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Municipal Solid Waste in The United States: 1999 Facts and Figures

Generation

reuse Source Reduction

recycle

Disposal

CHARACTERIZATION OF MUNICIPAL SOLID WASTE IN THE UNITED STATES: 1999 UPDATE

Table of Contents

Table of Contents

Table of Contents

Appendix **Page**

List of Tables

Table **Page**

List of Tables (continued)

Table **Page**

List of Figures

List of Figures (continued)

MUNICIPAL SOLID WASTE IN THE UNITED STATES: 1999 FACTS AND FIGURES

Executive Summary

OVERVIEW

This report describes the national municipal solid waste (MSW) stream based on data collected from 1960 through 1999. The historical perspective is useful for establishing trends in types of MSW generated and in the ways it is managed. In this Executive Summary, we briefly describe the methodology used to characterize MSW in the United States, and provide the latest facts and figures on MSW generation, source reduction, recycling, and disposal. Details regarding the characterization of municipal solid waste are presented in Chapters 2 through 4.

In this report, we are providing estimates for source reduction (waste prevention) for the first time. Also, we are providing additional detail on generation, recycling, and disposal of consumer electronics products. This consumer electronics information is briefly summarized in the Executive Summary and in Chapter 2, with additional detail in Appendix B.

In the United States, we generated approximately 229.9 million tons of MSW in 1999 – an increase of 6.9 million tons from 1998. This is about a 3 percent increase in waste generation from 1998. Excluding composting, the amount of MSW recycled increased to 50.8 million tons, an increase of 2.4 million tons. This is a 5 percent increase in the tons recycled since 1998. The tons recovered for recycling (including composting) rose to 64 million tons in 1999, up from 62 million tons in 1998. The recovery rate for recycling (including composting) was 27.8 percent in 1999, up from 27.6 percent in 1998. (See Tables ES-1 and ES-2 and Figures ES-1 and ES-2).

* Data shown for 1998 has been adjusted to reflect the latest revisions to the data and methodology and, therefore, may differ slightly from the same measure reported previously. For instance, the recycling rate for 1998 was revised from last year's report, to equal 27.6 percent.

Table ES-1
GENERATION, MATERIALS RECOVERY, COMPOSTING,
AND DISCARDS OF MUNICIPAL SOLID WASTE, 1960-1999
(In millions of tons)

Millions of Tons									
	1960	1970	1980	1990	1994	1995	1997	1998	1999
Generation	88.1	121.1	151.6	205.2	214.4	211.4	219.1	223.0	229.9
Recovery for recycling	5.6	8.0	14.5	29.0	42.2	45.3	47.3	48.4	50.8
Recovery for composting*	Neg.	Neg.	Neg.	4.2	8.5	9.6	12.1	13.1	13.1
Total Materials Recovery	5.6	8.0	14.5	33.2	50.6	54.9	59.4	61.6	63.9
Discards after Recovery	82.5	113.0	137.1	172.0	163.7	156.5	159.8	161.5	166

* Composting of yard trimmings and food wastes. Does not include mixed MSW composting or backyard composting.
Source: Franklin Associates

Table ES-2
GENERATION, MATERIALS RECOVERY, COMPOSTING,
AND DISCARDS OF MUNICIPAL SOLID WASTE, 1960-1999
(In pounds per person per day)

Pounds per Person per Day									
	1960	1970	1980	1990	1994	1995	1997	1998	1999
Generation	2.68	3.25	3.66	4.50	4.51	4.40	4.49	4.52	4.62
Recovery for recycling	0.17	0.22	0.35	0.64	0.89	0.94	0.97	0.98	1.02
Recovery for composting*	Neg.	Neg.	Neg.	0.09	0.18	0.20	0.25	0.27	0.26
Total Materials Recovery	0.17	0.22	0.35	0.73	1.06	1.14	1.22	1.25	1.28
Discards after Recovery	2.51	3.04	3.31	3.77	3.44	3.26	3.27	3.27	3.33
Population (thousands)	179,979	203,984	227,255	249,907	260,682	263,168	267,645	270,561	272,691

*Composting of yard trimmings and food wastes. Does not include mixed MSW composting or backyard composting.
Details may not add to totals due to rounding.
Source: Franklin Associates

MSW generation in 1999 rose to 4.62 pounds per person per day, up from 4.52 pounds per person per day in 1998. This is an increase of 0.1 pounds per person per day compared to 1998. The recycling rate in 1999 was 1.28 pounds per person per day, up from 1.25 in 1998. Discards after recycling rose to 3.33 from the 1998 value of 3.27 pounds per person per day (Table ES-3).

Table ES-3
GENERATION, MATERIALS RECOVERY, COMPOSTING,
AND DISCARDS OF MUNICIPAL SOLID WASTE, 1960-1999
(In percent of total generation)

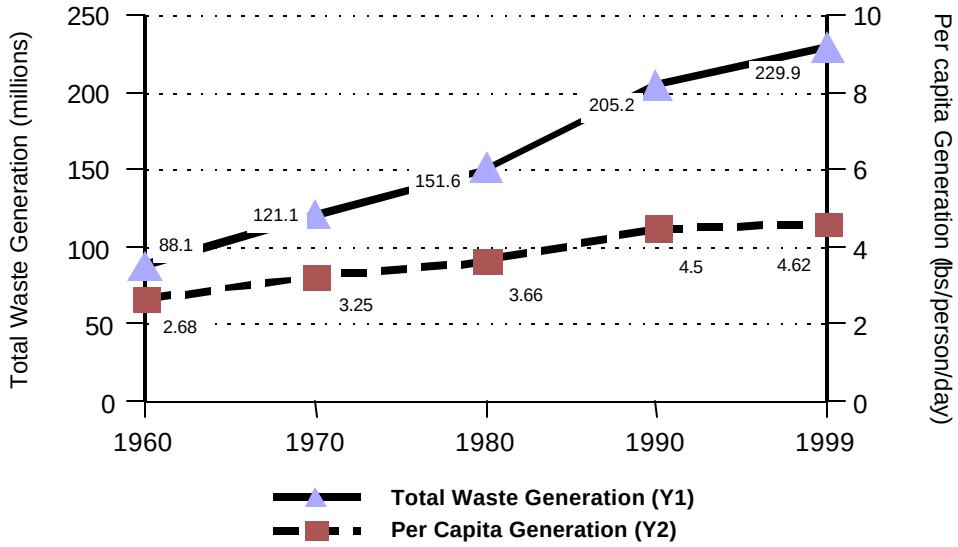
Percent of Total Generation									
	1960	1970	1980	1990	1994	1995	1997	1998	1999
Generation	100.0 %	100.0 %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Recovery for recycling	6.4%	6.6%	9.6%	14.2%	19.7%	21.5%	21.6%	21.7%	22.1%
Recovery for composting*	Neg.	Neg.	Neg.	2.0%	4.0%	4.5%	5.5%	5.9%	5.7%
Total Materials Recovery	6.4%	6.6%	9.6%	16.2%	23.6%	26.0%	27.1%	27.6%	27.8%
Discards after Recovery	93.6%	93.4%	90.4%	83.8%	76.4%	74.0%	72.9%	72.4%	72.2%

*Composting of yard trimmings and food wastes. Does not include mixed MSW composting or backyard composting.
Details may not add to totals due to rounding.
Source: Franklin Associates

The state of the economy has a direct impact on consumption and waste generation. With the strong economic growth that has occurred throughout the 1990s, waste generation has continued to increase. Source reduction efforts have helped to dampen the increases in waste generation. On-site yard waste composting, use of mulching mowers, and reductions in the weight of beverage containers have been the main reasons for this success.

Using a baseline year of 1990, and comparing the actual waste generation to what the waste generation would have been without source reduction, in 1999 about 50 million tons of waste was prevented, or source reduced. In 1999 229.9 million tons of MSW were generated. Therefore, had this level of source reduction not occurred, 22 percent more MSW would have been generated.

Figure ES-1: Waste Generation Rates From 1960 to 1999



WHAT IS INCLUDED IN MUNICIPAL SOLID WASTE?

MSW – otherwise known as trash or garbage – consists of everyday items such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries. Not included are materials that also may be disposed in landfills, but are not generally considered MSW, such as construction and demolition debris, municipal wastewater treatment sludges, and non-hazardous industrial wastes.

MUNICIPAL SOLID WASTE IN PERSPECTIVE

Trends Over Time

Over the last few decades, the generation, recycling, and disposal of MSW has changed substantially (see Tables ES-1, ES-2, and ES-3 and Figures ES-1 and ES-2). MSW generation has continued to increase from 1960, when it was 88 million tons per year. The generation rate in 1960 was just 2.7 pounds per person per day; it grew to 3.7 pounds per person per day in 1980; reached 4.5 pounds per person per day in 1990; and is now 4.62 pounds per person per day.

Waste generation rates would be even higher, if not for waste prevention practices such as on-site composting, leaving grass clippings on the lawn, and lightweighting of packaging materials. Generation of yard trimmings during 1999 is estimated at 27.7 million tons, down from 35 million tons in 1990 (Table ES-4). Source reduction of MSW increased from 630,000 tons in 1992 to 50 million tons in 1999. This is explained further at the end of this Executive Summary and in Chapter 4.

Over time, recycling rates have increased from 10 percent of the MSW generated in 1980 to 16 percent in 1990, to the current 28 percent. Disposal has decreased from 90 percent of the amount generated in 1980 to 72.2 percent of MSW in 1999. This compares to 72.4 percent in 1998.

Figure ES-2: Waste Recycling Rates From 1960 to 1999

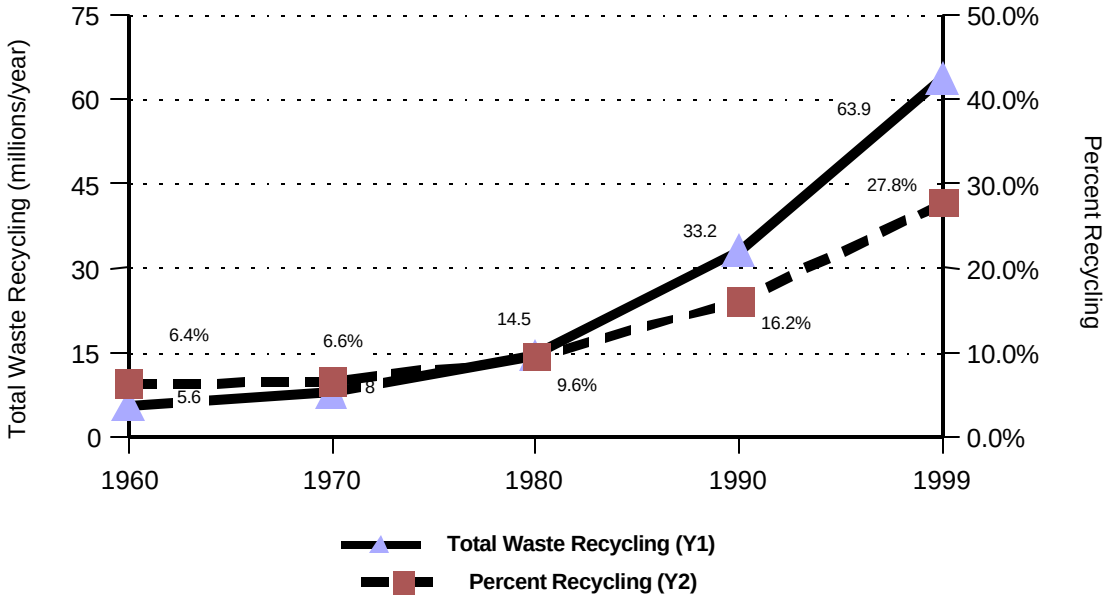


Table ES-4
GENERATION AND RECOVERY OF MATERIALS IN MSW, 1999
(In millions of tons and percent of generation of each material)

	Weight Generated	Weight Recovered	Recovery as a Percent of Generation
Paper and paperboard	**87.5**	**36.7**	**41.9%**
Glass	**12.6**	**2.9**	**23.4%**
Metals			
Steel	**13.3**	**4.5**	**33.6%**
Aluminum	**3.1**	**0.9**	**27.8%**
Other nonferrous metals*	**1.4**	**0.9**	**66.9%**
Total metals	**17.8**	**6.3**	**35.2%**
Plastics	**24.2**	**1.4**	**5.6%**
Rubber and leather	**6.2**	**0.8**	**12.7%**
Textiles	**9.1**	**1.2**	**12.9%**
Wood	**12.3**	**0.7**	**5.9%**
Other materials	**4.0**	**0.9**	**21.4%**
Total Materials in Products	**173.6**	**50.8**	**29.3%**
Other wastes			
Food, other**	**25.2**	**0.6**	**2.2%**
Yard trimmings	**27.7**	**12.6**	**45.3%**
Miscellaneous inorganic wastes	**3.4**	**Neg.**	**Neg.**
Total Other Wastes	**56.3**	**13.1**	**23.3%**
TOTAL MUNICIPAL SOLID WASTE	**229.9**	**63.9**	**27.8%**

Includes Wastes from residential, commercial, and institutional sources.
*Includes lead from lead-acid batteries.
**Includes recovery of paper for composting.
Neg.= Less than 50,000 tons or 0.05 percent.

MUNICIPAL SOLID WASTE IN 1999

EPA has two ways of analyzing the 229.9 million tons of MSW generated in 1999. The first is by **material** (paper and paperboard, yard trimmings, food scraps, plastics, metals, glass, wood, rubber, leather and textiles, and other), and the second is by several major **product** categories. The product-based categories are containers and packaging; nondurable goods (e.g.,

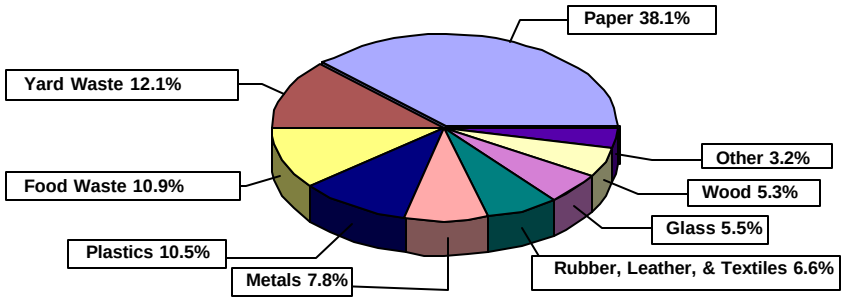
newspapers); durable goods (e.g., appliances); yard trimmings; food scraps; and other materials.

Materials in MSW

Figure ES-3 provides a breakdown, by weight, of the MSW **materials** generated in 1999. Paper and paperboard products made up the largest component of MSW generated (38 percent), and yard trimmings comprised the second-largest material component (12 percent). Glass, metals, plastics, wood, and food wastes each constituted between 5 and 11 percent of the total MSW generated. Rubber, leather, and textiles combined made up about 7 percent of MSW, while other miscellaneous wastes made up approximately 2 percent of the MSW generated in 1999.

A portion of each **material category** in MSW was recycled or composted in 1999. The highest rates of recycling were achieved with yard trimmings, metals and paper. About 45 percent (12.6 million tons) of yard trimmings were recovered for composting in 1999. This represents more than a three-fold increase since 1990. About 42 percent (37 million tons) of paper and paperboard were recovered for recycling in 1999. Recycling of these organic materials alone diverted over 21 percent of municipal solid waste from landfills and incineration.

Figure ES-3: 1999 Total Waste Generation - 230 Million Tons
(Before Recycling)



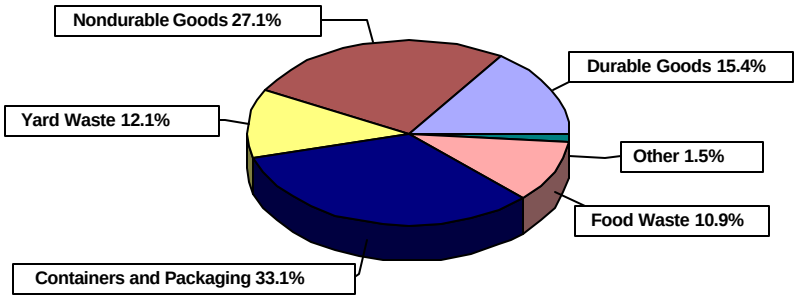
Percent of total generation and millions of tons generated in 1999

In addition, about 6.3 million tons of metals were recovered for recycling, or 35 percent. Table ES-4 lists the recycling rates for 1999 for all of the materials categories.

Products in MSW

Figure ES-4 shows the breakdown, by weight, of **product categories** generated in 1999. Containers and packaging comprised the largest portion of products generated, at 33 percent (76 million tons) of total MSW generation. Nondurable goods were the second-largest fraction, comprising about 27 percent (62 million tons). The third-largest category of products is durable goods, which comprised 15.4 percent (35 million tons) of total MSW generation.

Figure ES-4: Products Generated in MSW - 1999
(Total Weight = 230 million tons)



Percent of total generation and millions of tons generated in 1999

Table ES-5 shows the generation and recovery of the **product** categories in MSW. This table shows that recovery of *containers and packaging* was the highest of the three product categories – 37 percent of containers and packaging generated in 1999 was recovered for recycling. About 44 percent of aluminum packaging was recovered (mostly beverage cans), while 57 percent of steel packaging (mostly cans) was recovered. Paper and paperboard packaging recovery was estimated at 51 percent; corrugated containers accounted for most of that figure.

Table ES-5

GENERATION AND RECOVERY OF PRODUCTS IN MSW

BY MATERIAL, 1999

(In millions of tons and percent of generation of each product)

	Weight Generated	Weight Recovered	Recovery as a Percent of Generation
Durable goods			
Ferrous metals	10.4	2.8	26.9%
Aluminum	1.0	Neg.	Neg.
Other non-ferrous metals	1.4	0.9	66.9%
Total metals	12.8	3.7	29.3%
Glass	1.5	Neg.	Neg.
Plastics	7.2	0.3	3.8%
Rubber and leather	5.4	0.8	14.6%
Wood	4.7	Neg.	Neg.
Textiles	2.7	0.2	8.7%
Other materials	1.1	0.9	76.8%
Total durable goods	35.4	5.9	16.6%
Nondurable goods			
Paper and paperboard	46.3	15.7	33.9%
Plastics	5.8	Neg.	Neg.
Rubber and leather	0.8	Neg.	Neg.
Textiles	6.2	0.9	15.1%
Other materials	3.1	Neg.	Neg.
Total nondurable goods	62.2	16.6	26.8%
Containers and packaging			
Steel	2.9	1.7	57.3%
Aluminum	2.0	0.9	44.2%
Total metals	4.9	2.6	52.0%
Glass	11.1	2.9	26.6%
Paper and paperboard	41.2	21.0	51.0%
Plastics	11.2	1.1	9.7%
Wood	7.5	0.7	9.5%
Other materials	0.2	Neg.	Neg.
Total containers and packaging	76.0	28.3	37.2%
Other wastes			
Food wastes	25.2	0.6*	2.2%
Yard trimmings	27.7	12.6	45.3%
Miscellaneous inorganic wastes	3.4	Neg.	Neg.
Total other wastes	56.3	13.1	23.3%
TOTAL MUNICIPAL SOLID WASTE	229.9	63.9	27.8%

Includes wastes from residential, commercial, and institutional sources.

*Includes recovery of paper for composting.

Neg. = less than 50,000 tons or 0.05 percent.

Approximately 27 percent of glass containers was recovered overall, while about 10 percent of wood packaging (mostly pallets removed from service) was recovered for recycling. About 10 percent of plastic containers and packaging was recovered in 1999, mostly soft drink, milk, and water bottles.

Overall recovery of *nondurable goods* was 26.8 percent in 1999. The increase in recovery of paper and paperboard products has been due to increases in recovery, over time, from all categories. Newspapers constituted the largest portion of this recovery, with 59 percent of newspapers generated being recovered for recycling. Fifty-three percent of high-grade office papers and 23 percent of magazines were recovered in 1999.

Also within the *nondurable goods*, paper and paperboard category, key products whose recovery rose the most from 1997 to 1999 include directories, standard (A) mail*, and newspapers. In 1997, 12.8 percent of directories were recovered, which increased to 16.2 percent in 1999 (100,000 tons per year in 1999). Recovery of standard (A) mail has increased from 18.1 percent in 1997, to 22.1 percent in 1999 (1.2 million tons in 1999). Recovery of newspapers increased from 54 percent of newspapers in 1996 to 59 percent in 1999 (8.2 million tons in 1999.)

This year, selected consumer electronics, a new subcategory within *nondurable goods*, was measured for the first time. The "selected consumer electronics" category consists of video products such as TVs, VCRs and camcorders; audio products such as radios and some stereo systems; and information products such as telephones, personal computers, and computer monitors and printers. This "selected consumer electronics" category probably contains a major portion of consumer electronics, but it may underestimate generation of this category, because of data limitations**.

*Standard (A) mail was formerly called 3rd class mail by the U.S. Postal Service.

** "Selected consumer electronics," as a subset of *nondurable goods*, may be an underestimation because certain types of consumer electronics such as stereo systems made of components, were not included due to lack of sales data. In addition, there was limited data on consumer electronic products shipped directly from manufacturers (or their representatives) to large consumers. These products, though not included in "selected consumer electronics," are still included in the *nondurable goods* category.

In 1999, more than 400 million units of "selected consumer electronics" were shipped, up from less than 150 million units shipped in 1984. "Selected consumer electronics," compared with all MSW, resulted in 0.8 percent of the MSW generation; 0.3 percent of the recovery, and 1 percent of the discards. Recovery, which could be overestimated, was 0.1 percent for video products, 21 percent for information products, and negligible for audio products.

The nondurable category also includes clothing and other textile nondurable products – 15.2 percent of these were recovered for recycling in 1999.

Overall, *durable goods* were recovered at a rate of 16.6 percent in 1999. Nonferrous metals had one of the highest recovery rates, at 67 percent, due to the high rate of lead recovery from lead-acid batteries. Twenty-seven percent of ferrous metals were recovered from appliances and miscellaneous durable goods. Excluding retreads and tire-derived fuel use, more than 26 percent of tires also were recovered for recycling.

One of the products with particularly high recovery rates was lead-acid batteries, at 96.9 percent. Other products with particularly high recovery rates were corrugated boxes (65.1 percent), steel in major appliances (52.2 percent), steel cans (56.1 percent), aluminum beverage cans (54.5 percent) and newspapers (59 percent).

RESIDENTIAL AND COMMERCIAL SOURCES OF MSW

Sources of MSW, as characterized in this report, include both residential and commercial locations. We estimated residential waste (including waste from multi-family dwellings) to be 55 to 65 percent of total MSW generation. Commercial waste (including waste from schools, some industrial sites where packaging is generated, and businesses) constitutes between 35 and 45 percent of MSW. Local and regional factors, such as climate and level of commercial activity, contribute to these variations.

MANAGEMENT OF MSW

Overview

EPA's integrated waste management hierarchy includes the following three components,

listed in order of preference:

- Source reduction (or waste prevention), including reuse of products and on-site, or backyard composting of yard trimmings.
- Recycling, including off-site or community composting.
- Disposal, including waste combustion (preferably with energy recovery) and landfilling.

Although EPA encourages the use of strategies that emphasize the top of the hierarchy whenever possible, all three components remain important within an integrated waste management system.

Source Reduction

EPA has been measuring recycling rates for many years. When EPA established its waste management hierarchy in 1989, it emphasized the importance of *reducing* the amount of waste created, reusing whenever possible, and then recycling what is left. When municipal solid waste is reduced and reused, this is called "source reduction" – meaning the material never enters the waste stream. It is managed at the source of generation.

Source reduction, also called waste prevention, includes the design, manufacture, purchase, or use of materials, such as products and packaging, to reduce their amount or toxicity before they enter the MSW management system. Some examples of source reduction activities are:

- Designing products or packaging to reduce the quantity or the toxicity of the materials used, or to make them easy to reuse.
- Reusing existing products or packaging; for example, refillable bottles, reusable pallets, and reconditioned barrels and drums.
- Lengthening the lives of products such as tires to postpone disposal.
- Using packaging that reduces the amount of damage or spoilage to the product.
- Managing nonproduct organic wastes (e.g., food scraps, yard trimmings) through on-site composting or other alternatives to disposal (e.g., leaving grass clippings on the lawn).

EPA recently has been able to estimate source reduction for the nation based on national

production and disposal data. This has demonstrated some major successes in this area. In 1999, the U.S. prevented more than *50 million tons* of municipal solid waste from entering the waste stream.

Containers and packaging represent approximately 24 percent of the materials source reduced in 1999, in addition to nondurable goods (e.g., newspapers, clothing) at 18 percent, durable goods (e.g., appliances, furniture, tires) at 11 percent, and other MSW (e.g., yard trimmings, food scraps) at 47 percent.

As the nation has begun to realize the value of its resources, both financial and material, greater efforts have been made to reduce waste generation. Table ES-6 shows that steady progress has been made in waste prevention since 1990.

Table ES-6

Year	Tons Source Reduced
1992	**630,000**
1994	**7,974,000**
1995	**21,418,000**
1996	**23,286,000**
1997	**32,019,000**
1998	**40,319,000**
1999	**50,042,000**

Table ES-7 shows that almost half of the total waste prevented since 1990 comes from organic waste materials such as yard trimmings and food wastes. This is likely the result of many locally enacted bans on the disposal of yard waste from landfills around the country, as well as successful campaigns promoting backyard composting and mulching lawn mowers.

Table ES-7

1999 Source Reduction by Major Material Categories	
Waste Stream	**Tons Source Reduced**
Durable Goods (e.g. appliances, furniture)	**5,289,000**
Nondurable Goods (e.g. newspapers & clothing)	**8,956,000**
Containers & Packaging (e.g. bottles & boxes)	**12,004,000**
Other MSW (e.g. yard trimmings & food scraps)	**23,793,000**
Total Source Reduction (1990 baseline)	**50,042,000**

But there also have been several materials within the categories, above, whose disposal rates have increased. In particular, clothing and footwear show significant increased disposal rates, as do plastic containers. Some of the rise in plastics use can be attributed to the long-term trend of manufacturers substituting their glass packaging with plastic.

However, not all of these increases are due to material substitution. Much of this nation's increased waste generation is due to the booming economy of the 1990s. Americans now find themselves with a growing amount of discretionary spending dollars in their pockets after paying the mortgage or rent. As a result of this growth in Personal Consumption Expenditure (PCE) dollars, otherwise referred to as consumer spending, we have increasingly become a nation of consumers. The result is an increasing need for the disposal of municipal solid waste. Still, the United States has made progress in the area of waste reduction and reuse, as indicated by the 50 million tons of source reduction in 1999 (1990 baseline).

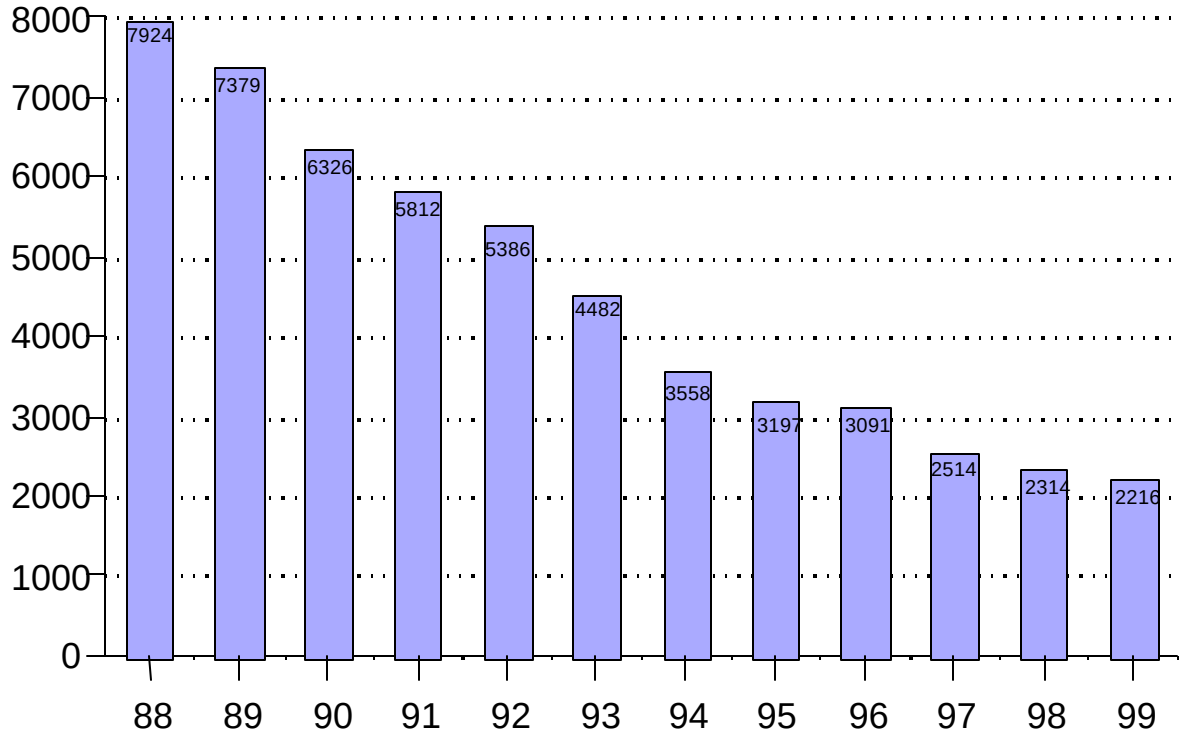
Recycling

- Recycling (including community composting) recovered 27.8 percent (63.9 million tons) of MSW in 1999.
- There were more than 9,300 curbside recycling programs in the United States in 1998. This is up from about 8,900 curbside recycling programs in 1997.
- About 3,800 yard trimmings composting programs were reported in 1998. This compared to about 3,500 yard trimmings composting programs reported in 1997.

Disposal

An estimated 14.8 percent of MSW was combusted in 1999, down from 15.4 percent in 1998.** During 1999, about 57.4 percent of MSW was landfilled. Figure ES-5 shows that the number of municipal solid waste landfills decreased substantially over the last 10 years, from nearly 8,000 in 1988 to 2,314 in 1998 to 2,216 in 1999 – while the average landfill size increased. At the national level, capacity does not appear to be a problem, although regional dislocations sometimes occur.

Figure ES-5: Number of Landfills in the U.S.



Source: *BioCycle* magazine, 1989-2000

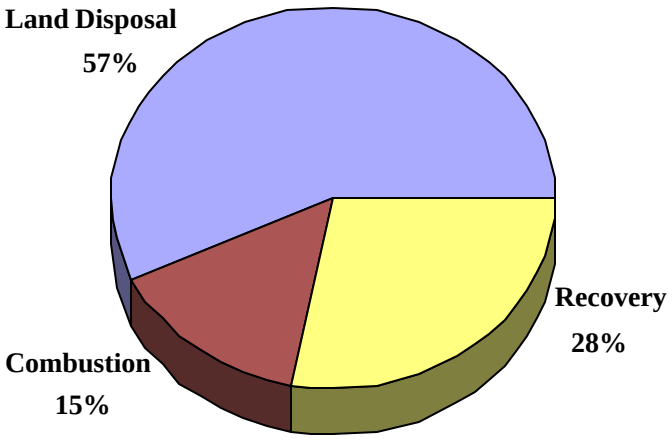
**Data shown for 1998 has been adjusted to reflect the latest revisions to data and methodology and therefore may differ slightly from the same measure reported previously. For instance the combustion fraction for 1998 was revised downward from last year's report, to equal 15.4 percent.

- As recovery rates have remained stable, and combustion decreased slightly**,** the percentage of MSW discarded to landfills increased slightly from 1997 to 1999. Over the long term, the tonnage landfilled rose from 123.4 million tons in 1980 to 131.9 million tons landfilled in 1999.

- The net per capita discard rate (after recovery for recycling) was 3.33 pounds per person per day in 1999, up slightly from 3.27 pounds per person per day in 1998 (Table ES-2).

Figure ES-6 shows MSW recovered for recycling (including composting) and disposed of by combustion and landfilling in 1999. In 1999, 63.9 million tons (27.8 percent) of MSW was recycled, 34 million tons was combusted (14.8 percent) and 131.9 million tons (57.4 percent) was landfilled. (Relatively small amounts of this total undoubtedly were littered or illegally dumped rather than landfilled.)

Figure ES-6: Management of MSW in the U.S.



PERSPECTIVE FOR THE NATION

As economic growth results in more products and materials being generated, there will be an increased need to invest in source reduction activities such as lightweighting of products and packaging, reuse of products, grasscycling, and backyard composting. Also important, will be utilizing existing recycling and composting facilities, further developing this infrastructure, and buying recycled products, to conserve resources and minimize our dependence on disposal through combustion and landfilling.

FOR FURTHER INFORMATION

This report and related additional data is available on the Internet at www.epa.gov/osw. Additional information on source reduction is available in *National Source Reduction Characterization Report for Municipal Solid Waste in the United States*, EPA530-R-99-034, November 1999.

