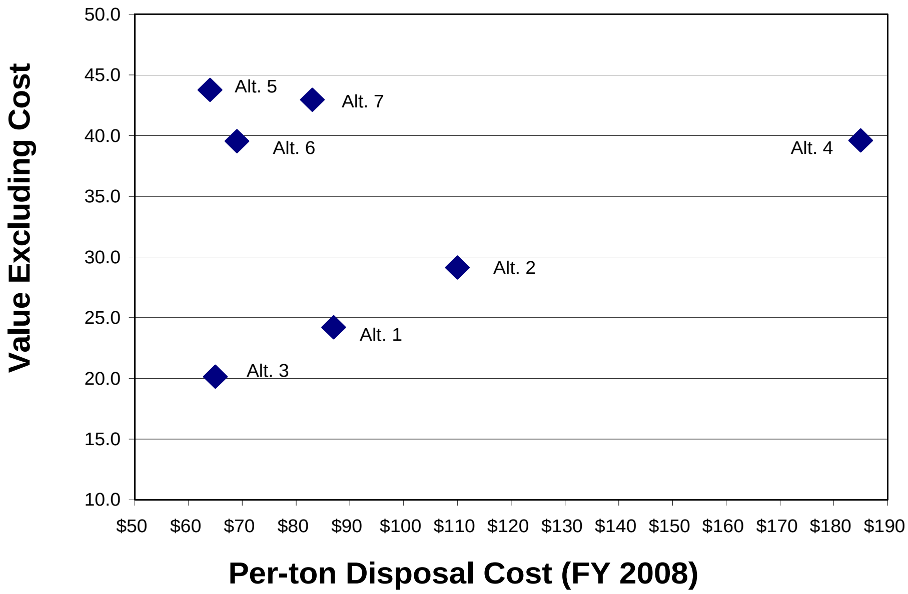


EXHIBIT 10
Sensitivity Analysis
Scores with Changes in Weights

	Value Scores						
Changes in Weights	**1. Waste-to-Energy Facility for East Hawai`i; Ash and Bypass Materials to SHSL**	**2. Waste-to-Energy Facility for all County Residuals; Ash and Bypass Materials to WHSL**	**3. One or More Modular Waste-to-Energy Facilities in Rural Areas; Ash and Bypass Waste to SHSL and WHSL**	**4. Develop Mechanical-Biological Treatment (MBT) Facility at the SHSL and/or WHSL Sites**	**5. Expand SHSL for East Hawai`i residuals, and use WHSL for West Hawai`i residuals**	**6. Close SHSL and landfill all County Waste at the WHSL**	**7. Bale and Barge East Hawai`i Waste and utilize WHSL for West Hawai`i residuals**
Baseline	43.3	44.3	43.0	42.1	66.7	61.7	62.7
GHG = 15	42.7	42.7	43.1	39.5	67.4	62.5	65.7
Worker Safety = 50	44.0	45.9	43.4	44.9	65.9	62.0	63.5
Cost = 200	52.7	49.5	56.3	34.8	74.6	69.9	68.2
Cost = 50	39.1	42.1	37.1	45.4	63.3	58.0	60.3
Zero Waste Compatible - no put or pay = 60	42.3	44.0	37.0	46.3	59.0	53.1	58.6

Rank Order with Changes in Weights (1 = Highest Scoring Alternative)

	Rank Ordering of Value Scores						
Baseline	5	4	6	7	1	3	2
GHG = 15	6	5	4	7	1	3	2
Worker Safety = 50	6	4	7	5	1	3	2
Cost = 200	5	6	4	7	1	2	3
Cost = 50	6	5	7	4	1	3	2
Zero Waste Compatible - no put or pay = 60	6	5	7	4	1	3	2

Risk

When developing an objectives hierarchy for a value modeling analysis, one must decide whether all risks should be accounted for as objectives, or in a separate accounting of risk. There is no "right answer" in how to account for risks. In the value model discussed above, some of the objectives have an element of risk included such as water pollution potential from landfills, but in general, most of the objectives are not specifically focused on risk. Thus, it is important to consider if there are any risks not included in the value model analysis. In this case, there is one important risk that should be investigated:

- *Can the alternative be implemented with confidence at the estimated cost, i.e., what is the uncertainty surrounding the cost of each alternative?*

A qualitative rating of the risk associated with each alternative (Exhibit 11) and a discussion of the implementation and cost uncertainty of each alternative follows.

