United States
Environmental Protection
Agency

Solid Waste
and Emergency Response
(5306W)

EPA530-R-01-018
November 2001

EPA

Multifamily Recycling
A National Study

Printed on paper that contains at least 30 percent postconsumer fiber.

Foreword

Multifamily Recycling: A National Study was prepared by the U.S. Conference of Mayors and ECODATA, Inc., under a cooperative agreement from the U.S. Environmental Protection Agency (EPA).

This study was undertaken to discover the extent to which multifamily recycling programs have been implemented in the United States and to attempt to discern factors that have been associated with successful programs. A *Multifamily and High Rise Recycling Assessment* was mailed to all member communities of the U.S. Conference of Mayors with a population greater than 25,000 people. The results and analysis presented in this report were drawn from a selected sample of respondents indicating they had implemented multifamily recycling programs.

EPA is making this document available to increase the dissemination of this information to elected officials and municipal solid waste management professionals. This expanded distribution will help promote a better understanding of the potential for increasing the number of multifamily recycling programs nationwide.

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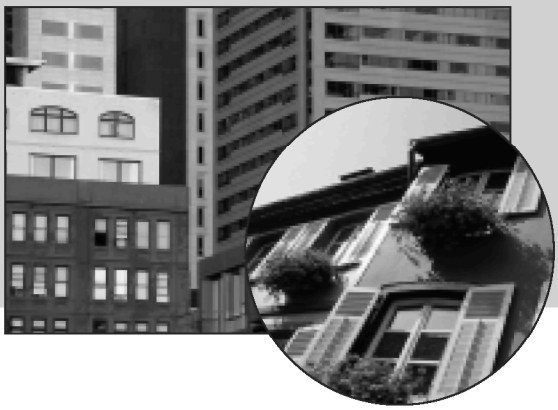


Executive Summary

Purpose

Multifamily recycling is often overlooked by public sector planners. The reasons for this omission are many, but perhaps the most important is the fact that multiple dwelling units are often considered part of the commercial sector, and many local governments exercise little control over this sector. Where refuse is collected under individual contracts between landlords and competing private firms, recycling is often similarly unregulated. Another reason is the perception that apartment dwellers are less likely to participate in recycling programs than are single family dwellers. Nonetheless, many communities have established and maintained successful multifamily recycling programs.

This report is the result of the first national study of multifamily recycling programs. Funded by the U.S. Environmental Protection Agency, and conducted by the U.S. Conference of Mayors and ECODATA, Inc., the study's three main goals include:

- To discover the extent to which multifamily recycling programs have been implemented in U.S. communities.
- To describe the programs that presently exist, including an analysis of the cost and diversion rates.
- To identify factors that have been associated with successful programs.

This section summarizes the results from this study, including a description of services provided, a presentation of measures indicating the effectiveness of these programs, and a discussion of factors that were associated with those programs that achieved the highest diversion rates.

The study's findings are based on a 1997 *Multifamily and High Rise Recycling Assessment*, which was mailed to all member communities of the U.S. Conference of Mayors with a population in excess of 25,000. Of the 227 communities that responded to the assessment, 118 reported having had a multifamily recycling program in place for at least 12 months. This study is based on detailed information obtained from 40 communities selected from those 118 communities (see ES Table 1). The objectives for choosing the samples were to provide representation from all geographic sectors of the United States, to include both large and small communities, to include only those communities whose programs have been in existence for at least a year, and to allow for potential projections to the entire national multifamily population.

ES Table 1 **40 Sample Communities Selected For Analysis**

Alameda, CA	East Orange, NJ	Lima, OH	Roswell, GA
Altoona, PA	Fountain Valley, CA	Maple Grove, MN	Saint Paul, MN
Bridgewater, NJ	Frankfurt, KY	Miami, FL	San Jose, CA
Broward County, FL	Greenfield, WI	Newport News, VA	Seattle, WA
Cherry Hill, NJ	Hillsboro, OR	New York City, NY	Syracuse, NY
Dayton, OH	Jacksonville, FL	North Tonawanda, NY	Tamarac, FL
Daytona Beach, FL	Lakewood, OH	Old Bridge, NJ	Tampa, FL
Diamond Bar, CA	Lancaster, OH	Olympia, WA	Vista, CA
Durham, NC	Laredo, TX	Placentia, CA	University City, MO
East Brunswick, NJ	Largo, FL	Portland, OR	Wallingford, CT

Methodology

To achieve the objectives of the study, programs were selected at random from each of the four U.S. Census-defined geographic sectors of the United States, with the proportion of programs sampled determined by the sector's relative share of all multifamily housing in buildings with 10 or more units. Of the 40 communities selected for this study, 10 are in the Northeast, 8 are in the Midwest, 12 are in the South, and 10 are in the West. Data were obtained and confirmed from these communities through the following methods:

- Mail contacts with recycling coordinators.
- Telephone followup with collectors (e.g., private sector firms and public sector managers), program administrators, and processors, as appropriate.
- Various internal consistency checks after initial collection (e.g., refuse plus recyclables per household was computed as a data reliability check).
- Re-contacts and data confirmation for communities with unlikely results.

While the study focused on multifamily recycling programs, data also were gathered on multifamily refuse collection in order to calculate diversion rates. In addition, for comparison purposes, statistics were gathered on single family recycling, refuse, and yard waste programs in the 40 communities.

Since multifamily refuse is frequently collected in the same trucks and on the same service routes as large commercial customers, estimation—either of multifamily refuse or recyclables—was often necessary in order to calculate the program's diversion rates. Indeed, many communities did not have data on their collected amounts of multifamily refuse or recyclables. In these cases, estimates were made using either the volume/density method or the per capita allocation method. For more information on these methods, see Appendices A and B. To find out which estimation method was used for each community, see Appendix C.

General Findings

This report includes information on how the programs are organized, their diversion rates, and costs (see ES Table 2). In some instances, where averages are calculated for all 40 communities, New York City's (NYC) statistics are omitted to avoid skewing the data. When individual per ton or per household costs or other factors are considered, however, NYC data are included. Following are some of the highlights from the overall results; more detailed information can be found in the full report.

ES Table 2 Productivity Measures and Multifamily Diversion Rates

Value	Multifamily Curbside Diversion <10%	10-20%	>20%	Statistical Significance**
Number of Observations	**13**	**16**	**11**	**40**
Collection Cost/Ton				
Multifamily Recycling*	$251.00	$159.00	$113.00	Yes-95%
Multifamily Refuse	$43.13	$72.60	$66.39	Yes-99%
Single Family Recycling	$151.80	$131.70	$81.64	Yes-99%
Single Family Refuse	$47.48	$60.28	$101.32	Yes-99%
Single Family Yard Trimmings	$75.03	$51.48	$127.16	No
Collection Cost/Household/Year				
Multifamily Recycling	$16.63	$20.56	$21.81	No
Multifamily Refuse	$45.17	$72.34	$36.01	No
TOTAL PER MF HOUSEHOLD	$61.80	$92.90	$57.82	
Single Family Recycling	$21.65	$30.96	$24.73	No
Single Family Refuse	$58.69	$64.71	$84.01	Yes-90%
Single Family Yard Trimmings	$16.05	$20.67	$15.89	No
TOTAL PER SF HOUSEHOLD	$96.39	$116.34	$124.63	
Households/Crew Shift				
Multifamily Recycling	2,333	2,246	1,676	No
Multifamily Refuse	1,205	1,537	2,144	No
Single Family Recycling	1,561	1,549	1,629	No
Single Family Refuse	618	1,142	3,962	Yes-90%
Tons/Household/Year				
Multifamily Recycling	0.061	0.145	0.211	Yes-99%
Multifamily Refuse	1.023	0.934	0.595	Yes-95%
TOTAL MF Municipal Solid Waste	1.084	1.079	0.806	Yes-95%
Single Family Recycling	0.139	0.260	0.297	Yes-99%
Single Family Refuse	1.312	1.123	0.951	Yes-95%
Single Family Yard Trimmings	0.317	0.258	0.209	No
TOTAL SF Municipal Solid Waste	1.768	1.641	1.457	Yes-95%
Curbside Diversion Rates				
Multifamily Recycling	6.04%	13.93%	27.76%	Yes-99%
Single Family Recycling	9.25%	17.70%	20.39%	Yes-99%
Single Family Yard Trimmings	16.94%	15.90%	12.48%	No
Complaints/Household/Year	**0.017**	**0.040**	**0.017**	**No**

* Excludes two cities with very high per ton costs, in the less than 10% diversion group.

** Indicates whether or not the difference in values is statistically significant, and the confidence level with which the null hypothesis of no difference can be rejected.

Scale of Multifamily Recycling Programs—Sample Communities

Including NYC, the 40 sample communities provide curbside recycling to 3.9 million multifamily households. Without NYC, the sample communities serve 887,558 multifamily households, a figure that represents 7.7 percent of the total 11.5 million multifamily households in the United States. In each sample community, an average of 96,993 multifamily households are served, with a range of 301 to 2,992,169 households (includes NYC) and a mean of 22,758 (excludes NYC). In comparison, an average of 44,069 single family households receive recycling service in each sample community.

Scale of Multifamily Recycling Programs—Nationwide

The data obtained from the 40 communities represent a national sample that can help determine the extent of multifamily recycling service in communities across the nation. It is possible to project the initial assessment survey data and acquire a reasonable estimate of the number of multifamily households served throughout the nation. Before the 40 sample communities are separated out, the 118 survey respondents with households with multifamily recycling programs (52 percent of the total 227 respondents) serve an estimated 23.4 percent of the 11.5 million multifamily households in buildings with 10 or more dwellings in the United States. The number of multifamily recycling programs could serve more than 23.4 percent of all multifamily households if some communities with programs did not respond to the assessment survey. If the survey data are applied nationally, then nearly 52 percent of U.S. multifamily households might currently be served by recycling programs. (Considering that communities with multifamily recycling programs were probably more likely to respond to the survey, the last figure is probably an upper bound estimate.)

Initial responses to the survey indicated that 37 percent of communities responding from the Midwest had multifamily recycling programs. The percentages of communities with multifamily recycling programs responding from other geographical quadrants in the United States were 68 percent in the West, 64 percent in the Northeast, and 45 percent in the South. An estimate of the potential for increased diversion also can be determined for each geographical region by applying the unserved percentages to the region's total number of multifamily housing units. In the Northeast, for example, where there are 3.46 million households in buildings with 10 or more units, if 36 percent do not receive service, then, at an average diversion rate of 0.14 tons per multifamily household per year (the figure calculated in this study), an additional 174,384 tons could be diverted from this region. Nationally, this methodology yields an estimated 847,205 additional tons that could be diverted from disposal. This figure for potential diversion might be even higher in reality, as the estimate of the percentage of households receiving recycling service is an upper bound.

Organizational Arrangement

Examining the 40 sample communities reveals a great deal about how multifamily recycling programs are encouraged, organized, and implemented. Compared to single family recycling programs, the multifamily recycling programs are slightly less likely to be mandatory (61.5 percent versus 64.1 percent), were more recently established (average inception in 1991 versus 1989), and generate slightly fewer complaints per household served (0.028 versus 0.034 per household per year). Private firms provide 67.5 percent of the multifamily recycling collection, while public sector collectors provide 32.5 percent. Most of the private collection for multifamily recycling falls under a contract or exclusive franchise agreement between a firm and a local government; only 17.5 percent of multifamily programs rely on subscrip-

tion agreements between private firms and customers. In comparison, single family programs use municipal employees for 30 percent of their programs, while 60 percent use exclusive franchise or contract arrangements with a private firm and 10 percent use subscription services.

For multifamily households, the average number of recycling collections per week is 0.98, with a range of 0.5 to 2. For single family households, the average number of recycling collections per week is 0.9. The 40 sample programs accept anywhere from 1 to 16 different commodities in their multifamily recycling programs; all collect old newspapers.

Diversion Percentages

The organization of service in the sample communities becomes even more important when considered next to the level of diversion that service achieves. In this report, diversion was determined by computing the tonnage of multifamily refuse generated and recyclables collected, and computing the ratio of per household multifamily recycling to the sum of per household multifamily recycling and refuse. The multifamily diversion rates presented below are what would be achieved if all households that receive refuse collection were included in the recycling program (see ES Figures 1a and 1b).

- An average 0.14 tons of multifamily recyclables and 0.87 tons of refuse were collected per household per year.
- The average multifamily recycling program diversion rate is 14.6 percent, with a range of 0.5 to 37.3 percent (diversion increases to 15.7 percent when drop-off tonnages are included). In comparison, the average single family curbside diversion rate is 16.0 percent, with a range of 6.0 to 36 percent (diversion increases to 17.1 percent when drop-off tonnages are included).

Multifamily households, with typically fewer persons per household than single family households, generate less refuse and recyclables than do single family households. Although the diversion rates for multifamily and single family programs average 14.6 percent and 16.0 percent, respectively, the recycling tonnage per household is 65 percent greater for single family households than for multifamily households. In both the multifamily and single family recycling programs studied, however, the following phenomena were observed when diversion rates increased:

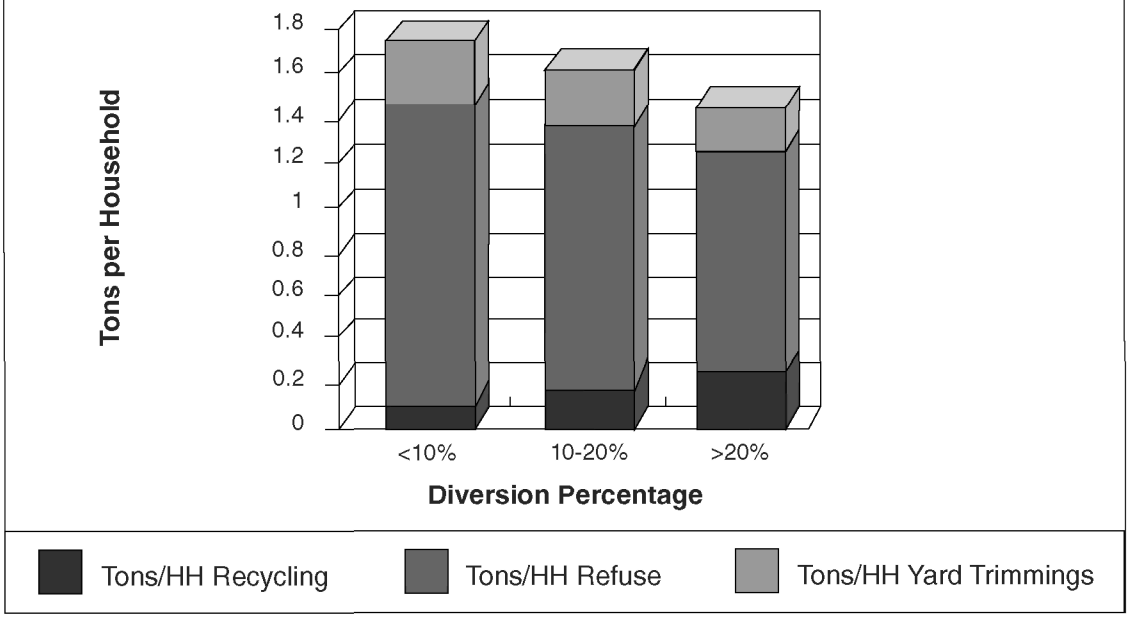
- The quantity of materials recycled increased.
- The quantity of materials discarded as refuse decreased.
- The *total* discard stream (recyclables plus refuse, for multifamily households, and recyclables plus refuse plus yard waste, for single family households) decreased.

It is possible that this decrease in the aggregate discard stream is due to households actually reducing their discards as they become attuned to recycling. Similarly, the decrease in the household discard stream (as diversion increases) might be a result of increased source reduction as residents actively participate in a recycling program. If true, these correlations would greatly enhance the economic viability of recycling.

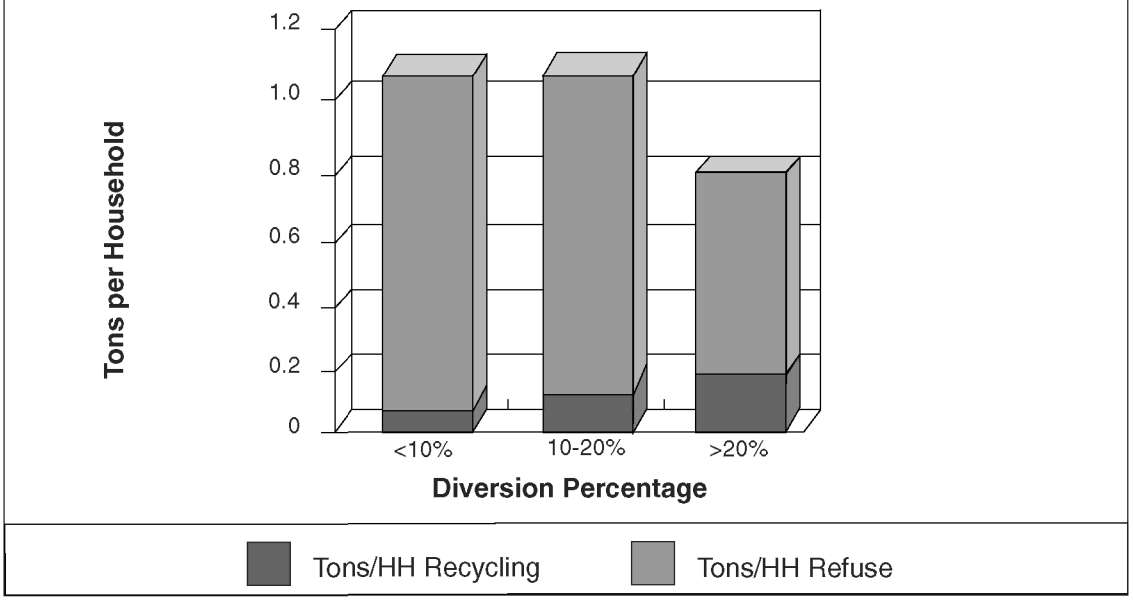
Costs

In addition to the materials a recycling program diverts, a key factor in any recycling program is its cost. Of all collection services studied (including multifamily and single family recycling and refuse, and yard trimmings collection), multifamily recycling has the highest average, minimum, and maximum cost per ton (see ES Figures 2a and 2b). In this study, the refuse collection costs per ton collected are the net of disposal expenses and processing costs. The following unit costs for the sample communities were obtained:

ES Figure 1a **Single Family: Diversion and Total Discards/Household**



ES Figure 1b **Multifamily: Diversion and Total Discards/Household**

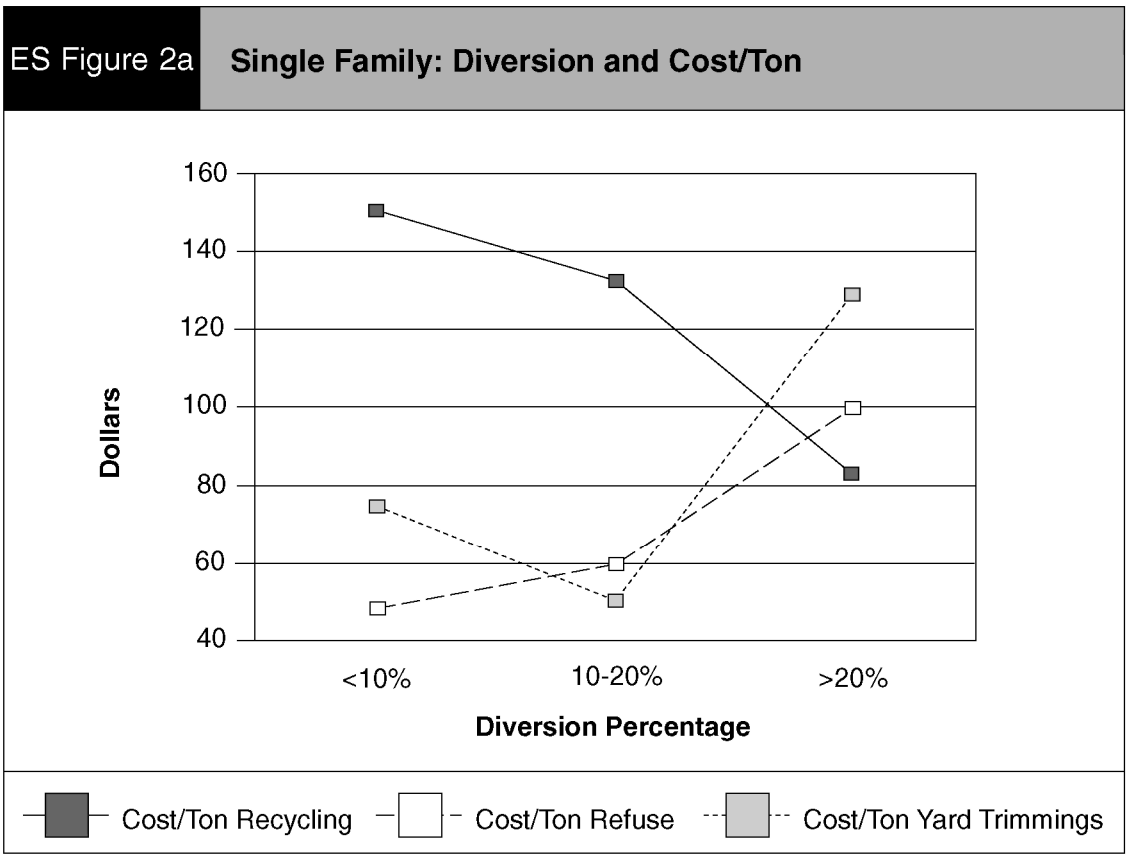


- Multifamily recycling costs an average of $177 per ton collected, with a range of $62 to $622. In comparison, single family recycling costs an average of $127 per ton, with a range of $11 to $420.
- Multifamily refuse collection costs an average of $63 per ton, just slightly less than single family refuse collection, which averages $69 per ton.