Chapter 1

INTRODUCTION AND METHODOLOGY

INTRODUCTION

This report is the most recent in a series of reports sponsored by the U.S. Environmental Protection Agency to characterize municipal solid waste (MSW) in the United States. Together with the previous reports, this report provides a historical database for a 39-year characterization (by weight) of the materials and products in MSW.

Management of the nation's MSW continues to be a high priority for communities as we enter the 21st century. The concept of integrated solid waste management – source reduction of wastes before they enter the waste stream, recovery of generated wastes for recycling (including composting), and environmentally sound disposal through combustion facilities and landfills that meet current standards – is being used by communities as they plan for the future.

In this chapter, background is provided on integrated waste management and this year's characterization report, followed by a brief overview of the method. Next, is a section on the variety of uses for the information in this report. Then, more detail on the method is provided, followed by a description of the contents of the remainder of the report.

BACKGROUND

The Solid Waste Management Hierarchy

EPA's 1989 Agenda for Action endorsed the concept of integrated waste management, by which municipal solid waste is reduced or managed through several different practices, which can be tailored to fit a particular community's needs. The components of the hierarchy are:

- Source reduction (including reuse of products and backyard composting of yard trimmings).
- Recycling of materials (including composting).
- Waste combustion (preferable with energy recovery) and landfilling.

New for This Year's Characterization Report

For the first time, this characterization report includes estimates of the amount of waste prevented, or source reduced, along with the quantities of MSW recycled, combusted, and landfilled. The report, therefore, now addresses waste and materials managed by each practice in the hierarchy. Because the method for estimating source reduction expands on the method used to develop the information on recycling and disposal, the recycling and disposal data are presented first, in Chapters 2 and 3, and the waste prevention, or source reduction, information is presented in Chapter 4. Another addition this year is detailed information on selected consumer electronics, which is provided in Chapter 2 and in Appendix C.

Overview of the Method

Readers should note that this report characterizes the municipal solid waste stream of *the nation as a whole*. This data can be used to at the national level. It can also be used to address state, regional, and local situations, where more detailed data is not available or would be too expensive to gather. More detail on uses for the information in this report for both national and local uses is provided later in this chapter.

The report is based on a *material flows method*. Often at the state or local level, recycling rates are developed by counting and weighing all the recyclables collected, and aggregating this data at the county or state level, yielding a recycling rate. At the national level, instead we use a *material flows method*, which relies heavily on a mass balance approach. From data gathered from trade associations, key businesses and industries, and supported by government data from sources such as the Department of Commerce and the U.S. Census Bureau, we estimate tons of materials and products generated, recycled, or discarded. Other sources of data, such as waste characterizations and surveys performed by governments, industry, or the press, supplement these data.

Information on amounts disposed, whether by combustion or landfilling, also is important – this comes from national sources as well. The data is adjusted by imports and exports from the U.S., where necessary. Allowances are made for the average life spans of different products.

Important in any estimation of municipal solid waste generation, is defining what is and is not included in municipal solid waste. EPA includes those materials which historically have been handled in the municipal solid waste stream – those materials from municipal sources, sent to municipal landfills. In this report, MSW includes wastes such as product packaging, newspapers, office and classroom paper, bottles, boxes, wood pallets, food scraps, grass clippings, clothing, furniture, appliances, automobile tires, consumer electronics, paint, and batteries.

A common error in using this report is to assume that *all* nonhazardous wastes are included. As shown later in this chapter, municipal solid waste as defined here does *not* include construction and demolition debris, biosolids (sewage sludges), industrial process wastes, or a number of other wastes that may well go to a municipal waste landfill. These materials, over time, have tended to be handled separately and are not included in the totals in this report. EPA has addressed several of these materials separately, for instance in *Biosolids Generation, Use, and Disposal in the United States*, EPA 530-R-99-009 September 1999 and *Characterization of Building-Related Construction and Demolition Debris in the United States*, EPA530-R-98-010, May 1998. Recycling (including composting) is encouraged for these materials as well.

In addition, the source of municipal solid waste is important. EPA's figures include municipal solid waste from homes, institutions such as schools and prisons, commercial sources such as restaurants and small businesses, and occasional industrial sources. MSW does not include wastes of other types or from other sources such as automobile bodies, municipal sludges, combustion ash, and industrial process wastes that also might be disposed of in municipal waste landfills or incinerators.

HOW THIS REPORT CAN BE USED

Nationwide. The data in this report provide a nationwide picture of municipal solid waste generation and management. The historical perspective is particularly useful in establishing trends and highlighting the changes that have occurred over the years, both in types of wastes generated and in the ways they are managed. This perspective on MSW and its management is useful in assessing national solid waste management needs and policy. The consistency in method and scope aids in the use of the document for reporting over time. The report is, however, of equal or greater value as a solid waste management planning tool for state and local governments and private firms.

Local or state level. At the local or state level, the data in this report can be used to develop approximate (but quick) estimates of MSW generation in a defined area. That is, the data on generation of MSW per person nationally may be used to estimate generation in a city or other local area based on the population in that area. This can be of value when a "ballpark" estimate of MSW generation in an area is needed. For example, communities may use such an estimate to determine the potential viability of regional versus single community solid waste management facilities. This information can help define solid waste management planning areas and the planning needed in those areas. However, for communities making decisions where knowledge of the amount and composition of MSW is crucial, e.g., where a solid waste management facility is being sited, local estimates of the waste stream should be made.

Another useful feature of this report for local planning is the information provided on MSW trends. Changes over time in total MSW generation and the mix of MSW materials can affect the need for and use of various waste management alternatives. Observing trends in MSW generation can help in planning an integrated waste management system that includes facilities sized and designed for years of service.

While the national average data are useful as a checkpoint against local MSW characterization data, any differences between local and national data should be examined carefully. There are many regional variations that require each community to examine its own waste management needs. Factors such as local and regional availability of suitable landfill space, proximity of markets for recovered materials, population density, commercial and industrial activity, and climatic and groundwater variations all may motivate each community to make its own plans.

Specific reasons for regional differences may include:

- Variations in climate and local waste management practices, which greatly influence generation of yard trimmings. For instance, yard trimmings exhibit strong seasonal variations in most regions of the country. Also, the level of backyard composting in a region will affect generation of yard trimmings.

- Differences in the scope of waste streams. That is, a local landfill may be receiving construction and demolition debris in addition to MSW, but this report addresses MSW only.

- A variance in the per capita generation of some products, such as newspapers and telephone directories, depending upon the average size of the publications. Typically, rural areas will generate less of these products on a per person basis than urban areas.

- The level of commercial activity in a community. This influences the generation rate of some products, such as office paper, corrugated boxes, wood pallets, and food wastes from restaurants.

- Variations in economic activity, which affect waste generation in both the residential and the commercial sectors.

- Local and state regulations and practices. Deposit laws, bans on landfilling of specific products, and variable-rate pricing for waste collection are examples of practices that can influence a local waste stream.

While caution should be used in applying the data in this report, for some areas, the national breakdown of MSW by material may be the only such data available for use in comparing and planning waste management alternatives. Planning a curbside recycling program, for example, requires an estimate of household recyclables that may be recovered. If resources are not available to adequately estimate these materials by other means, local planners may turn to the national data. This is useful in areas that may have typical MSW generation or in areas where appropriate adjustments in the data can be made to account for local conditions.

In summary, the data in this report can be used in local planning to:

- Develop approximate estimates of total MSW generation in an area.

- Check locally developed MSW data for accuracy and consistency.

- Account for trends in total MSW generation and the generation of individual components.

- Help set goals and measure progress in source reduction and recycling (including composting).

CHARACTERIZATION OF MUNICIPAL SOLID WASTE: IN PERSPECTIVE

The Two Methodologies for Characterizing MSW: Site-Specific versus Materials Flows

There are two basic approaches to estimating quantities of municipal solid waste at the national level.

Site-specific studies. In the first method, which is site-specific, sampling, sorting, and weighing the individual components of the waste stream could be used. This method is useful in defining a local waste stream, especially if large numbers of samples are taken over several seasons. Results of sampling also increase the body of knowledge about variations due to climatic and seasonal changes, population density, regional differences, and the like. In addition, quantities of MSW components such as food and yard trimmings can only be estimated through sampling and weighing studies.

A disadvantage of sampling studies based on a limited number of samples is that they may be skewed and misleading if, for example, atypical circumstances were experienced during the sampling. These circumstances could include an unusually wet or dry season, delivery of some unusual wastes during the sampling period, or errors in the sampling methodology. Any errors of this kind will be greatly magnified when a limited number of samples are taken to represent a community's entire waste stream for a year. Magnification of errors could be even more serious if a limited number of samples was relied upon for making the national estimates of MSW. Also, extensive sampling would be prohibitively expensive for making the national estimates. An additional disadvantage of sampling studies is that they do not provide information about trends unless performed in a consistent manner over a long period of time.

Of course at the state or local level, sampling may not be necessary – many states and localities count all materials recovered for recycling, and many weigh all wastes being disposed, to generate state or local recycling rates from the "ground up." To use these figures at the national level would require all states to perform these studies, and perform them in a way conducive to developing a national summary, which so far has not been practical.

Materials flow. The second approach to quantifying and characterizing the municipal solid waste stream – the method used for this report – utilizes a material flows approach to estimate the waste stream on a nationwide basis. In the late 1960s and early 1970s, EPA's Office of Solid Waste and its predecessors at the Public Health Service sponsored work that began to develop this methodology. This report represents the latest version of this database that has been evolving for more than 20 years.

The material flows methodology is based on production data (by weight) for the materials and products in the waste stream. Generation data is the result of making specific adjustments to the production data by each material and product category. Adjustments are made for imports and exports and for diversions from MSW (e.g., for building materials made of plastic and paperboard). Adjustments also are made for the life spans of various products. Finally, food wastes and yard trimmings and a small amount of miscellaneous inorganic wastes are accounted for by compiling data from a variety of waste sampling studies.

One problem with the material flows methodology is that product residues associated with other items in MSW (usually containers) are not accounted for. These residues would include, for example, food left in a jar, detergent left in a box or bottle, dried paint in a can, etc. Some household hazardous wastes, e.g., pesticide left in a can, also are included among these product residues.

Municipal Solid Waste Defined in Greater Detail

As stated earlier, EPA includes those materials which historically have been handled in the municipal solid waste stream – those materials from municipal sources, sent to municipal landfills. In this report, MSW includes wastes such as product packaging, newspapers, office and classroom paper, bottles, boxes, wood pallets, food scraps, grass clippings, clothing, furniture, appliances, automobile tires, consumer electronics, paint, and batteries. For purposes of analysis, these products and materials

are often grouped in this report into the following categories: durable goods, nondurable goods, containers and packaging, food wastes and yard trimmings, and miscellaneous inorganic wastes.

Municipal solid wastes characterized in this report come from residential, commercial, institutional, or industrial sources. Some examples of the types of MSW that come from each of the broad categories of sources are (Figure 1):

Sources and Examples	**Example Products**
Residential (single-and multi-family homes)	Newspapers, clothing, disposable tableware, food packaging, cans and bottles, food scraps, yard trimmings
Commercial (office buildings, retail and wholesale establishments, restaurants)	Corrugated boxes, food wastes, office papers, disposable tableware, paper napkins, yard trimmings
Institutional (schools, libraries, hospitals, prisons)	Cafeteria and restroom trash can wastes, office papers, classroom wastes, yard trimmings
Industrial (packaging and administrative, *not* process wastes)	Corrugated boxes, plastic film, wood pallets, lunchroom wastes, office papers.

The material flows methodology used in this report does not readily lend itself to the quantification of wastes according to their source. For example, corrugated boxes may be unpacked and discarded from residences, commercial establishments such as grocery stores, institutions such as schools, or factories. The methodology estimates only the total quantity of such boxes generated, not their places of disposal or recovery for recycling.

Figure 1. Municipal Solid Waste in the Universe of Subtitle D Wastes

Subtitle D Wastes

The Subtitle D Waste included in this report is Municipal Solid Waste, which includes: containers & packaging such as soft drink bottles and cardboard boxes; durable goods such as furniture and appliances, nondurable goods such as newspapers and clothing; scrap tires, food scraps, and yard trimmings.)

Subtitle D Wastes not included in this report are:

Municipal sludges	Agricultural wastes
Industrial nonhazardous wastes	Oil and Gas wastes
Construction and Demolition Debris	Mining wastes

Other Subtitle D Wastes

Some people assume that "municipal solid waste" must include everything that is landfilled in Subtitle D landfills. (Subtitle D of the Resource Conservation and Recovery Act deals with wastes other than the hazardous wastes covered under Subtitle C.) As shown in Figure 1, however, RCRA Subtitle D includes many kinds of wastes. It has been common practice to landfill wastes such as municipal sludge, nonhazardous industrial wastes, residue from automobile salvage operations, and construction and demolition debris along with MSW; but these other kinds of wastes are not included in the estimates presented in this report.

Materials and Products Not Included in these Estimates

As noted earlier, other Subtitle D wastes (illustrated in Figure 1) are not included in these estimates, even though some may be managed along with MSW (e.g., by combustion or landfilling). Household hazardous wastes, while generated as MSW with other residential wastes, are not identified separately in this report. Transportation equipment (including automobiles and trucks) is not included in the wastes characterized in this report.

Certain other materials associated with products in MSW often are not accounted for because the appropriate data series have not yet been developed. These include, for example, inks and other pigments and some additives associated with packaging materials. Considerable additional research would be required to estimate these materials, which constitute a relatively small percentage of the waste stream.

Some adjustments are made in this report to account for packaging of imported good, but there is little available documentation of these amounts.

OVERVIEW OF THIS REPORT

Following this introductory chapter, Chapter 2 presents the results of the municipal solid waste characterization (by weight). Estimates of MSW generation, recovery, and discards are presented in a series of tables, with discussion. Detailed tables and figures summarizing 1999 MSW generation, recovery and discards of products in each material category are included.

In Chapter 3 of the report, estimates of 1999 MSW management by the various alternatives are summarized. These include recovery for recycling (including composting), combustion, and landfilling. Also presented is a discussion of source reduction practices. Summaries of the infrastructure currently available for each waste management alternative also are included in Chapter 3.

Chapter 4, for the first time, incorporates an estimate of source reduction for the nation.

A brief discussion of the material flows methodology, for estimating generation, recycling, and disposal is presented in Appendix A. Appendix B provides the methodology and detailed results for source reduction. Appendix C provides the methodology and first cut at estimating selected consumer electronics.

Figure 1-A
Definition of Terms

The material flows methodology produces an estimate of total municipal solid waste generation in the united states, by material categories and by product categories.

The term ***generation*** as used in this report refers to the weight of materials and products as they enter the waste management system from residential, commercial, institutional, and industrial sources and before materials recovery or combustion takes place. Preconsumer (industrial) scrap is not included in the generation estimates. Source reduction activities (e.g., backyard composting of yard trimmings) take place *ahead of* generation.

Source reduction activities reduce the amount or toxicity of wastes before they enter the municipal solid waste management system. Reuse is a source reduction activity involving the recovery or reapplication of a package, used product, or material in a manner that retains its original form or identity. Reuse of products such as refillable glass bottles, reusable plastic food storage containers, or refurbished wood pallets is considered source reduction, not recycling.

Recovery of materials as estimated in this report includes products and yard trimmings removed from the waste stream for the purpose of recycling (including composting). For recovered products, recovery equals reported purchases of postconsumer recovered material (e.g., glass cullet, old newspapers) plus net exports (if any) of the material. This, recovery of old corrugated containers (OCC) is the sum of OCC purchases by paper mills plus net exports of OCC. If recovery as reported by a data source includes converting or fabrication (preconsumer) scrap, the preconsumer scrap is *not* counted towards the recovery estimates in this report. Imported secondary materials are also not counted in recovery estimates in this report. For some materials, additional uses, such as glass used for highway construction or newspapers used to make insulation, are added into the recovery totals.

Combustion of MSW was estimated with and without energy recovery. Combustion with energy recovery is often called "waste-to-energy," while combustion without energy is called incineration in this report. Combustion of separated materials–wood, rubber from tires, paper, and plastics–is included in the estimates of combustion in this report.

Discards include the MSW remaining after recovery for recycling (including composting). These discards would presumably be combusted or landfilled, although some MSW is littered, stored or disposed on-site, or burned on-site, particularly in rural areas. No good estimates for these other disposal practices are available, but the total amounts of MSW involved are presumed to be small.

Chapter 1

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Chapter 2

CHARACTERIZATION OF MUNICIPAL SOLID WASTE BY WEIGHT

INTRODUCTION

The tables and figures in this chapter present the results of the update of EPA's municipal solid waste characterization report through 1999. The data presented also incorporate some revisions to previously reported data for 1997 and 1998 and, in some instances, to data for earlier years. The revisions are generally due to revisions and improvements in the data available from data sources used in developing this report.

This chapter discusses how much municipal solid waste (MSW) is generated, recovered, and disposed. First, an overview presents this information for the most recent years, and for selected years back to 1960. This information is summarized in Tables 1 to 3 and Figures 10 to 13. Then, throughout the remainder of the chapter, MSW is characterized in more detail. Findings are presented in two basic ways: the first portion of the chapter presents data by *material type*. Some material types of most use to planners (paper and paperboard, glass, metals, plastic and rubber and leather) are presented in detail in Tables 4 to 8 and Figures 3 to 9, while data on others is also summarized in Figures 12 and 13.

The second portion of the chapter presents data by *product type*. Tables 9 to 23 and Figures 14 to 16 provide this information. Products are classified into durables (appliances, furniture, tires); nondurables (newspapers, clothing, sheets and towels); and containers and packaging (bottles, cans, corrugated boxes). A fourth major category includes other wastes, consisting of miscellaneous inorganic wastes, food wastes, and yard trimmings. Yard trimmings and food wastes are both products and materials, so this data appears in both the sections on material type and product type.

This chapter provides data on generation of MSW, recovery, and disposal. (See Chapter 1 for definitions of these terms.) Recovery, in this report, means that the materials have been removed from the municipal solid waste stream. Recovery of materials in products means that the materials are reported to have been purchased by an end-user or exported. For yard trimmings, recovery includes estimates of the trimmings delivered to a composting facility (not backyard composting). Under these definitions, residues from a materials recovery facility (MRF) or other waste processing facility are counted as generation (and, of course, discards), since they are not purchased by an end-user. Residues from an end-user facility (e.g., sludges from a paper deinking mill) are considered to be industrial process wastes that are no longer part of the municipal solid waste stream.

Additional detail is provided for some of the materials and products in MSW that are of the most interest to planners. These are paper, glass, metals, plastics, and rubber and leather (the latter includes rubber in tires and clothing and footwear.)

Table 1

MATERIALS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1999
(In thousands of tons and percent of total generation)

	Thousands of Tons							
Materials	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Paper and Paperboard	29,990	44,310	55,160	72,730	81,670	83,290	84,160	87,470
Glass	6,720	12,740	15,130	13,100	12,830	12,010	12,450	12,560
Metals								
Ferrous	10,300	12,360	12,620	12,640	11,640	12,330	12,380	13,320
Aluminum	340	800	1,730	2,810	2,960	3,010	3,080	3,130
Other Nonferrous	180	670	1,160	1,100	1,260	1,270	1,380	1,390
Total Metals	*10,820*	*13,830*	*15,510*	*16,550*	*15,860*	*16,610*	*16,840*	*17,840*
Plastics	390	2,900	6,830	17,130	18,900	21,470	22,370	24,170
Rubber and Leather	1,840	2,970	4,200	5,790	6,030	6,590	6,860	6,220
Textiles	1,760	2,040	2,530	5,810	7,400	8,240	8,600	9,060
Wood	3,030	3,720	7,010	12,210	10,440	11,570	11,930	12,250
Other **	70	770	2,520	3,190	3,650	3,760	3,900	4,010
Total Materials in Products	54,620	83,280	108,890	146,510	156,780	163,540	167,110	173,580
Other Wastes								
Food Wastes	12,200	12,800	13,000	20,800	21,740	24,620	24,910	25,160
Yard Trimmings	20,000	23,200	27,500	35,000	29,690	27,730	27,730	27,730
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,150	3,250	3,290	3,380
Total Other Wastes	33,500	37,780	42,750	58,700	54,580	55,600	55,930	56,270
Total MSW Generated - Weight	88,120	121,060	151,640	205,210	211,360	219,140	223,040	229,850
	Percent of Total Generation							
Materials	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Paper and Paperboard	34.0%	36.6%	36.4%	35.4%	38.6%	38.0%	37.7%	38.1%
Glass	7.6%	10.5%	10.0%	6.4%	6.1%	5.5%	5.6%	5.5%
Metals								
Ferrous	11.7%	10.2%	8.3%	6.2%	5.5%	5.6%	5.6%	5.8%
Aluminum	0.4%	0.7%	1.1%	1.4%	1.4%	1.4%	1.4%	1.4%
Other Nonferrous	0.2%	0.6%	0.8%	0.5%	0.6%	0.6%	0.6%	0.6%
Total Metals	*12.3%*	*11.4%*	*10.2%*	*8.1%*	*7.5%*	*7.6%*	*7.6%*	*7.8%*
Plastics	0.4%	2.4%	4.5%	8.3%	8.9%	9.8%	10.0%	10.5%
Rubber and Leather	2.1%	2.5%	2.8%	2.8%	2.9%	3.0%	3.1%	2.7%
Textiles	2.0%	1.7%	1.7%	2.8%	3.5%	3.8%	3.9%	3.9%
Wood	3.4%	3.1%	4.6%	6.0%	4.9%	5.3%	5.3%	5.3%
Other **	0.1%	0.6%	1.7%	1.6%	1.7%	1.7%	1.7%	1.7%
Total Materials in Products	62.0%	68.8%	71.8%	71.4%	74.2%	74.6%	74.9%	75.5%
Other Wastes								
Food Wastes	13.8%	10.6%	8.6%	10.1%	10.3%	11.2%	11.2%	10.9%
Yard Trimmings	22.7%	19.2%	18.1%	17.1%	14.0%	12.7%	12.4%	12.1%
Miscellaneous Inorganic Wastes	1.5%	1.5%	1.5%	1.4%	1.5%	1.5%	1.5%	1.5%
Total Other Wastes	38.0%	31.2%	28.2%	28.6%	25.8%	25.4%	25.1%	24.5%
Total MSW Generated - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Generation before materials recovery or combustion. Does not include construction & demolition debris, industrial process wastes, or certain other wastes.

** Includes electrolytes in batteries and fluff pulp, feces, and urine in disposable diapers.
Details may not add to totals due to rounding.
Source: Franklin Associates

Table 2

RECOVERY* OF MUNICIPAL SOLID WASTE, 1960 TO 1999
RECOVERY* OF MUNICIPAL SOLID WASTE, 1960 TO 2000

	Thousands of Tons							
Materials	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Paper and Paperboard	5,080	6,770	11,740	20,230	32,700	33,580	34,360	36,670
Glass	100	160	750	2,630	3,140	2,920	3,180	2,940
Metals								
Ferrous	50	150	370	2,230	4,130	4,730	4,320	4,480
Aluminum	Neg.	10	310	1,010	930	950	860	870
Other Nonferrous	Neg.	320	540	730	810	830	930	930
Total Metals	*50*	*480*	*1,220*	*3,970*	*5,870*	*6,510*	*6,110*	*6,280*
Plastics	Neg.	Neg.	20	370	990	1,110	1,210	1,350
Rubber and Leather	330	250	130	370	540	770	860	790
Textiles	50	60	160	660	900	1,060	1,110	1,170
Wood	Neg.	Neg.	Neg.	130	450	590	720	720
Other **	Neg.	300	500	680	750	760	860	860
Total Materials in Products	5,610	8,020	14,520	29,040	45,340	47,300	48,410	50,780
Other Wastes								
Food, Other^	Neg.	Neg.	Neg.	Neg.	570	580	580	550
Yard Trimmings	Neg.	Neg.	Neg.	4,200	9,000	11,490	12,560	12,560
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	4,200	9,570	12,070	13,140	13,110
Total MSW Recovered - Weight	5,610	8,020	14,520	33,240	54,910	59,370	61,550	63,890
	Percent of Generation of Each Material							
Materials	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Paper and Paperboard	16.9%	15.3%	21.3%	27.8%	40.0%	40.3%	40.8%	41.9%
Glass	1.5%	1.3%	5.0%	20.1%	24.5%	24.3%	25.5%	23.4%
Metals								
Ferrous	0.5%	1.2%	2.9%	17.6%	35.5%	38.4%	34.9%	33.6%
Aluminum	Neg.	1.3%	17.9%	35.9%	31.4%	31.6%	27.9%	27.8%
Other Nonferrous	Neg.	47.8%	46.6%	66.4%	64.3%	65.4%	67.4%	66.9%
Total Metals	*0.5%*	*3.5%*	*7.9%*	*24.0%*	*37.0%*	*39.2%*	*36.3%*	*35.2%*
Plastics	Neg.	Neg.	0.3%	2.2%	5.2%	5.2%	5.4%	5.6%
Rubber and Leather	17.9%	8.4%	3.1%	6.4%	9.0%	11.7%	12.5%	12.7%
Textiles	2.8%	2.9%	6.3%	11.4%	12.2%	12.9%	12.9%	12.9%
Wood	Neg.	Neg.	Neg.	1.1%	4.3%	5.1%	6.0%	5.9%
Other **	Neg.	39.0%	19.8%	21.3%	20.5%	20.2%	22.1%	21.4%
Total Materials in Products	10.3%	9.6%	13.3%	19.8%	28.9%	28.9%	29.0%	29.3%
Other Wastes								
Food, Other^	Neg.	Neg.	Neg.	Neg.	2.6%	2.4%	2.3%	2.2%
Yard Trimmings	Neg.	Neg.	Neg.	12.0%	30.3%	41.4%	45.3%	45.3%
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	7.2%	17.5%	21.7%	23.5%	23.3%
Total MSW Recovered - %	6.4%	6.6%	9.6%	16.2%	26.0%	27.1%	27.6%	27.8%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Recovery of electrolytes in batteries; probably not recycled.
Neg. = Less than 5,000 tons or 0.05 percent.
^ Includes recovery of paper for composting.
Details may not add to totals due to rounding.
Source: Franklin Associates

Table 3

MATERIALS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1999
(In thousands of tons and percent of total discards)

	Thousands of Tons							
Materials	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Paper and Paperboard	24,910	37,540	43,420	52,500	48,970	49,710	49,800	50,800
Glass	6,620	12,580	14,380	10,470	9,690	9,090	9,270	9,620
Metals								
Ferrous	10,250	12,210	12,250	10,410	7,510	7,600	8,060	8,840
Aluminum	340	790	1,420	1,800	2,030	2,060	2,220	2,260
Other Nonferrous	180	350	620	370	450	440	450	460
Total Metals	*10,770*	*13,350*	*14,290*	*12,580*	*9,990*	*10,100*	*10,730*	*11,560*
Plastics	390	2,900	6,810	16,760	17,910	20,360	21,160	22,820
Rubber and Leather	1,510	2,720	4,070	5,420	5,490	5,820	6,000	5,430
Textiles	1,710	1,980	2,370	5,150	6,500	7,180	7,490	7,890
Wood	3,030	3,720	7,010	12,080	9,990	10,980	11,210	11,530
Other **	70	470	2,020	2,510	2,900	3,000	3,040	3,150
Total Materials in Products	49,010	75,260	94,370	117,470	111,440	116,240	118,700	122,800
Other Wastes								
Food Wastes	12,200	12,800	13,000	20,800	21,170	24,040	24,330	24,610
Yard Trimmings	20,000	23,200	27,500	30,800	20,690	16,240	15,170	15,170
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,150	3,250	3,290	3,380
Total Other Wastes	33,500	37,780	42,750	54,500	45,010	43,530	42,790	43,160
Total MSW Discarded - Weight	82,510	113,040	137,120	171,970	156,450	159,770	161,490	165,960
	Percent of Total Discards							
Materials	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Paper and Paperboard	30.2%	33.2%	31.7%	30.5%	31.3%	31.1%	30.8%	30.6%
Glass	8.0%	11.1%	10.5%	6.1%	6.2%	5.7%	5.7%	5.8%
Metals								
Ferrous	12.4%	10.8%	8.9%	6.1%	4.8%	4.8%	5.0%	5.3%
Aluminum	0.4%	0.7%	1.0%	1.0%	1.3%	1.3%	1.4%	1.4%
Other Nonferrous	0.2%	0.3%	0.5%	0.2%	0.3%	0.3%	0.3%	0.3%
Total Metals	*13.1%*	*11.8%*	*10.4%*	*7.3%*	*6.4%*	*6.3%*	*6.6%*	*7.0%*
Plastics	0.5%	2.6%	5.0%	9.7%	11.4%	12.7%	13.1%	13.8%
Rubber and Leather	1.8%	2.4%	3.0%	3.2%	3.5%	3.6%	3.7%	3.3%
Textiles	2.1%	1.8%	1.7%	3.0%	4.2%	4.5%	4.6%	4.8%
Wood	3.7%	3.3%	5.1%	7.0%	6.4%	6.9%	6.9%	6.9%
Other **	0.1%	0.4%	1.5%	1.5%	1.9%	1.9%	1.9%	1.9%
Total Materials in Products	59.4%	66.6%	68.8%	68.3%	71.2%	72.8%	73.5%	74.0%
Other Wastes								
Food Wastes	14.8%	11.3%	9.5%	12.1%	13.5%	15.0%	15.1%	14.8%
Yard Trimmings	24.2%	20.5%	20.1%	17.9%	13.2%	10.2%	9.4%	9.1%
Miscellaneous Inorganic Wastes	1.6%	1.6%	1.6%	1.7%	2.0%	2.0%	2.0%	2.0%
Total Other Wastes	40.6%	33.4%	31.2%	31.7%	28.8%	27.2%	26.5%	26.0%
Total MSW Discarded - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Discards after materials and compost recovery. Does not include construction & demolition debris, industrial process wastes, or certain other wastes.

** Includes electrolytes in batteries and fluff pulp, feces, and urine in disposable diapers.

Details may not add to totals due to rounding.

Source: Franklin Associates

MUNICIPAL SOLID WASTE: CHARACTERIZED BY MATERIAL TYPE

Generation, recovery, and discards of materials in MSW, by weight and by percentage of generation and discards, are summarized in Tables 1 through 3. Figures 10 and 11 illustrate this data over time. Figures 12 and 13 provide a snapshot, by material, for 1999. Following these tables and figures, each material is discussed in detail.

Paper and Paperboard

Paper and paperboard products, as a group, constitute the largest component of MSW taken collectively, and the largest component of MSW. Paper and paperboard includes materials such as paper and cardboard, used in products such as office paper, newspaper, corrugated boxes, milk cartons, tissue paper, and paper plates and cups.