EXHIBIT 11
Qualitative Cost Implementation Risk Rating of Alternatives

Alternative	Risk
1. Waste-to-Energy Facility for East Hawai`i; Ash and Bypass Materials to SHSL	Low-Moderate
2. Waste-to-Energy Facility for all County Residuals; Ash and Bypass Materials to WHSL	Low-Moderate
3. One or More Modular Waste-to-Energy Facilities in Rural Areas; Ash and Bypass Waste to SHSL and WHSL	Low-Moderate
4. Develop Mechanical-Biological Treatment (MBT) Facility at the SHSL and/or WHSL Sites	High
5. Expand SHSL for East Hawai`i residuals, and use WHSL for West Hawai`i residuals	Moderate
6. Close SHSL and landfill all County Waste at the WHSL	Low
7. Bale and Barge East Hawai`i Waste and utilize WHSL for West Hawai`i residuals	Moderate

The costs estimated for the waste-to-energy (WTE) alternatives (1, 2, and 3) are fairly certain. The cost for the distributed system (Alternative 3) is uncertain because of the potential for challenges in siting, constructing, and operating a small plant in a remote location. However, the distributed model included only one small facility so potential cost increases wouldn't have a great impact on the total system. The larger WTE systems envisioned in Alternatives 1 and 2 have relatively certain costs. However, all three of these alternatives are likely to face tremendous implementation difficulties as witnessed by the recent challenges faced by the County to obtain public and political consensus for the proposed waste reduction facility for East Hawai`i, which is represented as Alternative 1.

Alternative 4, developing two mechanical-biological treatment facilities, has considerable cost and long-term feasibility risks. As discussed in Appendix B, there are many examples in North America where such plants have failed because of odor or operational/cost issues.

The facilities are complex and require a high level of operational expertise. The likelihood that costs could be substantially higher than shown are relatively high. This alternative carries the highest level of risk of all alternatives.

Alternative 5, expanding the SHSL, is not without risk. The cost estimate shown assumes a successful outcome of the State Land Use Boundary Amendment and County Change of Zone processes, completion of the Environmental Impact Statement, and resolution of Department of Health permitting issues at the SHSL site. It assumes that the proposed use of constructed wetlands for leachate treatment can be permitted with the state and work as engineered. Should difficulties arise with this option, residual waste could be hauled to the WHSL or baled and barged with a relatively small loss of capital investment. Thus, there is moderate risk associated with this alternative.

Alternative 6 has relatively low risk compared to the other alternatives. The sort station at the SHSL could be used to transfer waste into larger transfer trucks and hauled to the WHSL, which has many years of capacity. Thus the technical risks of this alternative are low. The main risk associated with this alternative is the challenge of gaining public and political acceptance for transporting waste from East Hawai`i to West Hawai`i. This alternative has been proposed before and has faced strenuous opposition from persons and businesses along the transportation route.

Alternative 7, baling and barging waste to the U.S. Mainland should be technically feasible, but there is no working system at this time for baling and barging residual waste from Hawai`i to the U.S. Mainland. One advantage of this alternative is that the County would not have to invest significant capital expense for implementation. Should it prove to be infeasible, the County could truck waste to West Hawai`i on relatively short notice at relatively modest cost. But, the disruption and bad press of the potential failure of this (or any alternative) should be considered.

APPENDIX H

Energy Balance

Energy Balance

This appendix provides information about the energy usage of the County's existing system and how the IRSWMP update might affect the use of energy in the future.

