

California Beverage Container Recycling Program

**Technical Details for the Study to
Determine the Refund Values and
Number of Containers per Pound
To be effective Jan. 1, 2014**

**Friday, Aug. 17, 2012
1:00 PM – 4:00 PM**

**Department of Resources Recycling and Recovery
(CalRecycle)
Division of Recycling, Operations Branch**

**Coastal Hearing Room, 2nd Floor
Joe Serna - Cal/EPA Building
1001 "I" Street, Sacramento, CA**

2014 COMMINGLED RATE DETERMINATION STUDY

I. **Objective:** Measure commingled rates by material type for five types of recycling programs:

1. Recycling Centers (RC)
2. Reverse Vending Machines (RV)
3. Service Program (SP)
4. Collection or Drop-off Programs (CP)
5. Curbside Programs (CS)

II. **Research Design:**

1. The sample size determination focuses on the total number of containers needed to measure the commingled rate, rather than on the number of sites visited.

2. Seasonality is controlled by:

a) Conducting two six-month studies per year; and

b) Distributing the sample collection of each six-month period study so that all participant types of recycling programs are represented in each two-month period.

III. **Dates of Sampling Collection:** Two six-month studies are to be conducted from October 2012 through September 2013. The collection of samples is scheduled during the following periods:

<u>Study I</u>	October 1- March 31
<u>Study II</u>	April 1- September 30

IV. **Sample Determination:** The number of containers to be sampled for each material at each program type is determined by using a transformed binomial sample size computation (See Attachment 1 for sample size determination calculation).

V. **Program Selection:** The sampling procedure focuses on the number of containers to be sampled. If we had all recycled containers in California in large piles in one location, there would be no need to go to individual sites to collect samples. Because recycled materials in California are spread throughout the state, we need to randomly select different sites to allow for the random distribution of the samples.

Based on previous studies, and considering cost effectiveness, the Division decided to sample a minimum of 150 sites for each six-month study. To control

seasonality, the same sites will be visited twice during the year. The following characteristics were taken into account in site selection:

- Type of program (RC, CS, etc.)
- Geographic location of sites (to account for climatic differences)
- Volume of PET plastic #1 received/redeemed at site

The study population will consist of all programs which meet the following criteria:

- Operational at least eight months of fiscal year 2011/12;
- Certified and operational at the time the population is defined;
- Reported volume during fiscal year 2011/12; and
- Not receiving an Individual Commingled Rate.

Five categories of recycling program types (Recycling Center, Reverse Vending Machine, Collection Program, Curbside Program, and Community Service Program) will be surveyed. Sites to be surveyed will be stratified based on:

- Geographic region (North, South); and
- Received/redeemed volume of PET plastic #1.

VI. Distribution of Selected Sites:

1. Recycling Centers (RC):

RC programs will be selected proportionally by region and by volume stratum within the region.

The sample of RC programs is distributed as follows:

Total: 53 RCs

North: 19 RCs (36% of RC recycling occurs in North*)

South: 34 RCs (64% RC recycling occurs in South*)

* Proportions based on historical data. Total sites sampled and proportion for each stratum updated prior to site selection.

RC North:

<u>Strata</u>	<u>Proportion of RC*</u>	<u>Proportion of Volume</u>	<u>Sample</u>
1	10%	50%	10
2	20%	25%	5
3	<u>70%</u>	<u>25%</u>	<u>4</u>
	100%	100%	19

RC South:

<u>Strata</u>	<u>Proportion of RC*</u>	<u>Proportion of Volume</u>	<u>Sample</u>
1	14%	50%	17
2	20%	25%	9
3	<u>66%</u>	<u>25%</u>	<u>8</u>
	100%	100%	34

2. Reverse Vending Machines (RV):

Total: 18 RV

3. Community Service Programs (SP):

Total: 14 SP*

North: 8

South: 6

4. Collection/Drop-Off Programs (CP):

Total: 29 CP*

North: 11

South: 18

5. Curbside Programs (CS):

CS programs were selected proportionally by region and by volume-stratum within the region

The sample of CS programs is distributed as follows:

Total: 36 CS*

North: 20

South: 16

* Proportions based on historical data. Total sites sampled and proportion for each stratum updated prior to site selection.