Table 4

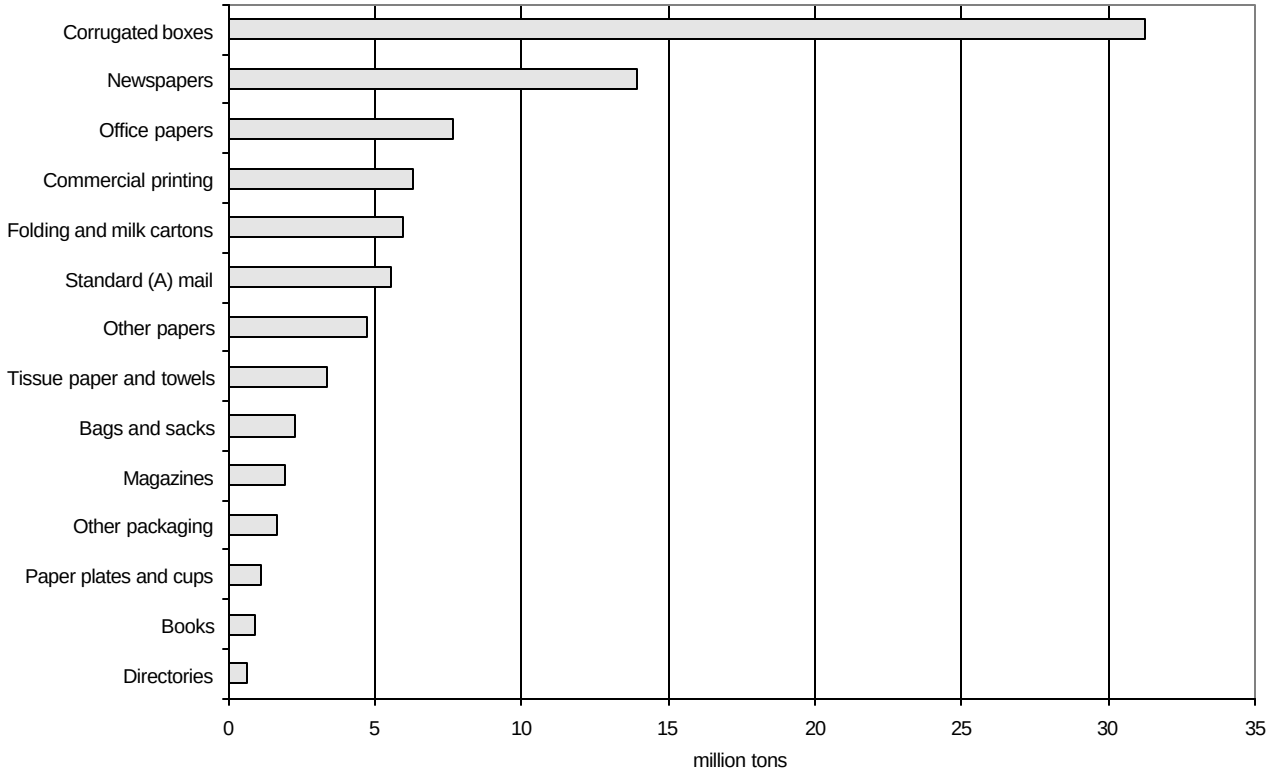
PAPER AND PAPERBOARD PRODUCTS IN MSW, 1999
(In thousands of tons and percent of generation)

Product Category	Generation (Thousands tons)	Recovery (Thousands tons)	Recovery (Percent of generation)	Discards (Thousands tons)
Nondurable Goods				
Newspapers				
Newsprint	11,330	6,800	60.0%	4,530
Groundwood inserts	2,630	1,430	54.4%	1,200
Total Newspapers	13,960	8,230	59.0%	5,730
Books	1,120	200	17.9%	920
Magazines	2,310	530	22.9%	1,780
Office Papers	7,670	4,040	52.7%	3,630
Telephone Directories	680	110	16.2%	570
Third Class Mail	5,560	1,230	22.1%	4,330
Other Commercial Printing	5,940	1,360	22.9%	4,580
Tissue Paper and Towels	3,360	Neg.	Neg.	Neg.
Paper Plates and Cups	930	Neg.	Neg.	930
Other Nonpackaging Paper*	4,790	Neg.	Neg.	4,790
Total Paper and Paperboard Nondurable Goods	46,320	15,700	33.9%	30,620
Containers and Packaging				
Corrugated Boxes	31,230	20,340	65.1%	10,890
Milk Cartons	490	Neg.	Neg.	Neg.
Folding Cartons	5,780	400	6.9%	5,380
Other Paperboard Packaging	290	Neg.	Neg.	290
Bags and Sacks	1,690	230	13.6%	1,460
Other Paper Packaging	1,670	Neg.	Neg.	1,670
Total Paper and Paperboard Containers and Packaging	41,150	20,970	51.0%	20,180
Total Paper and Paperboard	87,470	36,670	41.9%	50,800

* Includes tissue in disposable diapers, paper in games and novelties, cards, etc.
Neg. = Less than 5,000 tons or 0.05 percent.
Details may not add to totals due to rounding.

Source: Franklin Associates.

Figure 2. Paper and paperboard products generated in MSW, 1999



Total generation of paper and paperboard in MSW has grown from 30 million tons in 1960 to 87.5 million tons in 1999 (Table 1). As a percentage of total MSW generation, paper represented 34 percent in 1960 (Table 1). The percentage has varied over time, but increased to 38.1 percent of total MSW generation in 1999. As Figure 3 illustrates, paper generation increased over the last three years.

The sensitivity of paper products to economic conditions can be observed in Figure 3. The tonnage of paper generated in 1975 – a severe recession year – was actually less than the tonnage in 1970, and the percentage of total generation was also less in 1975. Similar but less pronounced declines in paper generation can be seen in other recession years.

The wide variety of products that comprise the paper and paperboard materials total is illustrated in Table 4 and Figures 2 and 3. In this report, these products are classified as either nondurable goods or as containers and packaging, with nondurable goods being the larger category.

Generation. Estimates of paper and paperboard generation are based on statistics published by the American Forest & Paper Association (AF&PA). These statistics include data on new supply (production plus net imports) of the various paper and paperboard grades that go into the products found in MSW. The AF&PA new supply statistics are adjusted to make products such as envelopes or boxes. Converting scrap rates vary from product to product; the rates used in this report were developed as part of a 1992 report for the Recycling Advisory

Council with a few more recent revisions as new data became available. Various deductions are also made to account for products diverted out of municipal solid waste, such as gypsum wallboard facings or toilet tissue.

Recovery. Estimates of recovery of paper and paperboard products for recycling are based on annual reports of recovery published by AF&PA. The AF&PA reports include recovery of paper and paperboard purchased by U.S. paper mills, plus exports of recovered paper, plus a small amount estimated to have been used in other products such as animal bedding. Recovery as reported by AF&PA includes both preconsumer and postconsumer paper.

Figure 3. Paper generation and recovery, 1960 to 1999

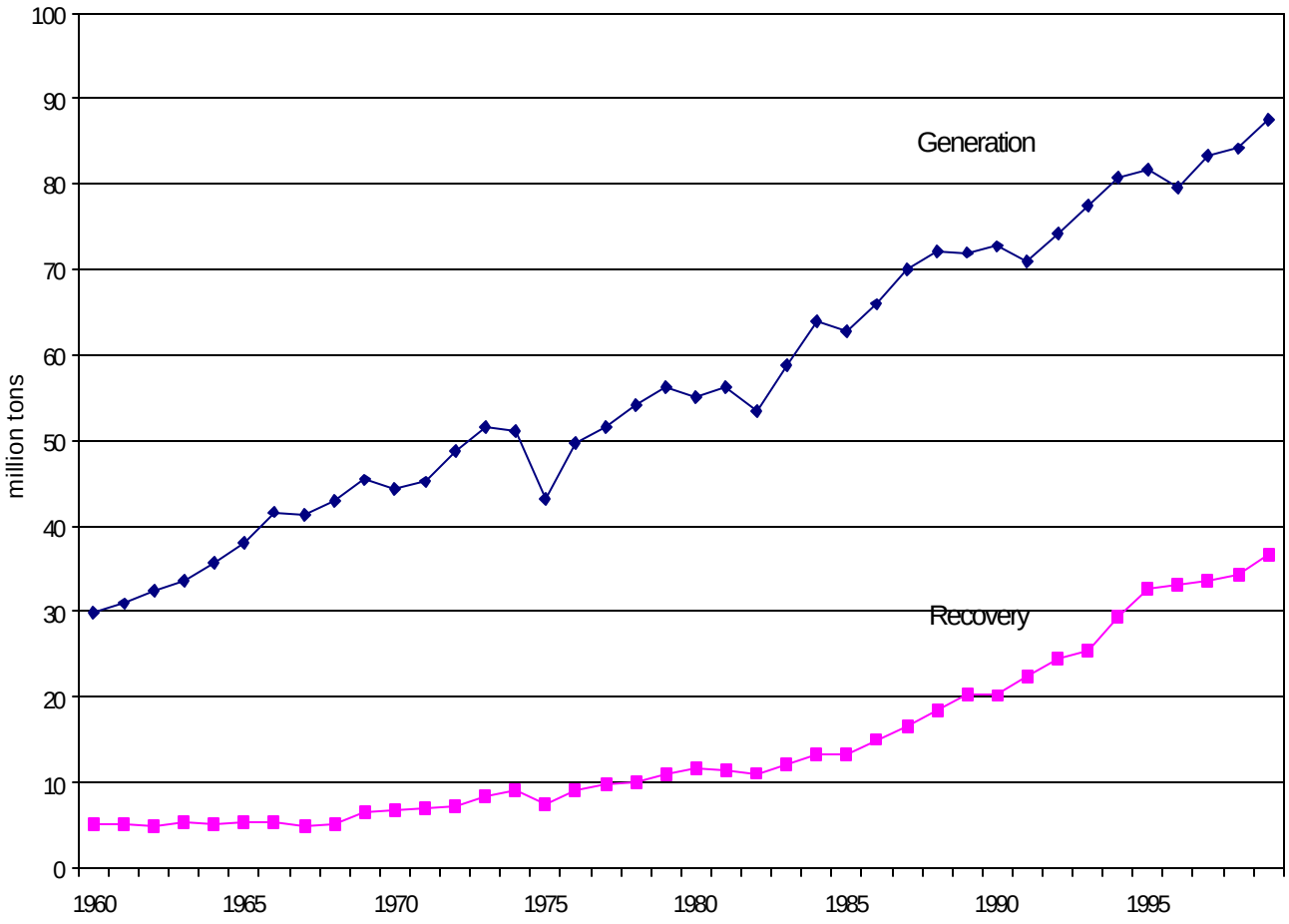


Table 5

GLASS PRODUCTS IN MSW, 1999
(In thousands of tons and percent of generation)

Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent of generation)	Discards (Thousand tons)
Durable Goods*	1,510	Neg.	Neg.	1,510
Containers and Packaging				
Beer and Soft Drink Bottles	5,450	1,560	28.6%	3,890
Wine and Liquor Bottles	1,830	440	24.0%	1,390
Food and Other Bottles and Jars	3,770	940	24.9%	2,830
Total Glass Containers	11,050	2,940	26.6%	8,110
Total Glass	12,560	2,940	23.4%	9,620

* Glass as a component of appliances, furniture, consumer electronics, etc.
Neg. = Less than 5,000 tons or 0.05 percent.
Details may not add to totals due to rounding.

Source: Franklin Associates.

To estimate recovery of postconsumer paper products for this EPA report, estimates of recovery of converting scrap and returned overissue newspapers (newspapers that were not solid) are deducted from the total recovery amounts reported by AF&PA. In earlier versions of this EPA report, a simplifying assumption that all converting scrap is recovered was made. For recent updates, various converting scrap recovery rates ranging from 70 percent to 98 percent were applied to the estimates for 1990 through 1999. The converting scrap recovery rates were developed for a 1992 report for the Recycling Advisory Council. Because converting scrap and overissue are deducted, the paper recovery rates presented in this report are always lower than the total recovery rates published by AF&PA.

When recovered paper is repulped, and often deinked, at a recycling paper mill, considerable amounts of sludge are generated in amounts varying from 5 percent to 35 percent of the paper feedstock. Since these sludges are generated at an industrial site, they are considered to be industrial process waste, not municipal solid waste; therefore they have been removed from the municipal waste stream.

Recovery of paper and paperboard for recycling is at the highest rate overall compared to most other materials in MSW. As Table 4 shows, 65.1 percent of all corrugated boxes were recovered for recycling in 1999. Newspapers were recovered at a rate of 59 percent, and high grade office papers at 52.7 percent, with lesser percentages of other papers being recovered also. Approximately 36.7 million tons of postconsumer paper were recovered in 1999 – 41.9 percent of total paper and paperboard generation.

Discards After Recovery. After recovery of paper and paperboard for recycling, discards were 50.8 million tons in 1999, or 30.6 percent of total MSW discards.

Figure 4. Glass products generated in MSW, 1999

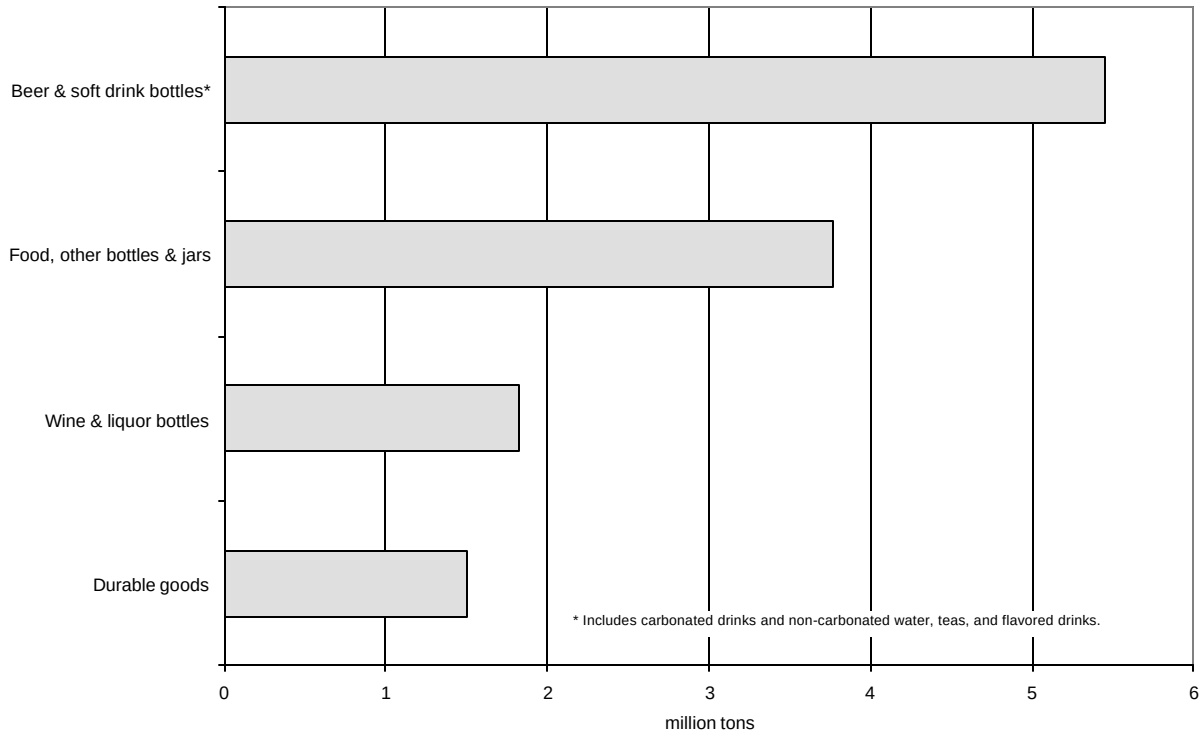
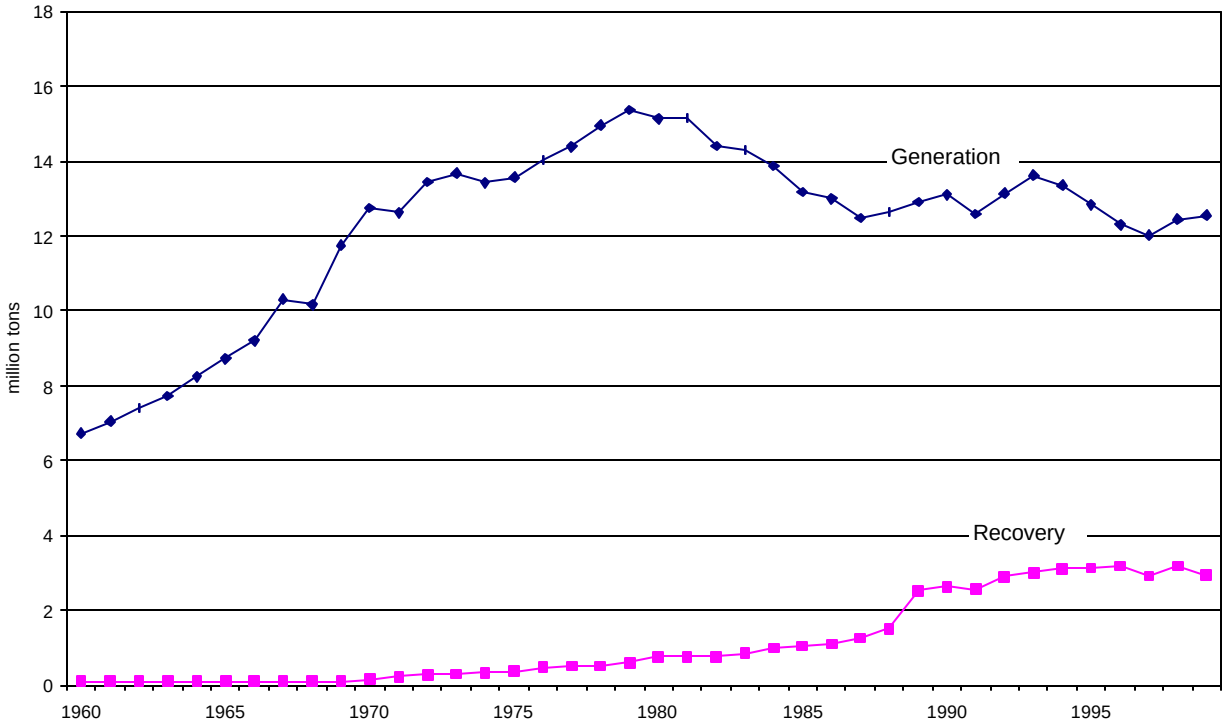


Figure 5. Glass generation and recovery, 1960 to 1999



Glass

Glass is found in MSW primarily in the form of containers (Table 5 and Figures 4 and 5), and also in durable goods like furniture, appliances, and consumer electronics. In the container category, glass is found in bottles for beer, soft drinks, wine and liquor, and in bottles and jars for food, cosmetics, and other products. More detail on these products is included in the later section on products in MSW.

Generation. Glass accounted for 6.7 million tons of MSW in 1960, or 7.6 percent of total generation. Generation of glass continued to grow over the next two decades, but then glass containers were widely displaced by other materials, principally aluminum and plastics. Thus the tonnage of glass in MSW declined in the 1980s, from approximately 15.1 million tons in 1980 to 13.2 million tons in 1985. Since 1987 glass generation has gone up and down but has remained within the 12 million to 14 million ton range. Most recently, in 1999, 12.6 million tons were generated. Glass was 10 percent of MSW generation in 1980, declining to 5.8 percent in 1999.

Recovery. Published estimates indicate that 2.9 million tons of glass containers were recovered for recycling in 1999. Based on 1999 glass generation, an estimated 26.6 percent of glass containers was recovered for recycling, with a 23.4 percent recovery rate for all glass in MSW. Most of the recovered glass went into new glass containers, but a portion went to other uses such as fiberglass and glasphalt for highway construction. The Glass Packaging Institute reported a recovery rate of 34.8 percent for glass containers in 1998**;** this recovery rate includes an allowance for refilling of bottles. Since this EPA report classifies refilling as reuse (source reduction) rather than recovery for recycling, the recovery rate estimated for this report is 26.6 percent of glass containers.

Discards After Recovery. Recovery for recycling lowered discards of glass to 9.6 million tons in 1999 (5.8 percent of total MSW discards).

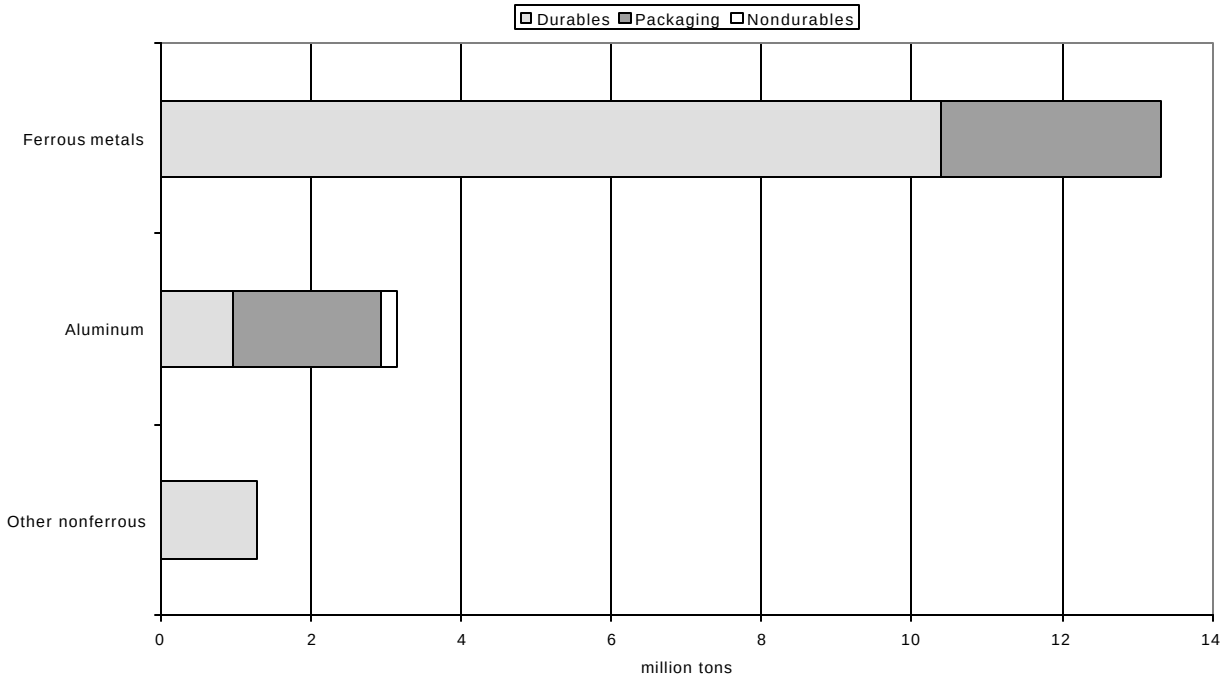
Ferrous Metals

By weight, ferrous metals (iron and steel) are the largest category of metals in MSW (Figure 6 and Table 6). The largest quantities of ferrous metals in MSW are found in durable goods such as appliances, furniture, and tires. Containers and packaging are the other source of ferrous metals in MSW. Large quantities of ferrous metals are found in construction materials and in transportation products such as automobiles, locomotives, and ships, but these are not counted as MSW in this report.

Total generation and recovery of all metals in MSW from 1960 to 1999 are shown in Figure 7.

Generation. Approximately 10.3 million tons of ferrous metals were generated in 1960. Like glass, the tonnages grew during the 1960s and 1970s, but began to drop as lighter materials like aluminum and plastics replaced steel in many applications. Generation of ferrous metals did, however, increase to 12.7 million tons in 1991, drop to 12.3 million tons in 1997, but rose again to 13.3 million tons in 1999. The percentage of ferrous metals generation in MSW has declined from 11.7 percent in 1960 to 5.3 percent in 1999.

Figure 6. Metal products generated in MSW, 1999



Recovery. The renewed emphasis on recovery and recycling in recent years has included ferrous metals. Based on data from the Steel Recycling Institute, recovery of ferrous metals from appliances ("white goods") was estimated to be 1.9 million tons of the total ferrous in appliances in 1999. Overall recovery of ferrous metals from durable goods (large and small appliances, furniture, and tires) was estimated to be 26.9 percent (2.8 million tons) in 1999 (Table 6).

Steel food cans and other cans were estimated to be recovered at a rate of 56.1 percent (1.5 million tons) in 1999. Approximately 170,000 tons of other steel packaging, mostly steel barrels and drums, was estimated to have been recovered for recycling in 1999.

Discards After Recovery. Discards of ferrous metals after recovery were 8.8 million tons in 1999, or 5.3 percent of total discards.

Aluminum

The largest source of aluminum in MSW is aluminum cans and other packaging (Table 6 and Figure 6). Other sources of aluminum are found in durable and nondurable goods.

Generation. In 1999, nearly 2 million tons of aluminum were generated as containers and packaging, while approximately 1 million tons were found in durable and nondurable goods. The total – 3 million tons – represented 1.4 percent of total MSW generation in 1999. Aluminum generation was only 340,000 tons (0.4 percent of MSW generation) in 1960.

Recovery. Aluminum beverage containers were recovered at a rate of 54.5 percent of generation (0.8 million tons) in 1999, and 44.2 percent of all aluminum in containers and packaging was recovered for recycling in 1999.

Discards After Recovery. In 1999, about 2.3 million tons of aluminum were discarded in MSW after recovery, which was 1.4 percent of total MSW discards.

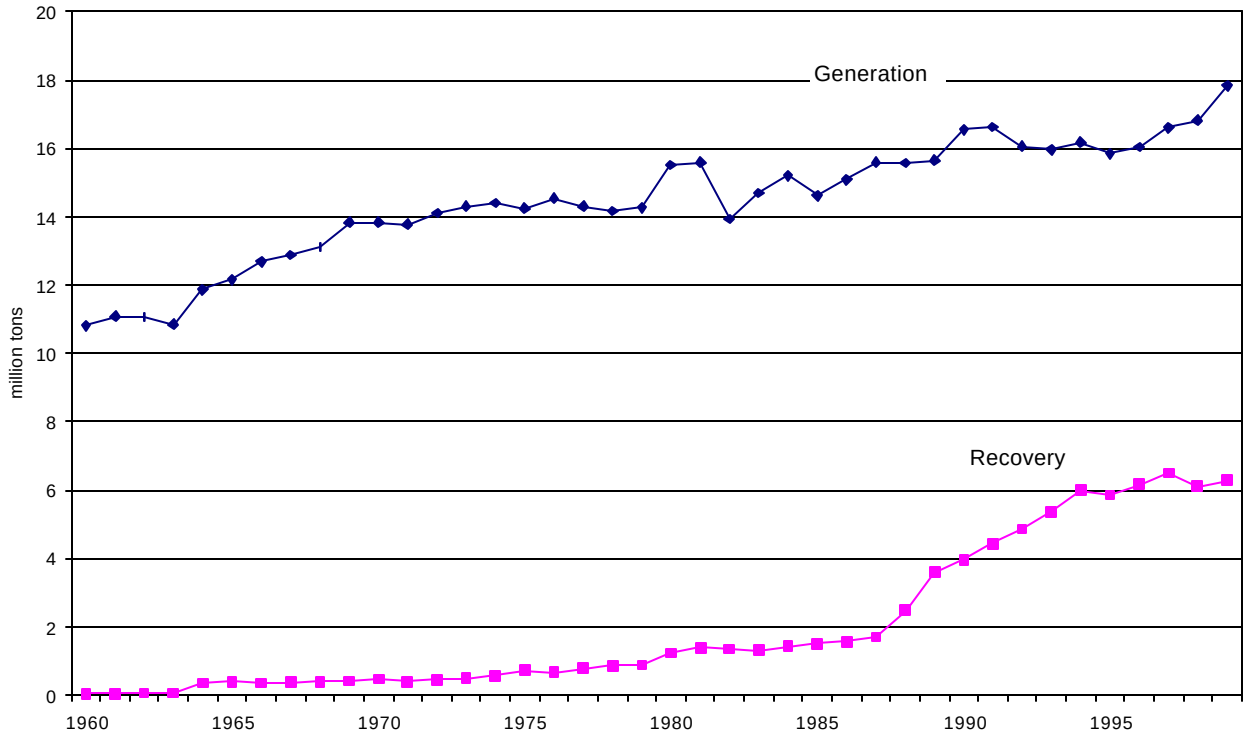
Table 6

METAL PRODUCTS IN MSW, 1999
(In thousands of tons and percent of generation)

Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent of generation)	Discards (Thousand tons)
Durable Goods				
Ferrous metals*	10,390	2,800	26.9%	7,590
Aluminum**	960	Neg.	Neg.	960
Lead†	970	930	95.9%	40
Other nonferrous metals‡	420	Neg.	Neg.	420
Total Metals in Durable Goods	12,740	3,730	29.3%	9,010
Nondurable Goods				
Aluminum	200	Neg.	Neg.	200
Containers and Packaging				
Steel				
Food and other cans	2,690	1,510	56.1%	1,180
Other steel packaging	240	170	70.8%	70
Total Steel Packaging	2,930	1,680	57.3%	1,250
Aluminum				
Beer and soft drink cans	1,540	840	54.5%	700
Food and other cans	50	Neg.	Neg.	50
Foil and closures	380	30	7.9%	350
Total Aluminum Packaging	1,970	870	44.2%	1,100
Total Metals in Containers and Packaging	4,900	2,550	52.0%	2,350
Total Metals	17,840	6,280	35.2%	11,560
Ferrous	13,320	4,480	33.6%	8,840
Aluminum	3,130	870	27.8%	2,260
Other nonferrous	1,390	930	66.9%	460

* Ferrous metals in appliances, furniture, tires, and miscellaneous durables.
** Aluminum in appliances, furniture, and miscellaneous durables.
† Lead in lead-acid batteries.
‡ Other nonferrous metals in appliances and miscellaneous durables.
Neg. = Less than 5,000 tons or 0.05 percent.
Details may not add to totals due to rounding.
Source: Franklin Associates.

Figure 7. Metals generation and recovery, 1960 to 1999



Other Nonferrous Metals

Other nonferrous metals (e.g., lead, copper, zinc) are found in durable products such as appliances, consumer electronics, etc. Lead in lead-acid batteries is the most prevalent nonferrous metal (other than aluminum) in MSW. Note that only lead-acid batteries from passenger cars, trucks, and motorcycles are included. Lead-acid batteries used in large equipment or industrial applications are not included.

Generation. Generation of other nonferrous metals in MSW totaled 1.4 million tons in 1999. Lead in batteries accounted for 970,000 tons of this amount. Generation of these metals has increased slowly, up from 180,000 tons in 1960. As a percentage of total generation, nonferrous metals have never exceeded one percent.

Recovery. Recovery of the other nonferrous metals was 930,000 tons in 1999, with most of this being lead recovered from batteries. It was estimated that 95.9 percent of battery lead was recovered in 1999, up from 94.3 percent in 1997.

Discards After Recovery. In 1999, 460,000 tons of nonferrous metals were discarded in MSW. Percentages of total discards remained less than one percent over the entire period.

Plastics

Plastics are a rapidly growing segment of MSW. The largest category plastics are found in is containers and packaging; they are also found in durable and nondurable goods. (Table 7 and Figure 8).

In durable goods, plastics are found in appliances, furniture, casings of lead-acid batteries, and other products. (Note that plastics in transportation products generally are not included in this report.) As shown in Table 7, a wide range of resin types is found in durable goods. While some detail is provided in Table 7 for resins in durable goods, there are hundreds of different resin formulations used in appliances, carpets, and other durable goods; a complete listing is beyond the scope of this report.

Plastics are found in nondurable products such as disposable diapers, trash bags, cups, eating utensils, sporting and recreational equipment, medical devices, household items such as shower curtains, etc. The plastic food service items are generally made of clear or foamed polystyrene, while trash bags are made of high-density polyethylene or low-density polyethylene. A wide variety of other resins are used in other nondurable goods.

Plastic resins also are used in a variety of container and packaging products such as polyethylene terephthalate (PET) soft drink bottles, high-density polyethylene (HDPE) bottles for milk and water, and a wide variety of other resin types used in other plastic containers, bags, sacks, wraps, lids, etc.

Generation. Production data on plastics resin use in products is taken from the *Modern Plastics* annual statistical issue and the American Plastics Council's (APC) annual plastic recovery survey. The basic data are adjusted for product service life, fabrication losses, and net imports of plastic products to derive generation of plastics in the various products in MSW.

Plastics made up an estimated 390,000 tons of MSW generation in 1960. The quantity has increased relatively steadily to 24.2 million tons in 1999 (Figure 9). As a percentage of MSW generation, plastics were less than one percent in 1960, increasing to 10.5 percent in 1999.

Recovery for Recycling. While overall recovery of plastics for recycling is relatively small – 1.4 million tons, or 5.6 percent of plastics generation in 1999 (Table 9) – recovery of some plastic containers has generally increased. PET soft drink bottles were recovered at a rate of 40 percent in 1999. Recovery of high-density polyethylene milk and water bottles was estimated at about 31.9 percent in 1999. Significant recovery of plastics from lead-acid battery casings and from some other containers also was reported. The primary source of data on plastics recovery is the annual survey conducted for APC.

Discards After Recovery. Discards of plastics in MSW after recovery were 22.8 million tons, or 13.8 percent of total MSW discards.

Table 7

PLASTICS IN PRODUCTS IN MSW, 1999
(In thousands of tons, and percent of generation by resin)

Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent of Gen.)	Discards (Thousand tons)
Durable Goods				
PET	390	30	7.7%	360
HDPE	530	50	9.4%	480
PVC	420	Neg.		420
LDPE/LLDPE	630	0	0.0%	630
PP	1,160	90	7.8%	1,070
PS	610	0	0.0%	610
Other resins	3,440	100	2.9%	3,340
Total Plastics in Durable Goods	7,180	270	3.8%	6,910
Nondurable Goods				
Plastic Plates and Cups				
LDPE/LLDPE	20			20
PS	890	Neg.		890
Subtotal Plastic Plates and Cups	910			910
Trash Bags				
HDPE	250			250
LDPE/LLDPE	700			700
Subtotal Trash Bags	950			950
All other nondurables*				
PET	190			190
HDPE	380			380
PVC	550			550
LDPE/LLDPE	1,440			1,440
PP	800			800
PS	530			530
Other resins	80			80
Subtotal All Other Nondurables	3,970			3,970
Total Plastics in Nondurable Goods, by resin				
PET	190			190
HDPE	630			630
PVC	550			550
LDPE/LLDPE	2,160			2,160
PP	800			800
PS	1,420	Neg.		1,420
Other resins	80			80
Total Plastics in Nondurable Goods	5,830	0	0.0%	5,830
Plastic Containers & Packaging				
Soft drink bottles				
PET	900	360		540
HDPE	Neg.	Neg.		Neg.
Subtotal Soft Drink Bottles	900	360	40.0%	540
Milk and water bottles				
HDPE	690	220	31.9%	470

HDPE=High density polyethylene PET=Polyethylene terephthalate PS=Polystyrene
LDPE=Low density polyethylene PP=Polypropylene PVC=Polyvinyl chloride
LLDPE=Linear Low density polyethylene

Source: Franklin Associates.