Energy Use of the County's Existing System

The main energy-using activities of the County's existing solid waste system consist of operating its network of recycling and transfer stations, and its two landfills. Estimated fuel use for these components of the County system are shown in Exhibit 1. As shown, it is estimated that approximately 345,000 gallons of fuel are used to operate the County's solid waste system.

EXHIBIT 1
Estimated Solid Waste System Fuel Use, Fiscal Year 2007-08

System Component	Fuel Use (gallons)
Recycling	95,000
Transfer	153,000
South Hilo and West Hawai`i Landfills	97,000
Total	345,000

Energy Use of the Proposed IRSWMP Update

The recommendations included in this IRSWMP Update include a number of activities and programs that would reduce energy usage and the County's carbon footprint, such as reducing waste at the source, increasing recycling, and increasing the composting of organic materials. The EPA WARM model[1] was used to assess the IRSWMP Update's effect on energy use and greenhouse gas (GHG) emissions (measured as metric ton equivalents). The WARM model was developed to allow for relatively rapid preparation of energy use and GHG emissions for solid waste systems.

The model requires estimating generation, recycling, composting, and disposal by material for both scenarios tested. For this analysis, information from the waste stream assessment and calculations made in preparation of the recycling and bioconversion estimates were used to populate the model's waste flows. The model also allows the user to specify a number of features about the system including the transportation distance to landfills, transfer stations, and recycling, and landfill gas collection efficiencies. Actual transportation

[1] Accessed at www.epa.gov

distances experienced by the County system for transfer and recycling were used for the transportation estimates. The model requires land miles for recycling: thus, for shipment of recyclable materials to the Mainland, it was assumed materials were shipped 3,500 container ship miles and that 10.24 container ship miles is equivalent to one land truck mile[2].

The analysis compares energy use and GHG emissions of the County's existing system in FY 2007-08, compared to the recommendations in the IRSWMP Update as if they were implemented in that same year. The results of the analysis are shown in Exhibit 2. As shown, the IRSWMP Update recommendations would result in substantial reductions in energy use and GHG emissions compared to the existing system.

EXHIBIT 2
Change in Energy Use: IRSWMP Recommendations Compared to the Existing System FY 2007-08

	Increase (Decrease) from Existing System
IRSWMP Update change in energy usage (million BTU)	(679,000)
IRSWMP Update change in Metric Ton Carbon Equivalents	(34,000)

Greenhouse Gas Emissions and Fuel Use of Treatment and Disposal Options

During deliberations on the IRSWMP Update, a number of treatment and disposal options for the County were evaluated (see Section 9 and Appendix F). During analysis of those options, annual GHG emissions and fuel use was estimated for seven treatment and disposal options. Each option was compared to the existing system (Option 5). The results of that analysis are shown in Exhibit 3.

[2] Ship miles converted to truck miles based on data from U.S. EPA's Smart Way Transportation Initiative.

EXHIBIT 3

Greenhouse Gas Emissions and Fuel Use Estimates for Treatment and Disposal Options.

	1. Waste-to-Energy Facility for East Hawai`i; Ash and Bypass Materials to SHSL	**2. Waste-to-Energy Facility for all County Residuals; Ash and Bypass Materials to WHSL**	**3. One or More Modular Waste-to-Energy Facilities in Rural Areas; Ash and Bypass Waste to SHSL and WHSL**	**4. Develop Mechanical-Biological Treatment (MBT) Facility at the SHSL and/or WHSL Sites**	**5. Expand SHSL for East Hawai`i residuals, and use WHSL for West Hawai`i residuals**	**6. Close SHSL and landfill all County Waste at the WHSL**	**7. Bale and Barge East Hawai`i Waste and utilize WHSL for West Hawai`i residuals**
Change in greenhouse gas production from process and/or vehicles (MTCE per year)	-22,887	-59,759	-1,596	-120,006	0	+244	+31,265
Change in fuel use from process and/or vehicles (Gallons per year)	0	+24,000	-13,000	0	0	+24,000	+7,000