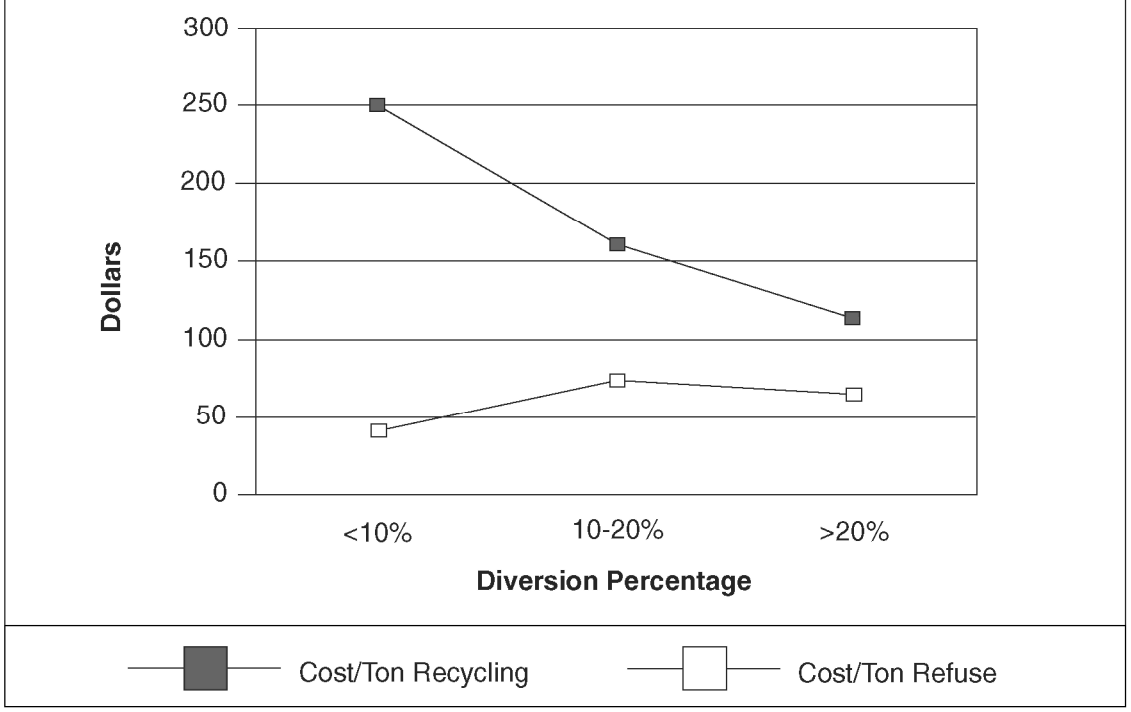
Collection costs per household served, for both single and multifamily households, however, tend to show the inverse relationship observed for costs per ton collected: the refuse collection figures are higher than the recycling figures. The following per household costs were obtained for the sample communities:

- Multifamily recycling costs an average of $20.50 per household served, with a range of $7.20 to $42.70. This compares to an average cost per single family household of $28.76, with a range of $6.04 to $64.82.
- Multifamily refuse collection costs an average of $53.69 per household per year, compared to an average of $68.23 for single family refuse collection. The cost per household receiving yard trimmings collection (typically a single family service) is $18.56.

ES Figure 2a **Single Family: Diversion and Cost/Ton**



ES Figure 2b **Multifamily: Diversion and Cost/Ton**



Successful Multifamily Recycling Programs

While these general data are an invaluable part of assessing the current status of multifamily recycling programs and their operations, another beneficial aspect of this study deals with program success and how it is attained. To help communities learn how to create or maintain a successful program, this report identifies and highlights the program characteristics that are associated with high diversion rates. The first step in this endeavor, though, is defining success. One definition of a successful multifamily recycling program might be any program that achieves a diversion rate higher than the 14.6 percent average calculated in this study. A more stringent definition, however, was applied during this research. Only communities that achieve a diversion rate of 20 percent or higher are considered successful in this study. Using this definition, the 40 communities can be grouped as follows:

- **High Diversion** (20 percent and up): 11 communities
- **Medium Diversion** (10 to 20 percent): 16 communities
- **Low Diversion** (less than 10 percent): 13 communities

Throughout this report, the terms *high*, *medium*, and *low* are used to describe the programs that fall into these three categories. Two important factors play into the success of a recycling program: efficiency and effectiveness. *Efficiency* refers to measures of the productivity of collection crews and *effectiveness* refers to how well a program meets policy objectives. A program can be very effective (i.e., high-diversion rate) and not very efficient (i.e., high unit costs). The most successful programs meet both of these criteria. The productivity measures for multifamily recycling used in this study are cost per ton collected, annual cost per household served, number of tons of recyclables collected per household per year, and diversion rates.

ES Table 3

Characteristics of Successful Multifamily Recycling Programs

Program Element	What Happens In High-Diversion Communities?	Percentage of High-Diversion Communities With This Practice
Management	Conduct recycling through a private firm under contract or exclusive franchise to local government.	82% of high-diversion group
Collection	Collect multifamily recyclables on the same routes as single family recyclables, using the same truck and crew.	61% of high-diversion group
Participation	Ensure compliance through mandatory participation, with sanctions available to local governments for enforcement.	90% of high-diversion group
Commodities	Include more recycled commodities: mixed waste paper, OCC, magazines, and phone books in addition to ONP, glass, plastics, and steel and aluminum cans.	82% of high-diversion group
Containers	Provide container with capacity of at least 90 gallons. Collect materials in sets of containers, with one set per 15-20 households and two to three containers in the average set.	64% of high- and medium-diversion groups
Fees	Charge monthly flat fee (usually $2 or more) to units for recycling. Charge variable fee for refuse (reduced solid waste fee as more materials are diverted to recycling). Average fee is lower in high-diversion communities.	63.6% of high-diversion group

What are the benefits of attaining that high-diversion level? Successful recycling programs often see the following results:

- Unit cost of collecting recyclables decreases. The average cost per ton to collect multifamily recycling in the low-diversion group is $177 versus $113 in the high-diversion group.
- Quantity of refuse set out for collection decreases. As diversion rates increase, however, the cost per ton to collect refuse increases from $43 per ton in the low-diversion group to $66 per ton in the high-diversion group.
- Decreases in refuse setouts exceed the increase in recycling, implying that waste reduction also is occurring in communities with the most successful recycling programs.

Part 1

General Survey Results

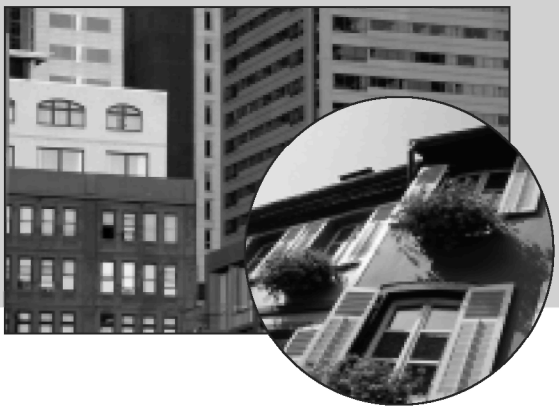
Chapter 1
What is Multifamily Recycling?

Chapter 2
Scale of Multifamily Recycling Programs

Chapter 3
Program Organization

Chapter 4
Diversion Percentages

Chapter 5
Costs



Chapter 1:

What is Multifamily Recycling?

At present, no universal definition of what constitutes a multifamily recycling program exists. Some or all multifamily dwellings within a community can receive recycling and refuse service as part of the regular single family service, for example. They also can receive service as part of the commercial sector. In some jurisdictions, multifamily units are served separately, distinct from either single family service or service for the commercial sector. Because so many variations exist, this study defines multifamily programs as *the recycling service provided to multifamily dwellings, distinct from that provided to single family establishments, if such a distinction exists*. Examples of how this definition was applied during the research phase of this study are described in this chapter.

Separate Multifamily Recycling Service

Some multifamily units in a community receive recycling service as part of their regular single family curbside recycling program, while other larger complexes receive separate service. Alameda, California, for example, includes duplexes in its single family curbside recycling program; triplexes and up are included in its multifamily recycling program. For this study, the multifamily program is defined as the service provided to triplexes and up.

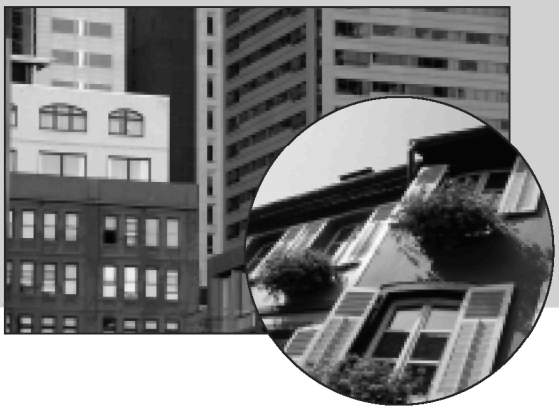
Differentiated Multifamily Recycling Service

In many communities, the multifamily recycling program is differentiated in some way (other than the number of units per complex) from the single family recycling program. This differentiation can be by collectors of recyclables, container types, collection frequencies, fee structures, or other elements. In cases where this distinction occurs, this study defines multifamily recycling as *the service provided to households served by the differentiated program*. Multifamily households receiving single family service (i.e., no differentiation in container type, collection frequency, etc.) are included in the single family service.

Townhouses, for example, frequently receive single family 18-gallon recycling bins, while larger multifamily complexes receive sets of 90-gallon carts. This study, therefore, includes the larger complexes in the multifamily recycling program and the townhouses in the single family program. Those units not included in either program are considered unserved.

Undifferentiated Multifamily Recycling Service

In a few communities, all households and establishments are included in the same recycling program. For these cases, this study defines the multifamily households by allocating the tonnages of recyclables collected proportionately to population in the single family households and in the multifamily households. For undifferentiated service, since multifamily and single family households are served on the same routes and by the same trucks, households per truck shift were calculated by dividing the total number of both multifamily and single family households by the total number of truck shifts. In this case, the number of households served per truck shift would be the same for multifamily and single family service. Households not included in the program are considered unserved.



Chapter 2:

Scale of Multifamily Recycling Programs

This study gathered information on multifamily recycling and refuse services, as well as single family recycling, refuse, and yard trimmings services, for all 40 sample communities. All of the communities provide single family recycling programs in addition to their multifamily service. Throughout this report, single family data gathered from the sample communities are included for comparison purposes. Unless otherwise indicated, references made to single family and multifamily data pertain to this same group of 40 communities. For more details on the study's methodology, see Appendix A.

Extent of Service—Sample Communities

The average number of multifamily households served in each sample program is 96,993, with a range of 301 to 2,992,169. The high-end estimate includes New York City (NYC); the mean without NYC is 22,758 households.[1] In comparison, the average number of single family households receiving curbside service in these communities, 44,069, is about twice as large. These data are displayed in Table 1.

Most multifamily households in the sample communities receive recycling service. In 27 out of the 40 communities, all of the multifamily households are included in the recycling programs. This means that in 67 percent of the communities with a multifamily recycling program, all multifamily households are served. In the remaining 33 percent of the communities, some multifamily households are not included in the program. The average number of multifamily households not included in each recycling program is 4,199, with a range of 0 to 45,125 (including NYC). In comparison, an average of 1,144 single family households are not included in the single family recycling programs.

The 40 communities collected an average of 14,714 tons of recyclables from multifamily households (2,665 excluding NYC). This compares to an average of 9,966 tons of recyclables collected from the single family households in these same communities. Including NYC, the 40 sample communities provide 3.9 million multifamily households with curbside recycling. Without NYC, the remaining 39 communities provide 887,558 multifamily households with curbside recycling. This figure represents 7.7 percent of the total 11.5 million multifamily households living in dwellings with 10 or more units in the United States (excluding NYC).

[1] In some instances, where an average of tonnage or total cost is calculated for the 40 communities, New York City's data are omitted in the interest of representative analysis. When per ton or per household costs or other factors are considered, however, New York City data are included.

Table 1

Multifamily Recycling—Sample Community Program Descriptions

Item	Multifamily Mean	Multifamily Minimum	Multifamily Maximum	Single Family Mean
Scale of Program:				
Number of HHs served	96,993	301	2,092,169	44,069
Excluding New York City	22,758	301	385,316	44,069
Number of HHs not served	4,199	0 (n=27)	45,125	1,144
Excluding New York City	4,307	0 (n=26)	45,125	1,144
Tons collected	14,714	36	484,640	9,966
Excluding New York City	2,665	36	44,773	9,966
Service Provided:				
Year program started	1991	1982	1996	1989
Percent mandatory	61.5%	0.0%	100.0%	64.1%
Number of set outs	2.6	0	7	2.3
Number of containers/set	2.4	1	7	1.6
Number of HHs/set	20.5	1	200	1
Percent to MRF	85.0%	100.0%	100.0%	88.0%
Complaints/HH/year	0.028	0	0.21	0.034
Number of collections/week	0.98	0.5	2	0.92
Type of container:				
Can or bag	0.0%	NA	NA	5.0%
Cart, 90-100 gal	50.0%	NA	NA	2.5%
Dumpster	17.5%	NA	NA	0.0%
Bin < 20 gal	17.5%	NA	NA	72.5%
Can or 60 gal cart	15.0%	NA	NA	20.0%
Who provides container:				
City	57.5%	NA	NA	60.0%
Private firm	35.0%	NA	NA	27.5%
Customer	7.5%	NA	NA	12.5%
Number of Items Recycled	9.4	1	16	NA

Projection of Sample Results Across the United States

The data obtained from the 40 sample communities represent a national sample. By calculating the number of multifamily households served in these communities, it is possible to project this information and obtain a reasonable estimate of the number of multifamily households served nationwide.[2] If the 118 communities with multifamily recycling programs (out of the total 227 communities) that responded to the assessment survey have an average size that parallels that of the 39 sample communities (excluding NYC), then approximately 2.68 million multifamily households are served by the 118 respondent communities. Following this logic, how prevalent is multifamily recycling in the United States? Consider the following assessments:

- The 118 communities (with multifamily recycling programs) that responded to the assessment are estimated to provide recycling service to 23.4 percent of 11.5 million multifamily households (living in buildings with 10 or more dwelling units) in the United States.
- The percentage of multifamily households receiving recycling services could exceed 23.4 percent, if some communities with programs did not respond to the assessment survey.
- Since 52 percent (118 out of 227 total respondents) of those communities responding to the assessment survey reported a multifamily recycling program, and if this fairly represents all communities in the United States, then nearly 52 percent of U.S. multifamily households might currently be served by recycling programs.
- As communities with a multifamily recycling program were probably more likely to have answered the assessment survey than were communities without such a program, 52 percent is probably an upper bound estimate of the percentage of multifamily households with access to recycling in the United States.

Distribution of Responses and National Potential Diversion Projection

A total of 118 communities indicated they had a multifamily recycling program. The following list shows the percentage of communities (in each region) that indicated they had such a program:

- Midwest: 37 percent
- South: 45 percent
- Northeast: 63 percent
- West: 68 percent

It is possible these responses are skewed toward those communities with recycling programs for multifamily housing since they were more likely to have responded to the assessment survey. Care should be taken, therefore, in generalizing as to the frequency of these programs across the nation.[3]

Statistics on the current diversion attained in the 40 sample communities enable a prediction of the potential for multifamily recycling's future national growth and diversion achievement. An estimate of the potential for increased diversion can be determined for each geographical region by applying the unserved percentages to the region's total number of multifamily housing units. In the Northeast, for example, where there are

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[2] The sampling methodology utilized selects programs in proportion to the entire universe of large multifamily housing units in each sector. This approach enables a reasonable projection to the entire universe of multifamily units, assuming full-scale adoption of recycling programs for these units. So, for example, the average diversion per multifamily unit, as predicted from the sampled programs, can validly be projected as the potential for the entire country, assuming recycling in multifamily housing were adopted everywhere.

[3] The sampling approach enables reasonably valid national projections to be made. The approach determines sample size per region based upon the regional distribution of multifamily units in the United States, not the regional distribution of multifamily recycling programs. Thus, the sampling approach does not provide an equal chance of all programs being included in the sample. Programs in a region with few cities providing multifamily recycling and many multifamily units are more likely to be selected for this study than are programs in a region with many multifamily recycling programs. Selection was most likely in the Northeast, where 10 out of 15 programs in existence for more than a year were selected. Selection is least likely in the West, where 10 out of 46 programs were selected. In the Midwest, 8 out of 21 programs were selected; in the South, 12 out of 27 programs were selected. In the actual sampling, numbers were assigned to all eligible programs in each geographic sector, and the desired number of samples was drawn at random.

3.46 million households in buildings with 10 or more units, if 36 percent do not receive service, then, at an average recycling rate of 0.14 tons per multifamily household per year, an additional 174,384 tons could be diverted from these households. Nationally, this methodology yields an estimated 847,205 additional tons that could be diverted from disposal. This figure for potential diversion might be even higher in reality. It is likely that cities with multifamily recycling programs were disproportionately likely to respond to the assessment survey, making the percentage of all communities with multifamily recycling programs significantly less than the regional figures cited above. In that case, the potential diversion from disposal possible by increasing coverage of multifamily recycling would only increase from the estimate presented above.

Chapter 3:

Program Organization

A multifamily or single family recycling program is typically defined by the following characteristics:

- Organizational arrangement for collection of recyclables
- Materials collected
- Set-out practice
- Containers used by households
- Frequency of collection
- Collection methodology
- Processing of materials
- Marketing of materials
- Program financing arrangement

Organizational Arrangement

For all collection services, there is a basic differentiation between services provided by employees of a local government (i.e., municipal service) and services provided by employees of a private firm (i.e., private service). Private service includes the following: contract service, franchise service, and subscription service. For a more detailed definition and explanation of these terms, see Appendix B.

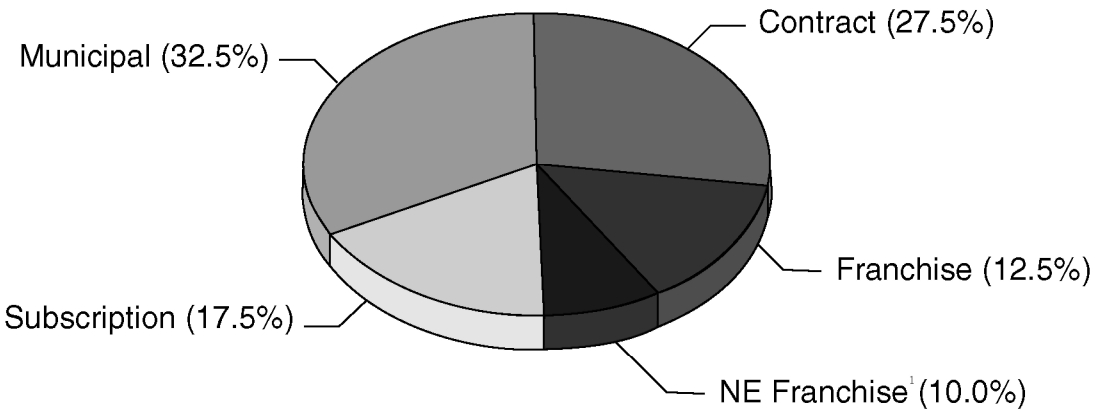
Figure 1 describes the types of organizational arrangements for multifamily recycling programs found among the 40 sample communities. The key findings are as follows:

- Private firms perform most of the multifamily recycling collection (67.5 percent).
- Only 32.5 percent of the communities have public sector recycling collection for multifamily complexes.
- Most private collection is under a contract or exclusive franchise agreement between the firm and the local government.
- Only 17.5 percent rely on subscription agreements between private firms and customers. Communities with subscription arrangements tend to be located in states such as Connecticut, where it is mandated that all refuse customers be provided with recycling services.
- 61.5 percent of the programs are mandatory.
- The average year of program inception was 1991.
- The average number of complaints per household is 0.028.

Compared to multifamily collection services, the study found that single family recycling services are:

- About as likely to be provided by municipal employees (30 percent).

Figure 1 Organizational Arrangements for Multifamily Recycling Collection



NOTE: See Appendix B for definitions of organizational arrangements.
[1] NE Franchise is nonexclusive franchise.

- Significantly more likely to be under exclusive franchise and contract arrangements (60 percent).
- Less likely to be controlled by subscription arrangements (10 percent).

These findings are consistent with the observation that communities often consider multifamily units to be a part of the commercial sector, and commercial garbage and recycling services are less frequently provided under municipal, contract, or exclusive franchise arrangements.