CS North:

<u>Strata</u>	<u>Proportion of Volume*</u>	<u>Sample</u>
1	50%	10
2	25%	5
3	<u>25%</u>	<u>5</u>
	100%	20

CS South:

<u>Strata</u>	<u>Proportion of Volume*</u>	<u>Sample</u>
1	50%	8
2	25%	4
3	<u>25%</u>	<u>4</u>
	100%	16

* Proportions based on historical data. Total sites sampled and proportion for each stratum updated prior to site selection.

- VII. **Sampling Procedures:** At each site, randomly selected samples of aluminum, mixed glass, PET plastic, and HDPE plastic are acquired.
- VIII. **Calculation of the Commingled Rate:** Once the data are recorded, the statewide average commingled rate for each material is calculated for each type of recycling program following these steps:

1. For the given six-month study, the commingled rate for each stratum is calculated as the ratio of the total weight of CRV sampled in the stratum divided by total sample weight from sites in the stratum. The overall six-month commingled rate is the weighted average of the strata commingled rates; the weighting factor is the stratum's volume as a proportion of the total six-month's volume.
2. The annual commingled rate is obtained as a weighted average of the commingled rates obtained in each six-month study; the weighting factor is the volume of material redeemed during each six-month period as a proportion of the total annual volume of material recycled.

IX. Calculations:

1. The Containers per Pound (CPP) value is calculated:

$$\text{CPP} = \frac{\text{Total \# CRV Containers}}{\text{Total Weight CRV Containers in Sample}}$$

2. The Refund Value per Segregated Pound (RVSP) is calculated:

$$\text{RVSP} = \frac{\text{Refund Value CRV Containers Sampled}}{\text{Total Weight CRV Containers Sampled}}$$

$$= \frac{(\# \text{ CRV Containers} \geq 24 \text{ oz.} \times \$0.10) + (\# \text{ CRV Containers} < 24\text{oz.} \times \$0.05)}{\text{Total Weight CRV Containers}}$$

3. The Refund Value per Commingled Pound (RVCP) is calculated:

$$\text{RVCP} = \frac{\text{Refund Value CRV Containers Sampled}}{\text{Total Weight all Containers Sampled}}$$

$$= \frac{(\# \text{ CRV Containers} \geq 24 \text{ oz.} \times \$0.10) + (\# \text{ CRV Containers} < 24\text{oz.} \times \$0.05)}{\text{Total Weight all Containers}}$$

SAMPLE DETERMINATION

The number of containers to be sampled for each study and each material type is determined as follows:

1. An ordinary binomial sampling procedure is used to calculate the number of containers (by material) to be sampled. In binomial sampling, the computation of the required size, n , for given precision and a specified confidence interval (level) is given by:

$$n = \frac{p * q * [Z_{\alpha/2}]^2}{e^2}$$

Where:

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|------------------|---|---|
| n | = | Number of containers to be sampled. |
| p | = | Proportion of CRV containers by count. The proportion p is usually estimated from a preliminary sample, but may also be taken as a $p = 0.5$ |
| q or $(1-p)$ | = | Proportion of non-CRV containers by count. |
| e | = | Maximum accepted error for each material and per program. See Attachment 2. |
| Z | = | “Z Score” or “Standard Score” is the number of standard deviations for a value from the mean. |
| α | = | Alpha is the area of the critical region (the region outside of our confidence interval). For the confidence level of 95%, the critical region is 0.05 ($1 - 0.95$). |
| $[Z_{\alpha/2}]$ | = | Z score for a given critical region determined by the selected confidence level, assuming a randomly distributed sample population. The Z score for our critical region ($0.05/2$) at the 95% confidence level is 1.96. |

2. Because the relevant measure is the commingled rate (CRV weight divided by total weight) instead of the number of CRV containers divided by all containers, the above equation must be transformed. Specifically, the commingled rate may be expressed as a function of p . Transforming from containers to weights affects the precision of the estimates. Mathematically, it can be shown that the appropriate n for estimating the commingled rate is obtained by multiplying the computed sample (n) from the binomial formula by the term M^2 where:

$$M = \frac{ab}{[a(1-p) + bp]^2}$$

Where:

- a = Number of CRV containers per pound
- b = Number of Non-CRV containers per pound.

The number of containers to be sampled was determined as the product of M^2 times n . Values for p , a , and b by program and material are based on the result of previous studies.