Table 7 (continued)

PLASTICS IN PRODUCTS IN MSW, 1999
(In thousands of tons, and percent of generation by resin)

Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent of Gen.)	Discards (Thousand tons)
Plastic Containers & Packaging, cont.				
Other plastic containers				
PET	820	80		740
HDPE	1,390	190		1,200
PVC	150	Neg.		150
LDPE/LLDPE	50	Neg.		50
PP	140	Neg.		140
PS	70	Neg.		70
Other resins	30	10		30
Subtotal Other Containers	2,650	280	10.6%	2,370
Bags, sacks, & wraps				
HDPE	670			670
PVC	70			70
LDPE/LLDPE	2,830	130		2,700
PP	590			590
PS	80			80
Other resins		10		
Subtotal Bags, Sacks, & Wraps	4,240	140	3.3%	4,100
Other Plastics Packaging**				
PET	130	Neg.		130
HDPE	1,430	20		1,430
PVC	260	Neg.		260
LDPE/LLDPE	350	Neg.		350
PP	370	30		340
PS	100	10		90
Other resins	40	10		40
Subtotal Other Packaging	2,680	70	2.6%	2,610
Total Plastics in Containers & Packaging, by resin				
PET	1,850	440		1,410
HDPE	4,180	440		3,740
PVC	480	Neg.		480
LDPE/LLDPE	3,230	130		3,100
PP	1,100	30		1,070
PS	250	10		240
Other resins	70	30		70
Total Plastics in Cont. & Packaging	11,160	1,080	9.7%	10,080
Total Plastics in MSW, by resin				
PET	2,430	470		1,960
HDPE	5,340	490		4,850
PVC	1,450	Neg.		1,450
LDPE/LLDPE	6,020	130		5,890
PP	3,060	120		2,940
PS	2,280	10		2,270
Other resins	3,590	130		3,460
Total Plastics in MSW	24,170	1,350	5.6%	22,820

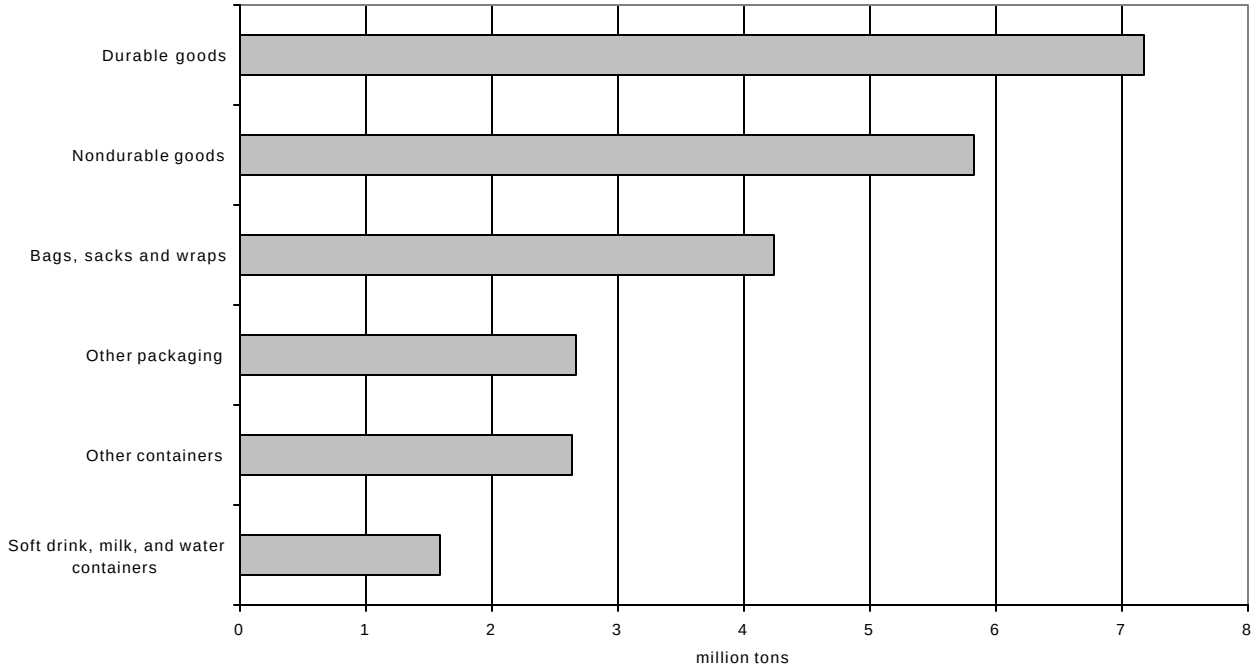
HDPE=High density polyethylene PET=Polyethylene terephthalate PS=Polystyrene
LDPE=Low density polyethylene PP=Polypropylene PVC=Polyvinyl chloride
LLDPE=Linear Low density polyethylene

* All other nondurables include plastics in disposable diapers, clothing, footwear, etc.

** Other plastic packaging includes coatings, closures, caps, trays, shapes, etc.
Neg. = Less than 5,000 tons or 0.05 percent. Details may not add to totals due to rounding.

Source: Franklin Associates.

Figure 8. Plastics products generated in MSW, 1999



Other Materials

Rubber and Leather. The predominant source of rubber in MSW is rubber tires from automobiles and trucks (Table 8). Other sources of rubber and leather include clothing and footwear and other miscellaneous durable and nondurable products. These other sources are quite diverse, including such items as gaskets on appliances, furniture, and hot water bottles, for example.

Generation. Generation of rubber and leather in MSW has shown slow growth over the years, increasing from 1.8 million tons in 1960 to 6.2 million tons in 1999. One reason for the relatively slow rate of growth is that tires have been made smaller and longer-wearing than in earlier years.

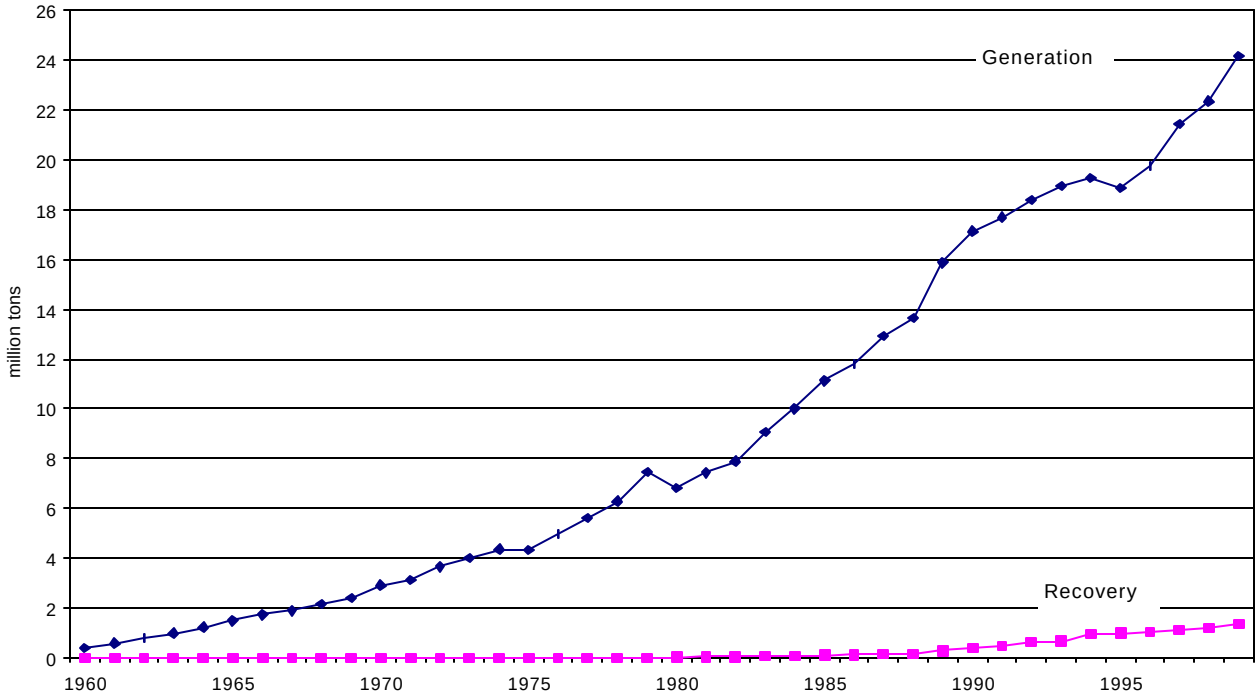
As a percentage of total MSW generation, rubber and leather has been about 3 percent for many years.

Recovery for Recycling. The only recovery for recycling identified in this category is rubber from tires, and that was estimated to be 790,000 tons (26.5 percent of rubber in tires in 19999) (Table 8). (This recovery estimate does not include tires retreaded or energy recovery from tires.) Overall, 12.7 percent of rubber and leather in MSW was recovered in 1999.

Discards After Recovery. Discards of rubber and leather after recovery were 5.4 million tons in 1999 (3.3 percent of total discards).

Textiles. Textiles in MSW are found mainly in discarded clothing, although other sources were identified to be furniture, carpets, tires, footwear, and other nondurable goods such as sheets and towels.

Figure 9. Plastics generation and recovery, 1960 to 1999



Generation. An estimated 9.1 million tons of textiles were generated in 1999 (3.9 percent of total MSW generation).

Recovery for Recycling and Discards. Significant amounts of textiles are recovered for reuse. However, the reused garments and wiper rags re-enter the waste stream eventually, so this is considered a diversion rather than recovery for recycling and, therefore, not included in the recovery for recycling estimates. Since data on elapsed time from recovery of textiles for reuse to final discard is limited, it was assumed that reused textiles re-enter the waste stream the same year that they are first discarded. It was estimated that 12.9 percent of textiles in clothing and items such as sheets and pillowcases was recovered for export or reprocessing in 1999 (1.2 million tons) leaving discards of 7.2 million tons of textiles in 1999.

Wood. The sources of wood in MSW include furniture, miscellaneous durable goods (e.g., cabinets for electronic equipment), wood packaging (crates, pallets), and some other miscellaneous products.

Generation. Generation of wood in MSW was 11.5 million tons in 1999 (6.9 percent of total MSW generation).

Recovery for Recycling and Discards. Wood pallet recovery for recycling (usually by chipping for uses such as mulch or bedding material, but excluding wood combusted as fuel) was estimated at 720,000 in 1999.

Accounting for pallet reuse and recovery for recycling, wood discards were 11.5 million tons in 1999, or 6.9 percent of total MSW discards.

Other products. Generation of "other products" waste is mainly associated with disposable diapers, which are discussed under the section on Products in Municipal Solid Waste. The only other significant sources of materials in this category are the electrolytes and other materials associated with lead-acid batteries that are not classified as plastics or nonferrous metal.

Table 8

RUBBER AND LEATHER PRODUCTS IN MSW, 1999
(In thousands of tons and percent of generation)

Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent of generation)	Discards (Thousand tons)
Durable Goods				
Rubber in Tires*	2,980	790	26.5%	2,190
Other Durables**	2,430	Neg.	Neg.	2,430
Total Rubber & Leather Durable Goods	5,410	790	14.6%	4,620
Nondurable Goods				
Clothing and Footwear	540	Neg.	Neg.	540
Other Nondurables	250	Neg.	Neg.	250
Total Rubber & Leather Nondurable Goods	790	Neg.	Neg.	790
Containers and Packaging	20	Neg.	Neg.	20
Total Rubber & Leather	6,220	790	12.7%	5,430

* Automobile and truck tires. Does not include other materials in tires.
** Includes carpets and rugs and other miscellaneous durables.
Neg. = Less than 5,000 tons or 0.05 percent.
Details may not add to totals due to rounding.

Source: Franklin Associates.

Food Wastes

Food wastes included here consist of uneaten food and food preparation wastes from residences, commercial establishments such as restaurants and fast food establishments, institutional sources such as school cafeterias, and industrial sources such as factory lunchrooms. Food waste generated during the preparation and packaging of food products is considered industrial waste and therefore not included in MSW food waste estimates.

Generation. No production data are available for food wastes. Food wastes from residential and commercial sources were estimated using data from sampling studies in variousparts of the country in combination with demographic data on population, grocery store sales, restaurant sales, numbers of employees, and numbers of prisoners and students in institutions. Generation of food wastes was estimated to be nearly 25.2 million tons in 1999, up from 24.6 million tons in 1997.

Recovery for Composting and Discards. Beginning in 1994 for this series of reports, a significant amount of food waste composting from commercial sources was identified. As the data source (a survey published by *BioCycle* magazine) has improved, it has become apparent that other composted materials (e.g., paper and industrial food processing wastes) have been included with food wastes classified as MSW in the past. For the 1999 estimate, a more careful separation of MSW food composted resulted in an estimate of approximately 235,000 tons.

Another *BioCycle* survey yielded an estimate of approximately 315,000 tons of MSW composted. The total – 550,000 tons* of food wastes and other organic materials composted – is shown in the recovery tables on the line where only food waste recovery was shown in previous reports.

Yard Trimmings

Yard trimmings* include grass, leaves, and tree and brush trimmings from residential, institutional, and commercial sources.

Generation. In earlier versions of this report, generation of yard trimmings was estimated using sampling studies and population data. While in past years generation of yard trimmings had been increasing steadily as population and residential housing grew (i.e., constant generation on a per capita basis), in recent years there has been a new trend, local and state legislation discouraging yard trimmings disposal in landfills.

Legislation affecting yard trimmings disposal in landfills was tabulated, using published sources. In 1992, 11 states and the District of Columbia – accounting for more than 28 percent of the nation's population – had legislation in effect that bans or discourages yard trimmings disposal in landfills. The tabulation of existing legislation also shows that by 1999, 23 states and the District of Columbia, representing more than 50 percent of the nations's population, had legislation affecting disposal of yard trimmings. This has led to an increase in backyard composting and the use of mulching mowers to allow grass trimmings to remain in place.

Using these facts, it was estimated that the effect of this legislation was no increase in yard trimmings generation (i.e., entering the waste management system) between 1990 and 1992 (i.e., the increase in yard trimmings due to natural population increases was offset by source reduction efforts). Furthermore, with 50 percent of the population having yard trimmings legislation in 1997, it was also estimated that yard trimmings generation declined approximately 6 percent annually between 1992 and 1997, and since then has remained stable. An estimated 27.7 million tons of yard trimmings were generated in MSW in 1999 (this compares to an estimated 35 million tons of yard trimmings generated in 1992).

*Although there are limited data available on the composition of yard trimmings, it is estimated that the average composition by weight is about 50 percent grass, 25 percent brush, and 25 percent leaves. These are "ballpark" numbers that will vary widely according to climate and region of the country.

Recovery for Composting and Discards. Recovery for composting of yard trimmings was estimated using a previous survey which estimated tonnages composted by facilities along with updated information on numbers of yard waste composting facilities. Data compiled by *BioCycle* magazine indicates that there were about 3,000 composting facilities for yard trimmings in 1992, increasing to 3,800 facilities in 1999.*

Removal of yard trimmings for composting was estimated to be 45.3 percent of generation in 1999 (12.6 million tons), leaving 15.2 million tons of yard trimmings to be discarded. (It should be noted that the estimated 12.6 million tons recovered for composting does not include yard trimmings used for landspreading disposal.)

It also should be noted that these recovery estimates do not account for backyard composting by individuals and practices such as less bagging of grass clippings. These are source reduction activities which take place on-site. The yard trimming estimates are based on material recovered and sent off-site. The information source is sampling studies which estimate the quantities received at landfills and transfer stations. Source reduction activities are estimated in Chapter 4.

Miscellaneous Inorganic Wastes

This relatively small category of MSW is also derived from sampling studies. It is not well defined and often shows up in sampling reports as "fines" or "other." It includes soil, bits of concrete, stones, and the like.

Generation, Recovery, and Discards. This category contributed an estimated 3.4 million tons of MSW in 1999. No recovery of these products was identified; discards are the same as generation.

Summary of Materials in Municipal Solid Waste

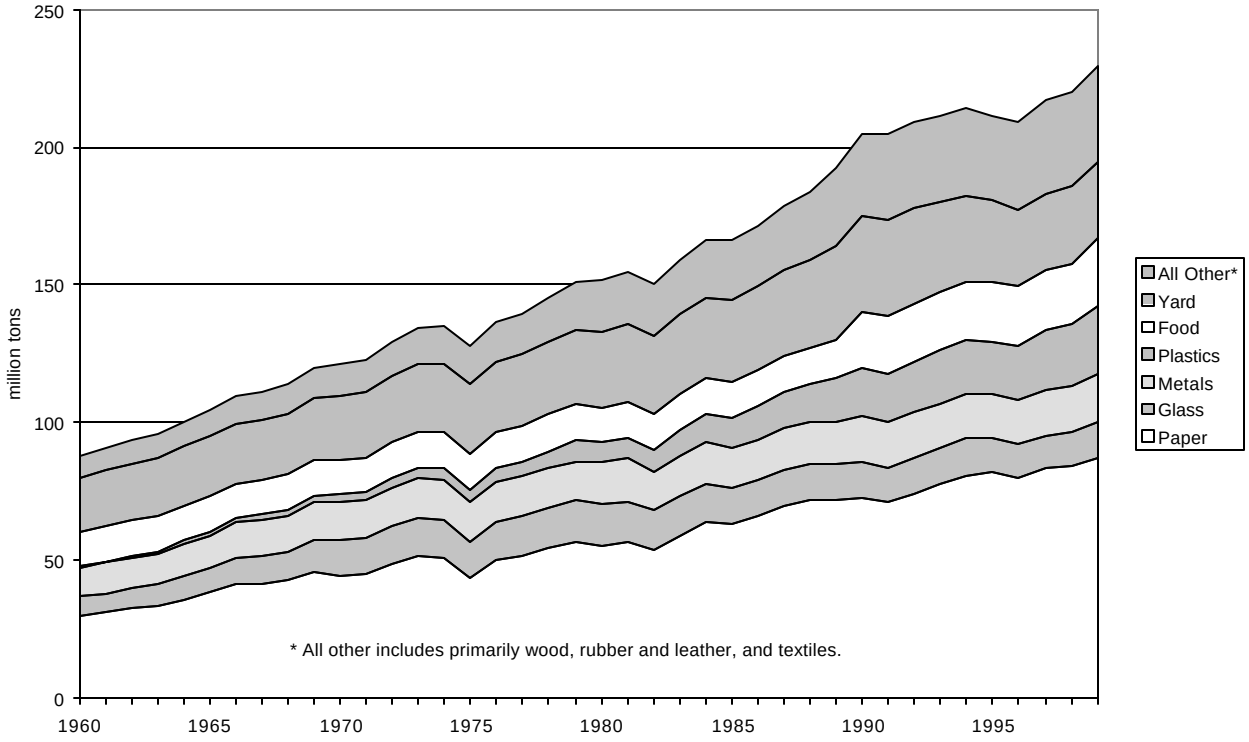
Generation. Changing quantities and composition of municipal solid waste generation are illustrated in Figure 10. Generation of MSW has grown relatively steadily, from 88.1 million tons in 1960 to 229.9 million tons in 1999.

Over the years, paper and paperboard has been the dominant material generated in MSW, accounting for 38.1 percent of generation in 1999. Yard trimmings, the second-largest material component of MSW (12.1 percent of MSW generation), have been declining as a percentage of MSW in recent years due to state and locally legislated landfill bans and increased emphasis on backyard composting and other source reduction measures such as the use of mulching mowers.

*Based on the April 1999 issue of *BioCycle*, which provides data on the amount of MSW composted and the number of yard trimmings composting facilities in 1998.

Metals account for 7.8 percent of MSW generation and have remained fairly constant as a source of MSW. Glass generation increased until the 1980s, but decreased somewhat in the 1990s. Glass generation was 12.6 million tons in 1999, 5.5 percent of MSW generated. Food wastes have remained fairly constant in terms of MSW tonnage (10.9 percent of generation in 1999). Plastics have increasingly been used in a variety of products and thus have been a rapidly growing component of MSW. In terms of tonnage contributed they ranked fourth in 1999 (behind paper, yard trimmings, and food waste), and account for 10.5 percent of MSW generation.

Figure 10. Generation of materials in MSW, 1960 to 1999



Recovery and Discards. The effect of recovery on MSW discards is illustrated in Figure 11. Recovery of materials for recycling and composting grew at a rather slow pace from 1960 to the 1980s, increasing only from 6.4 percent of generation in 1960 to 10.9 percent in 1985. Renewed interest in recycling (including composting) as waste management alternatives came about in the late 1980s, and the recovery rate in 1990 was estimated to be 16.2 percent of generation, increasing to 27.8 percent in 1999.

Figure 11. Recovery and discards of MSW,* 1960 to 1999

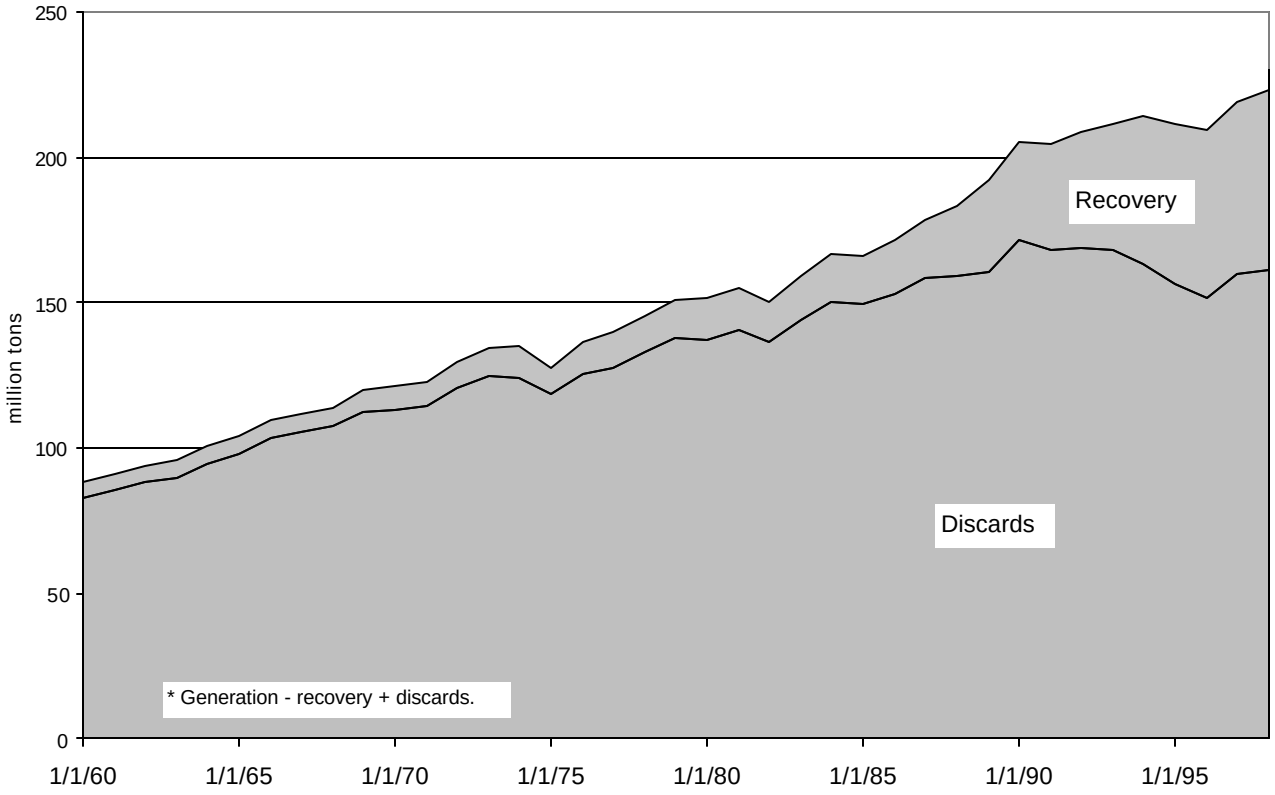
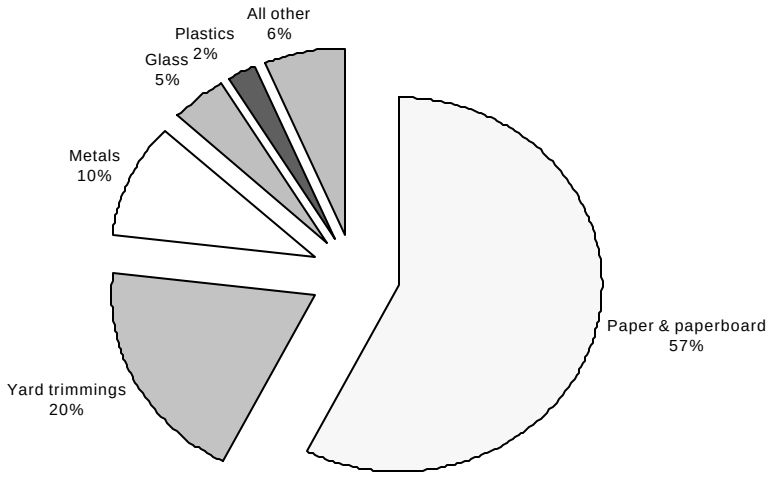


Figure 12. Materials recovery,* 1999



* In percent by weight of total recovery

Estimated recovery of materials (including composting) is shown in Figure 12. In 1999, recovery of paper and paperboard dominated materials recovery at 57 percent of total tonnage recovered. Recovery of other materials, while generally increasing, contributes much less tonnage, reflecting in part the relatively smaller amounts of materials generated in those categories.

Figure 13 illustrates the effect of recovery of materials for recycling, including composting, on the composition of MSW discards. For example, paper and paperboard were 38.1 percent of MSW generated in 1999, but after recovery, paper and paperboard were 30.6 percent of discards. Materials that have little or no recovery exhibit a larger percentage of MSW discards compared to generation.

The section of the chapter above, gave a breakdown of municipal solid waste by material. It described how the 229.9 million tons of MSW was generated, recycled (including composted), and disposed of. The following section breaks out the same 229.9 million tons of MSW by product.

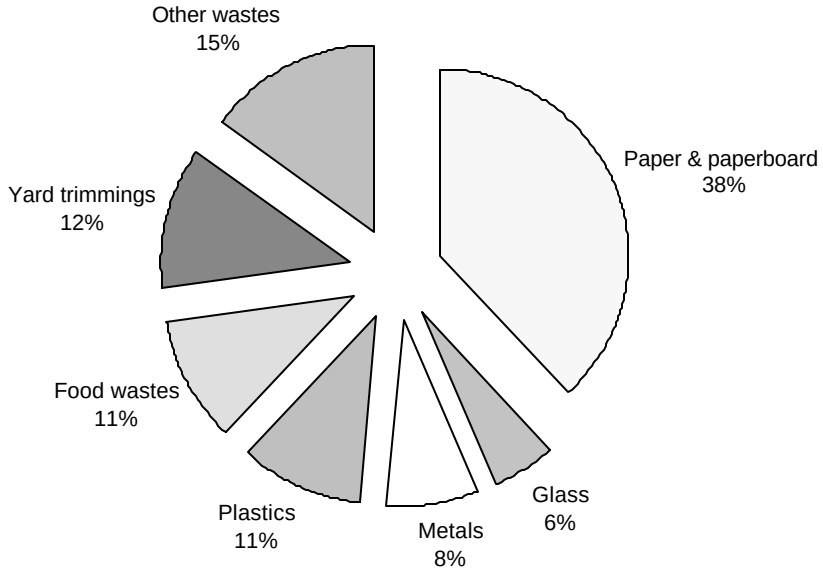
PRODUCTS IN MUNICIPAL SOLID WASTE

The purpose of this section is to show how the products that make up municipal solid waste are generated, recycled (including composting), and discarded. For ease of analysis, products are divided into three basic types: durable, non-durable, and containers and packaging. These three types were developed by the U.S. Department of Commerce, one of EPA's data sources, and were chosen based on differences in length of product life and type of use. Durables, such as major appliances, last the longest; non-durables, such as books, office paper, and plastic utensils, have a shorter life; and containers and packaging, such as beverage containers and plastic bags, presumably have the shortest life.

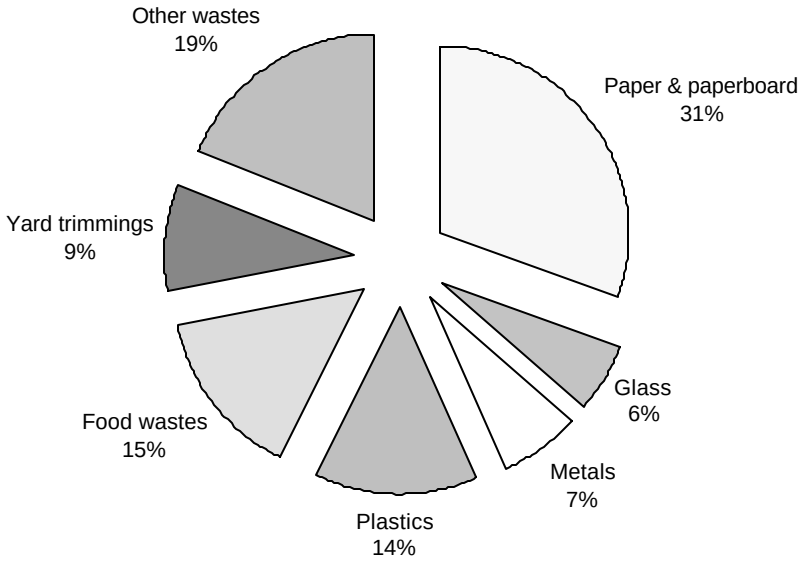
The following 15 tables (Tables 9 through 23) show generation, recycling (including composting) and discards of municipal solid waste, by durables/non-durables/containers and packaging. Within these 3 categories, products are listed by type – for instance office paper or magazines. The material the product is made of may be stated as well (for instance, glass beverage containers or aluminum beverage containers), or may be obvious (for instance, magazines are made of paper.) Some products may be composites, such as tires or appliances, made of several different material types.

At the bottom of each of these 15 tables (Tables 9 through 23), there is a section titled "Other Wastes." This contains information on food wastes, yard trimmings, and miscellaneous inorganic wastes. This information is the same as the information already provided in Tables 1 to 3, earlier in this chapter, in the section where MSW is analyzed by material. This is because wood wastes and yard trimmings are both a material and a product. Miscellaneous inorganic wastes also are handled this way.

Figure 13. Materials generated and discarded in municipal solid waste, 1999
(In percent of total generation and discards)



Generation



Discards

Within Tables 9 through 23, the first three tables, Tables 9 to 11, serve as an index to the other tables. Table 9 shows what tables to consult for detailed information on generation; Table 10 shows what tables to consult for detailed information on recovery; and Table 11 does the same for detailed information on discards. The tables on generation all have the same "bottom line," which is 229.9 million tons – but detail is provided in different areas – either durables, non-durables, or containers and packaging. For Table 10, the "bottom line" is how much MSW is recovered; and for Table 11, the "bottom line" is how much MSW is discarded.