Compared to single family recycling programs, the multifamily recycling programs are slightly less likely to be mandatory (61.5 percent versus 64.1 percent), more recently established (average inception in 1991 versus 1989), and generate slightly fewer complaints per household served (0.028 versus 0.034 per household per year).

Setout Practices/Container Type

According to the results from the sample communities, multifamily households are typically not provided with individual containers for their recyclables. Instead, sets of containers are shared, with each set serving an average of 20.5 households. A set of containers ranges from 1 to 7 receptacles, with an average of 2.4 containers per set. The number of containers, not surprisingly, corresponds almost exactly to the number of set-outs required: an average of 2.6, with a range of 0 (a community with a dirty materials recovery facility) to 7. In some cases, a material, such as old corrugated cardboard, may be placed alongside, instead of actually inside, the recycling containers.

Approximately 58 percent of local governments pay for the sets of containers provided for their multifamily programs. The most widely used multifamily recycling container, appearing in 50 percent of the sample communities,

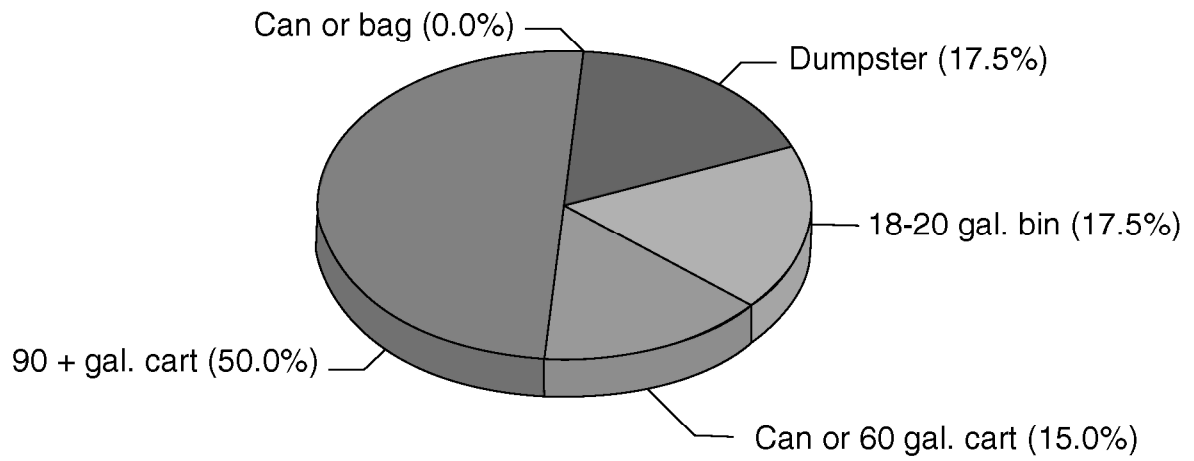
is the 90- to 100-gallon wheeled cart. The second most widely used containers, tied at 17.5 percent each, were Dumpsters (typically 1 to 4 cubic yards) or traditional rectangular plastic boxes of approximately 20-gallon capacity. The remaining 15 percent of the programs use a 60-gallon cart or large garbage can. Figure 2 shows the distribution of containers used for multifamily recycling collection. Note, these types of containers are loaded into the recycling vehicle, and are not provided to each multifamily household.

In comparison, single family recycling programs are overwhelmingly likely to use a rectangular plastic bin for holding recyclables (72.5 percent); the next most popular container for single family recycling programs is the 60-gallon cart. In contrast to multifamily recycling programs, where only 7.5 percent of customers must provide their own containers, in single family programs, 12.5 percent of communities require the generator to provide customers with the recycling container.

Collection Frequency

Recyclables are collected more frequently in multifamily dwellings than in single family households, perhaps because storage space is limited and relatively expensive in multifamily complexes. For multifamily households, the average number of recycling collections per week is 0.98, with a range of 0.5 to 2. Frequency is lower for single family programs than for multifamily programs; the average number of single family collections

Figure 2 Containers for Multifamily Recycling



is 0.9 per week. Approximately one in five communities collects single family recyclables every other week while four in five provide weekly collection. In comparison, only one of the 40 communities studied collected recyclables every other week in multifamily programs.

Commodities Collected

The 40 sample programs collected an average of 9.4 commodities, with a range of 1 to 16. The following list details the number of sample communities collecting different numbers of commodities:

- 1 community collects 1 item (old newspapers)
- 1 community collects 5 items
- 2 communities collect 7 items
- 7 communities collect 8 items
- 11 communities collect 9 items
- 4 communities collect 11 items
- 5 communities collect 12 to 16 items

The commodity most frequently recycled is old newspapers (ONP), with 100 percent of communities recycling this material.

The other materials are listed in descending order of prevalence:

- Aluminum and ferrous cans and clear and green glass (95 percent each).
- Brown glass (92.5 percent).
- Polyethylene terephthalate (PET) plastic (87.5 percent).
- High-density polyethylene (HDPE) plastic (85 percent).
- Old corrugated cardboard (OCC) (67.5 percent).
- Mixed waste paper (42.5 percent).
- Magazines and phone books (37.5 percent).
- Others—usually aseptics, gable tops, etc. (22.5 percent).
- Plastics other than #1 and #2 (12.5 percent).
- Fibers (i.e., textiles and fabric), ferrous scrap, and used oil (5 percent each).

Chapter 4:

Diversion Percentages

As an indicator of success, diversion is calculated for each of the sample communities. In multifamily recycling programs, diversion is determined by computing the tonnage of multifamily refuse generated and recyclables collected, and then computing the ratio of per household multifamily recycling to the sum of per household multifamily recycling and refuse. The per household approach allows for the fact that a different number of households is often included in the recycling and the refuse collection programs. The multifamily diversion rates computed in this study, therefore, are what would be achieved if all households that receive refuse collection were included in the recycling program. An alternative diversion rate, which would be lower in virtually all cases, would be the annual multifamily recycling tons divided by the sum of the annual multifamily recycling and refuse tons. For more information on how diversion rates were calculated, see Appendix B. Diversion rates, shown in Table 2, are as follows:

- Multifamily households included in multifamily recycling programs set out an average of 0.14 tons per household per year for recycling; this compares to an average of 0.23 tons per household receiving single family service.
- Refuse collected from multifamily households averages 0.87 tons per year; compared to an average 1.13 tons per year for single family households.
- By computing the ratio of tons recycled to the sum of all discards, the diversion rate for multifamily recycling can be computed. The average diversion rate for multifamily curbside recycling is 14.6 percent, with a range of 0.5 percent to 37.3 percent.
- Single family curbside diversion averages 16 percent with a range of 6 percent to 36 percent. Yard trimmings diversion ranges from 0.7 percent to 32.8 percent of single family discards, with a mean of 16.2 percent.
- These diversion rates show an upward trend for single family service, compared to 1993 data, where diversion rates of 13 percent for single family recycling and 15.4 percent for yard trimmings were obtained.[4]
- When materials delivered to local government drop-off facilities are added to tonnages collected at the curb, diversion rates increase. Multifamily diversion jumps to 15.7 percent, while the single family curbside diversion rate increases to 17.1 percent.
- Yard trimmings diversion actually decreases when drop-off center data is included, but this is attributable to a decrease in the number of communities for which data are available.

[4] Survey conducted by ECODATA, 1994. The data for 1993 can be found in Stevens, Barbara, "Recycling Collection Costs by the Numbers," *Resource Recycling*, Vol XIII #9 (September 1994), 53-60; and in Stevens, Barbara, "What Does It Cost to Collect Yard Debris?" *Resource Recycling*, Vol XIII #10 (October 1994), 22-24.

Participation in the multifamily recycling programs varies, yet the average multifamily program achieves a diversion rate just 1.4 percent below the average diversion rate achieved by single family curbside programs. The multifamily diversion rate is as high as it is because multifamily households, with typically fewer persons per household than single family households, generate both less refuse and less recyclables than do single family households. Thus, though the curbside diversion rate for multifamily programs averages 14.6 percent compared to 16.0 percent for single family programs, the recycling tonnage per household is 65 percent greater for single family households than for multifamily households. In terms of tonnages, single family households set out 0.23 tons of recyclables, and 0.28 tons of yard trimmings and 1.13 tons of refuse per household per year.

Table 2 **Multifamily and Single Family Diversion Rates**

Item	Mean	Minimum	Maximum	n
TONS/HH—CURBSIDE				
Multifamily Recycling	0.14	0.01	0.42	40
Multifamily Refuse	0.87	0.29	2.44	40
Single Family Recycling	0.23	0.05	0.66	39
Single Family Refuse	1.13	0.55	2.44	39
Yard Waste	0.28	0.01	0.65	27
% diverted—MF	14.6%	0.5%	37.3%	40
% diverted—SF Curbside	16.0%	6.0%	36.0%	27
% diverted—SF Yard Trimmings	16.2%	0.7%	32.8%	27
TONS/HH—CURBSIDE + DROP OFF				
Multifamily Recycling	0.15	0.01	0.42	40
Multifamily Refuse	0.87	0.29	2.44	40
Single Family Recycling	0.25	0.05	0.79	39
Single Family Refuse	1.14	0.55	2.44	27
Yard Waste	0.27	0.01	0.65	25
% diverted—MF	15.7%	0.5%	37.7%	40
% diverted—SF Curbside	17.1%	6.0%	32.3%	24
% diverted—SF Yard Trimmings	15.7%	0.7%	38.7%	25

Chapter 5:

Costs

Another important aspect of any collection program, in addition to its organizational and structural elements, is its cost. In this study, for comparison purposes, data were collected on the various costs reported from each sample community for multi- and single family recycling and refuse programs.

Definition—Cost of Service—the actual cost of municipal service or the payment to the private firm, in the cases where service is provided by a private firm. For recycling service, costs include costs to the local government—municipal costs or payments to a private firm less recycling revenues remitted to the local government, if any. For refuse collection, costs of transfer, if any, or disposal are not included. Thus, no profit is included for municipal service, whereas, the cost includes any profit the private firm might earn.

For municipal service, costs are defined as the sum of wages of personnel on vehicles used for the service, wages of persons supervising those crews, fringe benefits for the above personnel, vehicle operating and maintenance expenses (including labor), other operating expenses (including billing customers, office expenses, etc.), and depreciation of vehicles and containers. Backup personnel and vehicles also are included in the cost of the service. Depreciation of vehicles is computed on a 7-year straight-line basis, and depreciation of containers is computed on a 10-year straight-line basis.

Costs Per Ton

Table 3 displays the unit costs (or costs per ton) of refuse collection and recycling for the multi- and single family programs of the 40 sample communities. Multifamily recycling costs an average of $177 per ton collected, with a range of $62 to $622. In comparison, single family recycling costs an average of $127 per ton, with a range of $11 to $420. Out of all collection services studied (including multi- and single family recycling and refuse, and yard trimmings collection), multifamily recycling has the highest average, minimum, and maximum cost per ton. Multifamily refuse collection costs an average of $63 per ton, just slightly less than single family refuse collection, which averages $69 per ton. The refuse collection costs per ton collected are the net of disposal expenses and processing costs.

Costs Per Household

Multifamily recycling costs an average of $20.50 per household served, with a range of $7.20 to $42.70. This compares to an average cost per single family household of $28.76, with a range of $6.04 to $64.82. Multi- and single family refuse collection cost an average of $53.69 and $68.23, respectively, per household per year. The cost per household receiving yard trimmings collection is $18.56. Collection costs per household served, for both single and multifamily, tend to show the inverse relationship to costs per ton collected: the refuse collection figures are higher than recycling figures when the productivity measure is cost per household served. These data also are displayed in Table 3.

In several cases, very low tonnages in multifamily recycling programs were reported and reconfirmed during research. These communities then became associated with very high unit collection costs. In the final analysis, two communities (with collection costs per ton in excess of $2,000) were excluded from reported collection cost

Table 3	Cost/Ton and Cost/Household Multifamily and Single Family Recycling and Refuse			
Item	Mean	Minimum	Maximum	n
COLLECTION COST/TON COLLECTED:				
Multifamily Recycling*	$177.00	$62.00	$622.00	38
Multifamily Refuse	$63.00	$16.00	$171.00	36
Single Family Recycling	$127.00	$11.00	$420.00	35
Single Family Refuse	$69.00	$16.00	$286.00	38
Yard Trimmings	$74.00	$17.00	$195.00	19
COST/HH/YEAR, COLLECTION				
Multifamily Recycling	$20.50	$7.20	$42.70	38
Multifamily Refuse	$53.69	$16.53	$266.08	36
Single Family Recycling	$28.76	$6.04	$64.82	35
Single Family Refuse	$68.23	$8.86	$189.00	38
Yard Trimmings	$18.56	$2.91	$47.32	19

* Excludes two communities with very low tonnages (and high cost/ton).

data. These two communities had a similar profile. Each community had average costs per household served but abnormally low quantities of recyclables collected, which explains the high cost per ton collected. In both cases, little public information or onsite instruction was made available. Neither community tracked quantities of recyclables collected from multifamily establishments.

While costs are an important element in considering a multifamily recycling program's success, many other factors can influence the effectiveness and efficiency of a program. Part Two of this report assesses the many variables and measures of success.

Cost Trends Over Time

In comparison to 1993 data collected from a national survey of single family refuse, recycling, and yard trimmings programs, single family recycling costs have decreased from a level of $170 per ton.[5] This appears to be attributable to increased participation in recycling, with a slight increase in tonnage of recyclables and yard trimmings and a decrease in refuse collected per household. The per ton cost for yard trimmings collection averaged $74 in 1997, compared with $73 in 1993. Refuse collection costs for single family service were $54 per ton in 1993, whereas, in this study the costs are $68.23 per ton.

Also, over this period, the quantity of recyclables and refuse per household changed. In 1993, the tons of refuse collected per household averaged 1.36, compared to 1.13 in 1997. Recyclables collected per household have increased from 0.21 tons in 1993 to 0.23 tons in 1997. Thus, the diversion rate for single family recycling increased from 13 percent in 1993 to 16 percent in 1997. This is probably attributable to a combination of factors including increased inclusion of commodities, such as mixed waste paper, in recyclable collection, education of households, and, potentially, source reduction of waste. Yard waste is included in the denominator of these diversion percentages.

[5] Survey conducted by ECODATA, 1994. The data for 1993 can be found in Stevens, Barbara, "Recycling Collection Costs by the Numbers," *Resource Recycling*, Vol XIII #9 (September 1994), 53-60; and in Stevens, Barbara, "What Does It Cost to Collect Yard Debris?" *Resource Recycling*, Vol XIII #10 (October 1994), 22-24.

PART 2

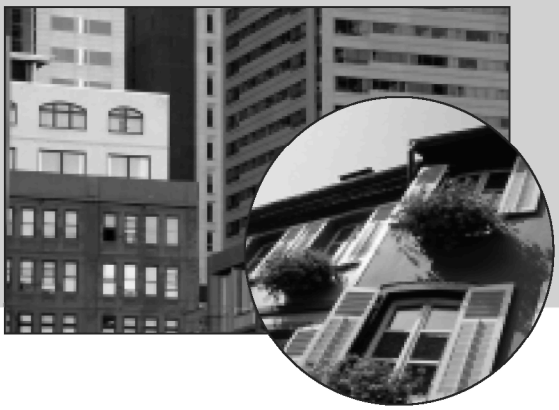
Characteristics of Successful Multifamily Recycling Programs

Chapter 6
Measuring Success

Chapter 7
Elements of Successful Programs

Chapter 8
Lessons Learned

Chapter 9
Summing Up Success



Chapter 6:

Measuring Success

A successful recycling program can be defined as one that achieves a high diversion rate, avoiding the disposal of a large percentage of the discard waste stream. One definition of success, then, could be any program that achieved a diversion rate higher than the 14.6 percent average calculated in this study. This study applied a more stringent definition, however, by considering only those communities that achieve a diversion rate of 20 percent or higher as successful. Using this definition, the 40 communities can be grouped as follows:

High Diversion (20 percent and up):
11 communities

Medium Diversion (10 to 20 percent):
16 communities

Low Diversion (less than 10 percent):
13 communities

Throughout this report, the terms high, medium, and low are used to describe the programs that fall into those three categories.

Program Efficiency and Effectiveness

Successful recycling programs also can be defined in terms of efficiency or effectiveness. *Efficiency* measures determine whether resources are used efficiently in producing the program's outputs. For refuse and recycling collection services, typical measures of efficiency involve the productivity of collection crews, such as households served per crew shift, households served per crew labor hour, or percentage of time vehicles are available for duty (i.e., not down for maintenance). If all other program elements are equal, *increases* in variables such as these imply a more efficient collection operation, perhaps attributable to more efficient routing, vehicle maintenance, scheduling and deployment of personnel, and the location of off-loading facilities and yards. Other measures of efficiency include cost measures, such as the cost per ton collected or the cost per household served. For these measures, the key words are: *other things being equal*. Other things being equal, *decreases* in the cost per ton collected and cost per household served can be associated with increases in program efficiency.

Effectiveness measures indicate the extent to which the program meets policy objectives. If a state has a recycling goal of 50 percent, for example, then a program's effectiveness is measured by the extent to which it diverted waste from disposal. A program can be very effective (i.e., high diversion rate) and not very efficient (i.e., high unit costs). Obviously, the most successful programs are those that are both effective and efficient, or those characterized by high diversion rates and low unit costs.

Interrelationship of Measures of Success

Effective and efficient programs, however, must take into consideration many interrelated variables. The various measures of effectiveness and efficiency of a recycling program need to be considered together, not in

isolation. A particular program can be identified as efficient and effective only by considering many variables. The costs of a program, for example, are dependent upon factors that are both within and beyond the control of local government officials. Population density, prevailing wages, weather patterns, and income levels can affect travel times between collection stops, quantities of materials set out at each stop, operation of a vehicle (vehicles are more prone to breakdowns in areas with severe winters), and the basic cost of a collection crew. Frequency of collection and location of pickup (almost always at curbside for recyclables, but sometimes in the backyard), also are elements of service not typically determined by the manager of collection operations (especially if the manager is a private firm hired under contract to the community).

These type of multivariate evaluations of local government services have been conducted in the past, for services ranging from solid waste collection to recycling to traffic signal maintenance, to wastewater treatment.[6] In multivariate analysis, the total cost function for delivering a particular local government service is estimated as a function of local geographic, economic, and demographic factors; service level features; and characteristics of local population. More than 85 percent of the variance in total costs of a refuse or recycling collection program, for example, can be explained by scale of operations (tons collected), density of stops, quantity of material per stop, frequency of collection, location of pickup, and prevailing wages. The logic for each of these relationships, assuming all other variables are equal, is as follows:

- Economic factors: the higher the local prevailing wages, the higher the program costs.
- Geographic factors: the higher the density per curb mile, the less time spent traveling between stops, and the lower the program costs.
- Demographic and income factors: the higher the amount of material set out for collection at each stop, holding constant the total amount of material collected, the lower the program costs.
- Scale of operations: the larger the total quantity of materials to collect, the higher the program costs.
- Service level: the more frequent, and less accessible to the road (e.g., backyard service), the collection service, the higher the program costs.

Consider the relationship between two measures of efficiency: cost per ton collected and cost per household served. For a constant number of households and a constant quantity of recyclables per household, programs with lower per ton costs are more efficient than programs with higher costs. Looking at just the cost per household without considering the quantity of materials recycled per household, however, can be deceptive. If the program provides weekly service but there is little participation, with crews driving the routes and finding setouts every tenth house instead of every other house, then the costs per household will be low but the cost per ton collected will be high. On the other hand, as a program becomes very effective in diverting a large portion of the discard waste stream, the cost per household may increase but the cost per ton collected may decrease, as it is less costly to collect larger quantities of material from a given number of stops than to collect small quantities of materials from a given number of stops, other things being equal. Further analysis of the data collected in this study could include multivariate analysis, but such analysis is beyond the scope of this study.

Measures of Program Success

Table 4 presents the following productivity measures for multifamily recycling programs:

- Cost per ton collected.
- Annual cost per household served.
- Number of households served per crew shift.
- Number of tons of recyclables collected per household served per year.
- Diversion rate.

[6] See, for example, Barbara J. Stevens, "Scale, Market Structure, and the Cost of Refuse Collection", *Review of Economics and Statistics*, LX, #3, (August 1978), 438-448, for a report on an econometric estimate of cost functions for solid waste collection, based on a sample of more than 300 randomly selected cities in the United States; Barbara J. Stevens, "Comparing Public- and Private-Sector Productive Efficiency: An Analysis of Eight Activities", *National Productivity Review*, Volume 3, #4, (Autumn 1984), 395-406, for a summary of research on eight local government services, each of which was analyzed with multivariate econometric techniques; and Roger Patrick, et. al. 1997 Benchmarking Wastewater Operations: Collection Treatment and Biosolids Management, Project 96-CTS-5, Water Environment Research Foundation, Alexandria, Virginia, for a multivariate analysis of wastewater collection and biosolids treatment.

