



Segregated Rate Statistical Analysis and Technical Assistance Final Report

Prepared for:

State of Hawaii
Department of Health
Office of Solid Waste Management
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Presented by:
Capital Pathways, LLC



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Summary

In November, 2006, Capital Pathways, LLC was retained by the State of Hawaii, Department of Health (DOH), Office of Solid Waste Management to perform the following scope of services:



Attachment - S1

STATE OF HAWAII SCOPE OF SERVICES

The CONTRACTOR shall provide a segregated rate evaluation of the STATE's Deposit Beverage Container program with assistance from the STATE. The CONTRACTOR shall work with the STATE and complete the following tasks.

1. The CONTRACTOR shall develop sampling procedures and methodology to determine a segregated rate for deposit beverage container redemption with assistance from the STATE.
2. The CONTRACTOR shall develop sampling procedures with assistance from the STATE that shall consider, at a minimum, the following:
 - a. Weight by separately aggregated size categories of containers (same size) in their original manufactured and unfilled state;
 - b. Weight by variously mixed aggregated sized of containers (different sizes) in their original manufactured and unfilled state; and
 - c. The segregated rates for each material type should incorporate a factor for typical contamination levels so refund value and handling fees paid by weight are based on container weights only and not contaminants.
3. The CONTRACTOR shall determine what constitutes a representative sample size with assistance from the STATE, to include, at a minimum:
 - a. Determine what size of sample is feasible to obtain;
 - b. Examine the number of deposit beverage containers sold and redeemed;
 - c. Examine types of redemption centers currently in operation; and
 - d. Select the number and locations of redemption centers on the islands of Hawaii, Kauai, Maui, and Oahu to sample.
4. The CONTRACTOR shall develop procedures for evaluating the segregated rate with assistance from the STATE in to include, at a minimum, the following:
 - a. Develop methodology to conduct sampling;
 - b. Create a schedule to conduct the sampling;
 - c. Develop a list of equipment and description of use for sampling; and
 - d. Investigate how demographics may influence segregated rate.
5. The CONTRACTOR shall train the STATE on the recommended sampling procedures, including coordinating with state staff to conduct sampling at redemption centers located on Oahu for a minimum of three (3) days.
6. The CONTRACTOR shall provide statistical analysis of data gathered from sampling with assistance from the STATE.
7. The CONTRACTOR shall submit one (1) progress report and one (1) final report in electronic and hardcopy format to the STATE based on the above tasks.

From November 13th - 17th, 2006, the Capital Pathways, LLC team conducted training for DOH staff and performed sampling at redemption center locations throughout the island of Oahu. Prior to these dates and based on an analysis of Hawaii's HI-5 deposit beverage container recycling program (HI-5), sample sizes for aluminum, glass, and plastic (PET & HDPE) were developed for each island/county. 25 redemption centers were randomly selected. Statewide, over 15,000 HI-5 deposit beverage containers (DBC's) were weighed and counted. These sample sizes resulted in a confidence level of 95% with confidence interval of +/- 3%, depending on material type.

Results

Based on the data in Attachment 1, "2007 Proposed Rates", the segregated containers per pound rates found during this study are:

Aluminum: 30.5
Glass: 2.2
Plastic: 17.5
*Bi-metal: 6.5**

*note: The rate for bi-metal was based on actual counts and not on the actual sample size proposed for this study due to the lack of available bi-metal containers at the sites.

Statistical Background

At the direction of DOH staff, a major goal of this exercise was to ensure that the segregated per pound rates were above reproach. To that end, a decision was made to follow the California model, upon which the HI-5 program was based. Like California, a sample size was selected to ensure a 95% confidence with a margin of error of 3% or less.

"The **confidence interval** is the plus-or-minus figure usually reported in newspaper or television opinion poll results. For example, if you use a confidence interval of 4 and 47% percent of your sample picks an answer you can be "sure" that if you had asked the question of the entire relevant population between 43% (47-4) and 51% (47+4) would have picked that answer. The **confidence level** tells you how sure you can be. It is expressed as a percentage and represents how often the true percentage of the population who would pick an answer lies within the confidence interval. The 95% confidence level means you can be 95% certain; the 99% confidence level means you can be 99% certain. Most researchers use the 95% confidence level."¹

¹ "The Survey System", retrieved from <http://www.surveysystem.com/sscalc.htm#terminology> on January 28, 2007.

Definitions and Formulae

Let the size of the population from i th county be denoted N_i .

Let the size of the sample from i th county be denoted n_i .