Table 9

CATEGORIES OF PRODUCTS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1999
(In thousands of tons and percent of total generation)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods *(Detail in Table 12)*	9,920	14,660	21,800	29,810	31,140	33,220	34,370	35,370
Nondurable Goods *(Detail in Table 15)*	17,330	25,060	34,420	52,170	57,250	59,280	60,310	62,200
Containers and Packaging *(Detail in Table 18)*	27,370	43,560	52,670	64,530	68,390	71,040	72,430	76,010
***Total Product** Wastes*	54,620	83,280	108,890	146,510	156,780	163,540	167,110	173,580
Other Wastes								
Food Wastes	12,200	12,800	13,000	20,800	21,740	24,620	24,910	25,160
Yard Trimmings	20,000	23,200	27,500	35,000	29,690	27,730	27,730	27,730
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,150	3,250	3,290	3,380
Total Other Wastes	33,500	37,780	42,750	58,700	54,580	55,600	55,930	56,270
Total MSW Generated - Weight	88,120	121,060	151,640	205,210	211,360	219,140	223,040	229,850
	Percent of Total Generation							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods *(Detail in Table 12)*	11.3%	12.1%	14.4%	14.5%	14.7%	15.2%	15.4%	15.4%
Nondurable Goods *(Detail in Table 15)*	19.7%	20.7%	22.7%	25.4%	27.1%	27.1%	27.0%	27.1%
Containers and Packaging *(Detail in Table 19)*	31.1%	36.0%	34.7%	31.4%	32.4%	32.4%	32.5%	33.1%
***Total Product** Wastes*	62.0%	68.8%	71.8%	71.4%	74.2%	74.6%	74.9%	75.5%
Other Wastes								
Food Wastes	13.8%	10.6%	8.6%	10.1%	10.3%	11.2%	11.2%	10.9%
Yard Trimmings	22.7%	19.2%	18.1%	17.1%	14.0%	12.7%	12.4%	12.1%
Miscellaneous Inorganic Wastes	1.5%	1.5%	1.5%	1.4%	1.5%	1.5%	1.5%	1.5%
Total Other Wastes	38.0%	31.2%	28.2%	28.6%	25.8%	25.4%	25.1%	24.5%
Total MSW Generated - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Generation before materials recovery or combustion. Does not include construction & demolition debris, industrial process wastes, or certain other wastes.
** Other than food products.
Details may not add to totals due to rounding.
Source: Franklin Associates

Table 10

RECOVERY* OF MUNICIPAL SOLID WASTE, 1960 TO 1999
(In thousands of tons and percent of generation of each category)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods *(Detail in Table 13)*	350	940	1,360	3,460	5,010	5,660	5,720	5,880
Nondurable Goods *(Detail in Table 16)*	2,390	3,730	4,670	8,800	13,610	14,020	14,980	16,640
Containers and Packaging *(Detail in Table 20)*	2,870	3,350	8,490	16,780	26,720	27,620	27,710	28,260
***Total Product** Wastes*	5,610	8,020	14,520	29,040	45,340	47,300	48,410	50,780
Other Wastes								
Food, Other^	Neg.	Neg.	Neg.	Neg.	570	580	580	550
Yard Trimmings	Neg.	Neg.	Neg.	4,200	9,000	11,490	12,560	12,560
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	4,200	9,570	12,070	13,140	13,110
Total MSW Recovered - Weight	5,610	8,020	14,520	33,240	54,910	59,370	61,550	63,890
	Percent of Generation of Each Category							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods *(Detail in Table 13)*	3.5%	6.4%	6.2%	11.6%	16.1%	17.0%	16.6%	16.6%
Nondurable Goods *(Detail in Table 16)*	13.8%	14.9%	13.6%	16.9%	23.8%	23.7%	24.8%	26.8%
Containers and Packaging *(Detail in Table 21)*	10.5%	7.7%	16.1%	26.0%	39.1%	38.9%	38.3%	37.2%
***Total Product** Wastes*	10.3%	9.6%	13.3%	19.8%	28.9%	28.9%	29.0%	29.3%
Other Wastes								
Food, Other^	Neg.	Neg.	Neg.	Neg.	2.6%	2.4%	2.3%	2.2%
Yard Trimmings	Neg.	Neg.	Neg.	12.0%	30.3%	41.4%	45.3%	45.3%
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	7.2%	17.5%	21.7%	23.5%	23.3%
Total MSW Recovered - %	6.4%	6.6%	9.6%	16.2%	26.0%	27.1%	27.6%	27.8%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Other than food products.
^ Includes recovery of paper for composting.
Neg. = Less than 5,000 tons or 0.05 percent.
Details may not add to totals due to rounding.
Source: Franklin Associates

Table 11

CATEGORIES OF PRODUCTS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1999
(In thousands of tons and percent of total discards)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods	9,570	13,720	20,440	26,350	26,130	27,560	28,650	29,490
(Detail in Table 14)								
Nondurable Goods	14,940	21,330	29,750	43,370	43,640	45,260	45,330	45,560
(Detail in Table 17)								
Containers and Packaging	24,500	40,210	44,180	47,750	41,670	43,420	44,720	47,750
(Detail in Table 22)								
***Total Product** Wastes*	49,010	75,260	94,370	117,470	111,440	116,240	118,700	122,800
Other Wastes								
Food Wastes	12,200	12,800	13,000	20,800	21,170	24,040	24,330	24,610
Yard Trimmings	20,000	23,200	27,500	30,800	20,690	16,240	15,170	15,170
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,150	3,250	3,290	3,380
Total Other Wastes	33,500	37,780	42,750	54,500	45,010	43,530	42,790	43,160
Total MSW Discarded - Weight	82,510	113,040	137,120	171,970	156,450	159,770	161,490	165,960
	Percent of Total Discards							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods	11.6%	12.1%	14.9%	15.3%	16.7%	17.2%	17.7%	17.8%
(Detail in Table 14)								
Nondurable Goods	18.1%	18.9%	21.7%	25.2%	27.9%	28.3%	28.1%	27.5%
(Detail in Table 17)								
Containers and Packaging	29.7%	35.6%	32.2%	27.8%	26.6%	27.2%	27.7%	28.8%
(Detail in Table 23)								
***Total Product** Wastes*	59.4%	66.6%	68.8%	68.3%	71.2%	72.8%	73.5%	74.0%
Other Wastes								
Food Wastes	14.8%	11.3%	9.5%	12.1%	13.5%	15.0%	15.1%	14.8%
Yard Trimmings	24.2%	20.5%	20.1%	17.9%	13.2%	10.2%	9.4%	9.1%
Miscellaneous Inorganic Wastes	1.6%	1.6%	1.6%	1.7%	2.0%	2.0%	2.0%	2.0%
Total Other Wastes	40.6%	33.4%	31.2%	31.7%	28.8%	27.2%	26.5%	26.0%
Total MSW Discarded - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Discards after materials and compost recovery. Does not include construction & demolition debris, industrial process wastes, or certain other wastes.

** Other than food products.

Details may not add to totals due to rounding.

Source: Franklin Associates

Durable Goods

Durable goods generally are defined as products having a lifetime of three years or more, although there are some exceptions. In this report, durable goods include large and small appliances, furniture and furnishings, carpets and rugs, rubber tires, lead-acid automotive batteries, and miscellaneous durable goods (e.g., luggage, consumer electronics) (see Tables 12 through 14). These products are often called "oversize and bulky" in municipal solid waste management practice, and they are generally handled in a somewhat different manner than other components of MSW. That is, they are often picked up separately, and may not be mixed with other MSW at the landfill, combustor, or other waste management facility. Durable goods are made up of a wide variety of materials. In order of tonnage in MSW in 1999, these include: ferrous metals, plastics, ruber and leather, wood, textiles, glass, other nonferrous metals (e.g., lead, copper), and aluminum.

Generation of durable goods in MSW totaled 35.4 million tons in 1999 (15.4 percent of total MSW generation). After recovery for recycling, 29.5 million tons of durable goods remained as discards in 1999.

Major Appliances. Major appliances in MSW include refrigerators, washing machines, water heaters, etc. They are often called "white goods" in the trade. Data on unit production of appliances are taken from the *Appliance Manufacturer Market Profile***.** The unit data are converted to weight using various conversion factors developed over the years, plus data on the materials composition of the appliances. Adjustments also are made for the estimated life spans of the appliances, which range up to 20 years.

Generation of these waste products in MSW has increased very slowly; it was estimated to be 3.7 million tons in 1999 (1.6 percent of total MSW). In general, appliances have increased in quantity but not in average weight over the years. Ferrous metals are the predominant materials in major appliances, but other metals, plastics, glass, and other materials also are present.

Data on recovery of ferrous metals from major appliances are taken from a survey conducted by the Steel Recycling Institute. Recovery of ferrous metals from shredded appliances was estimated to be 1.9 million tons in 1999, leaving 1.8 million tons of appliances to be discarded.

Small Appliances. This category includes items such as toasters, hair dryers, electric coffeepots, and the like. Information on shipments of small appliances was obtained from U.S. Department of Commerce data. Information on weights and materials composition of discarded small appliances was obtained through interviews. It was estimated that 940,000 tons of small appliances were generated in 1999. A small amount of ferrous metals in small appliances is recovered through magnetic separation.

Furniture and Furnishings. Data on sales of furniture and furnishings are provided by the Department of Commerce in dollars. These data are converted to tons using factors developed for this study over the years. Adjustments are made for imports and exports, and adjustments are made for the lifetimes of the furniture.

Table 12

PRODUCTS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1999
(WITH DETAIL ON DURABLE GOODS)
(In thousands of tons and percent of total generation)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods								
Major Appliances	1,630	2,170	2,950	3,310	3,420	3,600	3,650	3,680
Small Appliances**				460	710	830	890	940
Furniture and Furnishings	2,150	2,830	4,760	6,790	7,170	7,510	7,600	7,710
Carpets and Rugs**				1,660	2,230	2,330	2,410	2,470
Rubber Tires	1,120	1,890	2,720	3,610	3,770	4,260	4,510	4,650
Batteries, lead acid	Neg.	820	1,490	1,510	1,810	1,780	1,940	1,940
Miscellaneous Durables								
Selected Consumer Electronics***								1,760
Other Miscellaneous Durables								12,220
Total Miscellaneous Durables	5,020	6,950	9,880	12,470	12,030	12,910	13,370	13,980
Total Durable Goods	9,920	14,660	21,800	29,810	31,140	33,220	34,370	35,370
Nondurable Goods	17,330	25,060	34,420	52,170	57,250	59,280	60,310	62,200
(Detail in Table 15)								
Containers and Packaging	27,370	43,560	52,670	64,530	68,390	71,040	72,430	76,010
(Detail in Table 18)								
Total Product Wastes†	54,620	83,280	108,890	146,510	156,780	163,540	167,110	173,580
Other Wastes								
Food Wastes	12,200	12,800	13,000	20,800	21,740	24,620	24,910	25,160
Yard Trimmings	20,000	23,200	27,500	35,000	29,690	27,730	27,730	27,730
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,150	3,250	3,290	3,380
Total Other Wastes	33,500	37,780	42,750	58,700	54,580	55,600	55,930	56,270
Total MSW Generated - Weight	88,120	121,060	151,640	205,210	211,360	219,140	223,040	229,850
	Percent of Total Generation							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods								
Major Appliances	1.8%	1.8%	1.9%	1.6%	1.6%	1.6%	1.6%	1.6%
Small Appliances**				0.2%	0.3%	0.4%	0.4%	0.4%
Furniture and Furnishings	2.4%	2.3%	3.1%	3.3%	3.4%	3.4%	3.4%	3.4%
Carpets and Rugs**				0.8%	1.1%	1.1%	1.1%	1.1%
Rubber Tires	1.3%	1.6%	1.8%	1.8%	1.8%	1.9%	2.0%	2.0%
Batteries, Lead-Acid	Neg.	0.7%	1.0%	0.7%	0.9%	0.8%	0.9%	0.8%
Miscellaneous Durables								
Selected Consumer Electronics***								0.8%
Other Miscellaneous Durables								5.3%
Total Miscellaneous Durables	5.7%	5.7%	6.5%	6.1%	5.7%	5.9%	6.0%	6.1%
Total Durable Goods	11.3%	12.1%	14.4%	14.5%	14.7%	15.2%	15.4%	15.4%
Nondurable Goods	19.7%	20.7%	22.7%	25.4%	27.1%	27.1%	27.0%	27.1%
(Detail in Table 15)								
Containers and Packaging	31.1%	36.0%	34.7%	31.4%	32.4%	32.4%	32.5%	33.1%
(Detail in Table 19)								
Total Product Wastes†	62.0%	68.8%	71.8%	71.4%	74.2%	74.6%	74.9%	75.5%
Other Wastes								
Food Wastes	13.8%	10.6%	8.6%	10.1%	10.3%	11.2%	11.2%	10.9%
Yard Trimmings	22.7%	19.2%	18.1%	17.1%	14.0%	12.7%	12.4%	12.1%
Miscellaneous Inorganic Wastes	1.5%	1.5%	1.5%	1.4%	1.5%	1.5%	1.5%	1.5%
Total Other Wastes	38.0%	31.2%	28.2%	28.6%	25.8%	25.4%	25.1%	24.5%
Total MSW Generated - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Generation before materials recovery or combustion. Does not include construction & demolition debris, industrial process wastes, or certain other wastes. Details may not add to totals due to rounding.

** Not estimated separately prior to 1990. *** Not estimated separately prior to 1999.

† Other than food products.

Neg. = Less than 5,000 tons or 0.05 percent.

Source: Franklin Associates.

Table 13

RECOVERY* OF PRODUCTS IN MUNICIPAL SOLID WASTE, 1960 TO 1999
(WITH DETAIL ON DURABLE GOODS)
(In thousands of tons and percent of generation of each product)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods								
Major Appliances	10	50	130	1,070	2,070	2,320	1,940	1,920
Small Appliances**				10	10	10	10	10
Furniture and Furnishings	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Carpets and Rugs**				Neg.	20	30	30	30
Rubber Tires	330	250	150	440	670	950	1,060	1,230
Batteries, lead acid	Neg.	620	1,040	1,470	1,620	1,660	1,880	1,880
Miscellaneous Durables								
Selected Consumer Electronics***								160
Other Miscellaneous Durables								650
Total Miscellaneous Durables	10	20	40	470	620	690	800	810
Total Durable Goods	350	940	1,360	3,460	5,010	5,660	5,720	5,880
Nondurable Goods	2,390	3,730	4,670	8,800	13,610	14,020	14,980	16,640
(Detail in Table 16)								
Containers and Packaging	2,870	3,350	8,490	16,780	26,720	27,620	27,710	28,260
(Detail in Table 20)								
Total Product Wastes†	5,610	8,020	14,520	29,040	45,340	47,300	48,410	50,780
Other Wastes								
Food Wastes	Neg.	Neg.	Neg.	Neg.	570	580	580	550
Yard Trimmings	Neg.	Neg.	Neg.	4,200	9,000	11,490	12,560	12,560
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	4,200	9,570	12,070	13,140	13,110
Total MSW Recovered - Weight	5,610	8,020	14,520	33,240	54,910	59,370	61,550	63,890
	Percent of Generation of Each Product							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods								
Major Appliances	0.6%	2.3%	4.4%	32.3%	60.5%	64.4%	53.2%	52.2%
Small Appliances**				2.2%	1.4%	1.2%	1.1%	1.1%
Furniture and Furnishings	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Carpets and Rugs**				Neg.	0.9%	1.3%	1.2%	1.2%
Rubber Tires	29.5%	13.2%	5.5%	12.2%	17.8%	22.3%	23.5%	26.5%
Batteries, Lead-Acid	Neg.	75.6%	69.8%	97.4%	89.5%	93.3%	96.9%	96.9%
Miscellaneous Durables								
Selected Consumer Electronics***								9.1%
Other Miscellaneous Durables								5.3%
Total Miscellaneous Durables	0.2%	0.3%	0.4%	3.8%	5.2%	5.3%	6.0%	5.8%
Total Durable Goods	3.5%	6.4%	6.2%	11.6%	16.1%	17.0%	16.6%	16.6%
Nondurable Goods	13.8%	14.9%	13.6%	16.9%	23.8%	23.7%	24.8%	26.8%
(Detail in Table 16)								
Containers and Packaging	10.5%	7.7%	16.1%	26.0%	39.1%	38.9%	38.3%	37.2%
(Detail in Table 21)								
Total Product Wastes†	10.3%	9.6%	13.3%	19.8%	28.9%	28.9%	29.0%	29.3%
Other Wastes								
Food Wastes	Neg.	Neg.	Neg.	Neg.	2.6%	2.4%	2.3%	2.2%
Yard Trimmings	Neg.	Neg.	Neg.	12.0%	30.3%	41.4%	45.3%	45.3%
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	7.2%	17.5%	21.7%	23.5%	23.3%
Total MSW Recovered - %	6.4%	6.6%	9.6%	16.2%	26.0%	27.1%	27.6%	27.8%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Not estimated separately prior to 1990. *** Not estimated separately prior to 1999.
† Other than food products.
Neg. = Less than 5,000 tons or 0.05 percent.
Source: Franklin Associates.

Table 14

PRODUCTS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1999
(WITH DETAIL ON DURABLE GOODS)
(In thousands of tons and percent of total discards)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods								
Major Appliances	1,620	2,120	2,820	2,240	1,350	1,280	1,710	1,760
Small Appliances**				450	700	820	880	930
Furniture and Furnishings	2,150	2,830	4,760	6,790	7,170	7,510	7,600	7,710
Carpets and Rugs**				1,660	2,210	2,300	2,380	2,440
Rubber Tires	790	1,640	2,570	3,170	3,100	3,310	3,450	3,420
Batteries, lead acid	Neg.	200	450	40	190	120	60	60
Miscellaneous Durables								
Selected Consumer Electronics***								1,600
Other Miscellaneous Durables								11,570
Total Miscellaneous Durables	5,010	6,930	9,840	12,000	11,410	12,220	12,570	13,170
Total Durable Goods	9,570	13,720	20,440	26,350	26,130	27,560	28,650	29,490
Nondurable Goods	14,940	21,330	29,750	43,370	43,640	45,260	45,330	45,560
(Detail in Table 17)								
Containers and Packaging	24,500	40,210	44,180	47,750	41,670	43,420	44,720	47,750
(Detail in Table 22)								
Total Product Wastes†	49,010	75,260	94,370	117,470	111,440	116,240	118,700	122,800
Other Wastes								
Food Wastes	12,200	12,800	13,000	20,800	21,170	24,040	24,330	24,610
Yard Trimmings	20,000	23,200	27,500	30,800	20,690	16,240	15,170	15,170
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,150	3,250	3,290	3,380
Total Other Wastes	33,500	37,780	42,750	54,500	45,010	43,530	42,790	43,160
Total MSW Discarded - Weight	82,510	113,040	137,120	171,970	156,450	159,770	161,490	165,960
	Percent of Total Discards							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods								
Major Appliances	2.0%	1.9%	2.1%	1.3%	0.9%	0.8%	1.1%	1.1%
Small Appliances**				0.3%	0.4%	0.5%	0.5%	0.6%
Furniture and Furnishings	2.6%	2.5%	3.5%	3.9%	4.6%	4.7%	4.7%	4.6%
Carpets and Rugs**				1.0%	1.4%	1.4%	1.5%	1.5%
Rubber Tires	1.0%	1.5%	1.9%	1.8%	2.0%	2.1%	2.1%	2.1%
Batteries, Lead-Acid	Neg.	0.2%	0.3%	0.0%	0.1%	0.1%	0.0%	0.0%
Miscellaneous Durables								
Selected Consumer Electronics***								1.0%
Other Miscellaneous Durables								6.9%
Total Miscellaneous Durables	6.1%	6.1%	7.2%	7.0%	7.3%	7.6%	7.8%	7.9%
Total Durable Goods	11.6%	12.1%	14.9%	15.3%	16.7%	17.2%	17.7%	17.8%
Nondurable Goods	18.1%	18.9%	21.7%	25.2%	27.9%	28.3%	28.1%	27.5%
(Detail in Table 17)								
Containers and Packaging	29.7%	35.6%	32.2%	27.8%	26.6%	27.2%	27.7%	28.8%
(Detail in Table 23)								
Total Product Wastes†	59.4%	66.6%	68.8%	68.3%	71.2%	72.8%	73.5%	74.0%
Other Wastes								
Food Wastes	14.8%	11.3%	9.5%	12.1%	13.5%	15.0%	15.1%	14.8%
Yard Trimmings	24.2%	20.5%	20.1%	17.9%	13.2%	10.2%	9.4%	9.1%
Miscellaneous Inorganic Wastes	1.6%	1.6%	1.6%	1.7%	2.0%	2.0%	2.0%	2.0%
Total Other Wastes	40.6%	33.4%	31.2%	31.7%	28.8%	27.2%	26.5%	26.0%
Total MSW Discarded - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Discards after materials and compost recovery. Does not include construction & demolition debris, industrial process wastes, or certain other wastes. Details may not add to totals due to rounding.

** Not estimated separately prior to 1990. *** Not estimated separately prior to 1999.

† Other than food products.

Neg. = Less than 5,000 tons or 0.05 percent.

Source: Franklin Associates.

Generation of waste furniture and furnishings in MSW has increased from 2.2 million tons in 1960 to 7.7 million tons in 1999 (3.4 percent of total MSW). No significant recovery of materials from furniture was identified. Wood is the largest material category in furniture, with ferrous metals second. Plastics, glass, and other materials also are found in furniture.

Carpets and Rugs. An industry publication, *Carpet and Rug Industrial Review*, publishes data on carpet sales. These data, originally in square yards, are converted to tons using various factors developed for this report. An estimated 2.5 million tons of carpets and rugs were generated in MSW in 1999, which was 1.1 percent of total generation.

A small amount of recycling of carpet fiber was identified – estimated to be about 1 percent recovery in 1999.

Vehicle Tires. The methodology for estimating generation of rubber tires for automobiles and trucks is based on data on replacement tires purchased and vehicles deregistered as reported by the U.S. Department of Commerce. It is assumed that for each replacement tire purchased, a used tire enters the waste management system, and that tires on deregistered vehicles also enter the waste management system. Retreaded tires are treated as a diversion out of the waste stream; they are assumed to re-enter the waste stream after two years of use.

The quantities of tires in units are converted to weight and materials composition using factors developed for this series of reports. In addition to rubber, tires include relatively small amounts of textiles and ferrous metals. Generation of rubber tires increased from 1.1 million tons in 1960 to 4.7 million tons in 1999 (2 percent of total MSW).

Data on recovery of tires in recent years are based on data from the Scrap Tire Management Council. Rubber recovery from tires has been increasing in recent years. In 1999, an estimated 26.5 percent of the weight of tires generated was recovered for recycling, leaving 3.4 million tons to be discarded. (Tires going to combustion facilities as fuel are included in the combustion estimates in Chapter 3.)

Lead-Acid Batteries. The methodology for estimating generation of lead-acid batteries is similar to the methodology for rubber tires as described above. An estimated 1.9 million tons of lead-acid batteries from automobiles, trucks, and motorcycles were generated in MSW in 1999 (less than 1 percent of total generation).

Data on recovery of batteries has been provided by the Battery Council International. Recovery of batteries for recycling has fluctuated between 60 percent and 98 percent or higher; recovery has increased since 1980 as a growing number of communities have restricted batteries from disposal at landfills or combustion facilities. In 1999, 96.9 percent of the lead in these batteries was estimated to be recovered for recycling as well as substantial quantities of the polypropylene battery casings; so discards after recycling of these batteries decreased to 60,000 tons in 1999. (Some electrolytes and other materials in batteries are removed from the municipal solid waste stream along with recovered lead and polypropylene; these materials are counted as "recovered" along with the recyclable materials.)

Miscellaneous Durable Goods. Miscellaneous durable goods include consumer electronics such as television sets, video cassette recorders, personal computers, luggage, sporting equipment, and the like. An estimated 14 million tons of these goods were generated in 1999, amounting to 6.1 percent of MSW generated. An estimated 1.8 million tons of selected consumer electronics were generated. Of this, approximately 160,000 tons of selected consumer electronics were recovered for recycling. Additional information on consumer electronics, a subset of miscellaneous durable goods, can be found in Appendix C.

The miscellaneous durable goods category as a whole, includes ferrous metals, and also plastics, glass, rubber, wood, and other metals. An estimated 810,000 tons of ferrous metals were recovered from this category through pre-combustion and post-combustion magnetic separation at MSW combustion facilities in 1999, decreasing discards to 13.2 million tons.

Nondurable Goods

The Department of Commerce defines nondurable goods as those having a life span of less than three years, and this definition was followed for this report to the extent possible.

Products made of paper and paperboard comprise the largest portion of nondurable goods. Other nondurable products include paper and plastic plates, cups, and other disposable food service products; disposable diapers; clothing and footwear; linens; and other miscellaneous products. (See Tables 15 through 17.)

Generation of nondurable goods in MSW was 62.2 million tons in 1999 (27.1 percent of total generation). Recovery of paper products in this category is quite significant, resulting in 16.7 million tons of nondurable goods recovered in 1999 (26.8 percent of nondurables generation). This means that 45.6 million tons of nondurable goods were discarded in 1999 (27.5 percent of total MSW discards).

Paper and Paperboard Products. Generation, recovery, and discards of paper and paperboard products in nondurable goods are summarized in Tables 15 through 17. A summary for 1999 was shown earlier in Table 4. Since 1997, generation of nondurable paper products has increased. Each of the paper and paperboard product categories in nondurable goods is discussed briefly below.

- Newspapers are by far the largest single component of the nondurable goods category, at 14 million tons generated in 1999 (6.1 percent of total MSW). In 1999, 59 percent of newspapers generated were recovered for recycling, leaving 5.7 million tons discarded (3.5 percent of total MSW discarded). Estimates of newspaper generation are broken down into newsprint (the majority of the weight of the newspapers) and the groundwood* inserts (primarily advertising) that are a significant portion of the total weight of newspapers. This breakdown is shown in Table 4.

- Books amounted to approximately 1.1 million tons, or 0.5 percent of total MSW generation, in 1999. Recovery of books is not well documented, but it was estimated that approximately 200,000 tons of books were recovered in 1999. Books are made of both groundwood and chemical pulp.

* Groundwood papers, like newsprint, are made primarily from pulp prepared by a mechanical process. The nature of the pulp (groundwood vs. chemical) affects the potential uses for the recovered paper.

Table 15

PRODUCTS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1999
(WITH DETAIL ON NONDURABLE GOODS)
(In thousands of tons and percent of total generation)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods *(Detail in Table 12)*	9,920	14,660	21,800	29,810	31,140	33,220	34,370	35,370
Nondurable Goods								
Newspapers	7,110	9,510	11,050	13,430	13,140	13,490	13,630	13,960
Books and Magazines	1,920	2,470	3,390					
Books**				970	1,150	1,120	1,140	1,120
Magazines**				2,830	2,530	2,160	2,260	2,310
Office Papers	1,520	2,650	4,000	6,410	6,640	6,930	7,040	7,670
Directories**				610	490	470	740	680
Standard (A) Mail***				3,820	4,620	4,850	5,200	5,560
Other Commercial Printing	1,260	2,130	3,120	4,460	6,770	7,000	6,580	5,940
Tissue Paper and Towels	1,090	2,080	2,300	2,960	2,970	3,120	3,100	3,360
Paper Plates and Cups	270	420	630	650	970	970	890	930
Plastic Plates and Cups†			190	650	780	860	890	910
Trash Bags**				780	780	810	840	950
Disposable Diapers	Neg.	350	1,930	2,700	3,010	3,140	3,200	3,310
Other Nonpackaging Paper	2,700	3,630	4,230	3,840	4,270	4,390	4,420	4,740
Clothing and Footwear	1,360	1,620	2,170	4,010	5,070	5,770	6,040	6,250
Towels, Sheets and Pillowcases**				710	740	750	750	780
Other Miscellaneous Nondurables	100	200	1,410	3,340	3,320	3,450	3,590	3,730
Total Nondurable Goods	17,330	25,060	34,420	52,170	57,250	59,280	60,310	62,200
Containers and Packaging *(Detail in Table 18)*	27,370	43,560	52,670	64,530	68,390	71,040	72,430	76,010
Total Product Wastes‡	54,620	83,280	108,890	146,510	156,780	163,540	167,110	173,580
Other Wastes	33,500	37,780	42,750	58,700	54,580	55,600	55,930	56,270
Total MSW Generated - Weight	88,120	121,060	151,640	205,210	211,360	219,140	223,040	229,850
	Percent of Total Generation							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods *(Detail in Table 12)*	11.3%	12.1%	14.4%	14.5%	14.7%	15.2%	15.4%	15.4%
Nondurable Goods								
Newspapers	8.1%	7.9%	7.3%	6.5%	6.2%	6.2%	6.1%	6.1%
Books and Magazines	2.2%	2.0%	2.2%					
Books**				0.5%	0.5%	0.5%	0.5%	0.5%
Magazines**				1.4%	1.2%	1.0%	1.0%	1.0%
Office Papers	1.7%	2.2%	2.6%	3.1%	3.1%	3.2%	3.2%	3.3%
Directories**				0.3%	0.2%	0.2%	0.3%	0.3%
Standard (A) Mail***				1.9%	2.2%	2.2%	2.3%	2.4%
Other Commercial Printing	1.4%	1.8%	2.1%	2.2%	3.2%	3.2%	3.0%	2.6%
Tissue Paper and Towels	1.2%	1.7%	1.5%	1.4%	1.4%	1.4%	1.4%	1.5%
Paper Plates and Cups	0.3%	0.3%	0.4%	0.3%	0.5%	0.4%	0.4%	0.4%
Plastic Plates and Cups†			0.1%	0.3%	0.4%	0.4%	0.4%	0.4%
Trash Bags**				0.4%	0.4%	0.4%	0.4%	0.4%
Disposable Diapers	Neg.	0.3%	1.3%	1.3%	1.4%	1.4%	1.4%	1.4%
Other Nonpackaging Paper	3.1%	3.0%	2.8%	1.9%	2.0%	2.0%	2.0%	2.1%
Clothing and Footwear	1.5%	1.3%	1.4%	2.0%	2.4%	2.6%	2.7%	2.7%
Towels, Sheets and Pillowcases**				0.3%	0.4%	0.3%	0.3%	0.3%
Other Miscellaneous Nondurables	0.1%	0.2%	0.9%	1.6%	1.6%	1.6%	1.6%	1.6%
Total Nondurables	19.7%	20.7%	22.7%	25.4%	27.1%	27.1%	27.0%	27.1%
Containers and Packaging *(Detail in Table 19)*	31.1%	36.0%	34.7%	31.4%	32.4%	32.4%	32.5%	33.1%
Total Product Wastes‡	62.0%	68.8%	71.8%	71.4%	74.2%	74.6%	74.9%	75.5%
Other Wastes	38.0%	31.2%	28.2%	28.6%	25.8%	25.4%	25.1%	24.5%
Total MSW Generated - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Generation before materials recovery or combustion. Does not include construction & demolition debris, industrial process wastes, or certain other wastes. Details may not add to totals due to rounding.
** Not estimated separately prior to 1990.
*** Not estimated separately prior to 1990. Formerly called Third Class Mail by the U.S. Postal Service.
† Not estimated separately prior to 1980.
‡ Other than food products.
Neg. = Less than 5,000 tons or 0.05 percent.
Source: Franklin Associates.

Table 16

RECOVERY* OF PRODUCTS IN MUNICIPAL SOLID WASTE, 1960 TO 1999
(WITH DETAIL ON NONDURABLE GOODS)
(In thousands of tons and percent of generation of each product)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods	350	940	1,360	3,460	5,010	5,660	5,720	5,880
(Detail in Table 13)								
Nondurable Goods								
Newspapers	1,820	2,250	3,020	5,110	7,010	7,340	7,210	8,230
Books and Magazines	100	260	280					
Books**				100	220	160	160	200
Magazines**				300	650	440	470	530
Office Papers	250	710	870	1,700	3,040	3,500	3,550	4,040
Directories**				40	60	60	100	110
Standard (A) Mail***				200	710	880	980	1,230
Other Commercial Printing	130	340	350	700	1,120	750	1,580	1,360
Tissue Paper and Towels	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Paper Plates and Cups	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Plastic Plates and Cups†			Neg.	10	10	Neg.	Neg.	Neg.
Trash Bags**				Neg.	Neg.	Neg.	Neg.	Neg.
Disposable Diapers				Neg.	Neg.	Neg.	Neg.	Neg.
Other Nonpackaging Paper	40	110	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Clothing and Footwear	50	60	150	520	660	760	800	810
Towels, Sheets and Pillowcases**				120	130	130	130	130
Other Miscellaneous Nondurables	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Nondurable Goods	2,390	3,730	4,670	8,800	13,610	14,020	14,980	16,640
Containers and Packaging	2,870	3,350	8,490	16,780	26,720	27,620	27,710	28,260
(Detail in Table 20)								
Total Product Wastes‡	5,610	8,020	14,520	29,040	45,340	47,300	48,410	50,780
Other Wastes	Neg.	Neg.	Neg.	4,200	9,570	12,070	13,140	13,110
Total MSW Recovered - Weight	5,610	8,020	14,520	33,240	54,910	59,370	61,550	63,890
	Percent of Generation of Each Product							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods	3.5%	6.4%	6.2%	11.6%	16.1%	17.0%	16.6%	16.6%
(Detail in Table 13)								
Nondurable Goods								
Newspapers	25.6%	23.7%	27.3%	38.0%	53.3%	54.4%	52.9%	59.0%
Books and Magazines	5.2%	10.5%	8.3%					
Books**				10.3%	19.1%	14.3%	14.0%	17.9%
Magazines**				10.6%	25.7%	20.4%	20.8%	22.9%
Office Papers	16.4%	26.8%	21.8%	26.5%	45.8%	50.5%	50.4%	52.7%
Directories**				6.6%	12.2%	12.8%	13.5%	16.2%
Standard (A) Mail***				5.2%	15.4%	18.1%	18.8%	22.1%
Other Commercial Printing	10.3%	16.0%	11.2%	15.7%	16.5%	10.7%	24.0%	22.9%
Tissue Paper and Towels	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Paper Plates and Cups	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Plastic Plates and Cups†			Neg.	1.5%	1.3%	Neg.	Neg.	Neg.
Trash Bags**				Neg.	Neg.	Neg.	Neg.	Neg.
Disposable Diapers				Neg.	Neg.	Neg.	Neg.	Neg.
Other Nonpackaging Paper	1.5%	3.0%	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Clothing and Footwear	Neg.	Neg.	Neg.	13.0%	13.0%	13.2%	13.2%	13.0%
Towels, Sheets and Pillowcases**				16.9%	17.6%	17.3%	17.3%	16.7%
Other Miscellaneous Nondurables	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Nondurables	13.8%	14.9%	13.6%	16.9%	23.8%	23.7%	24.8%	26.8%
Containers and Packaging	10.5%	7.7%	16.1%	26.0%	39.1%	38.9%	38.3%	37.2%
(Detail in Table 21)								
Total Product Wastes‡	10.3%	9.6%	13.3%	19.8%	28.9%	28.9%	29.0%	29.3%
Other Wastes	Neg.	Neg.	Neg.	7.2%	17.5%	21.7%	23.5%	23.3%
Total MSW Recovered - %	6.4%	6.6%	9.6%	16.2%	26.0%	27.1%	27.6%	27.8%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Not estimated separately prior to 1990.
*** Not estimated separately prior to 1990. Formerly called Third Class Mail by the U.S. Postal Service.
† Not estimated separately prior to 1980.
‡ Other than food products.
Neg. = Less than 5,000 tons or 0.05 percent.
Source: Franklin Associates.