Table 4 Productivity Measures and Multifamily Diversion Rates

Value	Multifamily Curbside Diversion <10%	10-20%	>20%	Statistical Significance**
Number of Observations	**13**	**16**	**11**	**40**
Collection Cost/Ton				
Multifamily Recycling*	$251.00	$159.00	$113.00	Yes-95%
Multifamily Refuse	$43.13	$72.60	$66.39	Yes-99%
Single Family Recycling	$151.80	$131.70	$81.64	Yes-99%
Single Family Refuse	$47.48	$60.28	$101.32	Yes-99%
Single Family Yard Trimmings	$75.03	$51.48	$127.16	No
Collection Cost/Household/Year				
Multifamily Recycling	$16.63	$20.56	$21.81	No
Multifamily Refuse	$45.17	$72.34	$36.01	No
TOTAL PER MF HOUSEHOLD	$61.80	$92.90	$57.82	
Single Family Recycling	$21.65	$30.96	$24.73	No
Single Family Refuse	$58.69	$64.71	$84.01	Yes-90%
Single Family Yard Trimmings	$16.05	$20.67	$15.89	No
TOTAL PER SF HOUSEHOLD	$96.39	$116.34	$124.63	
Households/Crew Shift				
Multifamily Recycling	2,333	2,246	1,676	No
Multifamily Refuse	1,205	1,537	2,144	No
Single Family Recycling	1,561	1,549	1,629	No
Single Family Refuse	618	1,142	3,962	Yes-90%
Tons/Household/Year				
Multifamily Recycling	0.061	0.145	0.211	Yes-99%
Multifamily Refuse	1.023	0.934	0.595	Yes-95%
TOTAL MF Municipal Solid Waste	1.084	1.079	0.806	Yes-95%
Single Family Recycling	0.139	0.260	0.297	Yes-99%
Single Family Refuse	1.312	1.123	0.951	Yes-95%
Single Family Yard Trimmings	0.317	0.258	0.209	No
TOTAL SF Municipal Solid Waste	1.768	1.641	1.457	Yes-95%
Curbside Diversion Rates				
Multifamily Recycling	6.04%	13.93%	27.76%	Yes-99%
Single Family Recycling	9.25%	17.70%	20.39%	Yes-99%
Single Family Yard Trimmings	16.94%	15.90%	12.48%	No
Complaints/Household/Year	**0.017**	**0.040**	**0.017**	**No**

* Excludes two cities with very high per ton costs, in the less than 10% diversion group.

** Indicates whether or not the difference in values is statistically significant, and the confidence level with which the null hypothesis of no difference can be rejected.

This chapter examines each of those measures in detail and how they are affected by the *success* of a multifamily recycling program (i.e., as the diversion rate increases).

Diversion Rates

A key measure of the success of a recycling program is the diversion rate it achieves.

Based on this study's results, the following observations can be made about diversion rates for multifamily and single family households in the sample communities (see Table 4):

- The quantity of materials recycled increases as diversion rates increase.
- The quantity of materials discarded as refuse or garbage decreases as diversion rates increase.
- The aggregate discard stream (i.e., recyclables and refuse for multifamily households and recyclables, refuse, and yard trimmings for single family households) decreases as diversion rates increase.

The decrease in the aggregate discard stream is particularly interesting and has two possible explanations. First, it is possible that higher diversion rates occur in communities with smaller households than in communities with larger households. In this case, the per capita discard stream would not decrease with increases in diversion rates. Second, it is possible households actually reduce their discards as they become attuned to recycling and achieve high recycling diversion. In this scenario, there would be little difference between the persons per household in the high- and low-diversion communities, and discards per capita would decrease with increases in diversion.

Figure 3 **Multifamily: Diversion and Total Discards/Household**

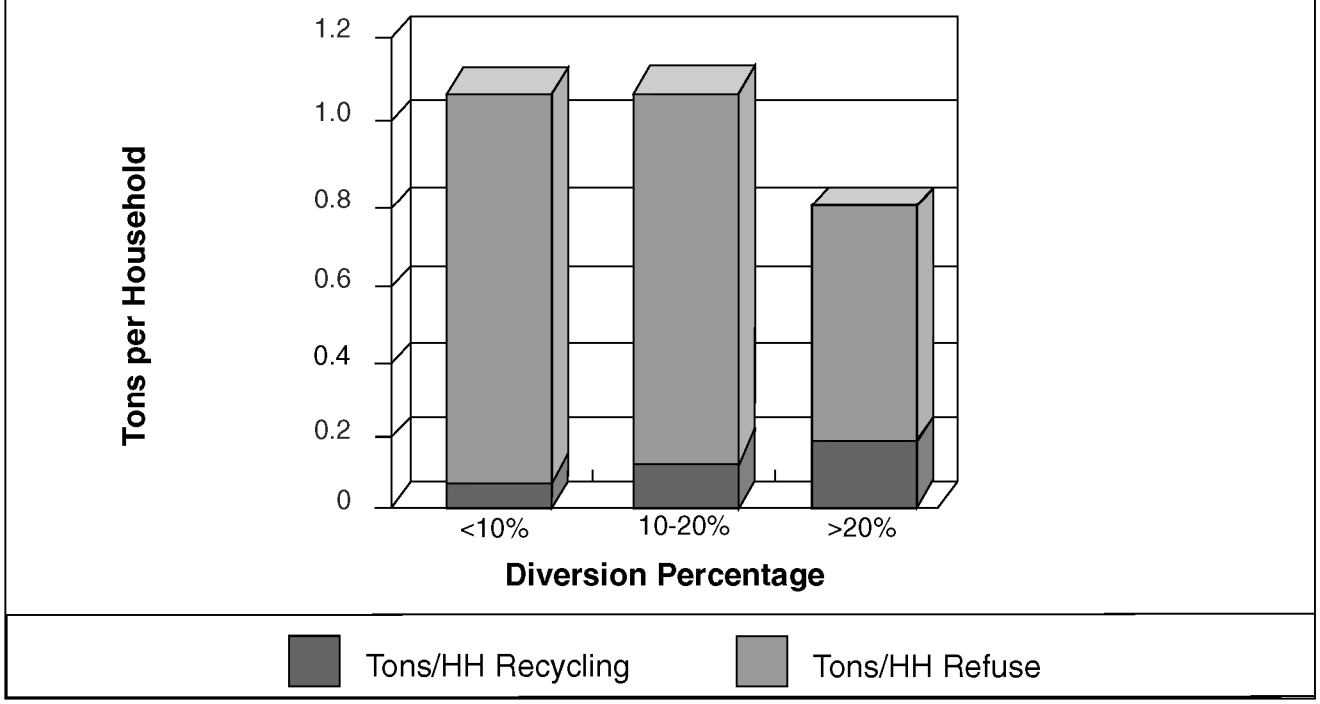
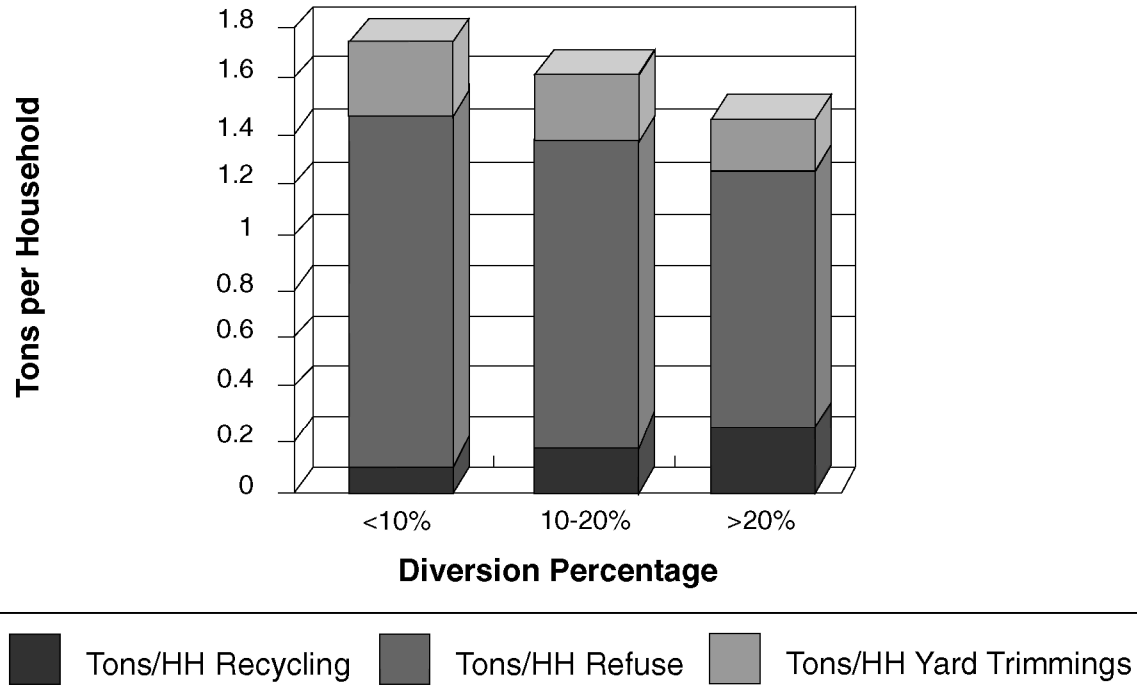


Figure 4 **Single Family: Diversion and Total Discards/Household**



As shown in Figure 3, in communities with low-diversion rates, the aggregate discard tons per multifamily household is 1.084. For communities with high diversion rates, the aggregate discard amount per multifamily household is 0.806 tons. For single family households, the aggregate discard stream reduction is 1.768 tons for households in communities with low-diversion rates and 1.457 tons for households in communities with high diversion rates (see Figure 4). These findings may indicate source reduction occurs as a byproduct of active participation in recycling programs—a fact that, if true, would greatly enhance the economic viability of recycling.

Collection Efficiency

Households per crew shift is a frequently used productivity measure. Table 5 shows the households served per crew shift for multifamily recycling, multifamily refuse, single family recycling, single family refuse collection, and yard trimmings collection (typically, a single family service). The number of households served per crew shift tends to increase or decrease based on the following variables:

- Collection Frequency—for a given quantity of recyclables, the more frequent the collection, the smaller the quantity to collect at each scheduled pickup. Less collection time is required per stop, and the number of households served per crew shift increases.
- Program Participation—as fewer households participate in a recycling program, the percentage of stops at which collections are made decreases, thereby decreasing the average collection time per stop, and the number of households served per crew shift increases.
- Quantities Collected—as the quantity of materials set out at each collection stop decreases, so does the time spent at each stop. This increases the number of households that can be served per crew shift.
- Collection Operation—as crew deployment becomes more efficient (e.g., reducing dispatch time from 30 minutes to 5 minutes or switching from a rear loader to a side loader with a low entry cab), the time available on route to service stops increases. This increases the number of households that can be served per crew shift.

In light of these observations, it follows that more

Table 5 Multifamily Recycling Program Efficiency Measures

Item	Mean	Minimum	Maximum	n
HOUSEHOLDS/CREW SHIFT				
Multifamily Recycling	2,167	395	5,156	31
Multifamily Refuse	1,559	16	4,372	20
Single Family Recycling	1,566	427	3,587	26
Single Family Refuse	924	480	3,066	26
Yard Trimmings	No Data	—	—	—
COLLECTION COST/TON COLLECTED:				
Multifamily Recycling*	$177.00	$62.00	$622.00	38
Multifamily Refuse	$63.00	$16.00	$171.00	36
Single Family Recycling	$127.00	$11.00	$420.00	35
Single Family Refuse	$69.00	$16.00	$286.00	38
Yard Trimmings	$74.00	$17.00	$195.00	19
COST/HH/YEAR, COLLECTION				
Multifamily Recycling	$20.50	$7.20	$42.70	38
Multifamily Refuse	$53.69	$16.53	$266.08	36
Single Family Recycling	$28.76	$6.04	$64.82	35
Single Family Refuse	$68.23	$8.86	$189.00	38
Yard Trimmings	$18.56	$2.91	$47.32	19

* Excludes two communities with very low tonnages (and high cost/ton).

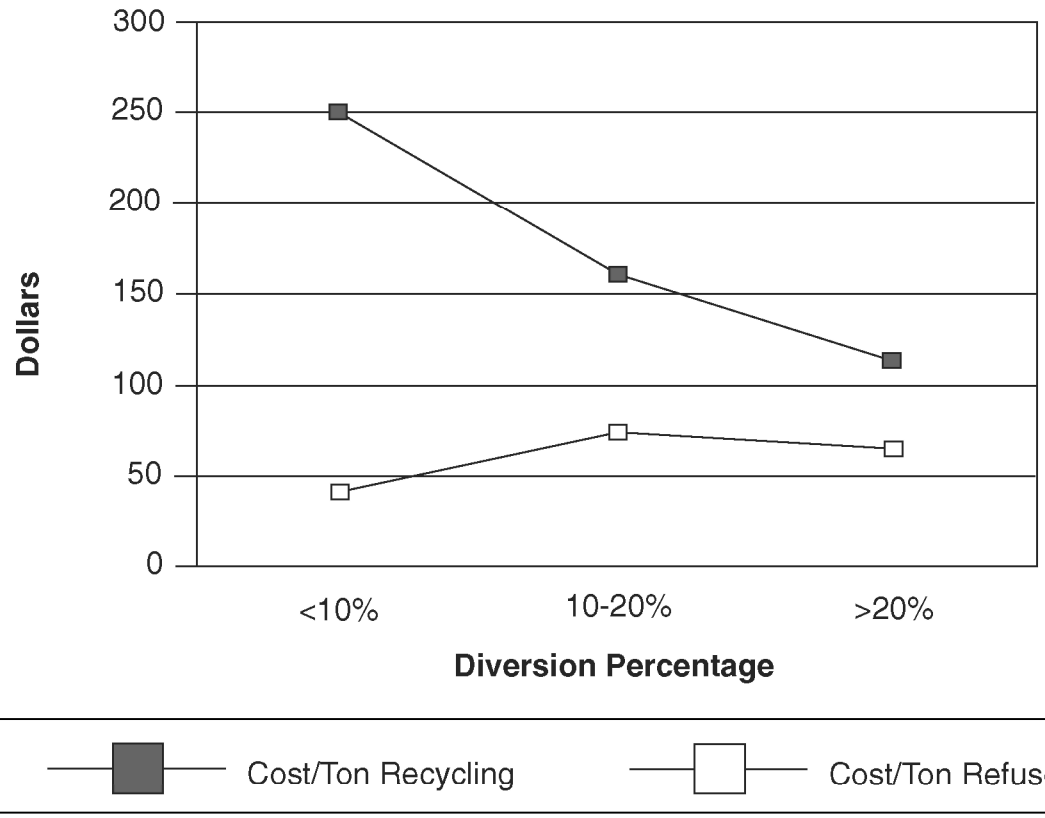
households would be served per crew shift for recycling than for refuse collection, as the latter service usually has more material set out for collection and higher participation. This is true for the sample communities, with multifamily recycling programs serving an average of 2,167 households per crew shift and multifamily refuse collection programs serving an average of 1,559 households per crew shift. In comparison, single family programs served an average of 1,577 households for recycling and 924 for refuse collection. The figures are lower for single family service than for multifamily because more containers must be emptied per ton collected. While households served per crew shift is of interest to managers evaluating their collection operations, it does not, in itself, serve to identify an efficient and effective recycling program.

Cost Per Ton Collected

In multifamily recycling, collection costs per ton tend to decrease as the tons to collect at each stop increase. Communities with fewer collection points serving many households, communities with high participation rates, and communities that include many materials in their recycling programs would all be expected to have lower collection costs per ton than communities with the opposite characteristics. Indeed, multifamily recycling costs per ton decrease as the diversion rate increases, from an average of $251 per ton for those communities with a low diversion rate to $113 per ton for those communities with a high diversion rate.

The opposite cost relationships occur with multifamily refuse collection. The cost per ton increases as the diversion rate increases. As multifamily diversion increases, the tons of refuse per household tend to decrease (from 1.023 tons per household in communities with low diversion rates, to 0.595 tons per household in communities with high diversion rates). This explains the fact that the refuse collection cost per ton is $43 in communities with the lowest diversion rate and

Figure 5 **Multifamily: Diversion and Cost/Ton**



$66 in communities with the highest diversion rate.

Figure 5 shows how the cost per ton for multifamily refuse and recyclables varies according to diversion rates. In this graph, as the diversion rate increases for multifamily recycling from less than 10 percent to greater than 20 percent, the difference between the per ton cost of providing refuse collection and the per ton cost of providing recycling collection decreases from approximately $200 to approximately $50. At low diversion rates, the cost per ton to provide multifamily recycling service is about five times the cost per ton to provide refuse collection service. At high diversion rates, the cost per ton to provide multifamily recycling service is less than twice as much as the cost to provide refuse collection service. The decrease in the difference is mostly due to a decrease in the cost of providing recycling service.

Return to Table 4 on page 31 to find data for single family recycling and refuse programs, again separated into categories of communities *according to the multi-family diversion rate*. This separation was made to determine if a correlation could be made between successful single family programs and successful multifamily programs. The average diversion rates for both multi- and single family programs in the three diversion categories are as follows:

LOW

Average multifamily: 6.04 percent

Average single family: 9.25 percent

MEDIUM

Average multifamily: 13.39 percent

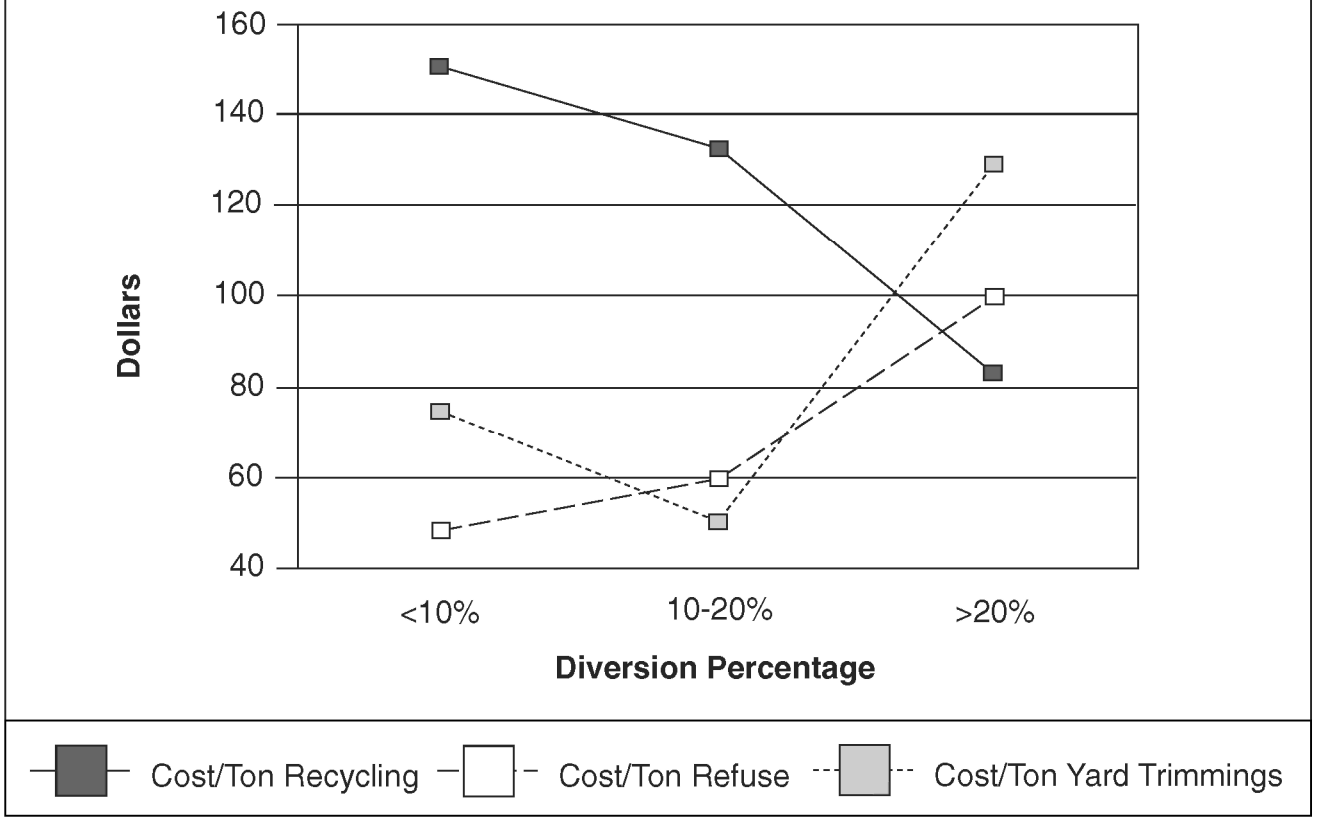
Average single family: 17.7 percent

HIGH

Average multifamily: 27.76 percent

Average single family: 20.39 percent

Figure 6 Single Family: Diversion and Cost/Ton



Communities with "successful" multifamily recycling programs also have lower costs per ton for single family recycling. For the lowest category of multifamily diversion, the collection cost per ton for single family recyclables is $151 (refuse collection cost per ton for this group is $47). For communities in the medium range of multifamily diversion rates, the single family recycling cost per ton decreases to $132 (refuse collection cost increases to $60 per ton). For the group with the highest multifamily diversion rate, the collection cost per ton for single family recyclables is $82 ($101 per ton for single family refuse). For the highest multifamily diversion group, the collection cost per ton for single family recyclables is actually less than the cost per ton for single family refuse. Figure 6 provides a single family graph comparable to that provided for the multifamily data in Figure 5.