Let the sample variance from i th county be denoted $S_{d_i}^2$

Let (x_{ji}, y_{ji}) represent the container-refund values pair for the j th participant sampled from the i th county.

$$\hat{r}_i = \frac{\sum_{j=1}^{n_i} y_{ji}}{\sum_{j=1}^{n_i} x_{ji}}$$

The sample size formula for estimating segregated rate study with an error rate of at most D and a confidence level of $(1 - \alpha)100\%$ is given by:

$$n = \frac{(\sum n_i S_{d_i}^2)^2}{D + \sum n_i S_{d_i}^2}; \text{ where } S_{d_i}^2 = \frac{\sum_{j=1}^{N_i} (y_{ji} - r_i x_{ji})^2}{n_i - 1}$$

Please note that the formulae given above may not apply to future sample size determinations, especially if any change is made to the program.

You may wish to consult *Mathematical Statistics with Applications* by Wackerly, Mendenhall III, and Schefter, chapter 8, and *Sampling Techniques* by William Cochran for detailed explanations of sampling formulae.

The sample sizes used for the segregated rates study conducted in November 2006 were determined using data provided by the Department of Health, Office of Solid Waste Management. This data was collected for the 2005 segregated rates study. Data for the most recent twelve months of redeemed volumes were also used.

$$n = \frac{(\sum N_i S_{d_i})^2}{D + \sum N_i S_{d_i}^2}; \text{ where } D = \frac{B^2}{Z_{\alpha/2}^2}$$

Confidence Level 95%

Aluminum

County	Cont Ct	Cont Wt (xi)	yi	r*x	$s_{d_i}^2$	$i b^2_{1 n}$	$n_i S_{d_i}^2$	ni	Ni	Proposed Sample Size
Big Island	1,205	42.58	60.25	62.21527168	0.0032	68.22	3.86	985	4,224,083	1,035
Kauai	967	32	48.35	46.96098713	0.0020	43.19	1.93	151	643,624	159
Maui	1,671	60.2	83.55	87.96052971	0.0116	180.29	19.45	1,107	4,745,892	1,163
Oahu	4,079	136.17	203.95	198.9632115	0.0061	318.49	24.87	4,864	20,855,606	5,108
Proposed Total Sample Size										7,465

Glass

County	Cont Ct	Cont Wt (xi)	yi	R*x	$s_{d_i}^2$	$i b^2_{1 n}$	$n_i S_{d_i}^2$	ni	Ni	Proposed Sample Size
Big Island	1,231	585	61.55	62.7728146	0.0012	42.90	1.50	357	1,724,534	375
Kauai	788	370	39.4	39.73386747	0.0001	9.37	0.11	81	387,381	86
Maui	1,454	677	72.7	72.59468154	0.0000	4.02	0.01	333	1,606,930	350
Oahu	3,663	1,693	183.15	181.6986364	0.0006	87.84	2.11	2,183	10,546,084	2,293
Proposed Total Sample Size										3,104

Plastic

County	Cont Ct	Cont Wt (xi)	yi	R*x	$s_{d_i}^2$	$i b^2_{1 n}$	$n_i S_{d_i}^2$	ni	Ni	Proposed Sample Size
Big Island	1,191	76	59.55	8.161817974	2.2173	1,773.45	2,640.75	611	1,630,907	642
Kauai	870	54	43.5	5.779588694	1.6354	1,112.59	1,422.83	99	263,173	104
Maui	1,398	86	69.9	9.201628862	2.6354	2,269.50	3,684.29	977	2,606,687	1,026
Oahu	3,441	212	172.05	22.77604345	6.4757	8,756.42	22,282.71	4,758	12,698,937	4,996
Proposed Total Sample Size										6,768

Proposed number of Containers to Survey at each Site

County	# of Site	Aluminum	Glass	Plastic	Total
Big Island	3	345	125	214	684
Kauai	1	159	86	104	349
Maui	4	291	88	257	636
Oahu	17	300	135	294	729

Sample Size

For the purpose of this study, sample size refers to the number of containers to sample and analyze (quantity and weight data by material type, color, and class) by container size and material type for each selected site (See Exhibit A, Site Section). Based on the formula shown on page 6, the following is breakout of required sample sizes broken out by material type by island.

Big Island:

Container	Aluminum	Bimetal	Glass	Plastic
Total	345	40	125	214

Kauai:

Container	Aluminum	Bimetal*	Glass	Plastic
Total	159	40	86	349

Maui:

Container	Aluminum	Bimetal*	Glass	Plastic
Total	291	40	88	257

Oahu:

Container	Aluminum	Bimetal*	Glass	Plastic
Total	300	40	135	294

* The number of containers sampled for bi-metal was based on actual counts obtained at each site.