Table 17

PRODUCTS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1999
(WITH DETAIL ON NONDURABLE GOODS)
(In thousands of tons and percent of total discards)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods *(Detail in Table 14)*	9,570	13,720	20,440	26,350	26,130	27,560	28,650	29,490
Nondurable Goods								
Newspapers	5,290	7,260	8,030	8,320	6,130	6,150	6,420	5,730
Books and Magazines	1,820	2,210	3,110					
Books**				870	930	960	980	920
Magazines**				2,530	1,880	1,720	1,790	1,780
Office Papers	1,270	1,940	3,130	4,710	3,600	3,430	3,490	3,630
Directories**				570	430	410	640	570
Standard (A) Mail***				3,620	3,910	3,970	4,220	4,330
Other Commercial Printing	1,130	1,790	2,770	3,760	5,650	6,250	5,000	4,580
Tissue Paper and Towels	1,090	2,080	2,300	2,960	2,970	3,120	3,100	3,360
Paper Plates and Cups	270	420	630	650	970	970	890	930
Plastic Plates and Cups†			190	640	770	860	890	910
Trash Bags**				780	780	810	840	950
Disposable Diapers	Neg.	350	1,930	2,700	3,010	3,140	3,200	3,310
Other Nonpackaging Paper	2,660	3,520	4,230	3,840	4,270	4,390	4,420	4,740
Clothing and Footwear	1,310	1,560	2,020	3,490	4,410	5,010	5,240	5,440
Towels, Sheets and Pillowcases**				590	610	620	620	650
Other Miscellaneous Nondurables	100	200	1,410	3,340	3,320	3,450	3,590	3,730
Total Nondurable Goods	14,940	21,330	29,750	43,370	43,640	45,260	45,330	45,560
Containers and Packaging *(Detail in Table 22)*	24,500	40,210	44,180	47,750	41,670	43,420	44,720	47,750
Total Product Wastes‡	49,010	75,260	94,370	117,470	111,440	116,240	118,700	122,800
Other Wastes	33,500	37,780	42,750	54,500	45,010	43,530	42,790	43,160
Total MSW Discarded - Weight	82,510	113,040	137,120	171,970	156,450	159,770	161,490	165,960
	Percent of Total Discards							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods *(Detail in Table 14)*	11.6%	12.1%	14.9%	15.3%	16.7%	17.2%	17.7%	17.8%
Nondurable Goods								
Newspapers	6.4%	6.4%	5.9%	4.8%	3.9%	3.8%	4.0%	3.5%
Books and Magazines	2.2%	2.0%	2.3%					
Books**				0.5%	0.6%	0.6%	0.6%	0.6%
Magazines**				1.5%	1.2%	1.1%	1.1%	1.1%
Office Papers	1.5%	1.7%	2.3%	2.7%	2.3%	2.1%	2.2%	2.2%
Directories**				0.3%	0.3%	0.3%	0.4%	0.3%
Standard (A) Mail***				2.1%	2.5%	2.5%	2.6%	2.6%
Other Commercial Printing	1.4%	1.6%	2.0%	2.2%	3.6%	3.9%	3.1%	2.8%
Tissue Paper and Towels	1.3%	1.8%	1.7%	1.7%	1.9%	2.0%	1.9%	2.0%
Paper Plates and Cups	0.3%	0.4%	0.5%	0.4%	0.6%	0.6%	0.6%	0.6%
Plastic Plates and Cups†			0.1%	0.4%	0.5%	0.5%	0.6%	0.5%
Trash Bags**				0.5%	0.5%	0.5%	0.5%	0.6%
Disposable Diapers	Neg.	0.3%	1.4%	1.6%	1.9%	2.0%	2.0%	2.0%
Other Nonpackaging Paper	3.2%	3.1%	3.1%	2.2%	2.7%	2.7%	2.7%	2.9%
Clothing and Footwear	1.6%	1.4%	1.5%	2.0%	2.8%	3.1%	3.2%	3.3%
Towels, Sheets and Pillowcases**				0.3%	0.4%	0.4%	0.4%	0.4%
Other Miscellaneous Nondurables	0.1%	0.2%	1.7%	1.9%	2.1%	2.2%	2.2%	2.2%
Total Nondurables	18.1%	18.9%	21.7%	25.2%	27.9%	28.3%	28.1%	27.5%
Containers and Packaging *(Detail in Table 23)*	29.7%	35.6%	32.2%	27.8%	26.6%	27.2%	27.7%	28.8%
Total Product Wastes‡	59.4%	66.6%	68.8%	68.3%	71.2%	72.8%	73.5%	74.0%
Other Wastes	40.6%	33.4%	31.2%	31.7%	28.8%	27.2%	26.5%	26.0%
Total MSW Discarded - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Discards after materials and compost recovery. Does not include construction & demolition debris, industrial process wastes, or certain other wastes. Details may not add to totals due to rounding.
** Not estimated separately prior to 1990.
*** Not estimated separately prior to 1990. Formerly called Third Class Mail by the U.S. Postal Service.
† Not estimated separately prior to 1980.
‡ Other than food products.
Neg. = Less than 5,000 tons or 0.05 percent.
Source: Franklin Associates.

Magazines accounted for an estimated 2.3 million tons, or 1 percent of total MSW generation, in 1999. Like books, recovery of magazines is not well documented. It was estimated that 530,000 tons of magazines were recovered in 1999. Magazines are predominately made of coated groundwood, but some uncoated groundwood and chemical pulps are also used.

- Many different kinds of papers are generated in offices. For this report, office-type paper estimates include the high-grade papers such as copier paper, computer printout, stationery, etc. Generation of these office papers was 7.7 million tons, or 3.3 percent of total MSW generation in 1999. These papers are almost entirely made of uncoated chemical pulp, although some amounts of groundwood are also used. It should be noted that some of these office-type papers are generated at locations other than offices, including homes and institutions such as schools. Also, other kinds of papers (e.g., newspapers, magazines, and packaging) are generated in offices, but are accounted for in other categories. An estimated 4 million tons of office-type papers were recovered in 1999, up from 3.6 million tons in 1997.

- Directories were estimated to generate 680,000 tons (0.3 percent of total MSW) in 1999. These directories are made of groundwood. It was estimated that 110,000 tons of directories were recovered in 1999, a 10 percent increase over 1998 recovery. The Yellow Pages Publishers Association (YPPA) publishes data on paper use in directories.

- Standard (A) mail* includes catalogs and other direct bulk mailings; these amounted to an estimated 5.6 million tons, or 2.4 percent of MSW generation, in 1999. Both groundwood and chemical pulps are used in these mailings. It was estimated that 1,230,000 tons were recovered in 1999, up from 880,000 tons in 1997. The program by the U.S. Postal Service to increase recovery of bulk mail appears to be showing results.

- Other commercial printing includes a wide range of paper items: brochures, reports, menus, invitations, etc. Both groundwood and chemical pulps are used in these varied items. Generation was estimated at 5.9 million tons, or 2.6 percent of MSW generation, in 1999, with recovery estimated at 1.1 million tons.

- Tissue paper and towels generation includes facial and sanitary tissues and napkins, but not bathroom tissue, which is nearly all diverted from MSW into the wastewater treatment system. Tissue paper and towels (not including bathroom tissue) amounted to 3.4 million tons (1.5 percent of total MSW generation) in 1999. No significant recovery of tissue products was identified for recycling, although there is some composting of these items.

- Paper plates and cups include paper plates, cups, bowls, and other food service products used in homes, in commercial establishments like restaurants, and in institutional settings such as schools. Generation of these products was estimated at 930,000 (0.4 percent of total MSW generation) in 1999. No significant recovery for recycling of these products was identified.

* Standard (A) mail was formerly called Third Class mail by the U.S. Postal Service.

- Other nonpackaging papers – including posters, photographic papers, cards and games, etc. – accounted for 4.7 million tons (2.1 percent of total MSW generation) in 1999. No significant recovery for recycling of these papers was identified.

Overall, generation of paper and paperboard products in nondurable goods was 46.3 million tons in 1999 (Table 4). While newspapers were recovered at the highest rate, other paper products, such as books, magazines, and office papers, also were recovered for recycling, and the overall recovery rate for paper in nondurables was 33.9 percent in 1999. Thus 30.6 million tons of paper in nondurables were discarded in 1999.

Plastic Plates and Cups. This category includes estimates of both infant diapers and adult incontinence products. Generation was estimated using data on sales of the products along with information on average weights and composition. An estimated 3.3 million tons of disposable diapers were generated in 1999, or 1.4 percent of total MSW generation. (This tonnage includes an adjustment for the urine and feces contained within the discarded diapers.) The materials portion of the diapers includes wood pulp, plastics (including the super-absorbent materials now present in most diapers), and tissue paper.

No significant recycling or composting of disposable diapers was identified in 1999.

Clothing and Footwear. Generation of clothing and footwear was estimated to be 6.3 million tons in 1999 (2.7 percent of total MSW). Textiles, rubber, and leather are major materials components of this category, with some plastics present as well. Generation estimates for these products are based on sales data from the Department of Commerce along with data on average weights for each type of products included. Adjustments are made for net imports of these products based on Department of Commerce data.

The Council for Textile Recycling has reported on recovery of textiles for exports, reprocessing, and reuse. Based on their data, it was estimated that 810,000 tons of textiles in clothing were recovered for export or recycling in 1999. (Reuse is not counted as recycling and is included in the estimates in Chapter 3.)

Towels, Sheets, and Pillowcases. An estimated 780,000 tons of towels, sheets, and pillowcases were generated in 1999. Generation was estimated using a methodology similar to that for clothing. An estimated 130,000 tons of these textiles were recovered for export or recycling in 1999.

Other Miscellaneous Nondurables. Generation of other miscellaneous nondurables was estimated to be 3.7 million tons in 1999 (1.6 percent of MSW). The primary material component of miscellaneous nondurables is plastics, although some aluminum, rubber, and textiles also are present. Typical products in miscellaneous nondurables include shower curtains and other household items, disposable medical supplies, novelty items, and the like.

Generation of plastic products in miscellaneous nondurables is taken from resin sales data published annually in *Modern Plastics*. Generation of other materials in these nondurable products is estimated based on information in past reports in this series.

Containers and Packaging

Containers and packaging make up a major portion of MSW, amounting to 76 million tons of generation in 1999 (33.1 percent of total generation). Generation, recovery, and discards of containers and packaging are shown in detail in Tables 18 through 23.

There is a substantial recovery of many container and packaging products, especially corrugated containers. In 1999, 37.2 percent of containers and packaging generated was recovered for recycling. Because of this recovery, containers and packaging comprised 28.8 percent of total MSW discards in 1999.

Containers and packaging in MSW are made of several materials: paper and paperboard, glass, steel, aluminum, plastics, wood, and small amounts of other materials. Material categories are discussed separately below.

Glass Containers. Glass containers include beer and soft drink bottles (which includes carbonated drinks and non-carbonated waters, teas, and flavored drinks containing not more than 10 percent fruit juice), wine and liquor bottles, and bottles and jars for food, cosmetics, and other products. Generation of glass containers is estimated using Department of Commerce data. Adjustments are made for imports and exports of both empty glass containers and containers holding products, e.g., imported beer.

Generation of these glass containers was 11.1 million tons in 1999, or 4.8 percent of MSW generation (Tables 18 and 19). This is a slight increase in generation compared to 1997.

The Glass Packaging Institute's reported recovery rate for glass containers includes reuse of refillable bottles. Since refilling is defined as reuse rather than recycling in this report, the refilled bottles are not counted as recovery here. An estimated 2.9 million tons of glass containers were recovered for recycling in 1999, or 26.6 percent of generation. Glass container discards were 8.1 million tons in 1999, or 4.9 percent of total MSW discards.

Steel Containers and Packaging. Steel food and other cans, and other steel packaging (e.g., steel barrels and drums), totaled 2.9 million tons in 1999 (1.3 percent of total MSW generation), with most of that amount being cans for food products (Tables 18 and 19). Generation estimates are based on data supplied by the Steel Recycling Institute, the Reusable Industrial Packaging Association, and the Can Manufacturers Institute. Estimates include adjustments for net imports.

Recovery data for steel containers and packaging were provided by the Steel Recycling Institute. An estimated 1.7 million tons of steel packaging were recovered in 1999, or 57.3 percent of generation. The Steel Recycling Institute estimates include recovery from residential sources, pre-combustion and post-combustion magnetic separation of steel cans and other ferrous products at MSW combustion facilities, and recycling of drums and barrels not suitable for reconditioning.

Aluminum Containers and Packaging. Aluminum containers and packaging include beer and soft drink cans (including all carbonated and non-carbonated soft drinks, tea, tonic, water, and juice

Table 18

PRODUCTS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1999
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In thousands of tons)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods *(Detail in Table 12)*	9,920	14,660	21,800	29,810	31,140	33,220	34,370	35,370
Nondurable Goods *(Detail in Table 15)*	17,330	25,060	34,420	52,170	57,250	59,280	60,310	62,200
Containers and Packaging								
Glass Packaging								
Beer and Soft Drink Bottles	1,400	5,580	6,740	5,640	5,120	4,960	5,350	5,450
Wine and Liquor Bottles	1,080	1,900	2,450	2,030	1,790	1,820	1,770	1,830
Food and Other Bottles & Jars	3,710	4,440	4,780	4,160	4,620	3,830	3,880	3,770
Total Glass Packaging	6,190	11,920	13,970	11,830	11,530	10,610	11,000	11,050
Steel Packaging								
Beer and Soft Drink Cans	640	1,570	520	150	Neg.	Neg.	Neg.	Neg.
Food and Other Cans	3,760	3,540	2,850	2,540	2,690	2,860	2,690	2,690
Other Steel Packaging	260	270	240	200	210	240	250	240
Total Steel Packaging	4,660	5,380	3,610	2,890	2,900	3,100	2,940	2,930
Aluminum Packaging								
Beer and Soft Drink Cans	Neg.	100	850	1,550	1,590	1,530	1,540	1,540
Other Cans	Neg.	60	40	20	40	50	50	50
Foil and Closures	170	410	380	330	350	360	370	380
Total Aluminum Packaging	170	570	1,270	1,900	1,980	1,940	1,960	1,970
Paper & Paperboard Pkg								
Corrugated Boxes	7,330	12,760	17,080	24,010	28,800	29,530	29,760	31,230
Milk Cartons**			790	510	510	460	470	490
Folding Cartons**			3,820	4,300	5,310	5,410	5,550	5,780
Other Paperboard Packaging	3,840	4,830	230	290	260	240	230	290
Bags and Sacks**			3,380	2,440	1,980	1,870	1,680	1,690
Wrapping Papers**			200	110	70			
Other Paper Packaging	2,940	3,810	850	1,020	1,150	1,230	1,420	1,670
Total Paper & Board Pkg	14,110	21,400	26,350	32,680	38,080	38,740	39,110	41,150
Plastics Packaging								
Soft Drink Bottles**			260	430	650	760	820	900
Milk Bottles**			230	530	620	670	700	690
Other Containers	60	910	890	1,430	1,180	1,540	2,330	2,640
Bags and Sacks**			390	940	1,200	1,520	1,480	1,690
Wraps**			840	1,530	1,710	2,130	1,980	2,550
Other Plastics Packaging	60	1,180	790	2,040	2,220	2,810	2,580	2,680
Total Plastics Packaging	120	2,090	3,400	6,900	7,580	9,430	9,890	11,150
Wood Packaging	2,000	2,070	3,940	8,180	6,170	7,030	7,310	7,540
Other Misc. Packaging	120	130	130	150	150	190	220	220
Total Containers & Pkg	27,370	43,560	52,670	64,530	68,390	71,040	72,430	76,010
Total Product Wastes†	54,620	83,280	108,890	146,510	156,780	163,540	167,110	173,580
Other Wastes								
Food Wastes	12,200	12,800	13,000	20,800	21,740	24,620	24,910	25,160
Yard Trimmings	20,000	23,200	27,500	35,000	29,690	27,730	27,730	27,730
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,150	3,250	3,290	3,380
Total Other Wastes	33,500	37,780	42,750	58,700	54,580	55,600	55,930	56,270
Total MSW Generated - Weight	88,120	121,060	151,640	205,210	211,360	219,140	223,040	229,850

* Generation before materials recovery or combustion.
Details may not add to totals due to rounding.
** Not estimated separately prior to 1980. Paper wraps not reported separately after 1996.
† Other than food products.
Neg. = Less than 5,000 tons or 0.05 percent.
Source: Franklin Associates

Table 19

PRODUCTS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1999
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In percent of total generation)

	Percent of Total Generation							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods *(Detail in Table 12)*	11.3%	12.1%	14.4%	14.5%	14.7%	15.2%	15.4%	15.4%
Nondurable Goods *(Detail in Table 15)*	19.7%	20.7%	22.7%	25.4%	27.1%	27.1%	27.0%	27.1%
Containers and Packaging								
Glass Packaging								
Beer and Soft Drink Bottles	1.6%	4.6%	4.4%	2.7%	2.4%	2.3%	2.4%	2.4%
Wine and Liquor Bottles	1.2%	1.6%	1.6%	1.0%	0.8%	0.8%	0.8%	0.8%
Food and Other Bottles & Jars	4.2%	3.7%	3.2%	2.0%	2.2%	1.7%	1.7%	1.6%
Total Glass Packaging	7.0%	9.8%	9.2%	5.8%	5.5%	4.8%	4.9%	4.8%
Steel Packaging								
Beer and Soft Drink Cans	0.7%	1.3%	0.3%	0.1%	Neg.	Neg.	Neg.	Neg.
Food and Other Cans	4.3%	2.9%	1.9%	1.2%	1.3%	1.3%	1.2%	1.2%
Other Steel Packaging	0.3%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%
Total Steel Packaging	5.3%	4.4%	2.4%	1.4%	1.4%	1.4%	1.3%	1.3%
Aluminum Packaging								
Beer and Soft Drink Cans	Neg.	0.1%	0.6%	0.8%	0.8%	0.7%	0.7%	0.7%
Other Cans	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Foil and Closures	0.2%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%
Total Aluminum Packaging	0.2%	0.5%	0.8%	0.9%	0.9%	0.9%	0.9%	0.9%
Paper & Paperboard Pkg								
Corrugated Boxes	8.3%	10.5%	11.3%	11.7%	13.6%	13.5%	13.3%	13.6%
Milk Cartons**			0.5%	0.2%	0.2%	0.2%	0.2%	0.2%
Folding Cartons**			2.5%	2.1%	2.5%	2.5%	2.5%	2.5%
Other Paperboard Packaging	4.4%	4.0%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%
Bags and Sacks**			2.2%	1.2%	0.9%	0.9%	0.8%	0.7%
Wrapping Papers**			0.1%	0.1%	0.0%			
Other Paper Packaging	3.3%	3.1%	0.6%	0.5%	0.5%	0.6%	0.6%	0.7%
Total Paper & Board Pkg	16.0%	17.7%	17.4%	15.9%	18.0%	17.7%	17.5%	17.9%
Plastics Packaging								
Soft Drink Bottles**			0.2%	0.2%	0.3%	0.3%	0.4%	0.4%
Milk Bottles**			0.2%	0.3%	0.3%	0.3%	0.3%	0.3%
Other Containers	0.1%	0.8%	0.6%	0.7%	0.6%	0.7%	1.0%	1.1%
Bags and Sacks**			0.3%	0.5%	0.6%	0.7%	0.7%	0.7%
Wraps**			0.6%	0.7%	0.8%	1.0%	0.9%	1.1%
Other Plastics Packaging	0.1%	1.0%	0.5%	1.0%	1.1%	1.3%	1.2%	1.2%
Total Plastics Packaging	0.1%	1.7%	2.2%	3.4%	3.6%	4.3%	4.4%	4.9%
Wood Packaging	2.3%	1.7%	2.6%	4.0%	2.9%	3.2%	3.3%	3.3%
Other Misc. Packaging	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Total Containers & Pkg	31.1%	36.0%	34.7%	31.4%	32.4%	32.4%	32.5%	33.1%
Total Product Wastes†	62.0%	68.8%	71.8%	71.4%	74.2%	74.6%	74.9%	75.5%
Other Wastes								
Food Wastes	13.8%	10.6%	8.6%	10.1%	10.3%	11.2%	11.2%	10.9%
Yard Trimmings	22.7%	19.2%	18.1%	17.1%	14.0%	12.7%	12.4%	12.1%
Miscellaneous Inorganic Wastes	1.5%	1.5%	1.5%	1.4%	1.5%	1.5%	1.5%	1.5%
Total Other Wastes	38.0%	31.2%	28.2%	28.6%	25.8%	25.4%	25.1%	24.5%
Total MSW Generated - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Generation before materials recovery or combustion.
Details may not add to totals due to rounding.
** Not estimated separately prior to 1980. Paper wraps not reported separately after 1996.
† Other than food products.
Neg. = Less than 5,000 tons or 0.05 percent.
Source: Franklin Associates

Table 20

RECOVERY* OF PRODUCTS IN MUNICIPAL SOLID WASTE, 1960 TO 1999
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In thousands of tons)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods	350	940	1,360	3,460	5,010	5,660	5,720	5,880
(Detail in Table 13)								
Nondurable Goods	2,390	3,730	4,670	8,800	13,610	14,020	14,980	16,640
(Detail in Table 16)								
Containers and Packaging								
Glass Packaging								
Beer and Soft Drink Bottles	90	140	730	1,890	1,670	1,550	1,680	1,560
Wine and Liquor Bottles	10	10	20	210	470	440	480	440
Food and Other Bottles & Jars	Neg.	Neg.	Neg.	520	1,000	930	1,020	940
Total Glass Packaging	100	150	750	2,620	3,140	2,920	3,180	2,940
Steel Packaging								
Beer and Soft Drink Cans	10	20	50	40	Neg.	Neg.	Neg.	Neg.
Food and Other Cans	20	60	150	590	1,510	1,730	1,510	1,510
Other Steel Packaging	Neg.	Neg.	Neg.	60	50	160	170	170
Total Steel Packaging	30	80	200	690	1,560	1,890	1,680	1,680
Aluminum Packaging								
Beer and Soft Drink Cans	Neg.	10	310	990	900	910	830	840
Other Cans	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Foil and Closures	Neg.	Neg.	Neg.	20	30	30	30	30
Total Aluminum Pkg	Neg.	10	320	1,010	930	940	860	870
Paper & Paperboard Pkg								
Corrugated Boxes	2,520	2,760	6,390	11,530	18,480	19,800	19,790	20,340
Milk Cartons**			Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Folding Cartons**			520	340	1,080	370	230	400
Other Paperboard Packaging			Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Bags and Sacks**			Neg.	200	340	290	290	230
Wrapping Papers**			Neg.	Neg.	Neg.			
Other Paper Packaging	220	350	300	Neg.	Neg.	Neg.	Neg.	Neg.
Total Paper & Board Pkg	2,740	3,110	7,210	12,070	19,900	20,460	20,310	20,970
Plastics Packaging								
Soft Drink Bottles**			10	140	300	270	290	360
Milk Bottles**			Neg.	20	190	210	220	220
Other Containers	Neg.	Neg.	Neg.	20	150	200	250	290
Bags and Sacks**			Neg.	30	40	40	10	10
Wraps**			Neg.	30	40	50	120	130
Other Plastics Packaging	Neg.	Neg.	Neg.	20	20	50	70	70
Total Plastics Packaging	Neg.	Neg.	10	260	740	820	960	1,080
Wood Packaging	Neg.	Neg.	Neg.	130	450	590	720	720
Other Misc. Packaging	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Containers & Pkg	2,870	3,350	8,490	16,780	26,720	27,620	27,710	28,260
Total Product Wastes†	5,610	8,020	14,520	29,040	45,340	47,300	48,410	50,780
Other Wastes								
Food Wastes	Neg.	Neg.	Neg.	Neg.	570	580	580	550
Yard Trimmings	Neg.	Neg.	Neg.	4,200	9,000	11,490	12,560	12,560
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	4,200	9,570	12,070	13,140	13,110
Total MSW Recovered - Weight	5,610	8,020	14,520	33,240	54,910	59,370	61,550	63,890

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Not estimated separately prior to 1980. Paper wraps not reported separately after 1996.
† Other than food products.
Details may not add to totals due to rounding.
Neg. = Less than 5,000 tons or 0.05 percent.
Source: Franklin Associates

Table 21

RECOVERY* OF PRODUCTS IN MUNICIPAL SOLID WASTE, 1960 TO 1999
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In percent of generation of each product)

Percent of Generation of Each Product								
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods	3.5%	6.4%	6.2%	11.6%	16.1%	17.0%	16.6%	16.6%
(Detail in Table 13)								
Nondurable Goods	13.8%	14.9%	13.6%	16.9%	23.8%	23.7%	24.8%	26.8%
(Detail in Table 16)								
Containers and Packaging								
Glass Packaging								
Beer and Soft Drink Bottles	6.4%	2.5%	10.8%	33.5%	32.6%	31.3%	31.4%	28.6%
Wine and Liquor Bottles	Neg.	Neg.	Neg.	10.3%	26.3%	24.2%	27.1%	24.0%
Food and Other Bottles & Jars	Neg.	Neg.	Neg.	12.5%	21.6%	24.3%	26.3%	24.9%
Total Glass Packaging	1.6%	1.3%	5.4%	22.1%	27.2%	27.5%	28.9%	26.6%
Steel Packaging								
Beer and Soft Drink Cans	1.6%	1.3%	9.6%	26.7%	Neg.	Neg.	Neg.	Neg.
Food and Other Cans	Neg.	1.7%	5.3%	23.2%	56.1%	60.5%	56.1%	56.1%
Other Steel Packaging	Neg.	Neg.	Neg.	30.0%	23.8%	66.7%	68.0%	70.8%
Total Steel Packaging	Neg.	1.5%	5.5%	23.9%	53.8%	61.0%	57.1%	57.3%
Aluminum Packaging								
Beer and Soft Drink Cans	Neg.	10.0%	36.5%	63.9%	56.6%	59.5%	53.9%	54.5%
Other Cans	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Foil and Closures	Neg.	Neg.	Neg.	6.1%	8.6%	8.3%	8.1%	7.9%
Total Aluminum Pkg	Neg.	1.8%	25.2%	53.2%	47.0%	48.5%	43.9%	44.2%
Paper & Paperboard Pkg								
Corrugated Boxes	34.4%	21.6%	37.4%	48.0%	64.2%	67.1%	66.5%	65.1%
Milk Cartons**			Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Folding Cartons**			Neg.	Neg.	20.3%	6.8%	4.1%	6.9%
Other Paperboard Packaging			Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Bags and Sacks**			Neg.	Neg.	17.2%	15.5%	17.3%	13.6%
Wrapping Papers**			Neg.	Neg.	Neg.			
Other Paper Packaging	7.5%	9.2%	35.3%	Neg.	Neg.	Neg.	Neg.	Neg.
Total Paper & Board Pkg	19.4%	14.5%	27.4%	36.9%	52.3%	52.8%	51.9%	51.0%
Plastics Packaging								
Soft Drink Bottles**			3.8%	32.6%	46.2%	35.5%	35.4%	40.0%
Milk Bottles**			Neg.	3.8%	30.6%	31.3%	31.4%	31.9%
Other Containers	Neg.	Neg.	Neg.	1.4%	12.7%	13.0%	10.7%	11.0%
Bags and Sacks**			Neg.	3.2%	3.3%	2.6%	0.7%	0.6%
Wraps**			Neg.	2.0%	2.3%	2.3%	6.1%	5.1%
Other Plastics Packaging	Neg.	Neg.	Neg.	1.0%	0.9%	1.8%	2.7%	2.6%
Total Plastics Packaging	Neg.	Neg.	Neg.	3.8%	9.8%	8.7%	9.7%	9.7%
Wood Packaging	Neg.	Neg.	Neg.	1.6%	7.3%	8.4%	9.8%	9.5%
Other Misc. Packaging	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Containers & Pkg	10.5%	7.7%	16.1%	26.0%	39.1%	38.9%	38.3%	37.2%
Total Product Wastes†	10.3%	9.6%	13.3%	19.8%	28.9%	28.9%	29.0%	29.3%
Other Wastes								
Food Wastes	Neg.	Neg.	Neg.	Neg.	2.6%	2.4%	2.3%	2.2%
Yard Trimmings	Neg.	Neg.	Neg.	12.0%	30.3%	41.4%	45.3%	45.3%
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	
Total Other Wastes	Neg.	Neg.	Neg.	7.2%	17.5%	21.7%	23.5%	23.3%
Total MSW Recovered - %	6.4%	6.6%	9.6%	16.2%	26.0%	27.1%	27.6%	27.8%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Not estimated separately prior to 1980. Paper wraps not reported separately after 1996.
† Other than food products.
Details may not add to totals due to rounding.
Neg. = Less than 5,000 tons or 0.05 percent.
Source: Franklin Associates

Table 22

PRODUCTS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1999
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In thousands of tons)

	Thousands of Tons							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods	9,570	13,720	20,440	26,350	26,130	27,560	28,650	29,490
(Detail in Table 14)								
Nondurable Goods	14,940	21,330	29,750	43,370	43,640	45,260	45,330	45,560
(Detail in Table 17)								
Containers and Packaging								
Glass Packaging								
Beer and Soft Drink Bottles	1,310	5,440	6,010	3,750	3,450	3,410	3,670	3,890
Wine and Liquor Bottles	1,070	1,890	2,430	1,820	1,320	1,380	1,290	1,390
Food and Other Bottles & Jars	3,710	4,440	4,780	3,640	3,620	2,900	2,860	2,830
Total Glass Packaging	6,090	11,770	13,220	9,210	8,390	7,690	7,820	8,110
Steel Packaging								
Beer and Soft Drink Cans	630	1,550	470	110	Neg.	Neg.	Neg.	Neg.
Food and Other Cans	3,740	3,480	2,700	1,950	1,180	1,130	1,180	1,180
Other Steel Packaging	260	270	240	140	160	80	80	70
Total Steel Packaging	4,630	5,300	3,410	2,200	1,340	1,210	1,260	1,250
Aluminum Packaging								
Beer and Soft Drink Cans	Neg.	90	540	560	690	620	710	700
Other Cans	Neg.	60	40	20	40	50	50	50
Foil and Closures	170	410	380	310	320	330	340	350
Total Aluminum Pkg	170	560	950	890	1,050	1,000	1,100	1,100
Paper & Paperboard Pkg								
Corrugated Boxes	4,810	10,000	10,690	12,480	10,320	9,730	9,970	10,890
Milk Cartons**			790	510	510	460	470	490
Folding Cartons**			3,300	3,960	4,230	5,040	5,320	5,380
Other Paperboard Packaging	3,840	4,830	230	290	260	240	230	290
Bags and Sacks**			3,380	2,240	1,640	1,580	1,390	1,460
Wrapping Papers**			200	110	70			
Other Paper Packaging	2,720	3,460	550	1,020	1,150	1,230	1,420	1,670
Total Paper & Board Pkg	11,370	18,290	19,140	20,610	18,180	18,280	18,800	20,180
Plastics Packaging								
Soft Drink Bottles**			250	290	350	490	530	540
Milk Bottles**			230	510	430	460	480	470
Other Containers	60	910	890	1,410	1,030	1,340	2,080	2,350
Bags and Sacks**			390	910	1,160	1,480	1,470	1,680
Wraps**			840	1,500	1,670	2,080	1,860	2,420
Other Plastics Packaging	60	1,180	790	2,020	2,200	2,760	2,510	2,610
Total Plastics Packaging	120	2,090	3,390	6,640	6,840	8,610	8,930	10,070
Wood Packaging	2,000	2,070	3,940	8,050	5,720	6,440	6,590	6,820
Other Misc. Packaging	120	130	130	150	150	190	220	220
Total Containers & Pkg	24,500	40,210	44,180	47,750	41,670	43,420	44,720	47,750
Total Product Wastes†	49,010	75,260	94,370	117,470	111,440	116,240	118,700	122,800
Other Wastes								
Food Wastes	12,200	12,800	13,000	20,800	21,170	24,040	24,330	24,610
Yard Trimmings	20,000	23,200	27,500	30,800	20,690	16,240	15,170	15,170
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,150	3,250	3,290	3,380
Total Other Wastes	33,500	37,780	42,750	54,500	45,010	43,530	42,790	43,160
Total MSW Discarded - Weight	82,510	113,040	137,120	171,970	156,450	159,770	161,490	165,960

* Discards after materials and compost recovery. Does not include construction & demolition debris, industrial process wastes, or certain other wastes. Details may not add to totals due to rounding.