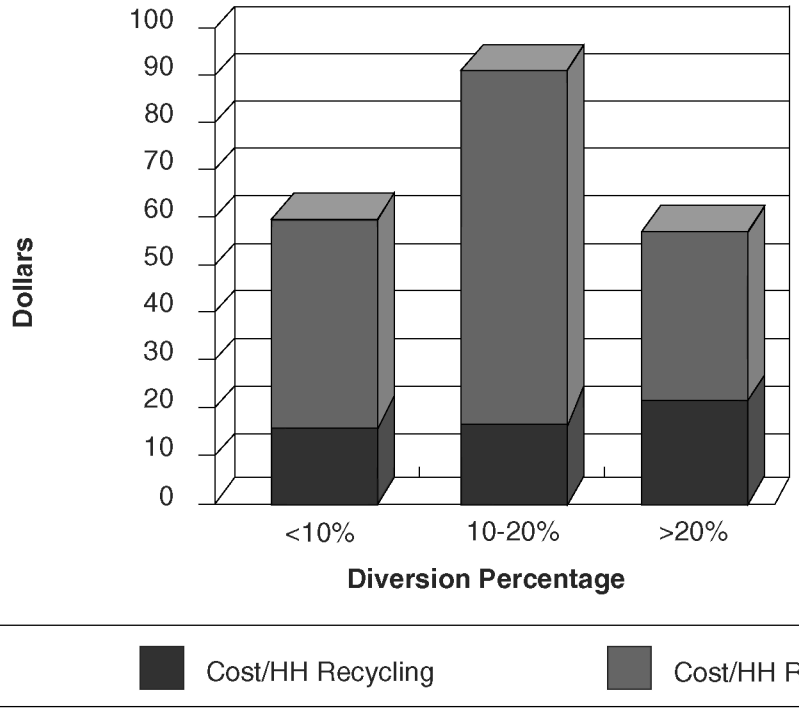
Cost Per Household Served

On a cost per household basis, multifamily recycling costs increase as diversion rates increase, indicating it costs more to collect more materials from a stop. Conversely, multifamily refuse collection costs per household decrease with increases in diversion rates.

It is interesting to examine the total cost of serving a household with refuse collection and recycling services. Figures 7 and 8 present this information graphically, for multifamily and single family households, respectively. For multifamily households, the total costs of providing both refuse and recycling service increase for medium diversion rates and are approximately equal for high and low diversion rates. From this information, it could be concluded that a successful program—which for recycling means a somewhat more expensive program—can be just as cost-effective as an ineffective program. While this study did not examine the reasons for this finding, it is possible it takes a while for successful programs to be recognized as such and for customers to adjust the cost of their refuse service downward. Refuse costs per household, therefore, might be higher in the medium-diversion communities than they are in the high-diversion communities for that adjustment period.

In comparison, the pattern of costs per household for single family programs is somewhat different. Single family recycling costs per household do not vary significantly with the diversion rate of multifamily recycling programs. As displayed in Figure 8, however, the per household cost of single family refuse collection increases from $58 to $84 as the multifamily diversion rate increases from the

Figure 7 **Multifamily: Diversion and Total Cost/Household**



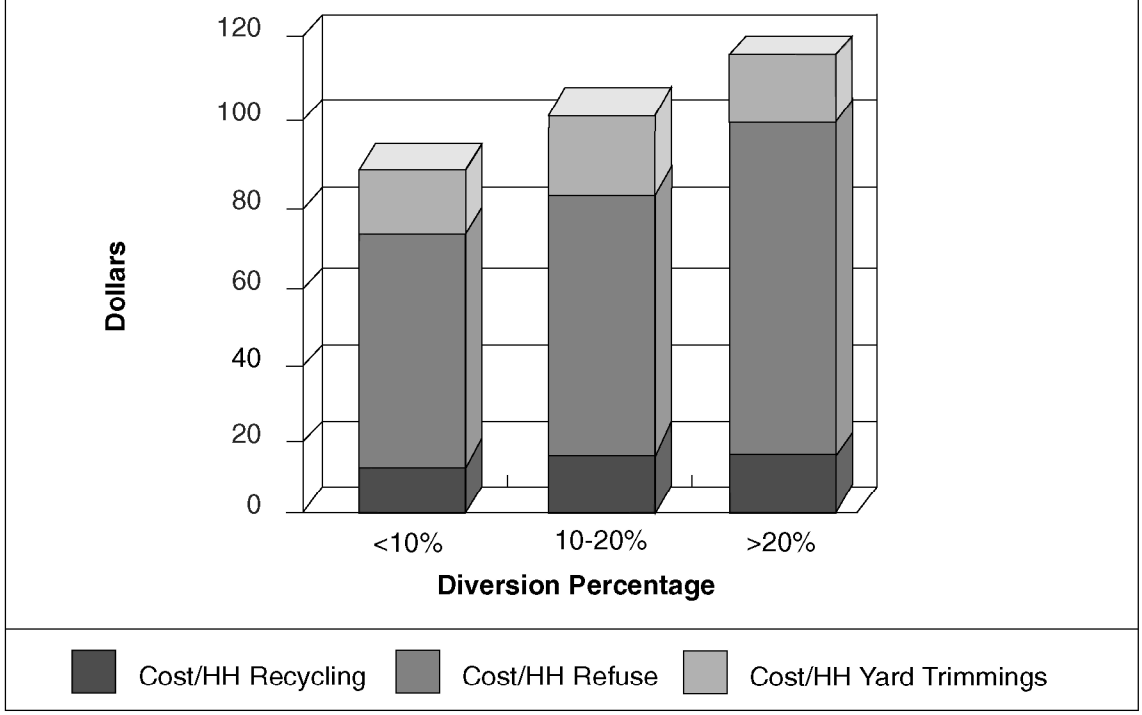
lowest to the highest category. Here, refuse collection costs increase on a per household basis, even as diversion increases. Thus, the overall costs of providing refuse, recycling, and yard trimmings services increase as diversion increases. This finding might be due to the nature of the refuse service provided to single family households: the individual stop and minimal frequency of collection (e.g., once per week in most cases) means that a given percentage reduction in the quantity of materials will not result in an equal percentage reduction in costs. Indeed, the cost of service per household increases as the quantity of refuse set out for collection decreases. This is the driving force behind the overall increase in per household service costs as diversion rates increase.

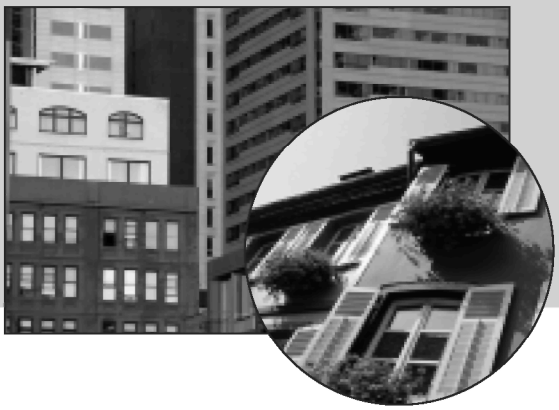
Households Per Crew Shift

If other things are equal, a recycling or refuse program is considered more efficient if it serves a greater number of households per crew shift, whether they are single family or multifamily households. In any collection operation, many nonparticipating households can be served on a drive-by basis in a single crew shift. As there are more non-participating households in low-diversion communities than in high diversion communities, it would be expected that households served per recycling crew shift would decrease with increases in the diversion rate. This is certainly the case for multifamily recycling, with the number of households served per crew shift decreasing from 2,333 for the group with a low diversion rate to 1,676 for the group with a high diversion rate. There seems to be no distinct pattern in households per crew shift for single family recycling, perhaps because the grouping is according to multifamily diversion rates.

The converse pattern is found in households served per crew shift for refuse collection, for both multifamily and single family service. Here, as the quantity of material to collect at each stop decreases (a consequence of increased diversion), the number of households that can be served per crew shift increases. The increase is due to a reduction in the number of trips required to the disposal site, as more households can be served before the collection truck becomes full, and also to the reduced load time per stop.

Figure 8 **Single Family: Diversion and Total Cost/Household**





Chapter 7

Elements of Successful Programs

Table 6 displays basic data about multifamily recycling programs, according to three levels of diversion achieved. Examination of trends in each element, as the diversion in the programs increases, identifies factors associated with more or less successful programs. This methodology does not show causality but, rather, association. Although causality is not proved, it also is not ruled out.

The final column in Table 6 indicates whether the pattern of data for the variable, across the three categories of multifamily recycling programs, is statistically significant. Statistical significance is indicated, as is the level of significance (e.g., 90 percent, 95 percent, or 99 percent). The level of statistical significance means the degree to which one can be confident that the difference in values among the groups did not arise by chance.

Factors Affecting Collection

Who collects the recyclables from multifamily households is the first element. Of the low-diversion programs, more than 61 percent have municipal collection; only 18.8 percent of the programs with medium or high-diversion rates have municipal collection. Contract and exclusive franchise collection—where one firm is awarded the right to collect all multifamily recyclables—is the most common arrangement for those communities with high-diversion rates; 63.6 percent use this system, compared to about 30 percent that have this arrangement in the other categories. The pattern of organizational arrangement is statistically significant. Programs with high diversion rates, therefore, are more likely to:

- Rely on a private firm to collect the recyclables.
- Award one private firm the exclusive right to collect the recyclables.

In most communities, multifamily units are considered hybrid customers. Those buildings with fewer (two to six) units may be considered single family units, receiving refuse and recycling services as though they were single family units. Those in buildings with more than the cutoff number of housing units are often considered to be commercial customers, and their refuse is often collected according to the prevailing arrangement for commercial customers. Recycling for these customers

also might be mandated by the local government and allowed to occur according to the arrangement prevailing for commercial customers (e.g., the system in Connecticut), or the local government might contract for services, creating a different arrangement for multifamily recycling as compared to multifamily refuse collection.

Table 7 indicates the manner by which sample community multifamily recyclables are collected. The data suggest the following:

- Only 25 to 38 percent of programs collect multifamily recyclables on separate multifamily routes.
- Collection of multifamily recyclables along with commercial recyclables is associated with the subscription arrangement for collection.
- A large percentage of programs collect multifamily recyclables on the same routes as single family recyclables, using the same truck and crew to serve both types of customers on a single route.

Almost all of the programs tip the recyclables at a materials recovery facility (MRF) rather than hauling source-separated commodities directly to market. Between 76 and 94 percent of all programs haul to a MRF (see Table 6).

Containers

Most communities provide containers to the complexes (not, typically, to the individual households) for storage of commodities. Although this relationship is not statistically significant, it appears that providing a container to the complex (rather than requiring the customer to provide the container) and having the local government rather than the private firm provide the container are factors associated with higher diversion.

The *type of container* used, however, does have significant bearing on the diversion rates achieved. High-diversion programs, as compared to the other programs, are more likely to use 90-gallon carts. They are less likely to use cans or 60-gallon carts or to use 18- to 20-gallon plastic bins (the typical single family container).

The 90-gallon (or more) wheeled cart has several advantages, including mobility on site, low square footage required for siting, and compatibility with the semi-automated side loading compartmentalized trucks frequently used for single family recycling. Many communities use the same type of trucks for single and multifamily recycling, serving both multi- and single family units on the same routes with this type of truck, thus maximizing route density.

Setouts

In terms of household preparation for recycling, there is a positive relationship between the number of setouts (i.e., sorts) required and the diversion rates achieved. The programs with the highest diversion rates average 3.2 setouts, while programs with the lowest diversion rates average 2 setouts. As diversion rates increase, the number of containers per recycling site increases, from 1.5 in the low-diversion rate group to 3.3 in the high-diversion rate group. Also, as diversion rates increase, the number of communities with totally commingled setouts (i.e., just one container per set) decreases from 61.5 percent to 45.5 percent.

Judging from these data, it appears requiring multifamily households to place their recyclables in three or more containers (e.g., mixed containers, ONP, and OCC) is positively associated with increased diversion. Perhaps the sorting of recyclables into several containers reduces the temptation to contaminate the containers with garbage. This result is counterintuitive, as one would expect less sorting would be easier for households than more sorting, and participation and diversion would consequently be higher for those communities with the easiest, least time-consuming setout requirements. There is, however, probably a correlation between the number of materials collected and the number of setouts, and accepting many materials is a key element in achieving a high-diversion rate. Also, at least some sorting may reduce contamination, which is a frequent problem in multifamily recycling.

Higher diversion programs also serve fewer households per set of recycling containers than lower diversion programs. Less sharing of containers means each set is located closer to each apartment unit, making it more convenient for residents to drop off their recyclables. Compared to low-diversion programs, high-diversion programs:

- Have more containers (more than 3) per set.
- Have a set of recycling containers for each 15 to 19 households, as compared to a set for each 26 households in the low-diversion programs.

Table 6 Elements of Successful Multifamily Recycling Programs

Elements	Multifamily Curbside Diversion <10%	10-20%	>20%	Statistical Significance*
Number of Observations	**13**	**16**	**11**	**40**
Recyclables Collected By:				
Local government employees	61.50%	18.80%	18.18%	
Contractor	15.40%	18.80%	54.55%	
Exclusive franchise	15.40%	12.40%	9.09%	
Nonexclusive franchise	0.00%	25.00%	0.00%	
Subscription	7.70%	25.00%	18.18%	
Total	100.00%	100.00%	100.00%	Yes-95%
Number of collections/week	0.96	1.00	0.96	No
Types of Container Used:				
Can or 60 gallon cart	30.77%	12.50%	0.00%	
90+ gallon cart	23.08%	62.50%	63.64%	
Dumpster	15.38%	18.75%	18.18%	
<20 gallon bin	30.77%	6.25%	18.18%	
Total	100.00%	100.00%	100.00%	Yes-99%
Containers Provided By:				
Local government	61.54%	37.50%	81.82%	
Private firm	23.08%	56.25%	18.18%	
Generator	15.38%	6.25%	0.00%	
Total	100.00%	100.00%	100.00%	No
Recyclables Tipped At:				
MRF	76.92%	93.75%	81.82%	
Hauled directly to market	15.38%	6.25%	0.00%	
Transfer station	7.69%	0.00%	18.18%	
Total	100.00%	100.00%	100.00%	No
System Configuration:				
Percent mandatory	30.80%	68.80%	90.00%	Yes-99%
Number of setouts required	2.0	2.6	3.2	Yes-99%
Number containers/set	1.5	2.6	3.3	Yes-99%
% with 1 container (commingled)	61.50%	43.80%	45.50%	Yes-99%
Number of HHs/set of containers	26.7	15.7	19.1	No

* Indicates whether or not the difference in values is statistically significant, and the confidence level with which the null hypothesis of no difference can be rejected.

Table 7	Successful Multifamily Recycling Programs—How Materials are Collected			
	Multifamily Curbside Diversion			
Collection Characteristics	<10%	10-20%	>20%	Statistical Significance**
Number of Observations	**13**	**16**	**11**	**40**
How Recyclables Are Collected:				
Separately	38.46%	25.00%	36.36%	
With single family materials	61.54%	43.75%	36.36%	
With commercial materials	0.00%	25.00%	18.18%	
With multifamily & commercial refuse	0.00%	6.25%	9.09%	
Total	100.00%	100.00%	100.00%	No
How Tons Are Determined:				
Separate data	38.46%	31.25%	27.27%	
Per capita allocation	61.54%	43.75%	27.27%	
Volume based	0.00%	12.50%	27.27%	
Avg. volume & per capita	0.00%	0.00%	0.00%	
Other*	0.00%	12.50%	18.18%	
Total	100.00%	100.00%	100.00%	Yes-95%

* Other includes information obtained from a rate review document, information from previous consulting engagements conducted by ECODATA, and data from previous studies performed by another consulting firm.

** Indicates whether or not the difference in values is statistically significant, and the confidence level with which the null hypothesis of no difference can be rejected.

Commodities Collected

If more materials are included in a program, a higher percentage of the waste stream can potentially be recycled. As the number of materials accepted increases, diversion will increase, so long as participation does not drop off. Table 8 (on page 44) shows the commodities included in multifamily recycling programs, according to the diversion rate achieved. Following are some conclusions that can be made from these data:

- Most programs (81.8 percent) include the "standard" list of newspapers, aluminum and bimetal cans, HDPE and PET plastics, and glass.
- Communities with high diversion rates are more likely to include each of the above listed materials in their recycling programs.
- Communities with high diversion rates include more materials in their multifamily recycling programs, an average of 10.3 materials, compared to 8.2 materials in the communities with low-diversion rates.
- Communities with high-diversion rates are more than twice as likely to include mixed waste paper (73 percent versus 23 percent in the low-diversion programs) and other plastics (18 percent versus 8 percent in the low-diversion programs).
- Communities with high-diversion rates are much more likely to include OCC, (82 percent versus 46 percent in the low-diversion programs) and magazines and phone books (46 percent versus 31 percent in the low-diversion programs).
- Of the communities with high-diversion rates, 10 percent included the following additional materials: other fibers (textiles and paper), other metals, and used oil. None of the communities in the low-diversion category collected these materials.

Recordkeeping

As shown in Table 7 (on page 42), only in a minority of cases are separate data available for multifamily recycling tonnages. Approximately 30 percent of the communities have separate data available for multifamily recyclables collection. These communities are distributed relatively evenly across the three categories of diversion rate levels. When these materials are collected on the same routes that service single family households or commercial accounts, the reported tonnages would be for the aggregate of customers on the routes. Some allocation is necessary to estimate the tonnage attributable to just the multifamily units. For more information on the various methodologies used in determining quantities of multifamily recyclables and refuse, see Appendices A and B.

Communities with data that allow either a volume-based estimate or a separate recycling tonnage estimate, however, are more likely to be in the high-diversion group than communities that use a per capita estimate. Since the per capita methodology is used only when other data sources are unavailable, it is indicative of weak recordkeeping. The use of the volume-based or separate estimate indicates the community gave greater administrative attention to the performance of the program, and availability of such information might itself be an indicator of success. For example, communities that know where containers have been distributed and how often they are emptied are better able to target their program promotions, education efforts, and outreach elements, which encourage participation. The analysis showed the following:

- Only 27 percent of communities with high-diversion rates lacked enough data to require the use of the per capita estimation method.
- More than 60 percent of communities with low-diversion rates had no data available to compile recycling tonnages by any other means than the per capita method.
- Keeping track of the performance of a program (in terms of the number of setouts, number of containers distributed, how often the containers are emptied, number of households in complexes receiving service, number of complaints registered and service violation notices issued, and quantity of materials collected) is itself a probable causal factor in achieving high or improved program performance.
- As in virtually any activity, keeping track of achievements is usually a key element in making progress.

While recordkeeping for single family recycling is less of an issue than for multifamily recycling—as single family service is typically provided by dedicated crews—good records and regular tracking of progress are still typically associated with high single family program performance. Seattle, Washington, and San Jose, California, for example, are two cities with high-diversion rates. Both keep excellent records, not just on tons collected but also on households served. They require this information to be provided by their contractors for both single family and multifamily refuse and recycling service.

Costs

Table 9 (on page 46) displays data regarding multifamily recycling collection costs and fees. The total annual costs for multifamily recycling service averaged just under $100,000 for the group of communities with low diversion rates and just over $350,000 for the communities with high diversion rates. The medium diversion rate included NYC, so the average costs are deceptively high. With NYC, the average total collection cost for this middle group is $3,783,471; without NYC, it is $613,839.

Table 8

Materials Included in Multifamily Recycling Programs by Diversion Rate

Items	Multifamily Curbside Diversion <10%	10-20%	>20%	Statistical Significance**
Number of Observations	**13**	**16**	**11**	**40**
Number of Items Collected	8.23	9.80	10.27	Yes-90%
Commodities Collected:				
Old newsprint	100.00%	100.00%	100.00%	
Old corrugated cardboard	46.20%	75.00%	81.80%	
Mixed waste paper	23.10%	37.50%	72.70%	
Other fibers	0.00%	6.30%	9.10%	
Aluminum	92.30%	93.80%	100.00%	
Ferrous bimetal cans	84.60%	100.00%	100.00%	
Other ferrous	0.00%	6.30%	9.10%	
HDPE plastic	84.60%	87.50%	81.80%	
PET plastic	84.60%	93.80%	81.80%	
Other plastics	7.70%	12.50%	18.20%	
Glass, clear	84.60%	100.00%	100.00%	
Glass, brown	84.60%	100.00%	90.90%	
Glass, green	84.60%	100.00%	100.00%	
Magazines, phone books	30.80%	37.50%	45.50%	
Used oil	0.00%	6.30%	9.10%	
Other*	15.40%	25.00%	27.30%	

* Other includes aseptics and gables (3), textiles (2), garbage—for a dirty MRF—(2); books or Kraft or styrofoam (1 each).

** Indicates whether or not the difference in values is statistically significant, and the confidence level with which the null hypothesis of no difference can be rejected.

Municipal collection is most likely in the group with the lowest diversion rate, so a cost estimate was the most common method of determining recycling costs in this group. The cost estimate involves determining how many truck shifts are dispatched each day, including number of operators and supervisors. From this basic information, wages for the identified personnel are noted, plus fringe benefits, operating and maintenance expenses for the noted trucks and percentage of time they are used for this service, depreciation for vehicles and containers (straight line 7 years for trucks and straight line 10 years for containers), provision for back-up vehicles and replacement workers for absences, supervisory workers, and other general office expenditures. The estimated cost is the total of all these elements.