Study Objective

The objective of this study was to measure the following statewide average rates:

Containers per Segregated Pound: The statewide average number of deposit beverage containers (DBC) in a segregated pound for each material type.

Application of Study Results

The Hawaii Deposit Beverage Container (DBC) Recycling Program requires consumers to pay 6¢ for each beverage container purchased from dealers in the state of Hawaii. The program allows consumers to return beverage containers made of aluminum, bimetal, glass and plastic to recycling centers where they receive refunds for the deposits they paid. The containers per pound rates are established by material type so that DBC containers can be redeemed by weight rather than count.

Rate Calculations

Number of Segregated Containers Per Pound (CPP)

$$\text{CPP} = \frac{\text{Number of DBC containers}}{\text{Total weight (lbs) of DBC containers}}$$

General Study Overview & Methodology

The methodology used in the Segregated Rate Determination Study was the following:

1. The *sample size* (the number of containers to sample and analyze at each site) was determined (See Exhibit A).
2. The *survey population* was determined; grouped by island/company.
3. The *survey sample* (facilities to be surveyed) was randomly selected.
4. Initial *phone calls* were made to verify each facility's operational status and information (address, phone number, contact person, etc.)

Collecting Samples

Appropriate Material

Efforts were made to ensure that the survey sample contained only those container and material types covered by the Hawaii DBC program.

Consumer Loads

When possible, to ensure genuine random sampling, material was pulled from consumer loads as they came in. If a consumer's load contained more than the required sample size, only the required amount was sampled in the order it was pulled out of the bucket/pile.

Previously Redeemed Material already on-site

If consumer loads were not available, the samples were selected from material already redeemed and available on-site. A visual "grid" was made on the material and the sample was collected from random grid sectors.

Containers were randomly sampled from DBC loads of whole and unbroken containers for each material type.

For each material type, the containers sampled were separated into three or four categories or classes based on size (see attached tables for survey results). The containers were counted and weighed, and the results recorded on a data collection Microsoft Excel spreadsheet.

Analyzing Survey Samples

Once the sample size had been collected and prepared, the sample analysis for one material type was completed before beginning another.

Sampling Procedures

1. The scale was placed on a solid, flat surface and centered.
2. The bucket was zeroed.
3. Containers were randomly selected from the survey sample, contaminants removed.
4. Containers were counted as they were placed into the zeroed bucket, ensuring that the containers were unbroken
5. Total bucket quantity was counted.
6. Total bucket weight was recorded.
Containers from the bucket were sorted by class categories.
Glass was sorted by color first and then each color was further broken down by class category (size).
7. Containers in each class category were counted followed by confirmation of the total bucket quantity
8. Quantity of containers in one class were recorded.
9. Containers from each class category were placed into the zeroed bucket and dirty weight was recorded.
10. Bucket was zeroed.

Steps 8 to 10 were repeated for each class.

Additional Observations & Recommendations

The Hawaii “HI-5” Deposit Beverage Container Program is enjoying remarkable success considering its relative infancy. Achieving such high recycling and redemption rates despite such challenges as a very large tourist population and a lack of consistent/formal collection programs is impressive, to say the least. As the program matures, opportunities exist to add elements that will increase recycling, reduce opportunities for fraud, and ensure that these aluminum, glass, and plastic beverage containers are diverted from scarce landfill space while conserving scarce natural resources. To that end, we make the following recommendations:

- *Add 2-liter containers to the program.* To exclude these popular containers when other recycling opportunities (e.g., curbside or drop-off) are not universally available is confusing to the consumer and forces the landfill disposal of these prolific large plastic bottles.
- *Certify collection programs.* A significant number of scavengers (i.e. mosquitoes) appear to be recycling relatively high volumes of DBC material. However, they are also responsible for potentially lengthy delays for consumers redeeming smaller “residential” loads at the same redemption centers.
- *Separate enforcement, research, and compliance assistance staff.* Hawaii is a small state. Having the same staff conducting enforcement and compliance assistance activities creates unnecessary potential conflicts and can hinder effectiveness.
- *Utilize excess deposit funds to further recycling goals.* Excess deposit funds could be used to increase recycling through implementation of grant programs to increase the recycling collection infrastructure and to cover increased staffing costs for underserved program areas (e.g., technical assistance, auditing, enforcement, etc.).
- *Ensure redemption center scales are accurate.* Consider a partnership with state or county staff responsible for sealing scales. Nothing will deter consumer recycling and redemption more than believing that their loads are being short-weighted.
- *Merge the DBC and ADF programs and establish commingled redemption rates.* By allowing the redemption of both DBC and non-DBC material, you will encourage greater recycling, conserve more natural resources, and increase diversion of materials from landfills.
- *Perform year round sampling for segregated rate studies.* Performing these studies year round, while staff/labor intensive, will allow DOH to take into account seasonal beverage consumption/recycling variations and provide insights into periodic recycling “spikes” by material type.
- *The program is working - get the word out.* Most of the media coverage around the DBC program seems to focus on perceived negatives. The HI-5 DBC program is enjoying remarkable success. Scarce natural resources are being conserved, energy is being saved, and tons of material are being diverted from