** Not estimated separately prior to 1980. Paper wraps not reported separately after 1996.

† Other than food products.

Neg. = Less than 5,000 tons or 0.05 percent.

Source: Franklin Associates

Table 23

PRODUCTS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1999
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In percent of total discards)

	Percent of Total Discards							
Products	**1960**	**1970**	**1980**	**1990**	**1995**	**1997**	**1998**	**1999**
Durable Goods	11.6%	12.1%	14.9%	15.3%	16.7%	17.2%	17.7%	17.8%
(Detail in Table 14)								
Nondurable Goods	18.1%	18.9%	21.7%	25.2%	27.9%	28.3%	28.1%	27.5%
(Detail in Table 17)								
Containers and Packaging								
Glass Packaging								
Beer and Soft Drink Bottles	1.6%	4.8%	4.4%	2.2%	2.2%	2.1%	2.3%	2.3%
Wine and Liquor Bottles	1.3%	1.7%	1.8%	1.1%	0.8%	0.9%	0.8%	0.8%
Food and Other Bottles & Jars	4.5%	3.9%	3.5%	2.1%	2.3%	1.8%	1.8%	1.7%
Total Glass Packaging	7.4%	10.4%	9.6%	5.4%	5.4%	4.8%	4.8%	4.9%
Steel Packaging								
Beer and Soft Drink Cans	0.8%	1.4%	0.3%	0.1%	Neg.	Neg.	Neg.	Neg.
Food and Other Cans	4.5%	3.1%	2.0%	1.1%	0.8%	0.7%	0.7%	0.7%
Other Steel Packaging	0.3%	0.2%	0.2%	0.1%	0.1%	0.1%	0.0%	0.0%
Total Steel Packaging	5.6%	4.7%	2.5%	1.3%	0.9%	0.8%	0.8%	0.8%
Aluminum Packaging								
Beer and Soft Drink Cans	Neg.	0.1%	0.4%	0.3%	0.4%	0.4%	0.4%	0.4%
Other Cans	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Foil and Closures	0.2%	0.4%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%
Total Aluminum Pkg	0.2%	0.5%	0.7%	0.5%	0.7%	0.6%	0.7%	0.7%
Paper & Paperboard Pkg								
Corrugated Boxes	5.8%	8.8%	7.8%	7.3%	6.6%	6.1%	6.2%	6.6%
Milk Cartons**			0.6%	0.3%	0.3%	0.3%	0.3%	0.3%
Folding Cartons**			2.4%	2.3%	2.7%	3.2%	3.3%	3.2%
Other Paperboard Packaging	4.7%	4.3%	0.2%	0.2%	0.2%	0.2%	0.1%	0.2%
Bags and Sacks**			2.5%	1.3%	1.0%	1.0%	0.9%	0.9%
Wrapping Papers**			0.1%	0.1%	0.0%			
Other Paper Packaging	3.3%	3.1%	0.4%	0.6%	0.7%	0.8%	0.9%	1.0%
Total Paper & Board Pkg	13.8%	16.2%	14.0%	12.0%	11.6%	11.4%	11.6%	12.2%
Plastics Packaging								
Soft Drink Bottles**			0.2%	0.2%	0.2%	0.3%	0.3%	0.3%
Milk Bottles**			0.2%	0.3%	0.3%	0.3%	0.3%	0.3%
Other Containers	0.1%	0.8%	0.6%	0.8%	0.7%	0.8%	1.3%	1.4%
Bags and Sacks**			0.3%	0.5%	0.7%	0.9%	0.9%	1.0%
Wraps**			0.6%	0.9%	1.1%	1.3%	1.2%	1.5%
Other Plastics Packaging	0.1%	1.0%	0.6%	1.2%	1.4%	1.7%	1.6%	1.6%
Total Plastics Packaging	0.1%	1.8%	2.5%	3.9%	4.4%	5.4%	5.5%	6.1%
Wood Packaging	2.4%	1.8%	2.9%	4.7%	3.7%	4.0%	4.1%	4.1%
Other Misc. Packaging	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Total Containers & Pkg	29.7%	35.6%	32.2%	27.8%	26.6%	27.2%	27.7%	28.8%
Total Product Wastes†	59.4%	66.6%	68.8%	68.3%	71.2%	72.8%	73.5%	74.0%
Other Wastes								
Food Wastes	14.8%	11.3%	9.5%	12.1%	13.5%	15.0%	15.1%	14.8%
Yard Trimmings	24.2%	20.5%	20.1%	17.9%	13.2%	10.2%	9.4%	9.1%
Miscellaneous Inorganic Wastes	1.6%	1.6%	1.6%	1.7%	2.0%	2.0%	2.0%	2.0%
Total Other Wastes	40.6%	33.4%	31.2%	31.7%	28.8%	27.2%	26.5%	26.0%
Total MSW Discarded - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Discards after materials and compost recovery. Does not include construction & demolition debris, industrial process wastes, or certain other wastes. Details may not add to totals due to rounding.

** Not estimated separately prior to 1980. Paper wraps not reported separately after 1996.

† Other than food products.

Neg. = Less than 5,000 tons or 0.05 percent.

Source: Franklin Associates

beverages), other cans, and foil and closures. Aluminum can generation has been estimated based on can shipments data from the Can Manufacturers Institute and can weight data from the Aluminum Association, while data on other aluminum packaging is based on Department of Commerce data.

In 1996, the Can Manufacturers Institute began publishing data on consumption of beverages in cans. The consumption data are adjusted for imports and exports of beverages in cans, and therefore are more accurate for generation calculations than shipments alone. Total aluminum container and packaging generation in 1999 was 2 million tons, or 0.9 percent of total MSW generation.

Aluminum can recovery data has been obtained from the Aluminum Association. For this report, the aluminum can recovery methodology has been revised to account for imports of used beverage cans (UBC); these imports have been increasing in recent years. The imported UBC were subtracted from the tonnage of UBC reported by the Aluminum Association to have been melted by U.S. end-users and recovered for export.* The effect of this change is to lower the aluminum beverage can recovery rate.

Recovery of aluminum beverage cans in 1999 was 0.8 million tons, or 54.5 percent of generation. Recovery of all aluminum packaging was estimated to be 44.2 percent of total generation in 1999. After recovery for recycling, 1.1 million tons of aluminum packaging were discarded in 1999.

Paper and Paperboard Containers and Packaging. Corrugated boxes are the largest single product category of MSW at 31.2 million tons generated, or 13.6 percent of total generation, in 1999. Corrugated boxes also represent the largest single category of product recovery, at 20.3 million tons of recovery in 1997, (65.1 percent of boxes generated were recovered). After recovery, 10.9 million tons of corrugated boxes were discarded, or 6.6 percent of MSW discards in 1999.

Other paper and paperboard packaging in MSW includes milk cartons, folding boxes (e.g., cereal boxes, frozen food boxes, some department store boxes), bags and sacks, wrapping papers, and other paper and paperboard packaging. Overall, paper and paperboard containers and packaging totaled 41.2 million tons of MSW generation in 1999, or 17.9 percent of total generation.

While recovery of corrugated boxes is by far the largest component of paper packaging recovery, smaller amounts of other paper packaging products are recovered (estimated at 630,000 tons in 1999). The overall recovery rate for paper and paperboard packaging in 1999 was 51 percent. Other paper packaging such as folding boxes and sacks is mostly recovered as mixed papers.

*Note, however, that the imported UBC do contribute to recycled aluminum content in can sheet and other aluminum products.

Plastic Containers and Packaging. Many different plastic resins are used to make a variety of packaging products. Some of these include polyethylene terephthalate (PET) soft drink bottles, high-density polyethylene (HDPE), and containers and other packaging (including coatings, closures, etc.) made of polyvinyl chloride, polystyrene, polypropylene, and other resins. Estimates of generation of plastic containers and packaging are based on data on resin sales by end use published annually by *Modern Plastics*, a trade publication, and the most recent American Plastics Council annual plastic recovery survey.*

Plastic containers and packaging have exhibited rapid growth in MSW, with generation increasing from 120,000 tons in 1960 (0.1 percent of generation) to 11.2 million tons in 1999 (4.9 percent of MSW generation). (Note: plastic packaging as a category in this report does not include single-service plates and cups and trash bags, which are classified as nondurable goods.)

Estimates of recovery of plastic products are based on data published annually by the American Plastics Council. Plastic soft drink bottles were estimated to have been recovered at a 40 percent rate in 1999 (360,000 tons). Recovery of plastic milk and water bottles was estimated to have been 220,000 tons, or 31.9 percent of generation. Overall, recovery of plastic containers and packaging was estimated to be 1.1 million tons, or 9.7 percent in 1999. Discards of plastic packaging were thus 10.1 million tons in 1999, or 6.1 percent of total MSW discards.

Wood Packaging. Wood packaging includes wood crates and pallets (mostly pallets). Data on production of wood packaging is from the Wooden Pallet and Container Association, as well as other studies on the pallet industry (Busch, Reddy, Araman). In 1999, 7.5 million tons of wood pallets and other wood packaging were estimated to have been generated, or 3.3 percent of total MSW generation.

Wood pallets recovery for recycling (usually by chipping for uses such as mulch or bedding material, but excluding wood combusted as fuel) was estimated at 720,000 tons in 1999.

Accounting for pallet reuse and recovery for recycling, wood packaging discards were 6.8 million tons in 1999, or 4.1 percent of total MSW discards.

Other Packaging. Estimates are included for some other miscellaneous packaging such as bags made of textiles, small amounts of leather, and the like. These latter quantities are not well documented, but were estimated to amount to 220,000 tons generated in 1999.

Summary of Products in Municipal Solid Waste

Changing quantities and composition of municipal solid waste generation by product category are illustrated in Figure 14. This figure shows graphically that generation of durable goods has increased very gradually over the years. Nondurable goods and containers and packaging have accounted for the large increases in MSW generation.

*Data source was the American Plastics Council annual plastic recovery survey published in 1999, using 1998 data.

The materials composition of municipal solid waste generation by product category are illustrated in Figure 14. This figure shows graphically that generation of durable goods has increased very gradually over the years. Nondurable goods and containers and packaging have accounted for the large increases in MSW generation.

The materials composition of nondurable goods in 1999 is shown in Figure 15. Paper and paperboard made up 75 percent of nondurables in MSW generation, with plastics contributing 9 percent, and textiles 10 percent. Other materials contributed lesser percentages. After recovery for recycling, paper and paperboard were 66 percent of nondurable discards, with plastics being 13 percent, and textiles 12 percent.

The materials composition of containers and packaging in MSW in 1999 is shown in Figure 16. By weight, paper and paperboard products made up 54 percent of containers and packaging generation, with glass and plastic tied for 15 percent, each, of containers and packaging generation. Wood was 10 percent of containers and packaging generation, while metals were 6 percent.

After recovery for recycling takes place, the percentages of these different materials in MSW from containers and packaging is affected. After recovery for recycling, paper and paperboard is only 42 percent of the MSW containers and packaging discarded. Glass containers accounted for 17 percent of discards of containers and packaging, plastics were 21 percent, wood was 15 percent, and metals were 5 percent.

SUMMARY

The data presented in this chapter can be summarized by the following observations:

MSW Generation

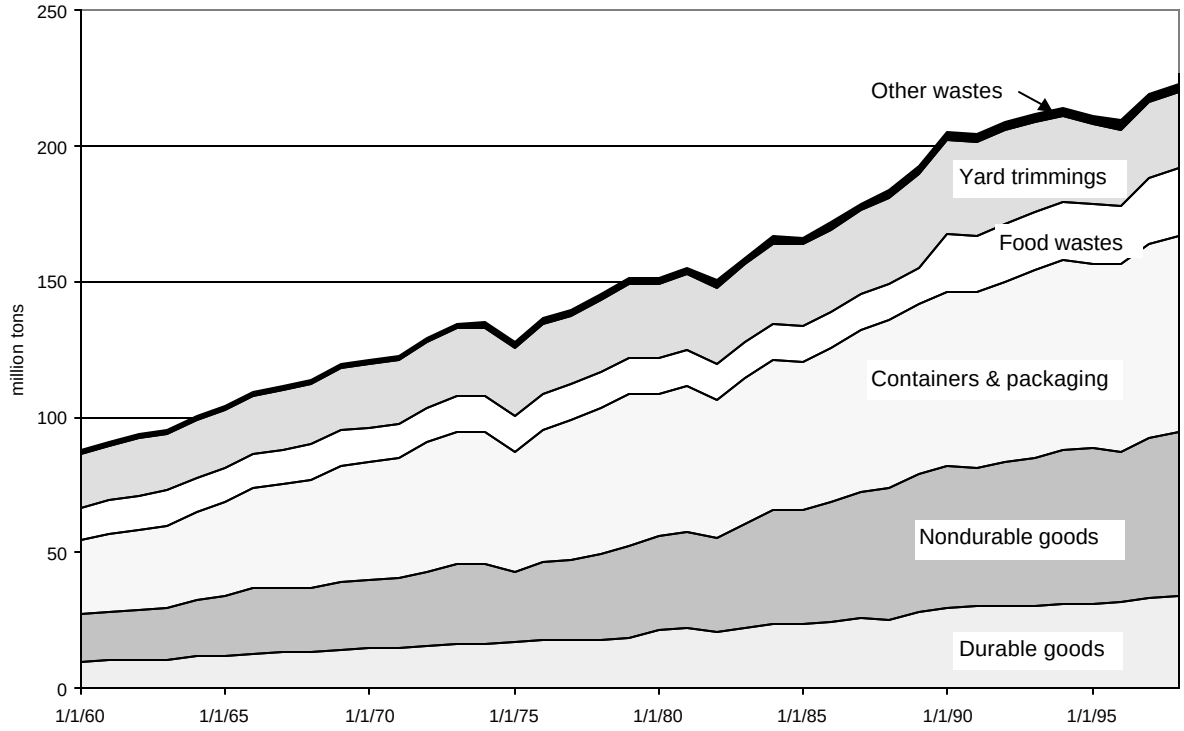
- Total generation of municipal solid waste in 1999 was 229.9 million tons. This is up from 1998, when 223 million tons was generated. This compares to 1990, when total generation of MSW was 205.2 million tons.

- Paper and paperboard products made up the largest percentage of all the materials in MSW. In 1999, 87.5 million tons of paper and paperboard products were generated, up from 84.2 million tons in 1998. In 1999, paper and paperboard accounted for 38.1 percent of total generation. This figure has remained steady around the 38 percent level for the past four years.

- Yard trimmings comprised the second-largest material category, estimated at 27.7 million tons, or 12.1 percent of total generation, in 1999. This compared to 35 million tons (17.1 percent of total generation) in 1990. This decline is largely due to state legislation discouraging yard trimmings disposal in landfills, including source reduction measures such as backyard composting and leaving grass trimmings on the yard.

- Plastic products increased to 24.2 million tons in 1999, up from 22.4 million tons in 1998. Plastics used for containers and packaging accounted for the majority of this increase. Plastics accounted for 10.5 percent of MSW generated in 1999, up from 10 percent in 1998 and 4.5 percent in 1980.

Figure 14. Generation of products in MSW, 1960 to 1999



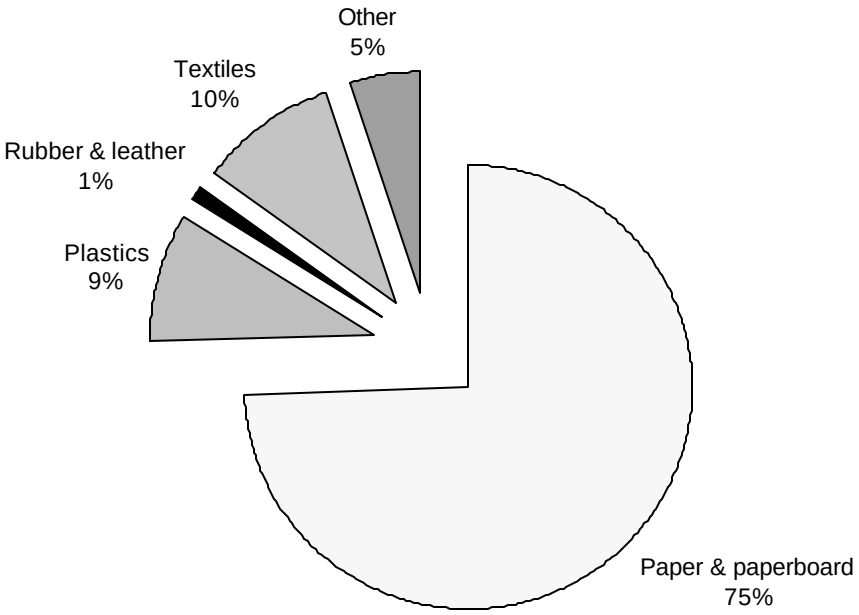
MSW Recovery

- Recovery of materials in MSW increased from 61.6 million tons in 1998 (27.6 percent) to 63.9 million tons (27.8 percent) in 1999.

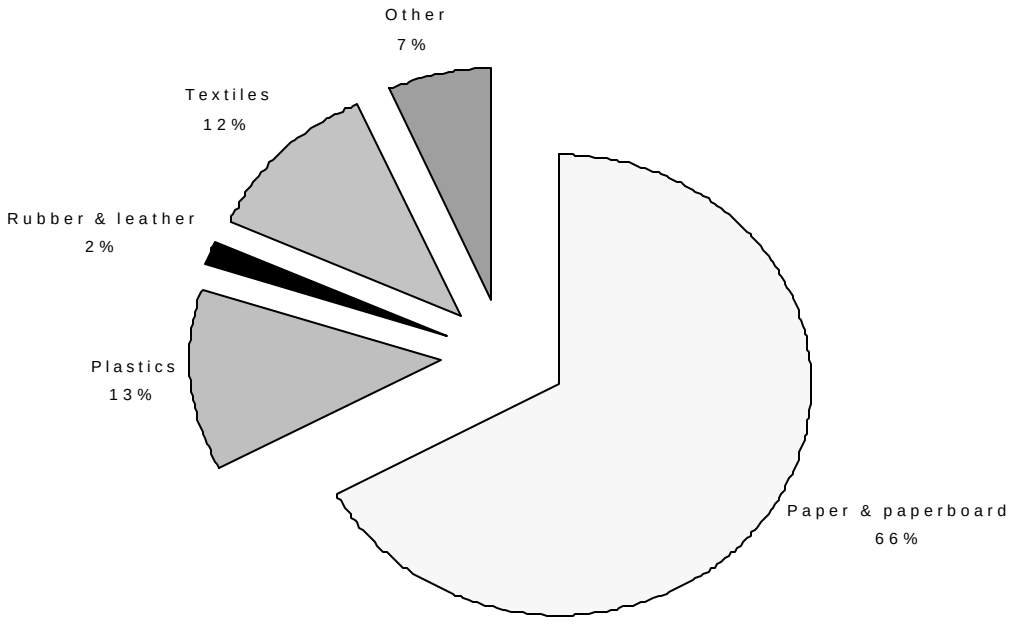
- Recovery of products in MSW increased by 2.4 tons since 1998. Recovery of paper and paperboard products accounted for most of this increase by growing 2.3 million tons since 1998. Recovery of paper and paperboard was up from 41 percent in 1998 to 42 percent in 1999.

- The increase in recovery of paper and paperboard products has been due to increases in recovery, over time, from all categories: newspapers, books, magazines, directories, standard (A) mail (advertisements, circulars, etc.), and other commercial printing. Key categories whose recovery rose from 1998 to 1999, are newspapers, and standard (A) mail. Newspapers increased from 7.2 million tons recovered in 1998 to 8.2 million tons recovered in 1999. This is an increase from 52.9 percent of newspapers recovered in 1998, to 59 percent of newspapers recovered in 1999. (There was a slight dip for newspaper recovery rates in 1998, but the overall trend has been up.) Recovery of standard (A) mail has increased substantially, from

Figure 15. Nondurable goods generated and discarded in municipal solid waste, 1999
(In percent of total generation and discards)

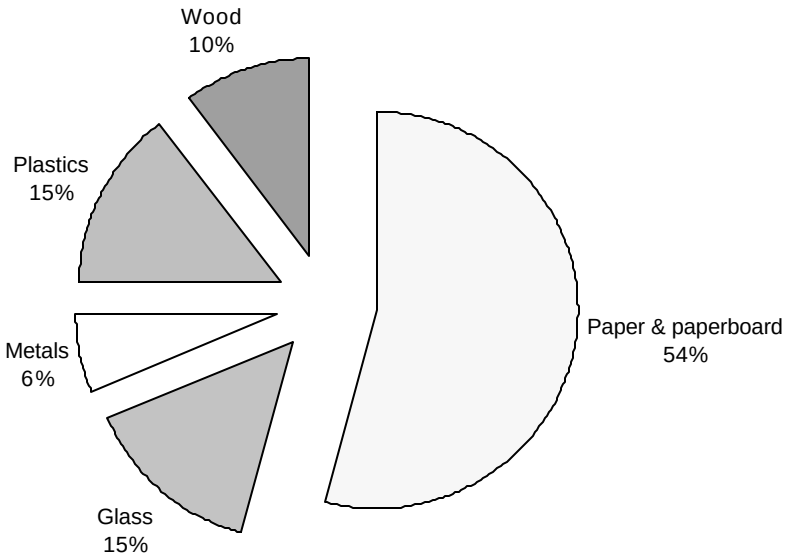


Generation

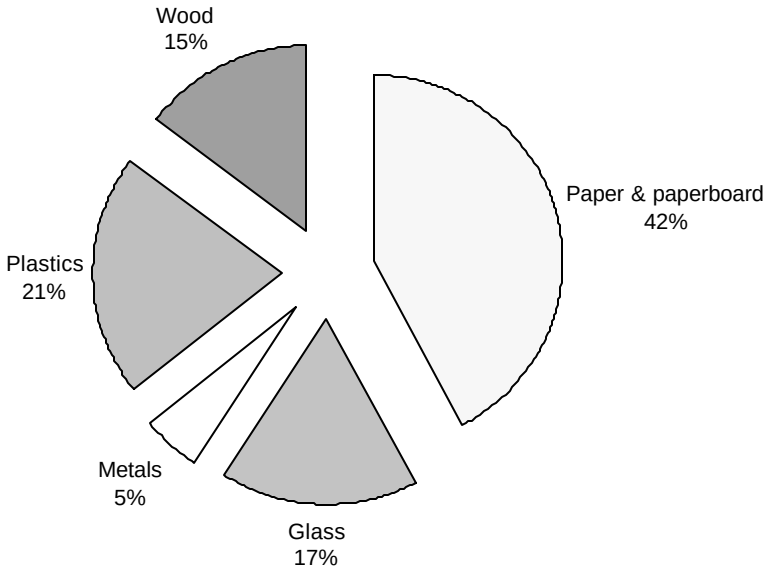


Discards

Figure 16. Containers and packaging generated and discarded in municipal solid waste, 1999
(In percent of total generation and discards)



Generation



Discards

200,000 tons recovered in 1990 to 1,230,000 tons in 1999. Percent of standard (A) mail recovered has risen from 5.2 percent in 1990 to 22.1 percent in 1999. In addition, recovery of directories rose from 60,000 tons in 1997 to 110,000 tons in 1999.

- Containers and packaging led the major product categories in tonnage and percentage recovery, increasing from 27.7 million tons in 1998 to 28.2 million tons million tons (37.2 percent of generation) in 1999. Nondurable goods had the second-highest tonnage recovery in 1999 – 16.6 million tons, or 26.8 percent of generation.

- Measured by tonnage, the products and materials with the highest tonnages recovered in 1999 were corrugated boxes (20.3 million tons), yard trimmings (12.6 million tons), newspapers (8.2 million tons), high-grade office papers (4 million tons), glass containers (2.9 million tons), and steel from large appliances (1.9 million tons). Collectively, these products accounted for nearly 80 percent of total MSW recovery in 1999.

- Measured by percentage of generation, products with the highest recovery rates in 1999 were lead-acid batteries (96.9 percent), corrugated boxes (65.1 percent), newspapers (59 percent), steel cans (56.1 percent), aluminum beverage cans (54.5 percent), and steel in major appliances (52.2 percent).

Long-Term Trends

- Generation of MSW has increased (except in recession years), from 88.1 million tons in 1960 to 229.9 million tons in 1999.

- Generation of paper and paperboard, the largest material component of MSW, has increased in almost every year. Yard trimmings, the second largest component, has remained stable during recent years. State legislation affecting yard trimmings disposal in landfills and source reduction measures at residences, has helped contain the generation of yard trimmings. Generation of other materials is generally on an upward trend.

- In percentage of total MSW generation, recovery for recycling (including composting) did not exceed 15 percent until 1990. Growth in the recovery rate to current levels (27.8 percent) reflects a rapid increase in the infrastructure for recovery starting in the late 1980s.

- Recovery (as a percentage of generation) of most materials in MSW has increased dramatically over the 39 years for which statistics have been tabulated. Some examples:

	1960	**1980**	**1999**
Paper and paperboard	17%	21%	42%
Glass	2%	5%	23%
Metals	1%	8%	35.2%
Plastics	--	<1%	6%
Yard trimmings	--	--	45%

Chapter 2

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Chapter 3

MANAGEMENT OF MUNICIPAL SOLID WASTE

INTRODUCTION

EPA's tiered integrated waste management strategy includes the following components:

1. Source reduction (including reuse of products and backyard composting of yard trimmings).
2. Recycling of materials (including composting).
3. Waste combustion (preferably with energy recovery) and landfilling.

These three components are put into context in Figure 17.

This chapter addresses how source reduction activities are included within an integrated waste management system. Source reduction activities have the effect of reducing MSW generation, while other management alternatives deal with MSW once it is generated. National estimates of source reduction can be found in Chapter 4.

Estimates of the historical recovery of materials for recycling including yard trimmings for composting are presented in Chapter 2. Chapter 3 presents estimates of MSW combustion. It also presents the estimates for quantitities of waste landfilled , which are obtained by subtracting the amounts recovered for recycling (including composting) and the amounts combusted from total MSW generation.

Also included in this chapter is a discussion of the current MSW management infrastructure. Current solid waste collection, processing, and disposal programs and facilities are highlighted with tables and figures.

SOURCE REDUCTION

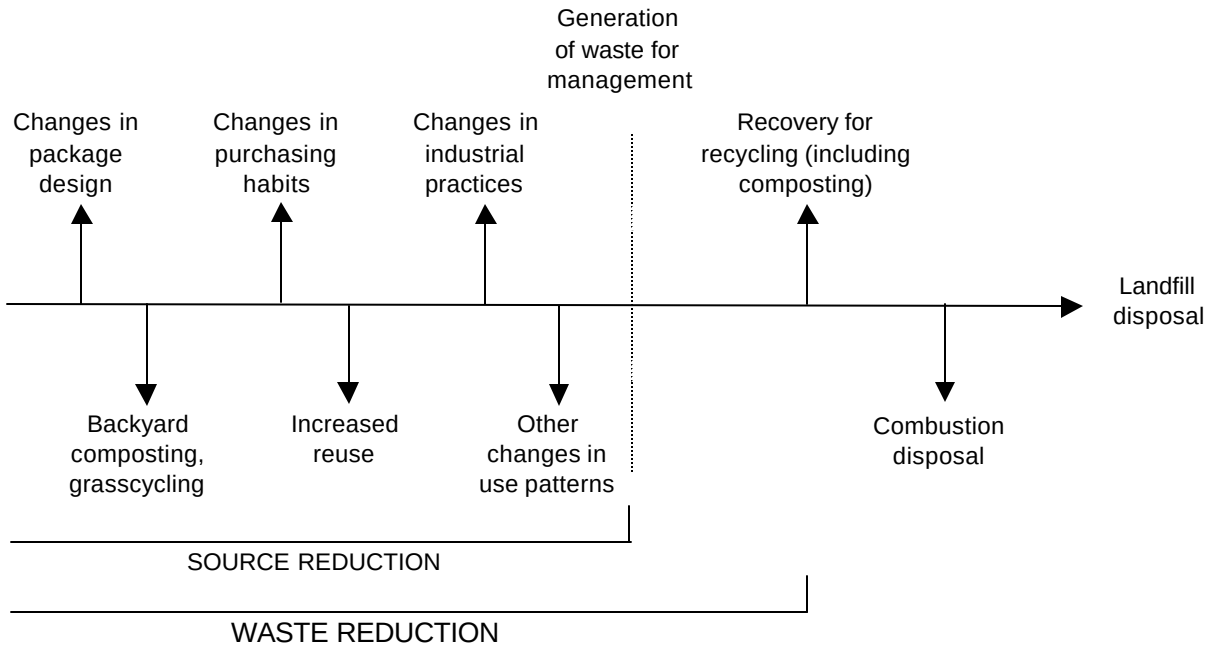
Source reduction is gaining more attention as an important solid waste management option. Source reduction, often called "waste prevention," is defined by EPA as "any change in the design, manufacturing, purchase, or use of materials or products (including packaging) to reduce the amount or toxicity before they become municipal solid waste. Prevention also refers to the reuse of products or materials." Thus, source reduction activities affect the waste stream before the point of waste generation. In this report, MSW is considered to have been generated if it is placed at curbside or in a receptacle such as a dumpster for pickup, or if it is taken by the generator to another site for recycling (including composting) or disposal.

Source reduction encompasses a very broad range of activities by private citizens, communities, commercial establishments, institutional agencies, and manufacturers and distributors. Examples of source reduction actions are shown in Table 24 and include:

- Redesigning products or packages so as to reduce the quantity of materials or the toxicity of the materials used, by substituting lighter materials for heavier ones and lengthening the life of products to postpone disposal.

- Using packaging that reduces the amount of damage or spoilage to the product.
- Reducing amounts of products or packages used through modification of current practices by processors and consumers.
- Reusing products or packages already manufactured.
- Managing non-product organic wastes (food wastes, yard trimmings) through backyard composting or other on-site alternatives to disposal.

Figure 17. Diagram of solid waste management



Source: Franklin Associates

Source Reduction Through Redesign

Since source reduction of products and packages can save money through reducing materials and energy costs, manufacturers and packaging designers have been pursuing these activities for many years. Combined with other source reduction measures, redesign can have a significant effect on material use and eventual discards. Design for source reduction can take several approaches.

Materials substitution can make a product or package lighter and cheaper to transport. For example, there has been a continuous trend of substitution of lighter materials such as plastics and aluminum for materials such as glass and steel. The substitution also may involve a flexible package instead of a rigid package. A product or package can be redesigned to reduce weight or volume. Toxic materials in products or packaging can be replaced with non-toxic substitutes. Considerable efforts have been made in this area in the past few years.

Lengthening product life delays the time when the products enter the municipal waste stream. The responsibility for lengthening product life lies partly with manufacturers and partly with consumers. Products can be designed to last longer and be easier to repair. Since some of these design modifications may make products more expensive, at least initially, manufacturers must be willing to invest in new product development and consumers must demand the products and be willing to pay for them to make the goal work. Consumers and manufacturers also must be willing to care for and repair products.

Table 24

SELECTED EXAMPLES OF SOURCE REDUCTION PRACTICES

Source Reduction Practice	MSW Product Categories			
	Durable Goods	**Nondurable Goods**	**Containers & Packaging**	**Organics**
Redesign				
Materials reduction	• Downgauge metals in appliances	• Paperless purchase orders	• Concentrates	• Xeriscaping
Materials substitution	• Use of composites in appliances and electronic circuitry		• Cereal in bags • Coffee brick • Multi-use products	
Lengthen life	• High mileage tires • Electronic components reduce moving parts	• Regular servicing • Look at warranties • Extend warranties	• Design for secondary uses	
Consumer Practices				
	• Purchase long lived products	• Repair • Duplexing • Sharing • Reduce unwanted mail	• Purchasing: products in bulk, concentrates	
Reuse				
By design	• Modular design	• Envelopes	• Pallets • Returnable secondary packaging	
Secondary	• Borrow or rent for temporary use • Give to charity • Buy or sell at garage sales	• Clothing • Waste paper scratch pads	• Loosefill • Grocery sacks • Dairy containers • Glass and plastic jars	
Reduce/Eliminate Toxins				
	• Eliminate PCBs	• Soy ink, waterbased • Waterbased solvents • Reduce mercury	• Replace lead foil on wine bottles	
Reduce Organics				
Food wastes				• Backyard composting • Vermi-composting
Yard trimmings				• Backyard composting • Grasscycling

Source: Franklin Associates

Modifying Practices to Reduce Materials Use

Businesses and individuals often can modify their current practices to reduce the amounts of waste generated. In a business office, electronic mail can replace printed memoranda and data. Reports can be copied on both sides of the paper (duplexed). Modifying practices can be combined with other source reduction measures to reduce generation and limit material use.

Individuals and businesses can request removal from mailing lists to reduce the amount of mail received and discarded. When practical, products can be purchased in large sizes or in bulk to minimize the amount of packaging per unit of product. Concentrated products also can reduce packaging requirements. Some of these products, such as fabric softeners and powdered detergent, are designed to be used with refillable containers.

Reuse of Products and Packages

Similar to lengthening product life, reuse of products and packages delays the time when the items must finally be discarded as waste. When a product is reused, presumably purchase and use of a new product is delayed, although this may not always be true.