For communities where service is provided by a private firm, the cost of recycling service is the payment to the firm, less the cost of processing the recyclables, after subtracting any revenues received by local government. This option for determining costs was most commonly used for the group with high diversion rates, accounting for 75 percent of the communities in this group.

Fees

Multifamily recycling programs can present a challenge for funding. In those communities where multifamily refuse collection is considered a service to be paid for by the apartment complex, typically through a contract between the property manager and a private hauler,

there is no governmental expenditure for solid waste services to this category of customer. Implementing a recycling program to these customers, via any system except mandated subscription service, generally requires government funding. This can be derived from the general fund, or from a fee or tax. Of course, charging units to recycle is often politically difficult to justify. For single family units there is often a single refuse fee, which covers the costs of refuse collection, refuse disposal, and recycling services. Generally, a specific fee for single family recycling is found only in cases of subscription service.

As the data in Table 9 indicate, just over half of the communities report a separate fee for multifamily recycling. As diversion rates increase, the percentage of communities with a fee below $2 per month decreases, and the percentage of communities with a fee in excess of $2 per household per month increases.

Higher fees and a greater likelihood of a fee for multifamily recycling is associated with higher diversion rates. Seventy percent of those communities with high-diversion rates charge multifamily households for recycling, compared to only 50 percent of communities with low-diversion rates. The proportion of communities paying for this service from taxes decreases from 50 percent of those with the lowest diversion rate to 27 percent of those with the highest diversion rate. The most common charge is a monthly flat fee, generally per household or per complex. This fee system exists in 37.5 percent of communities with the lowest diversion rate, 46.2 percent of communities with average diversion rates, and 63.6 percent of communities with the highest diversion rates. A smaller percentage of communities charge for recycling based on the size of the containers used for recycling.

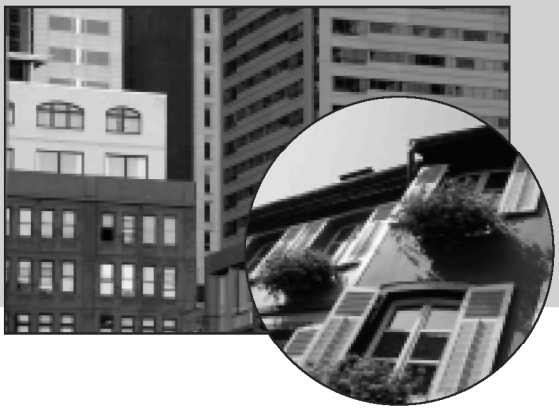
In contrast to the fees for multifamily recycling, virtually all of the sample communities have a fee for multifamily refuse collection, with just four communities reporting that multifamily refuse collection is paid for from taxes. The most typical refuse fee is a volume-based fee. The average volume-based fee is lower for the communities with high-diversion rates than for those with low- and medium-diversion rates. It is important to note there is more often a variable-based fee for multifamily refuse in communities achieving a high-diversion rate. The variable-based fee for refuse collection provides the opportunity for customers to reduce the overall cost of waste and recyclables service by active participation in recycling, so as to reduce the size of the refuse container and, thus, the refuse collection fee.

Table 9 Successful Multifamily Recycling Programs Fees and Charges

Type of Fee or Charge	Multifamily Curbside Diversion <10%	10-20%	>20%	Statistical Significance**
Number of Observations	**13**	**16**	**11**	**40**
Average Total Collection Costs	$99,832	$3,783,471	$358,444	NA
Excluding New York City	$99,832	$613,839	$358,444	NA
How Collection Costs Determined:				
Contractor payment	7.69%	18.75%	58.33%	
Payment to firm less processing	30.77%	56.25%	16.67%	
Cost estimate	61.54%	18.75%	25.00%	
Other*	0.00%	6.25%	0.00%	
Total	100.00%	100.00%	100.00%	Yes-99%
Fee/HH for Recycling:				
Zero	58.33%	57.14%	45.45%	
< $2.00/month	25.00%	21.43%	18.18%	
>$2.00/month	16.67%	21.43%	36.36%	
Total	100.00%	100.00%	100.00%	No
Type of fee for recycling:				
Monthly flat fee	37.50%	46.15%	63.64%	
Variable fee—volume based	12.50%	23.08%	9.09%	
In taxes	50.00%	30.77%	27.27%	
Total	100.00%	100.00%	100.00%	Yes-90%
Fee for Multifamily Refuse	$7.19	$7.26	$4.72	No
Fee for:				
Refuse only	50.00%	42.86%	77.78%	
Refuse & recycling	30.00%	28.57%	11.11%	
Refuse, recycling, & yard trimmings	10.00%	14.29%	0.00%	
In taxes	10.00%	14.29%	11.11%	
Total	100.00%	100.00%	100.00%	No
Type of fee:				
Monthly flat fee	40.00%	14.29%	11.11%	
Variable fee—volume based (cubic yards)	50.00%	71.43%	66.67%	
In taxes	10.00%	14.29%	22.22%	
Total	100.00%	100.00%	100.00%	No

* Other includes information obtained from a rate review document, information from previous consulting engagements conducted by ECODATA, and data from previous studies performed by another consulting firm.

** Indicates whether or not the difference in values is statistically significant, and the confidence level with which the null hypothesis of no difference can be rejected.



Chapter 8:
Lessons Learned

In addition to the factors mentioned earlier, program success also can depend on the tactics used to solve problems during start-up and operations. Representatives from the 40 sample communities were asked their opinions about their multifamily recycling programs, including what they would have done differently, what they would recommend to other communities, what data needs they perceived, what tactics were used to deal with contamination, and what role the local government played in enforcing participation according to their community's rules. Results of these conversations have been tabulated according to the most frequently cited responses. They are presented in Table 10, where all responses are recorded and subdivided according to the diversion rates achieved. In general, the most common sample community problems, in descending order of frequency, include:

- Low participation—35 percent.
- Problems with contractor cooperation (e.g., haulers would not share data and/or the contractor stopped reporting quantities)—15 percent.
- Tenant/apartment complex communication problems (e.g., turnover by tenants, non-English speaking tenants, and/or uninterested property managers)—15 percent.
- Reduced commodities collected due to low prices—10 percent.

Low Participation

The most frequently cited difficulty in multifamily recycling programs, low participation, appeared more often in communities with high-diversion rates. What was cited as low participation ranged from 10 percent of households participating (probably low in anyone's opinion), to 65 percent (probably considered good or excellent by many). Communities with the lowest diversion rates were likely to cite external problems; for example, an inability to get the haulers to provide data, problems with scavengers, or a narrow avoidance of a lawsuit. One community that experienced difficulty retaining the same list of recyclable materials when markets plunged has a subscription service and no local government ordinance (specifying which materials are to be included in the program). The haulers are free to change the list of acceptable materials as market prices indicate, even if this confuses or discourages participation in the recycling program.

Table 10 Comments About Multifamily Recycling Programs By Diversion Rate

Comments	Multifamily Curbside Diversion <10%	10-20%	>20%	All
Number of Observations	**13**	**16**	**11**	**40**
Difficulties encountered in establishing a multifamily recycling program:				
• Turnover of tenants	0.00%	8.30%	0.00%	5.00%
• Non-English speaking tenants	0.00%	8.30%	0.00%	5.00%
• Contractor stopped reporting quantities	0.00%	8.30%	0.00%	5.00%
• Lack of concern on the part of property managers	0.00%	8.30%	0.00%	5.00%
• Haulers won't share data	20.00%	8.30%	0.00%	10.00%
• Almost had a lawsuit	20.00%	0.00%	0.00%	5.00%
• Low participation (10% to 65%)	40.00%	16.60%	100.00%	35.00%
• Mayor lost election after trying to set a fee	0.00%	8.30%	0.00%	5.00%
• Public upset about ending drop-off program	0.00%	8.30%	0.00%	5.00%
• Wait list to get on program—complaints	0.00%	8.30%	0.00%	5.00%
• Reduced commodities due to low prices	0.00%	16.60%	0.00%	10.00%
• Scavengers	20.00%	0.00%	0.00%	5.00%
TOTAL	100.00%	99.60%	100.00%	100.00%
What would the community do differently if setting up the program today?				
Container & Truck Issues				
• Use different containers	0.00%	9.10%	0.00%	3.80%
• Different containers—Dumpsters instead of sheds	0.00%	0.00%	28.50%	7.80%
• Provide containers	12.50%	9.10%	0.00%	7.80%
• Use carts & automated collection	12.50%	9.10%	14.30%	11.50%
• Make customer provide the container	0.00%	9.10%	0.00%	3.80%
• Change truck to avoid manual loading	0.00%	9.10%	0.00%	3.80%
System Design Issues				
• Less frequent collection	0.00%	0.00%	0.00%	0.00%
• Change system—stop putting bags of recyclables in garbage Dumpster	0.00%	9.10%	0.00%	3.80%
• Fewer setouts	12.50%	0.00%	0.00%	3.80%
• Let each building set up own internal system	0.00%	9.10%	14.30%	7.80%
Contractual Provisions				
• Would try to get better data	12.50%	18.10%	0.00%	11.50%
• Make recycling mandatory	25.00%	9.10%	0.00%	11.50%
• Make MF & SF part of unified system	0.00%	0.00%	28.60%	7.80%
• Stop splitting revenues with hauler	0.00%	0.00%	14.30%	3.80%
Other				
• Might like a drop-off yard trimmings program	0.00%	9.10%	0.00%	3.80%
• Include more materials	12.50%	0.00%	0.00%	3.80%
• Would change nothing	12.50%	0.00%	0.00%	3.80%
TOTAL	100.00%	100.00%	100.00%	99.90%

Table 10 Comments About Multifamily Recycling Programs By Diversion Rate (Continued)

Comments	Multifamily Curbside Diversion <10%	10-20%	>20%	All
Number of Observations	**13**	**16**	**11**	**40**
What is done to avoid contamination?				
Collection Actions				
• Pull containers—if necessary, stop service	10.00%	13.30%	11.10%	12.12%
• Collect as garbage	10.00%	6.70%	0.00%	6.06%
• Leave materials at stop	20.00%	13.30%	0.00%	12.12%
• Truckside sorting eliminates this problem	0.00%	13.30%	0.00%	6.06%
• Make them pay twice (1X refuse/1X recycle)	10.00%	6.70%	0.00%	6.06%
Education Actions				
• Sort materials to identify offenders	10.00%	0.00%	11.10%	0.00%
• Write letters to complexes with problems	10.00%	0.00%	11.10%	6.06%
• Use containers with slits and slots	0.00%	6.70%	0.00%	3.03%
• Place clear signs & labels on containers	0.00%	13.30%	0.00%	6.06%
• Leave a notice if there is a problem	10.00%	13.30%	0.00%	9.10%
• Place cameras in problem areas (county)	0.00%	0.00%	22.30%	6.06%
General Reactions				
• Not a problem—no MRF rejections	10.00%	6.70%	33.30%	18.18%
• Dirty MRF system—people bag putrescibles such as pet waste. Separate restaurant collection	0.00%	0.00%	11.10%	3.03%
• Big problem	10.00%	6.70%	0.00%	6.06%
TOTAL	100.00%	100.00%	100.00%	100.00%
What role does the community play in enforcing regulations and compliance?				
• Little role, as it is not mandatory	60.00%	0.00%	0.00%	15.00%
• Issues violation notices, fines and/or liens	20.00%	20.00%	60.00%	30.00%
• Fine graded by size of complex*	0.00%	10.00%	0.00%	5.00%
• Places a property lien if don't pay bill	0.00%	10.00%	0.00%	5.00%
• Health Dept. can fine, but has not done so	0.00%	0.00%	20.00%	5.00%
• New program—will be separate billing; payment is mandatory	0.00%	10.00%	0.00%	5.00%
• 3 contacts with each complex**	0.00%	10.00%	0.00%	5.00%
• Must have a trained recycling captain	0.00%	10.00%	0.00%	5.00%
• Issue citations if haulers pick up at wrong time of day	0.00%	10.00%	0.00%	5.00%
• Failure to submit a quarterly report—$300 fine to hauler	0.00%	10.00%	0.00%	5.00%
• Contractor supervision very active	0.00%	10.00%	20.00%	10.00%
• Pull containers if don't do a good job	20.00%	0.00%	0.00%	5.00%
TOTAL	100.00%	100.00%	100.00%	100.00%

* Fine is $100 <25 units; $200 for 26-100 units; $300 for 101+ units.

** Contacts are office worker, board member, and recycling captain.

Table 10 Comments About Multifamily Recycling Programs By Diversion Rate (Continued)

Comments	Multifamily Curbside Diversion <10%	10-20%	>20%	All
Number of Observations	**13**	**16**	**11**	**40**
What public education practices are followed?				
• Multilanguage brochure for property managers	28.50%	15.40%	0.00%	16.00%
• Brochure for recycling & yard trimmings	14.30%	7.70%	0.00%	8.00%
• Use same education materials for MF and SF programs	0.00%	0.00%	14.40%	4.00%
• Quarterly newsletters—to each apartment	0.00%	23.00%	14.40%	12.00%
• Annual recycling handbook	0.00%	0.00%	28.40%	8.00%
• Biannual recycling cards mailed	14.30%	0.00%	0.00%	4.00%
• Technical assistance—visit complexes	14.30%	15.40%	28.40%	16.00%
• Labels*	14.30%	0.00%	0.00%	4.00%
• Display trucks and give financial incentives to recycle	14.30%	0.00%	0.00%	4.00%
• Intergovernmental preparation of materials	0.00%	7.70%	0.00%	4.00%
• Television, radio commercials	0.00%	7.70%	0.00%	4.00%
• Telephone company prints information at beginning of phone book	0.00%	15.40%	0.00%	8.00%
• Each complex chooses 3 commodities in addition to 2 mandated commodities	0.00%	0.00%	14.40%	4.00%
• Ask haulers to include flier in bills	0.00%	7.70%	0.00%	4.00%
TOTAL	100.00%	100.00%	100.00%	100.00%

* Have had to improve labels to avoid confusions such BRN GLASS means brown glass, not broken glass.

Contract Provisions

Contract provisions are the next most frequently cited areas for improvements in multifamily recycling. Here are just a few of the lessons learned about contracts:

- Make the program mandatory (for complexes, not for households).
- Make the contractor provide better data.
- Simplify the contract by eliminating a revenue split with the contractor.
- Specify which materials should be recycled.

Some communities wanted to make their programs mandatory and place the responsibility on each complex, while others would place responsibility on the refuse collector to provide recycling service to all customers.

What They Would Do Differently

Perhaps the greatest number of responses addressed what the community would do differently if it were setting up the multifamily program now. The most frequently cited areas to revisit were containers and trucks. More than one third of the communities would use different containers and try to avoid manual loading. Although the preferred container differed from community to community, no one indicated a desire to switch to single family bins or cans. A majority of those communities citing this element indicated a desire for automated or semi-automated loading of carts.

With regard to system design, the communities made the following comments:

- None of the communities suggested less frequent collection.
- One indicated a desire to reduce the number of set-outs required.
- One expressed dissatisfaction with the system that required bags of recyclables to be deposited in garbage Dumpsters.
- Two expressed interest in letting complexes set up their own individualized system for getting the materials from the apartments to the collection points in the complex.

Complaints Received

Return to Table 4 (page 31) to see the number of complaints received per household per year. This averages out to about 2 per 100 households served each year, or, if a household is served once a week, about 2 per 5,200 collections. Clearly, there is not a significant number of complaints about the services being provided to multifamily households by their recycling collectors.

Contamination

Contamination was another frequently cited problem, although one third of the communities with high diversion rates reported this was not a problem in their program (see Table 10 on page 49). Collection actions to deal with contamination ranged from stopping the service (pulling containers), tagging and leaving the materials, treating the material as garbage, or sorting at truckside and leaving the unacceptable materials.

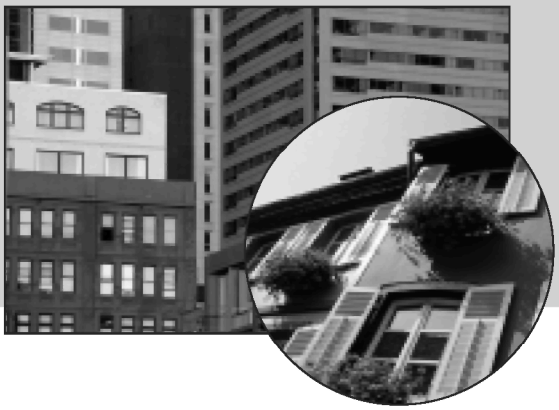
Most communities attempted to avoid contamination through public education and detective work. One community, for example, reported it discovered the hard way that "BRN GLASS" can reasonably be interpreted as broken glass, rather than brown glass, and that clear labeling goes a long way to avoid contamination. Other communities try to identify the individual households responsible for contamination (e.g., via sorting through the rejected materials to look for addressed objects or, in one case, by video taping the collection area) and contact them to explain the recycling rules. Communities with all levels of diversion were equally likely to cite active programs to avoid contamination.

Enforcement Activities

Communities play varied roles in enforcing their local regulations regarding multifamily recycling. In general, communities with low-diversion rates report less enforcement activities, and those with high-diversion rates are more likely to report the use of fines, liens, or other sanctions against rule breakers. One community levies a fine against complexes that do not recycle properly—$100 for complexes with up to 25 units, $200 for complexes with 26 to 100 units, and $300 for complexes with 101 units or more. Other communities have extensive education programs, including increased contacts at each complex, and requiring any participating complexes to have a trained recycling captain.

Education

Finally, communities were asked about the practices they use to educate multifamily households about recycling rules. It is often difficult to reach the individual households in an apartment complex, especially in a high rise or mid-rise. Sixteen percent of the communities rely on the property manager to distribute educational materials to individual households. An equal percentage make personal visits to apartment complexes to help set up recycling programs. Mailings to the individual households range from an initial move-in flyer to materials mailed biannually, annually, or quarterly. Those communities with high diversion rates are more likely to have more frequent mailings to individual households, while communities with lower diversion rates tend to have less frequent mailings and rely more on the property managers. Various other public education techniques, mentioned less frequently, include public relations at public fairs and gatherings, television commercials, including information at the beginning of telephone books, and intergovernmental arrangements for the preparation of educational materials.



Chapter 9:
Summing Up Success

Table 11 — Characteristics of Successful Multifamily Recycling Programs

Program Element	What Happens In High-Diversion Communities?	Percentage of High-Diversion Communities With This Practice
Management	Conduct recycling through a private firm under contract or exclusive franchise to local government.	82% of high-diversion group
Collection	Collect multifamily recyclables on the same routes as single family recyclables, using the same truck and crew.	61% of high-diversion group
Participation	Ensure compliance through mandatory participation, with sanctions available to local governments for enforcement.	90% of high-diversion group
Commodities	Include more recycled commodities: mixed waste paper, OCC, magazines, and phone books in addition to ONP, glass, plastics, and steel and aluminum cans.	82% of high-diversion group
Containers	Provide container with capacity of at least 90 gallons. Collect materials in sets of containers, with one set per 15-20 households and two to three containers in the average set.	64% of high- and medium-diversion groups
Fees	Charge monthly flat fee (usually $2 or more) to units for recycling. Charge variable for refuse (reduced solid waste fee as more materials are diverted to recycling). Average fee is lower in high diversion communities.	63.6% of high-diversion group

Benefits of high-diversion rates in multifamily recycling:

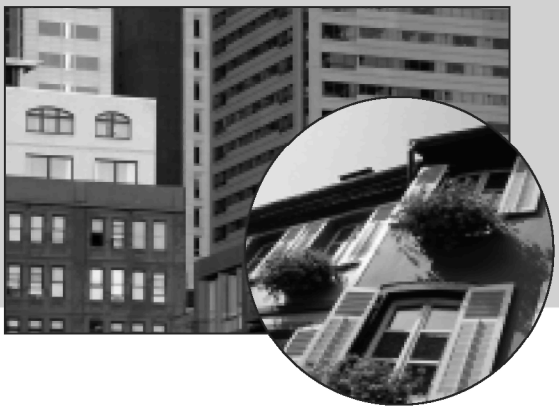
- Unit cost of collecting recyclables decreases. The average cost per ton to collect multifamily recycling is $177; this drops to $113 for communities with diversion rates in excess of 20 percent.
- Quantity of refuse set out for collection decreases. As diversion rates increase, however, the cost per ton to collect refuse increases from $43 per ton in communities with diversion rates of 10 percent to $66 per ton in communities with diversion rates of 20 percent.
- Decreases in refuse setouts exceed the increase in recycling, implying that waste reduction is also occurring in communities with the most successful recycling programs.

Appendices

Appendix A
Methodology

Appendix B
Definitions

Appendix C
Individual Program Information



Appendix A: Methodology

The *Multifamily and High Rise Recycling Assessment* was mailed to 1,100 member communities of the U.S. Conference of Mayors (with populations in excess of 25,000) in April 1997. By June 12, 1997, 227 communities responded to the assessment. Of those, 118 reported having had a multifamily recycling program in place for a least 12 months. From that pool of 118 communities, 40 were selected to serve as samples for this study.