landfills. Develop an integrated marketing campaign (PR and advertising) that reminds the citizens of Hawaii of the importance of recycling and the great environmental benefits already achieved.

Exhibit A - Sites Randomly Selected for Sampling

<u>County</u>	<u>RC/RVM Name</u>	<u>RC/RVM Location</u>	<u>RC/RVM ID</u>
Hawaii	Waimea	Waimea Convenience Center	RY-0119-04
Hawaii	Keaau	Keaau Convenience Center	RY-0120-04
Hawaii	Puako	Puako Convenience Center	RY-0125-04
Kauai	Lihue	Kanoa St.	CC-0024-03
Maui	Haiku	Pauwela Road and Hana Hwy	RY-0112-04
Maui	Lahaina	Keawe St. and Oil Rd	RY-0111-04
Maui	Puunene	2000 Mokulele Hwy	RY-0010-01
Maui	Kahului	310 Kaahumanu Ave.	RY-0114-04
Oahu	Moiliili	2424 S. Beretania St.	CC-0028-03
Oahu	Kunia	94-640 Kupuohi St.	CC-0083-04
Oahu	Kalihi	2295 N. King St.	CC-0030-03
Oahu	Waimanalo	41-853 Kalaniana'ole Hwy.	CC-
Oahu	Kalihi	204 Sand Island Access Road	RY-0051-02
Oahu	Hickam AFB	Bldg. 1715, Kuntz Avenue	RY-0108-04
Oahu	Nanakuli	87-2070 Farrington Hwy	CC-0009-04
Oahu	Kalihi	207 Puuhale Road	RY-0093-04
Oahu	Kaneohe	46-047 Kamehameha Hwy.	CC-0032-03
Oahu	Mililani	95-1249 Meheula Pkwy	CC-0027-03
Oahu	Ewa Beach	91-919 Ft. Weaver Rd.	CC-0035-03
Oahu	Kailua	1090 Keolu Drive, Suite C-7	exempt 11/19/04
Oahu	Hawaii Kai	300 Keahole St.	CC-0082-04
Oahu	Hawaii Kai	501 Kealahou St.	CC-0033-03
Oahu	Wahiawa	1001 California Ave.	CC-0065-04
Oahu	Waianae	86-120 Farrington Hwy	CC-0036-03
Oahu	Mililani	95-1101 Ukuwai St.	CC-0081-04

Exhibit B -- Final 2007 Recommended Segregated Container Per Pound Rates

Aluminum

County	Cont. Count	% Tot Count	Cont. Weigh	% Tot Weigh	Pop Volume	% Pop Volume	CPP	CPP* Pop	FSP	FSP* Pop
Oahu	5440	69.79%	178.48	70.05%	187,503,664	0.625090958	30.47960556	19.05252584	1.5239803	0.9526263
Maui	1163	14.92%	37.67	14.78%	44,994,404	0.150000243	30.87337404	4.631013621	1.5436687	0.2315507
Kauai	159	2.04%	5.52	2.17%	18,762,716	0.062550265	28.80434783	1.801719604	1.4402174	0.090086
Hawaii	1033	13.25%	33.118	13.00%	48,701,424	0.162358533	31.19149707	5.064205705	1.5595749	0.2532103
Proposed Rates									30.5	\$1.53