Data were obtained from the 40 sample communities for a variety of specific program elements via U.S. mail with recycling coordinators and via telephone with collectors (i.e., private sector firms and public sector managers), program administrators, and processors, as appropriate. After initial data collection, various internal consistency checks were run (e.g., tons of refuse and recyclables per household were computed as a data reliability check) and communities with unlikely results were recontacted to confirm statistics.

Sample Program Selection Process

The objectives of the sampling were to provide representation from all regions of the United States, including large and small communities; to include only those communities whose programs had been in existence for at least a year (so as to have adequate data); and to allow for projections to the entire multifamily population in the United States.

To achieve these objectives, programs were selected at random from each of the four U.S. Census-defined geographic sectors of the United States, with the proportion of programs to be sampled determined by the sector's relative share of all multifamily housing units in buildings with 10 or more units. Table A-1 displays the proportion of programs sampled from each of the geographic areas.

Table A-1 Sampling Proportions from Each Geographic Quadrant

Region	Number of Multifamily Units in 10+ Unit Buildings (Millions)	Percent of Total Multifamily Units in 10+ Unit Buildings	Number of Programs to Select (40 Total)
Northeast	3.46	26.3 %	10
Midwest	2.47	18.8 %	8
South	4.07	30.9 %	12
West	3.16	24.0 %	10
TOTAL	**13.16**	**100.0 %**	**40**

SOURCE: 1990 Census of Population and Housing: Summary Population and Housing Characteristics. US GPO (1990CPH-1-1) issued March 1992, Table 4 Page 176.

The total number of responses from which sampling occurred was 227. These included 27 responses from the Northeast, 60 responses from the Midwest, 66 responses from the South, and 72 responses from the West. Two responses also were received from Puerto Rico. Table A-2 presents the responses by region and state.

Table A-2 Responses to *Multifamily and High Rise Recycling Assessment*, as of June 12, 1997

Region	Number of Multifamily Recycling Programs			Number with No Multifamily Recycling	Total Responses	Percentage of Responding Communties with Multifamily Recycling Program
	≤ 1 Year	> 1 Year	All			
Northeast (ME, NH, VT, MA, RI, CT, NY, NJ, PA)	2	15	17	10	27	63%
Midwest (OH, IN, IL, MI, WI, MN, IA, MO, ND, SD, NE, KS)	1	21	22	38	60	37%
South (DE, MD, DC, VA, WV, NC, SC, GA, FL, KY, TN, AL, MS, AR, LA, OK, TX)	3	27	30	36	66	45%
West (MT, ID, WY, CO, NM, AZ, UT, NE, WA, OR, CA, AK, HI)	3	46	49	23	72	68%
Puerto Rico	0	0	0	2	2	0%
TOTAL	**9**	**109**	**118**	**109**	**227**	**52%**

SOURCE: Responses to U.S. Conference *Multifamily and High Rise Recycling Assessment,* U.S. Conference of Mayors, June 12, 1997.

The percentage of respondents with multifamily recycling programs ranged from 37 percent in the Midwest to 68 percent in the West, with the Northeast reporting multifamily recycling programs 63 percent of the time and the South reporting multifamily recycling programs 45 percent of the time. Communities with recycling programs for multifamily housing might have been more likely to respond, which would skew the data. Care should be taken, therefore, in generalizing as to the frequency of these programs across the nation.

In the sampling methodology, the number of programs was selected in proportion to the entire set of large multifamily housing units in each region. This approach allows for a reasonable projection to the entire set of multifamily units, assuming full-scale adoption of recycling programs for these units. The average diversion per multifamily unit, for example, as predicted from the sampled programs, can be projected as the potential for the entire country, assuming recycling in multifamily housing was adopted everywhere.

The sampling approach enables reasonably valid projections to be made. This approach determined sample size per region based on the regional distribution of multifamily units in the United States, not the regional distribution of multifamily recycling projects. Therefore, this approach does not provide an equal chance of all programs being included in the sample. Programs in a region with few cities providing multifamily recycling and many multifamily units were more likely to be selected for this study than were programs in a region with many multifamily recycling programs but fewer total units. Selection favored programs in the Northeast, where 10 of 15 programs in existence for more than a year were selected. Selection was least likely in the West, where 10 of 46 programs were selected. In the Midwest, 8 of 21 programs were selected; in the South, 12 of 27 programs were selected.

In the actual sampling, numbers were assigned to all eligible programs in each geographic sector, and the desired number of samples was drawn at random. Table A-3 presents the list of cities from which the surveyed cities (in bold type) were randomly selected.

Table A-3 Cities with Multifamily Recycling Programs

Cities selected for analysis are in bold type.

SOUTH:

Boca Raton, FL
Broward County, FL (Unincorporated)
Charlottesville, VA
Daytona Beach, FL
Deerfield Beach, FL
Durham, NC
Fayettesville, VA
Frankfurt, KY
Goldsboro, NC
Greensboro, NC
Greenville, NC
Hallandale, FL
Jacksonville, FL
Laredo, TX
Largo, FL
Louisville, KY
Miami, FL
Melbourne, FL
Newport News, VA
Orlando, FL
Roswell, GA
Saint Petersburg, FL
Sumter, GA
Tamarac, FL
Tampa, FL
Titusville, FL
Washington, DC

WEST:

Alameda, CA
Antioch, CA
Bellevue, WA
Bellingham, WA
Bremerton, WA
Carmarillo, CA
Chino, CA
Chula Vista, CA
Contra Costa Co., CA
Dana Point, CA
Diamond Bar, CA
Dublin, CA
Everett, WA
Fountain Valley, CA
Glendale, CA
Hillsboro, OR
Honolulu, HI
Kent, WA
La Mesa, CA
Laguna Niguel, CA
Lakewood, CA
Longview, WA
Pittsburgh, CA
Mesa, AZ
Milpetos, CA
Mission Viejo, CA
Olympia, WA
Oxnard, CA
Phoenix, AZ
Placentia, CA
Portland, OR
Rialto, CA
San Francisco, CA
San Jose, CA
San Louis Obispo, CA
San Ramon, CA
Santa Cruz, CA
Santa Fe, NM
Seattle, WA
Simi Valley, CA
Tacoma, WA
Town of Apple Valley, CA
Vancouver, WA
Ventura, CA
Vista, CA
Whittier, CA

NORTHEAST:

Altoona, PA
Bridgewater, NJ
Cherry Hill, NJ
East Brunswick, NJ
East Orange, NJ
Gloucester, NJ
Jamistown, NY
Lancaster, PA
Manchester, NH
Middletown, CT
North Tonawanda, NY
New York City, NY
Old Bridge, NJ
Syracuse, NY
Wallingford, CT

MIDWEST:

Dayton, OH
Des Plains, IL
Brookfield, WI
Brooklyn Park, MN
Chillicothe, MO
Eden Prairie, MN
Greenfield, WI
Lakewood, OH
Lancaster, OH
Lima, OH
Madison, WI
Maple Grove, MN
Menton, OH
Milwaukee, WI
Orland Park, IL
Royal Oak, MI
Saint Paul, MN
Skokie, IL
University City, MO
Upper Arlington, IL

Comparison of Selected Sample to Entire Population

Table A-4 shows how the selected cities in each region compare in number of multifamily housing units in structures with 10 or more units and in number of units included in the multifamily curbside recycling programs. In the Northeast, the presence of NYC has such a dramatic influence on the total and average data, that the information for this region is shown with and without the inclusion of NYC.

The 40 selected communities contain a total of 2.5 million housing units located in structures with 10 or more dwellings. This is 19.3 percent of the total number of such dwelling units in the United States.

Table A-4 also shows the number of multifamily households receiving curbside recycling services, by region and for the United States as a whole. Not every community selected provides multifamily recycling to every multifamily dwelling in its boundaries. Seattle, Washington, for example, provides multifamily recycling to approximately 57 percent of the multifamily households in its jurisdiction. Alternatively, some communities provided multifamily recycling to more households than are housed in structures with 10 or more units.

In projecting the results of this study to the nation as a whole, each community is afforded equal weight by using the average of each of the data items from all 40 communities. This methodology retains the original emphasis in affording more weight to regions with more multifamily housing, but prevents projections from overemphasizing the results achieved by the largest cities, such as NYC. An overemphasis would result from using a projection method based on aggregate values. For example, estimating the diversion rate by dividing the tons recycled across all 40 communities by the total waste tonnage of the 40 communities, would overemphasize the results of the larger communities and, consequently, the regions in which these communities are located. Equal weighting to the data of each community enables valid projections to the nation as a whole.

Data Collection

To facilitate data collection, an initial memorandum

Table A-4 Comparison of Selected Cities to Regions as a Whole

Region	Millions of MF Units*	Number of Communities Chosen	Number of MF Units in 10+ Unit Structures		Percent of Region's MF Units	Number of MF Units Provided With Curbside Recycling		Percent of Region's MF Units
			Mean	Total		Mean	Total	
Northeast								
With NYC	3.46	10	170,089	1,700,897	49.2 %	303,183	3,031,835	87.6 %
Without NYC	1.80	9	4,672	42,053	2.3 %	4,407	39,666	1.1 %
Midwest	2.47	8	7,606	60,851	2.5 %	8,369	66,952	2.7 %
South	4.07	12	50,775	609,297	15.0 %	46,288	555,466	13.6 %
West	3.16	10	17,215	172,158	5.4 %	22,547	225,471	7.1 %
TOTAL								
With NYC	13.16	40	63,580	2,543,203	19.3 %	96,993	3,879,724	29.5 %
Without NYC	11.50	39	22,675	884,359	7.7 %	22,758	887,555	7.7 %

* In structures with 10 or more dwelling units.
Number of Multifamily (MF) units in structures with 10 or more units from 1990 Census of Population and Housing. Number of MF units provided with curbside recycling services obtained for this study from individual selected communities.

was mailed to each selected city or local government, identifying the community as having been selected for inclusion in this extended study of multifamily recycling. Each community was asked to gather materials relating to its multifamily recycling program, including data on the name of the collector, households serviced, tons collected, materials included in the program, method of setout and containerization prior to pickup, collection technology and number of trucks deployed per week, method of marketing of recyclables, revenues collected, public education information, and enforcement. A copy of pertinent regulations and laws also was requested. About half of the selected communities responded to this request; in some cases, voluminous materials, including solid waste reports, videos of programs, and computer printouts of detailed route information, were submitted.

An 8-page data recording sheet was prepared, detailing all the information to be obtained, ideally, from each community. While the emphasis was placed on multifamily recycling programs, multifamily refuse collection data were gathered so a diversion rate could be calculated. Data about single family refuse and recycling programs also were obtained to answer the question regarding the relative diversion rates of single family recycling programs and multifamily recycling programs. Finally, data were obtained for yard trimmings collection, which is typically provided to single family households; multifamily complexes typically rely on commercial yard services for collection.

Using the data supplied by those communities that responded to the initial data request, the data recording sheet was filled out as much as possible. Telephone contacts or in-person contacts (with community representatives attending several conferences where the study was introduced) then were initiated for each community. Census data also were obtained for each community, indicating the number of housing units in buildings containing 1, 2 to 4, 5 to 9, and 10 and more housing units. The populations in each of these categories were obtained as well, so the persons per household could be computed for each category of multifamily housing, as defined in each community.

Telephone conversations were conducted with recycling program administrators, solid waste supervisors, planners, disposal facility operators, and private solid waste firms. Solid waste collection firms often provided the prevailing prices for refuse collection service to multifamily households and the typical service level (size of container and number of times emptied per week) for several typical apartment complexes. Often, the solid waste collectors knew the number of apartments in each complex, but sometimes it was necessary to call the apartment complex itself to determine this information. It was then possible to use this information to make an estimate of the quantity of refuse a community generated, per multifamily housing unit. The solid waste firm or municipal collection supervisor also was interviewed about the management practices employed in deploying the vehicles and crews used to collect recyclables from multifamily establishments.

Finally, each community was asked how successful it felt its program was. These were open-ended queries, but the responses were grouped around several main themes. Communities also were asked what they would do differently and what they would recommend to another community. The free-response section of the conversations also discussed education practices, efforts to avoid contamination, and enforcement programs.

Data Analysis

The data from the data recording sheets were subjected to internal consistency checks. The tons of material per household were computed, for example, as was the cost per ton collected. Communities with excessively high or low figures were contacted again, to verify information. In several cases, special computer runs were made to double check the data from the transfer station or disposal facility. In two cases, however, the quantities of multifamily recyclables collected were repeatedly reported to be so low that the unit cost of collection was extremely high (more than $2,000 per ton), and these observations were omitted in computing the average cost figures for collecting multifamily recyclables.

Data from free response questions were coded so analysis could take place. Frequencies of each variable were run, and the sample was subsequently divided according to the diversion rate achieved. T-tests, statistical tests used in testing hypotheses about means of normal distributions when the standard deviations are unknown, were computed across three categories to determine the correlation between diversion rates and factors associated with particular programs.

Measuring Tons

The difficulty of measuring the tons of multifamily recyclables and multifamily refuse was somewhat anticipated in advance of this study. It was known, for exam-

ple, that each community typically has a unique definition of multifamily household, and very few had any idea what their multifamily diversion rates might be, as most did not know their multifamily refuse and recycling tonnages. Typically, multifamily refuse was mixed together in front-end loaders along with commercial refuse. To overcome this problem, two methods of estimating multifamily refuse quantities were adopted: the volume method and the per capita method. For more information on these methods, see Appendix B.

Considerations for Using the Per Capita Method

To the extent that multifamily households might generate more waste per capita than do single family residences, the estimated diversion rates for multifamily households might be somewhat overestimated. Existing data, however, do not necessarily support making an adjustment or indicate what the magnitude of such an adjustment should be.

The literature on solid waste generation sometimes indicates that per capita waste generation increases with decreases in the number of persons per household. This finding is discussed in the work of Franklin Associates, where waste generation per capita is plotted against persons per household over the period spanning 1960 to 1993.[1] Note that Franklin Associates, when projecting residential wastes for purposes of estimating diversion from residential and commercial waste streams, makes no distinction between multifamily and single family residential waste generation.[2] This finding is pertinent to all municipal solid waste, residential as well as commercial, and results from an analysis of aggregate data over a period of several decades. The finding could be attributable to higher per capita waste generation in smaller households or it could be capturing other waste generation effects which have occurred over the decades. Several cross-sectional studies, for example, have established that waste generation per employee is significantly greater for small firms than for larger firms.[3] If the size of firms decreased over the same period in which household size decreased, the increase in aggregate per capita waste generation could be wholly or partially attributable to the change in the size distribution of commercial firms. Whether the residential waste generation per household at any one point in time is greater for households with fewer members than for households with more members, however, cannot be determined from the data used in the longitudinal studies such as that conducted by Franklin Associates.

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[1] Franklin Associates, Ltd, *Characterization of Municipal Solid Waste in the United States, 1994 Update.* (Franklin Associates, Prairie Village, KS. Prepared for Office of Solid Waste, US EPA Report No. EPA530-94-042: December 1994), pp. 129-130.

[2] Franklin Associates, *The Role of Recycling in Integrated Solid Waste Management to the Year 2000, Appendices.* (Prepared for Keep America Beautiful by Franklin Associates, Prairie Village, KS: September 1994), See Appendixes H and J.

[3] Barbara Stevens and Thomas Kusterer, "Targeting Business Categories," *Biocycle,* (July 1995, Vol 36 #7), pp. 61-62.

Appendix B: Definitions

This appendix provides definitions of terms used frequently throughout this report as well as the methodology behind calculations, such as diversion rate. The terms are listed alphabetically.

Cost of Service: The actual cost of municipal service, or the payment to the private firm, in the cases where service is provided by a private firm. Thus, no profit is included for municipal service, whereas the cost includes any profit the private firm might earn. This definition is useful to public officials, as it indicates the cost to the community of providing service via a public or private entity.

Diversion Rate, Multifamily: For multifamily service, the diversion rate is the ratio of tons of recyclables per household, *for households in the multifamily recycling program,* divided by the sum of tons of refuse per household, for all multifamily households, plus tons of recyclables per household, for households in the multifamily recycling program. This definition gives a diversion ratio that would typically be greater than would be obtained by dividing the total tons of multifamily recyclables by the sum of the total tons of multifamily recyclables and multifamily refuse, especially in communities where a significant percentage of multifamily households do not receive recycling service. The virtue of the definition, however, is it provides an idea of the tonnages that could be expected to be diverted were the services to be provided universally.

Diversion Rate, Single Family: A similar definition to multifamily recycling is used for single family recycling, except in this case the denominator includes yard waste collected. A yard waste diversion ratio also is computed for single family households, using yard waste per household divided by the sum of the per household collections of yard waste, recyclables, and refuse. The divergence between this definition of diversion for single family households and the ratio of the total tons is less than for multifamily households, as most single family recycling programs serve all households.

Effectiveness Measures: These measures indicate the extent to which the program meets policy objectives. If a state has a recycling goal of 50 percent, for example, then a program's effectiveness would be measured by the extent to which it diverted waste from disposal sites.

Efficiency Measures: These measures determine whether there is efficient use of resources in producing the program's outputs. Typical measures of efficiency involve productivity of collection crews, such as households per crew shift, households per crew labor hour, or percentage of time vehicles are available for duty. Other measures of efficiency include cost measures such as the cost per ton collected or the cost per household served.

Measuring Tons, Per Capita Method: In some cases, where the municipality provided refuse service but did not have data on the containers in place or frequency of collection, or where a private firm refused to cooperate, the per capita method was used. Here, single family refuse generation, plus recyclables generation, were divided by the population in the single family residences. The number of persons per household in multifamily units was determined from U.S. Census data, and this figure was multiplied by the per capita generation derived from single family information. Multifamily recycling was then subtracted from the total discard stream to estimate multifamily refuse generation. Typically, there are approximately two persons per household in multifamily housing and approximately three persons per household in single family housing, so the per capita method adjusts for size of household but not for propensity to comply with recycling program requirements.

Measuring Tons, Volume Method: Several haulers were contacted and asked about the service (container size and frequency of collection) provided to typical apartment complexes. The number of households in each complex also was determined. Tonnages were estimated based on 100 to 120 pounds per cubic yard, determined from previous studies throughout the United States,

with the lower figure used for complexes involved in glass recycling. A per household refuse figure was determined for each complex, these data were averaged and applied to the total number of multifamily households in the community, as an estimate of multifamily refuse.

Multifamily Household: Many communities have different definitions of multifamily household. One community might define multifamily as any building with two or more units, while another might define a multifamily building as one with four or more units or six or more units. Very often, the community defines any multifamily establishment not included in its single family definition to be a commercial customer.

Municipal Service: Services provided by employees of a local government.

Municipal Service Costs: For municipal service, costs are defined on a full cost accounting basis, including wages of personnel on vehicles used for the service, wages of persons supervising those crews, fringe benefits for the above personnel, vehicle operating and maintenance expenses (including labor), other operating expenses (including billing customers, office expenses, etc.), and depreciation of vehicles and containers. Care was taken to avoid any double counting of wages (e.g., where a fee for vehicle maintenance included maintenance labor, no direct maintenance labor would be added). Particular care was taken to allocate labor performing several functions (e.g., single family and multifamily recycling service) accurately. This was typically accomplished according to the percentage of each worker's weekly time devoted to performing each service. Backup personnel and vehicles also are included in the cost of the service. Depreciation of vehicles is computed on a 7-year straight-line basis, and depreciation of containers is computed on a 10-year straight-line basis. For recycling, costs included processing of recyclables less revenues remitted to the community. Disposal fees were not included in the refuse collection costs.

Private Firm Cost: The cost of recycling is the payment to the firm including the cost of processing the recyclables, less any revenues remitted to the community. For refuse collection, disposal fees were subtracted from private firm payment.

Private Service: Services provided by employees of a private firm, including contract service, franchise service, and subscription service.

- **Contract Service:** Occurs when a single firm is hired by a local government to provide collection services of specified materials to a group of customers; the firm has the exclusive right to serve all eligible customers in a specified territory. *The firm is paid by the local government, submitting only one invoice per month to the government.* Any billing of customers that takes place is done by the local government.
- **Franchise Service, Exclusive:** Exclusive franchise service is the same as contract service, except the selected firm bills customers directly for services provided.
- **Franchise Service, Nonexclusive:** The same as exclusive franchise service, except that more than one firm is authorized to provide service in a given geographical territory.
- **Subscription Service:** In this type of service there is free competition between any licensed firm to obtain the business of any potential customer. There is typically no rate regulation whatsoever, and the prices are set by the market forces of supply and demand.

Productivity Measures: These measures include the cost per ton collected, the annual cost per household served, the number of households served per crew shift, the number of tons of recyclables collected per household served each year, and the diversion rate.

Single Family Household: Usually consists of a building with one family unit, but also depends on an individual community's definition of multifamily household. Some communities define a single family unit as any establishment setting out six or fewer cans or bags for collection, whether the customer be a commercial store or a residential establishment. Typically, a community oversees programs for the collection of refuse and recyclables from those establishments it defines to be single family establishments.

Statistical Significance: Whether one can be reasonably confident the pattern observed differs from what would occur randomly. The level of statistical significance means the degree to which one can be confident the difference in values among the groups did not arise by chance.

Total/Aggregate Discard Stream: For multifamily households, recyclables plus refuse; for single family households, recyclables plus refuse plus yard waste.