Bimetal

County	Cont. Count	% Tot Count	Cont. Weigh	% Tot Weigh	Pop Volume	% Pop Volume	CPP	CPP* Pop	FSP	FSP* Pop
Oahu	250	73.10%	34.41	62.00%	365,372	0.534843292	7.265329846	3.885812931	0.3632665	0.1942906
Maui	90	1.15%	20.82	37.51%	137,319	0.201012821	4.322766571	0.868931503	0.2161383	0.0434466
Kauai	0	0.00%	0	0.00%	20,118	0.029449063	0	0	0	0
Hawaii	2	0.03%	0.27	0.49%	160,329	0.234694824	7.407407407	1.738480178	0.3703704	0.086924
Proposed Rates									6.5	\$0.32

Glass

County	Cont. Count	% Tot Count	Cont. Weigh	% Tot Weigh	Pop Volume	% Pop Volume	CPP	CPP* Pop	FSP	FSP* Pop
Oahu	2294	73.86%	1035.86	73.04%	93,967,360	0.634895155	2.214584983	1.406029275	0.1107292	0.0703015
Maui	351	11.30%	165.99	11.70%	22,123,437	0.149478108	2.114585216	0.316084198	0.1057293	0.0158042
Kauai	86	2.77%	37.42	2.64%	10,220,277	0.069053812	2.298236237	0.158701973	0.1149118	0.0079351
Hawaii	375	12.07%	178.9	12.61%	21,693,457	0.146572925	2.096143097	0.307237825	0.1048072	0.0153619
Proposed Rates									2.2	\$0.11

Plastic

County	Cont. Count	% Tot Count	Cont. Weigh	% Tot Weigh	Pop Volume	% Pop Volume	CPP	CPP* Pop	FSP	FSP* Pop
Oahu	4952	74.38%	283.25	74.64%	112,812,974	0.659871803	17.48278906	11.53639954	0.8741395	0.57682
Maui	1020	15.32%	56.15	14.80%	27,003,431	0.157949943	18.16562778	2.869259873	0.9082814	0.143463
Kauai	104	1.56%	6	1.58%	9,327,290	0.054557692	17.33333333	0.945666666	0.8666667	0.0472833
Hawaii	582	8.74%	34.1	8.99%	21,818,261	0.127620562	17.06744868	2.178157392	0.8533724	0.1089079
Proposed Rates									17.5	\$0.88

Exhibit C –Equipment List

- 1) Five 10-gallon buckets (per team)
- 2) Thick gloves
- 3) Steel toed boots
- 4) 30-lb scale (digital, certified) (1 per team and a backup)
- 5) Safety glasses
- 6) Hard hats
- 7) Safety vests
- 8) Orange cones (4 per team)
- 9) Metal Rake (1 per team)
- 10) Sanitizing wipes (for hands)
- 11) Laptop (1 per team)
- 12) USB thumb drives and CD-R's (to backup data daily)
- 13) Extra batteries for laptop
- 14) Extension cords
- 15) Surge protectors
- 16) Car charger (for laptop)
- 17) Mask/respirator
- 18) Folding table (1 per team)
- 19) Folding chairs (2 per team)
- 20) Pop-up canopies (1 per team)

Miscellaneous:

- 1) Large brushes (to clean buckets)
- 2) Simple Green (or other environmentally friendly cleaning agent)
- 3) First aid kit
- 4) Clip boards
- 5) Note pads
- 6) Pens
- 7) Rain Coats

Exhibit D – Supporting Data

Containers Per Pound (CPP) by Class Size

Aluminum

Class	Cont. Count	% Tot Count	Cont. Weigh	% Tot Weigh	CPP
1	467	5.99%	13.59	5.33%	34.3635
2	6879	88.25%	217.95	85.54%	31.5626
3	319	4.09%	15.67	6.15%	20.3574
4	130	1.67%	7.58	2.98%	17.1504

Glass

Class	Cont. Count	% Tot Count	Cont. Weigh	% Tot Weigh	CPP
1	160	5.15%	77.49	5.46%	2.0648
2	2766	89.05%	1193.44	84.15%	2.3177
3	124	3.99%	87.87	6.20%	1.4112
4	56	1.80%	59.37	4.19%	0.9432

Plastics

Class	Cont. Count	% Tot Count	Cont. Weigh	% Tot Weigh	CPP
1	4088	61.40%	180.43	47.54%	22.6570
2	2200	33.04%	158.04	41.64%	13.9205
3	370	5.56%	41.03	10.81%	9.0178

Class Sizes by Fluid Ounces

Aluminum & Glass

Class 1:	0 -11.9 oz
Class 2:	12 oz
Class 3:	12.1 - 23.9 oz
Class 4:	24 - 64 oz

Plastic

Class 1:	0 -17 oz
Class 2:	17.1 - 35 oz
Class 3:	35.1 - 64 oz