Appendix C:

Individual Program Information

The following table provides a summary of the recycling and refuse systems in the 40 sample communities and describes which methods of estimation were required in each community. The table also lists type of service and collection logistics.

Chart Acronyms:

MF	Multifamily
SF	Single Family
HH	Household
MRF	Materials Recovery Facility
MWP	Mixed Wastepaper
ONP	Old Newspaper

Table C-1	Individual Program Information	
Community	Refuse Collection	Recycling Collection
Alameda, CA	**MF & SF** *Service:* — Exclusive franchise *Collection Logistics:* — Collected mixed with commercial waste *Calculations:* — Estimate based on volume and persons per HH	**MF & SF** *Service:* — Exclusive franchise *Collection Logistics:* — Different containers for MF & SF; same trucks and same routes *Calculations:* — Number of MF & SF containers collected known, tonnage allocated based on volume ratio of containers collected
Altoona, PA	**MF & SF** *Service:* — Subscription *Calculations:* — Per capita estimate of MF refuse tonnages based on SF per capita estimate — Haulers provided fees	**MF & SF** *Service:* — Mandated, provided by subscription *Collection Logistics:* — City provides Dumpsters for MF and bins for SF *Calculations:* — Quantities estimated by container volumes
Bridgewater, NJ	**MF & SF** *Service:* — Mandatory subscription with several haulers *Calculations:* — Estimate refuse from container size and number of HHs	**MF** *Service:* — Provided by county *Collection Logistics:* — Buy Dumpsters and get a credit for 50 barrels/Dumpster; two Dumpsters per every 50 HHs *Calculations:* — Single report on MF & SF tonnage — Net container cost: $700 for 50 HHs **SF** *Service:* — Provided by county *Collection Logistics:* — Barrels provided free *Calculations:* — Single report on MF & SF tonnage

Table C-1	**Individual Program Information (Continued)**	
Community	Refuse Collection	Recycling Collection
Broward County, FL	**MF & SF** *Service:* — Nonexclusive franchise *Calculations:* — Tonnage data mixed with commercial; estimate MF tonnage using SF tonnage and per capita method	**MF & SF** *Service:* — Nonexclusive franchise *Calculations:* — Separate tonnage reports for recycling
Cherry Hill, NJ	**MF & SF** *Service:* — Contract service *Calculations:* — Separate tonnage reported — Allocate contractor payment based on number of HHs, then divide by tonnage for cost per ton	**MF & SF** *Service:* — Mandatory, contract service *Collection Logistics:* — Toters for MF, pails for SF *Calculations:* — Used old separate contract to determine MF recycling tonnage — Saved 27 percent by combining SF & MF into one service contract
Dayton, OH	**MF** *Service:* — Subscription *Calculations:* — Used per capita method to estimate MF tonnage **SF** *Service:* — Municipal collection *Calculations:* — Costs determined based on labor, fringe, other operating costs, overhead, and depreciation	**MF** *Calculations:* — Per capita method to estimate tonnage **SF** *Service:* — Municipal, includes 2- to 4-unit buildings *Calculations:* — Costs determined from labor, other cost elements
Daytona Beach, FL	**MF & SF** *Service:* — Exclusive franchise *Collection Logistics:* — Twice per week collection *Calculations:* — Estimate MF tonnage based on per capita method — Good data on number of customers, as they are billed for service	**MF & SF** *Calculations:* — Separate tonnage and fees for MF and SF

Table C-1	**Individual Program Information (Continued)**	
Community	Refuse Collection	Recycling Collection
Durham, NC	**MF & SF** *Service:* — SF municipal and MF largely municipal *Calculations:* — Estimated tonnage by volume and per capita method — Fees provided	**MF & SF** *Service:* — Contract with nonprofit organization that operates the MRF; paid per HH *Collection Logistics:* — 90-gallon carts for MF, small stacks (towers) for SF *Calculations:* — Tonnage separated for MF and SF
Diamond Bar, CA	**MF & SF** *Service:* — Subscription *Collection Logistics:* — Dumpsters used for MF refuse *Calculations:* — Obtained total residential tonnage, added recycling, and divided by population to determine generation rate; subtracted recycling to obtain refuse tonnage for those who recycle	**MF** *Service:* — Voluntary, by subscription *Collection Logistics:* — 90-gallon barrels; list of six complexes with recycling obtained, including number of HHs per complex **SF** *Service:* — Includes condos *Collection Logistics:* — 90-gallon barrels
East Brunswick, NJ	**MF & SF** *Service:* — Same contract as for recycling *Collection Logistics:* — Contractor paid based on bid price per ton *Calculations:* — Invoices show MF and SF tonnage separately; 88lbs/cu yd=MF density	**MF** *Service:* — With SF in same contract as refuse *Collection Logistics:* — 96-gallon carts for MF collected weekly; county pays for containers *Calculations:* — Invoices show total tonnage; used per capita method to allocate **SF** *Service:* — With MF in same contract as refuse *Collection Logistics:* — Bins collected every 2 weeks; county pays for containers *Calculations:* — Invoices show total tonnage; used per capita method to allocate

Table C-1	**Individual Program Information (Continued)**	
Community	Refuse Collection	Recycling Collection
East Orange, NJ	**MF & SF** *Service:* — Municipal contract and some private subscription *Calculations:* — Direct tonnage data — Cost data	**MF** *Service:* — Municipal service for complexes with 50+ units *Collection Logistics:* — Weekly *Calculations:* — Tonnage available — Costs determined from cost elements **SF** *Service:* — Contract for complexes with less than 50 units *Collection Logistics:* — Every 2 weeks *Calculations:* — Tonnage available — Costs determined from cost elements
Fountain Valley, CA	**MF & SF** *Service:* — MF has exclusive franchise with same firm as commercial and SF; SF has a contract with the same firm *Collection Logistics:* — Refuse and recyclables collected commingled and sorted at a MRF; public education program reminds HHs to bag putrescibles to keep from contaminating recyclables *Calculations:* — Per capita method used to estimate MF refuse tonnage — Given collection method, allocated per ton after subtracting disposal and net processing costs; added all processing costs to yard waste and recycling programs — Good data on costs; fees to contractor allocated between refuse and recycling	**MF & SF** *Service:* — Exclusive franchise to same firm as SF *Collection Logistics:* — See refuse *Calculations:* — See refuse

Table C-1	Individual Program Information (Continued)	
Community	Refuse Collection	Recycling Collection
Frankfurt, KY	**MF & SF** *Service:* — Municipal service *Calculations:* — Tonnages allocated on per capita basis — Cost computed by cost elements, allocated by tonnage	**MF & SF** *Service:* — Municipal service *Collection Logistics:* — Inmate labor collects 4 days per week, repair trucks on 5th day *Calculations:* — Tonnage determined using per capita method — Costs allocated by tonnage
Greenfield, WI	**MF & SF** *Service:* — Contract *Collection Logistics:* — Different fee rates for Dumpster and can service *Calculations:* — Per capita method used to estimate MF tonnage — Used fees to determine costs	**MF & SF** *Service:* — Contract with private hauler *Collection Logistics:* — Toters for MF, bins for SF; same truck serves MF & SF HHs *Calculations:* — Estimated percentage of payment for yard waste and recycling based on number of truck shifts per week
Hillsboro, OR	**MF & SF** *Service:* — Exclusive franchise collects 95 percent of MF & SF refuse *Calculations:* — Good tonnage data for SF; used per capita method to estimate MF tonnage — Estimated fee allocations based on number of truck shifts and cost per truck shift	**MF & SF** *Collection Logistics:* — MF, ONP, and OCC collected commingled with commercial recyclables — MF & SF mixed containers collected on same routes *Calculations:* — MF & SF tonnages all together, tonnage allocated on per capita basis

Table C-1	Individual Program Information (Continued)	
Community	Refuse Collection	Recycling Collection
Jacksonville, FL	**MF** *Service:* — Choice between municipal or contract *Collection Logistics:* — Municipal can/bag once per week — Contractors to city serve 233,500 HHs; another 89,000 HHs are served by private firms *Calculations:* — Estimated tonnage on per capita basis **SF** *Service:* — Three contracts and one municipal area *Collection Logistics:* — No user fee	**MF** *Service:* — Voluntary; private contract; 75 percent to 80 percent have service *Collection Logistics:* — One-sort commingled set out — Drop off locations (Igloos) collected 500 tons in 1996, but discontinued due to lack of grant funds *Calculations:* — Tonnage estimated by container volume — Little to no fees **SF** *Service:* — Contract/municipal *Collection Logistics:* — Weekly collection of recyclables and yard waste
Lakewood, OH	**MF & SF** *Service:* — Municipal *Collection Logistics:* — MF and SF served by same trucks *Calculations:* — Used per capita method to estimate tonnage; cost determined from cost elements	**MF & SF** *Service:* — Municipal *Calculations:* — Used per capita method to allocate tonnage — Cost determined from cost component buildup; cost per ton same for SF & MF, but cost per HH varies
Laredo, TX	**MF & SF** *Service:* — Municipal *Calculations:* — Used per capita method to estimate MF tonnage — Estimated costs per week and per truck shift	**MF & SF** *Service:* — Municipal; no real separation between MF & SF *Collection Logistics:* — Blue bags, picked up on second day of refuse collection by same trucks as refuse, but on a separate trip *Calculations:* — Little quantitative data available

Table C-1	**Individual Program Information (Continued)**	
Community	Refuse Collection	Recycling Collection
Largo, FL	**MF** *Service:* — Municipal *Collection Logistics:* — Collected with commercial *Calculations:* — Tonnage determined by per capita method — Cost determined from cost elements **SF** *Service:* — Municipal *Calculations:* — Cost determined from cost elements	**MF** *Service:* — Municipal *Collection Logistics:* — ONP in Dumpsters, drop-off for other materials; no ferrous collected *Calculations:* — Tonnage estimated; had to allocate between Dumpster and drop-off **SF** *Service:* — Municipal
Lancaster, OH	**MF & SF** *Service:* — All municipal *Calculations:* — Tonnage allocated between residential and commercial, then on a per capita basis between MF & SF — Cost estimate from cost elements	**MF & SF** *Service:* — None provided to MF with Dumpster refuse service *Collection Logistics:* — Same routes *Calculations:* — Good data on tonnages; had to allocate between MF & SF on per capita basis
Lima, OH	**MF** *Service:* — Subscription *Collection Logistics:* — Collected with commercial *Calculations:* — SF refuse per capita used to estimate MF refuse **SF** *Service:* — Contract covers refuse, recycling, and yard waste *Collection Logistics:* — Separate monthly fees per HH	**MF & SF** *Service:* — Contract for both same as SF refuse *Calculations:* — Tonnage: estimated MF & SF split by per capita method

Table C-1	Individual Program Information (Continued)	
Community	Refuse Collection	Recycling Collection
Maple Grove, MN	**MF** *Service:* — Subscription *Calculations:* — Has dumpster service levels for each MF complex to estimate tonnage **SF** *Service:* — Subscription *Calculations:* — Tonnage estimated by volume — Good fee data for cost	**MF & SF** *Service:* — Contract *Calculations:* — Volume-based estimate of tonnage for MF
Miami, FL (Dade County)	**MF** *Service:* — Subscription *Calculations:* — Used per capita and volume method **SF** *Service:* — Unincorporated Dade County and three cities provided with intergovernmental contract for service by county *Collection Logistics:* — Twice per week *Calculations:* — Good data due to solid waste enterprise fund	**MF** *Service:* — Mandated service for five materials; haulers by subscription *Calculations:* — Good data on tonnages by material from private sector haul reports — Hauler provided fee estimates, recycling billed separately **SF** *Service:* — Unincorporated Dade County and 17 to 18 cities have contract with private hauler *Calculations:* — Good data on tonnages and costs
Newport News, VA	**MF** *Service:* — Subscription, some municipal *Calculations:* — Allocate tonnage by per capita method, extend tonnage to MF served by subscription **SF** *Service:* — Municipal	**MF** *Collection Logistics:* — Roll-off container with two compartments at seven high rise sites *Calculations:* — Good data on tonnages — Pay per pull **SF** *Service:* — Contract includes garden apartments *Collection Logistics:* — Bins, curbside *Calculations:* — Good data on tonnages

Table C-1	**Individual Program Information (Continued)**	
Community	Refuse Collection	Recycling Collection
New York, NY	**MF & SF** *Service:* — Municipal *Collection Logistics:* — Less than 10 percent of HHs live in SF *Calculations:* — Good tonnage data — Estimated costs from cost elements	**MF & SF** *Service:* — Municipal, all one system *Collection Logistics:* — Reliance on building staff to set out and arrange systems *Calculations:* — Good tonnage data — Estimated costs from cost elements
North Tonawanda, NY	**MF & SF** *Service:* — Municipal for SF and 95 percent of MF *Calculations:* — Tonnage allocated by per capita method — Costs determined from cost-element analysis	**MF & SF** *Service:* — Municipal *Calculations:* — Tonnage generation estimated on per capita basis — Costs determined from cost-element buildup
Old Bridge, NJ	**MF** *Service:* — Contract with private hauler *Collection Logistics:* — Fee information from hauler *Calculations:* — Estimated tonnage per HH from apartment data provided by hauler **SF** *Service:* — Subscription *Calculations:* — Estimated tonnage on a per capita basis using data from MF	**MF** *Service:* — Contract with private hauler *Calculations:* — Good tonnage data from township — Cost information provided by hauler **SF** *Service:* — County contract with hauler *Calculations:* — Good tonnage, cost, and number of HHs data

Table C-1	Individual Program Information (Continued)	
Community	Refuse Collection	Recycling Collection
Olympia, WA	**MF** *Service:* — Municipal *Collection Logistics:* — Collected with commercial *Calculations:* — Tonnage estimated by per capita method — Cost data allocated by tonnage, MF versus commercial **SF** *Service:* — Municipal *Calculations:* — Good tonnage and cost data	**MF & SF** *Service:* — Municipal *Collection Logistics:* — MF uses same trucks as SF, but collected on different day *Calculations:* — Good separate MF and SF tonnage data — Cost allocation based on weekly number of crew and shifts
Placentia, CA	**MF** *Service:* — Exclusive franchise *Collection Logistics:* — Large apartments have 3-cubic-yard bins for refuse and recyclables that are separated at dirty MRF — Collected with commercial *Calculations:* — Costs based on fees less disposal **SF** *Service:* — Exclusive franchise *Collection Logistics:* — Color coded cart system: black-refuse — Includes condos *Calculations:* — Cost allocated to refuse, recycling, and yard waste based on truck shifts	**MF** *Service:* — Exclusive franchise *Collection Logistics:* — Bagged and put in refuse bin for separation at dirty MRF *Calculations:* — Tonnage estimated on per capita basis, with 50 percent downward adjustment (based on city input) — Costs based on fees less disposal/net processing **SF** *Service:* — Exclusive franchise *Collection Logistics:* — Color coded cart system: green-recyclables and brown-yard waste — Includes condos

Table C-1	**Individual Program Information (Continued)**	
Community	Refuse Collection	Recycling Collection
Portland, OR	**MF** *Service:* — Subscription *Calculations:* — Tonnage estimated by per capita method — Costs from Ecodata model for Portland — Truck shifts from model **SF** *Service:* — Exclusive franchises (49) *Calculations:* — Tonnage from annual report, rate audit where sample of containers were weighed — Lists customers by type of service, fees charged; lists truck shifts and volumes collected	**MF** *Service:* — Subscription — Mandatory collection of five materials: ONP, MWP, and three others *Collection Logistics:* — Must be at least as convenient as garbage set out location *Calculations:* — Tonnage estimated from per capita method — Costs estimated from cost model **SF** *Service:* — 12 exclusive franchises *Calculations:* — Tonnage from extended rate review of haulers — Costs from fees, less net processing
Roswell, GA	**MF** *Service:* — Municipal *Collection Logistics:* — Collected with commercial *Calculations:* — Tonnage estimated by per capita method — Costs based on fees less disposal **SF** *Service:* — Municipal, but collected separately from MF *Calculations:* — Good tonnage data — Costs from cost element buildup	**MF** *Service:* — Subscription *Collection Logistics:* — Complexes buy toters, then pay a small monthly fee *Calculations:* — Per capita method used to determine tonnage **SF** *Service:* — Contract *Calculations:* — Good tonnage data — Costs based on fee to contractor less net processing

Table C-1	Individual Program Information (Continued)	
Community	Refuse Collection	Recycling Collection
St. Paul, MN	**MF** *Service:* — Subscription *Calculations:* — Tonnage estimated by per capita method — Fee-based costs (less disposal) **SF** *Service:* — Subscription *Collection Logistics:* — Variable fee/volume based system *Calculations:* — Estimated tonnage and costs based on distribution of container sizes	**MF & SF** *Service:* — Contract *Collection Logistics:* — MF collected with commercial *Calculations:* — Estimated tonnage based on volume — Excellent data on tonnage, number of HHs, number of buildings, and costs
San Jose, CA	**MF** *Service:* — Contract *Collection Logistics:* — Separate from SF and commercial *Calculations:* — Good tonnage data — Cost based on number of truck shifts **SF** *Service:* — Contract (1- to 4-unit buildings) *Collection Logistics:* — Variable-sized can; semi-automated *Calculations:* — Good tonnage and customer data	**MF** *Service:* — Contracts for 9+ units (4- to 9-unit buildings can choose between MF or SF contract) *Calculations:* — Good separate tonnage data; per capita method used to estimate tonnage — Allocate contractor payment between refuse and recycling **SF** *Service:* — Contract *Collection Logistics:* — Separate contract for yard waste *Calculations:* — Good separate tonnage data

Table C-1	**Individual Program Information (Continued)**	
Community	Refuse Collection	Recycling Collection
Seattle, WA	**MF & SF** *Service:* — Contract; single payment *Calculations:* — Allocate tonnage based on per capita and volume basis at known Seattle density-agreed closely — Allocate costs based on truck shifts	**MF** *Service:* — Contract; fees paid to contractors *Calculations:* — Separate and clean tonnage data **SF** *Service:* — Contract; fees paid to contractors *Calculations:* — Separate and clean tonnage data — Separate data for yard waste
Syracuse, NY	**MF** *Service:* — Subscription for 10+ units *Calculations:* — Estimated tonnage and costs from fees and service levels obtained from private firm **SF** *Service:* — Municipal *Calculations:* — Good tonnages — Costs not fully obtained	**MF** *Service:* — Private firms for 10+ unit complexes *Collection Logistics:* — Two-sort program typical; separate recycling bills *Calculations:* — Tonnage estimated by volume — Obtained fees from housing complex **SF** *Service:* — Municipal, includes yard waste — Recycling mandated by county *Calculations:* — Good tonnage information — Cost by cost buildup method
Tamarac, FL	**MF** *Service:* — Nonexclusive franchise *Collection Logistics:* — Collected with commercial *Calculations:* — Tonnage estimated based on volume — Costs based on fees less disposal **SF** *Service:* — Exclusive franchise *Calculations:* — Separate tonnage data, from county — Good cost data	**MF & SF** *Service:* — City owns recycling trucks, pays contractor to collect *Calculations:* — Tonnage allocated based on per capita method — Costs based on fees

Table C-1	**Individual Program Information (Continued)**	
Community	Refuse Collection	Recycling Collection
Tampa, FL	**MF & SF** *Service:* — Some contract, 60 percent municipal *Collection Logistics:* — MF collected with commercial *Calculations:* — MF tonnage estimated by per capita method — Separate data for SF tonnage — Costs estimated by contractor fees	**MF** *Service:* — Municipal to 5,000 units, no service to 38,000 *Calculations:* — Separate tonnage data — Cost estimated from cost buildup analysis **SF** *Service:* — Contract; yard waste by municipal *Calculations:* — Separate data and fees for costs
University City, MO	**MF & SF** *Service:* — Municipal *Calculations:* — Tonnage allocated by per capita method — Costs determined by cost buildup	**MF & SF** *Service:* — Municipal *Calculations:* — Tonnage provided directly; separate data — Costs determined by cost buildup
Vista, CA	**MF & SF** *Service:* — Exclusive franchise *Collection Logistics:* — MF collected with commercial *Calculations:* — For MF, used per capita estimating method for tonnage — Costs based on fees allocated to SF by truck shifts after subtracting disposal	**MF & SF** *Service:* — Exclusive franchise *Collection Logistics:* — MF uses sets of three carts — Materials collected on same trucks as SF, but with dedicated routes *Calculations:* — Separate tonnage data — Costs based on MF fee per unit

Table C-1	Individual Program Information (Continued)	
Community	Refuse Collection	Recycling Collection
Wallingford, CT	**MF** *Service:* — Subscription *Calculations:* — MF tonnage by volume — Fees less disposal used to estimate costs **SF** *Service:* — Subscription *Calculations:* — SF tonnage available separately — Fees less disposal used to estimate costs	**MF** *Service:* — Subscription, mandatory ordinance for all businesses and MF complexes *Collection Logistics:* — 14-gallon bin; materials collected with SF *Calculations:* — Used per capita method of tonnage allocation — Costs based on fees **SF** *Service:* — Subscription *Collection Logistics:* — 14-gallon bin; materials collected with MF *Calculations:* — Used per capita method of tonnage allocation — Costs based on fees

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