Many of the products characterized for this report are reused in sizable quantities (e.g., furniture, wood pallets, clothing, etc.). The recovery of products and materials for recycling (including composting) as characterized in Chapter 2 does *not* include reuse of products, but reuse is discussed in this section, and estimated in Chapter 4.

Durable Goods. There is a long tradition of reuse of durable goods such as large and small appliances, furniture, and carpets. Often this is done informally as individuals pass on used goods to family members and friends. Other durable goods are donated to charitable organizations for resale or use by needy families. Some communities and other organizations have facilitated exchange programs for citizens, and there are for-profit retail stores that deal in used furniture, appliances, and carpets. Other goods are resold by individuals at garage sales, flea markets, and the like. Borrowing and sharing items like tools also can reduce the number of products to be discarded ultimately. There is generally a lack of data on the volume of durable goods reused in the United States, and what the ultimate effect on MSW generation might be.

Nondurable Goods. While nondurable goods by their very nature are designed for short-term use and disposal, there is considerable reuse of some items classified as nondurable. In particular, footwear, clothing, and other textile goods often are reused. Much of the reuse is accomplished through the same types of channels as those described above for durable goods. That is, private individuals, charitable organizations, and retail outlets (consignment shops) all facilitate reuse of discarded clothing and footwear. In addition, considerable amounts of textiles are reused as wiping cloths before being discarded.

Another often-cited waste prevention measure is the use of washable plates, cups, napkins, towels, diapers, etc. instead of the disposable variety. (This will reduce solid waste but will have other environmental effects, such as increased water and energy use.) Other reusable items are available, for example: reusable air filters, reusable coffee filters, reconditioned printer cartridges, etc.

Containers and Packaging. Containers and packaging can be reused in two ways: they can be used again for their original purpose, or they can be used in other ways.

Glass bottles are a prime example of reuse of a container for its original purpose. Refillable glass beer and soft drink bottles can be collected, washed, and refilled for use again. Some years ago large numbers of refillable glass soft drink bottles were used, but these have largely been replaced by single-use glass bottles, plastic bottles, and aluminum cans. Considerable numbers of beer bottles are collected for refilling, often by restaurants and taverns, where the bottles can easily be collected and returned by the distributor. The Glass Packaging Institute estimates that refillable glass bottles achieve a rate of 8 trips (refillings) per bottle.

Another example in this category is the use of refurbished wood pallets for shipping palletized goods. The national Wood Pallet & Container Association estimates that more than 60 percent of new wood pallets produced are reusable. It also is common practice to recondition steel drums and barrels for reuse.

Many other containers and packages can be recycled but are not often reused. Some refillable containers (e.g., plastic laundry softener bottles) have been introduced: the original container can be refilled using concentrate purchased in small packages. This practice can achieve a notable source reduction in packaging. As another example, some grocery stores will allow customers to reuse grocery sacks, perhaps allowing a refund for each sack brought back for reuse. Also, many parcel shippers will take back plastic packaging "peanuts" for reuse.

Many ingenious reuses for containers and packaging are possible in the home. People reuse boxes, bags, jars, jugs, and cans for many purposes around the house. There are no reliable estimates as to how these specific activities affect the waste stream.

Management of Organic Materials

Food wastes and yard trimmings combined made up about 23 percent of MSW generation in 1999, so source reduction measures aimed at these products can have an important effect on waste generation. Composting is the usual method for recovering these organic materials. As defined in this report, composting of organic materials after they are taken to a central composting facility is a waste management activity comparable to recovery for recycling. Estimates for these off-site composting activities are included in this chapter.

There are several types of source reduction that take place at the point of generation (e.g., the yard of a home or business). Estimates for these practices are provided in Chapter 4. The practice of backyard composting of yard trimmings and certain food discards has been growing. There also is a trend toward leaving grass clippings on lawns, sometimes through the use of mulching mowers. Other actions contributing to reduced organics disposal are: establishing variable rates for collection of wastes (also known as unit-based pricing or pay-as-you-throw), which encourage residents to reduce the amount of wastes set out; improved technology (mulching mowers); xeriscaping (landscaping with plants that use minimal water and generate minimal waste); and certain legislation such as bans on disposal of yard trimmings in landfills.

Part of the impetus for source reduction of yard trimmings is the large number of state regulations discouraging landfilling or other disposal of yard trimmings. The Composting

Council and other sources report that in 1992, 12 states, amounting to more than 28 percent of the nations's population, had in effect legislation affecting management of yard trimmings. By 1998, 23 states plus the District of Columbia (amounting to about 50 percent of the nation's population) had legislation discouraging the disposal of yard trimmings.

RECOVERY FOR RECYCLING (INCLUDING COMPOSTING)

Recyclables Collection

Before recyclable materials can be processed and recycled into new products, they must be collected. Most residential recycling involves curbside recyclables collection, drop-off programs, buy-back operations, and/or container deposit systems. Collection of recyclables from commercial establishments is usually separate from residential recyclables collection programs.

Curbside Recyclables Collection. In 1998, more than 9,000 curbside recyclables collection programs were reported in the U.S. As shown in Table 25 and Figure 18, the extent of residential curbside recycling programs varies tremendously by geographic region, with the most extensive curbside collection occurring in the Northeast.

In 1998 slightly over one-half (54 percent) of the U.S. population, or 140 million persons, had access to curbside recyclables collection programs. The Northeast region had the largest population served – 43 million persons. In the Northeast, about 83 percent of the population had access to curbside recyclables collection, while in the South, 39 percent of the population had access to curbside recycling programs. Most of the programs were located in the Northeast and Midwest regions of the country.

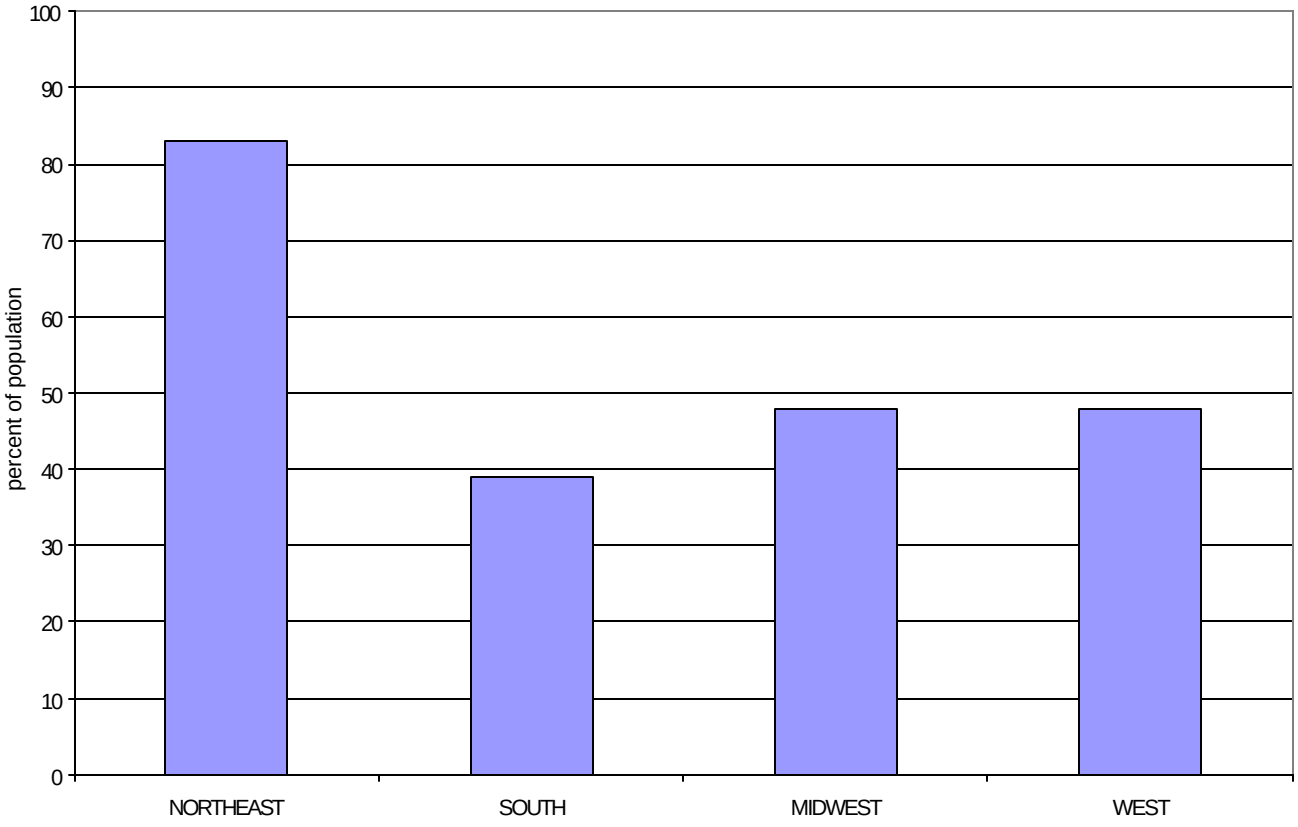
Drop-off Centers. Drop-off centers typically collect residential materials, although some accept materials from businesses. They are found in locations such as grocery stores, sheltered workshops, charitable organizations, city-sponsored sites, and apartment complexes. Types of materials collected vary greatly; however, drop-off centers can usually accept a greater variety of materials than a curbside collection program.

It is difficult to quantify drop-off centers in the U.S. It is estimated that there were 12,694 programs in 1997, according to a *BioCycle* survey (Goldstein 1998). In some areas, particularly those with sparse population, drop-off centers may be the only option for collection of recyclable materials. In other areas, they supplement other collection methods.

Buy-Back Centers. A buy-back center is typically a commercial operation that pays individuals for recovered materials. This could include scrap metal dealers, aluminum can centers, waste haulers, or paper dealers. Materials are collected by individuals, small businesses, and charitable organizations.

Deposit Systems. Nine states have container deposit systems: Connecticut, Delaware, Iowa, Maine, Massachusetts, Michigan, New York, Oregon, and Vermont (Figure 19). In these programs, the consumer pays a deposit on beverage containers at the point of purchase, which is

Figure 18. Population served by curbside recycling, 1999



Source: *BioCycle* 1999 (1998 data).

redeemed on return of the empty containers. In addition, California has a similar system where containers can be redeemed, but the consumer pays no deposit. With the exception of California, no new deposit laws have been enacted since the early 1980s, due in part to the convenience and economics of curbside recycling.

Deposit systems generally target beverage containers (primarily beer and soft drink containers), which account for less than 4 percent of total MSW generation. It is estimated that about 35 percent of all recovery of beverage containers comes from the 9 traditional deposit states mentioned above, and an additional 20 percent of recovered beverage containers comes from California. (Note: These recovery estimates reflect not only containers redeemed by consumers for deposit, but also containers recovered through existing curbside and drop-off recycling programs. Containers recovered through these programs eventually are credited to the distributor and counted towards the redemption rate.)

Commercial Recyclables Collection. The largest quantity of recovered materials comes from the commercial sector. Old corrugated containers (OCC) and office papers are widely collected from commercial establishments. Grocery stores and other retail outlets that require corrugated packaging are part of an infrastructure that brings in the most recovered material. OCC is often baled at the retail outlet and picked up by a paper dealer.

Figure 19.

Table 25

NUMBER AND POPULATION SERVED BY CURBSIDE RECYCLABLES COLLECTION PROGRAMS, 1999

Region	Number of Programs	Population (in thousands)	Population Served (in thousands)	Population Served (%)
NORTHEAST	3,414	51,830	43,162	83%
SOUTH	1,581	96,468	37,914	39%
MIDWEST	3,477	63,242	30,106	48%
WEST	877	59,965	28,644	48%
U.S. Total (1)	9,349	271,505	139,826	52%

(1) Percent of population served by curbside programs was calculated using population of states reporting data.

Source: Statistical Abstract 1999, Bureau of Census 1999, BioCycle 1999 (1998 data).

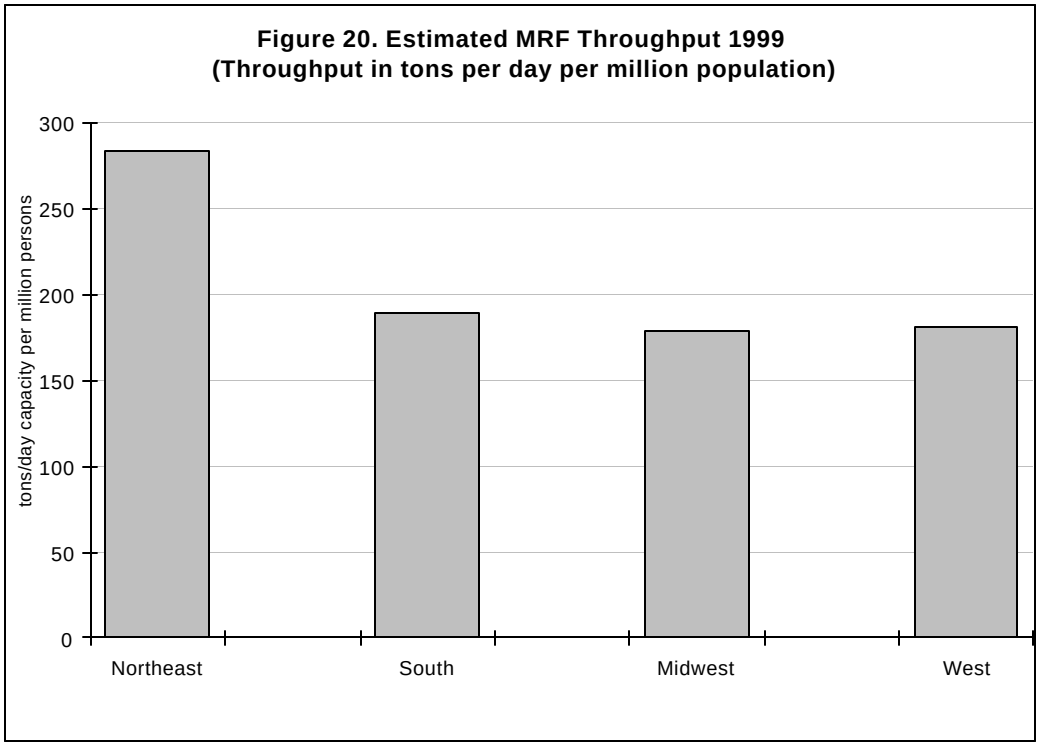
Office paper (e.g., white, mixed color, computer paper, etc.) is part of another commercial recyclables collection infrastructure. Depending on the quantities generated, businesses (e.g., banks, institutions, schools, printing operations, etc.) can sort materials and have them picked up by a paper dealer, or self deliver the materials to the recycler. It should be noted that commercial operations also make recycling available for materials other than paper.

Multi-family residence recycling could be classified as either residential or commercial recyclables collection. Multi-family refuse is usually handled as a commercial account by waste haulers. These commercial waste haulers may handle recycling at multi-family dwellings (typically 5 or more units) as well.

Recyclables Processing

Processing recyclable materials is performed at materials recovery facilities (MRFs), mixed waste processing facilities, and mixed waste composting facilities. Some materials are sorted at the curb and require less attention. Other materials are sorted into categories at the curb, such as a paper category and a container category, with additional sorting at a MRF. Mixed waste also can be processed to pull out recyclable and compostable materials.

Figure 20. Estimated MRF Throughput 1999
(Throughput in tons per day per million population)



Materials Recovery Facilities. Materials recovery facilities vary widely across the U.S., depending on the incoming materials and the technology and labor used to sort the materials. In 1999, 480 MRFs were operating in the U.S., with an estimated total daily throughput of 55,000 tons per day (Table 26). The most extensive recyclables processing throughput occurs in the Northeast (Figure 20).

Table 26

MATERIALS RECOVERY FACILITIES, 1999

Region	Number	Estimated Throughput (tpd)
Northeast	119	14,903
South	138	18,162
North Central	118	11,523
West	105	10,779
U.S. Total	**480**	**55,367**

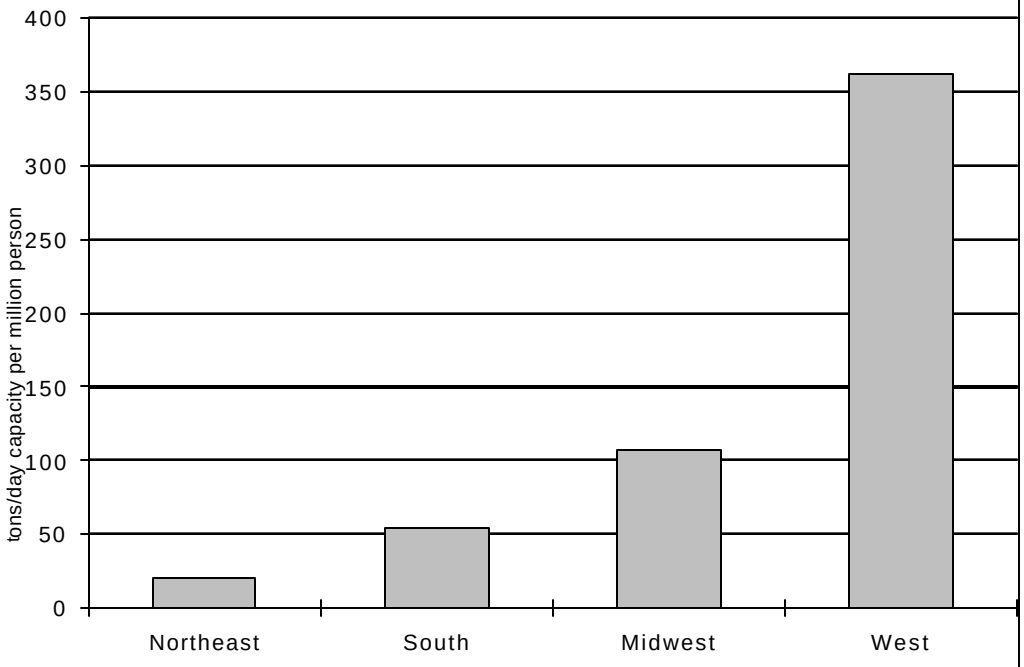
Source: Governmental Advisory Associates, Inc. 2000 report release pending.

The majority of MRFs are considered low technology, meaning the materials are predominantly sorted manually. MRFs classified as high technology sort recyclables using eddy currents, magnetic pulleys, optical sensors, and air classifiers. As MRFs change and grow, many low-technology MRFs add high-tech features, and high-technology MRFs include manual sorting, reducing the distinction between high- and low-technology MRFs.

Mixed Waste Processing. Mixed waste processing facilities are less common than conventional MRFs, but there are several facilities in operation in the U.S., as shown in Figure 21. Mixed waste processing facilities receive waste just as if it were going to a landfill. The mixed waste is loaded on conveyors and, using both mechanical and manual (high and low technology) sorting, recyclable materials are removed for further processing. In 1997, there were reported 58 mixed waste processing facilities in the U.S., handling about 34,800 tons of waste per day (Governmental Advisory Associates, 1998). The Western region of the U.S. has the largest concentration of these processing facilities.

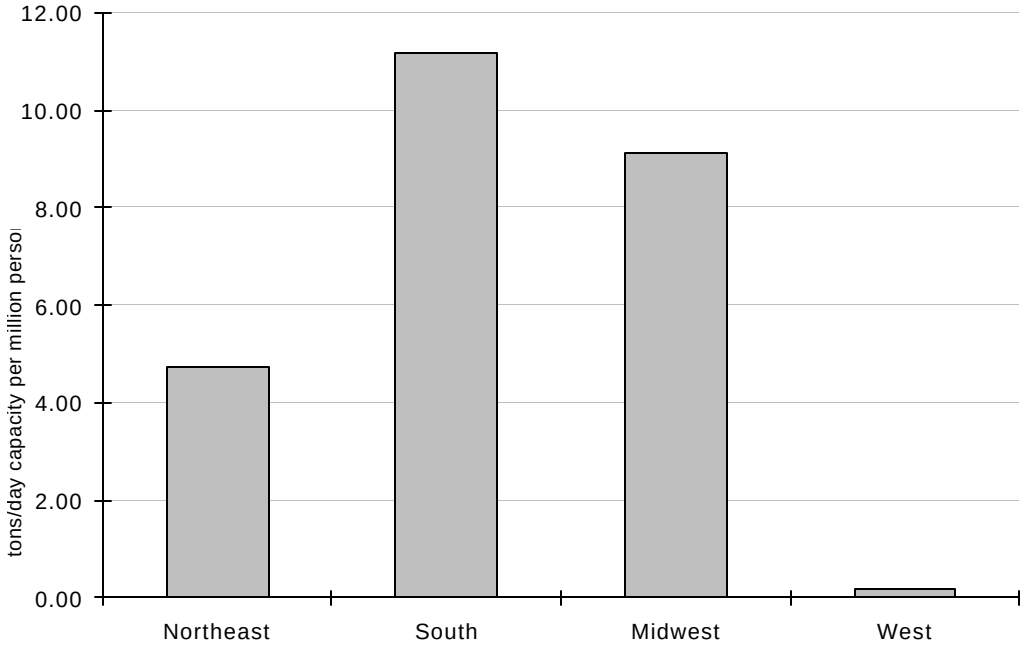
Mixed Waste Composting. Mixed waste composting starts with unsorted MSW. Large items are removed, as well as ferrous and other metals, depending on the type of operation. Mixed waste composting takes advantage of the high percentage of organic components of MSW, such as paper, food wastes and yard trimmings, wood, and other materials. In 1999, there were 19 mixed waste composting facilities, up from 14 in 1997. In 1999, 12 of these were located in the Midwest. The greatest throughput, however, was in the South, as shown in Figure 22. Nationally, mixed waste composting facilities handled about 813 tons per day in 1999, up from 670 tons per day in 1997.

Figure 21. Mixed Waste Processing Estimated Throughput, 1999 (tons per day per million population)



Source: Governmental Advisory Associates, Inc. 2000 and U.S. Bureau of Census.

Figure 22. MSW Composting Capacity, 1999 (Throughput in tons per day per million population)



Source: *BioCycle* 1999 and U.S. Bureau of Census.

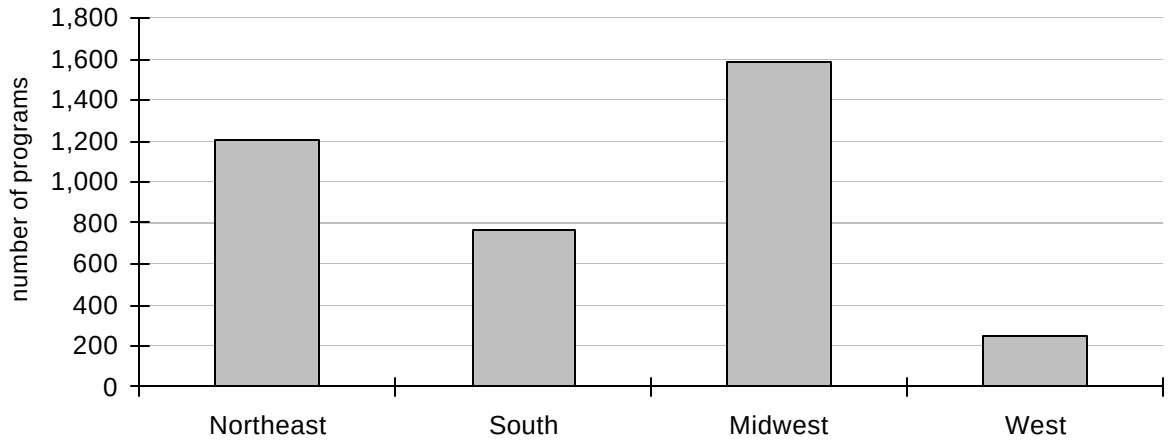
Yard Trimmings Composting. Yard trimmings composting is much more prevalent than mixed waste composting. On-site management of yard trimmings is not included in this section, but is discussed in the source reduction section in Chapter 4. In 1998, 3,807 yard trimmings composting programs were reported (*BioCycle 1999*). About 78 percent of these programs are in the Northeast and Midwest regions, as shown in Figure 23. Based on 12.6 million tons of yard trimmings recovered for composting in the United States (Table 2, Chapter 2), yard trimmings composting facilities handled approximately 34,400 tons per day in 1999.

COMBUSTION

Most of the municipal solid waste combustion currently practiced in this country incorporates recovery of an energy product (generally steam or electricity). The resulting energy reduces the amount needed from other sources, and the sale of the energy helps to offset the cost of operating the facility. In past years, it was common to burn municipal solid waste in incinerators as a volume reduction practice; energy recovery became more prevalent in the 1980s.

Total U.S. MSW combustion with energy recovery, referred to as waste-to-energy (WTE) combustion, had a 1999 design capacity of 95,700 tons per day. There were 102 WTE facilities in 1999 (Table 27). The Northeastern and Southern regions had most of the MSW combustion capacity in 1999 (Figure 24) In addition to facilities combusting mixed MSW (processed or unprocessed), there is a small but growing amount of combustion of source-separated MSW. In particular, there is considerable interest in using rubber tires as fuel in dedicated facilities or as fuel in cement kilns. In addition, there is combustion of wood wastes and some paper and plastic wastes, usually in boilers that already burn some other type of solid fuel. For this report, it was estimated that about 2.6 million tons of MSW were combusted in this manner in 1999, with tires contributing a majority of the total.

Figure 23. Yard Trimmings Composting Programs, 1999
(In number of programs)



Source: *BioCycle* 1999 (1998 data).

Table 27

MUNICIPAL WASTE-TO-ENERGY 1999

Region	WTE (1)(2) Number Operational	WTE (1)(2) Design Capacity (tpd)
NORTHEAST	40	44,865
SOUTH	34	34,115
MIDWEST	21	12,198
WEST	7	4,559
U.S. Total (1)	102	95,737

(1) Projects on hold or inactive were not included.
Facilities in Hawaii and Alaska not included.
(2) WTE includes MB, MCU, RDF-Combustion.

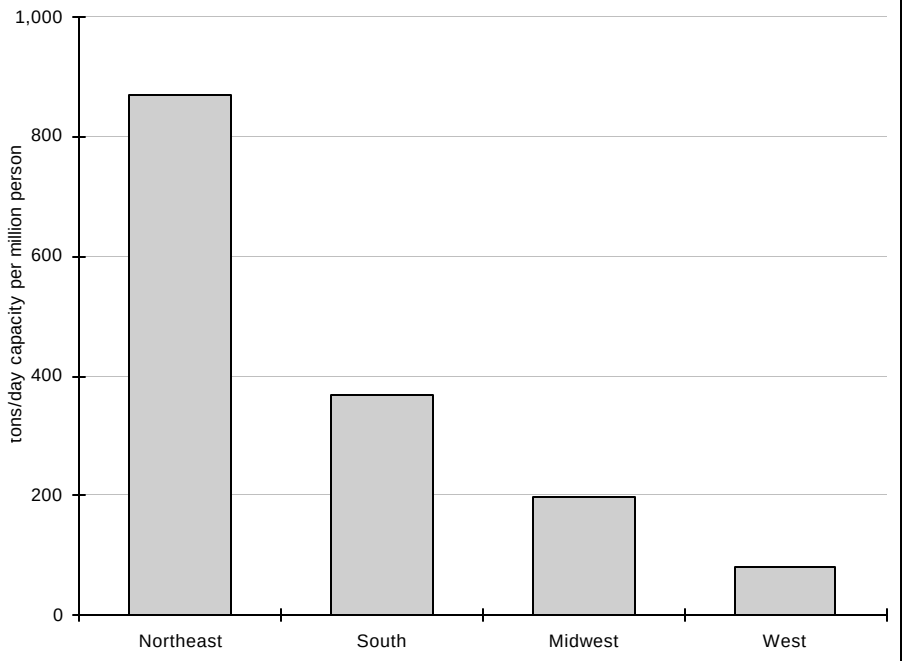
Source: "The IWSA Directory of Waste-To-Energy Plants."
Integrated Waste Services Association, 2000.

In most cases the facilities have a stated daily capacity, but they normally operate at less than capacity over the course of a year. It was assumed for this report that throughput over a year of operation is 90 percent of rated capacity. The total throughput of MSW through all combustion facilities was an estimated 34 million tons, or 14 percent of MSW generation, in 1999.

RESIDUES FROM WASTE MANAGEMENT FACILITIES

Whenever municipal wastes are processed, residues will remain. For the purposes of this report, it is assumed that most of these residues are landfilled. MRFs and compost facilities generate some residues when processing various recovered materials. These residues include materials that are unacceptable to end users (e.g., broken glass, wet newspapers), other contaminants (e.g.,products made of plastic resins that are not wanted by the end user), or dirt. While residue generation varies widely, 5 to 10 percent is probably typical for a MRF. Residues from a MRF or compost facility are generally landfilled. Since the recovery estimates in this report are based on recovered materials purchased by end users rather than materials entering a processing facility, the residues are counted with other disposed materials.

Figure 24. Municipal Waste-To-Energy Capacity, 1999
(Capacity in tons per day per million population)



Source: Integrated Waste Services Association 2000 and U.S. Bureau of Census.

When municipal solid waste is combusted, a residue (usually called ash) is left behind. Years ago, this ash was commonly disposed of along with municipal solid waste, but combustor ash is *not* counted as MSW in this report because it generally must be managed separately.* (There are a number of efforts under way to reuse ash.) As a general "rule of thumb," MSW combustor ash amounts to about 25 percent (dry weight) of unprocessed MSW input. This percentage will vary from facility to facility depending upon the types of waste input and the efficiency and configuration of the facility.

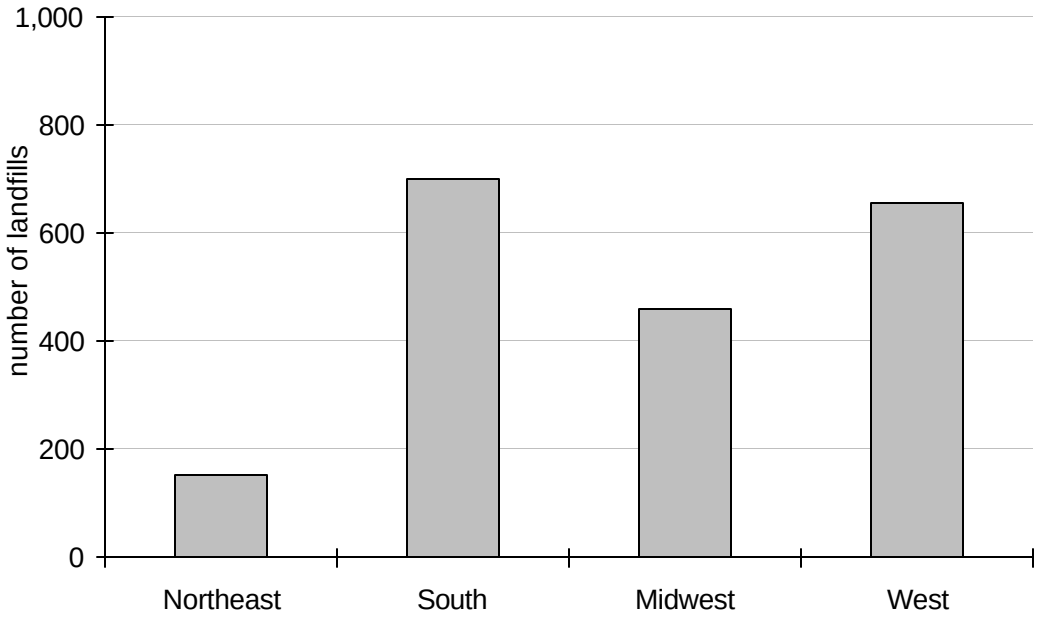
LANDFILLS

Athough the number of landfills is decreasing, the total available capacity for landfilling in the United States has remained relatively constant. In 1999, approximately 2,300 municipal solid waste landfills were reported in the contiguous U.S. New landfills are now much larger than in the past.

Table 28 and Figure 25 show the number of landfills in each region. The Southeast and West had the greatest number of landfills. Thirty-one states had more than 10 years of capacity left, down from 1997, in which 42 states had more than 10 years of capacity left. Two states reported having less than 5 years of capacity remaining.

*Note that many combustion facilities do magnetic separation of residues to recover ferrous metals, e.g., steel cans and steel in other miscellaneous durable goods. This recovered steel is included in the total recovery of ferrous metals in MSW reported in Chapter 2.

Figure 25. Number of Landfills in the U.S., 1999



Source: *BioCycle* , April 2000.

Table 28

LANDFILL FACILITIES, 1999

Region	Number of Landfills *	Number of States with Years Capacity Remaining		
		> 10 yr	5 to 10 yr	< 5 yr
NORTHEAST	154	6	2	1
SOUTHEAST	699	12	3	1
MIDWEST	459	7	5	0
WEST	655	9	2	0
U.S. Total *	1,967	34	12	2

* Excludes landfills reported in Alaska (239) and Hawaii (10).
Source: *BioCycle* April 2000.

SUMMARY OF HISTORICAL AND CURRENT MSW MANAGEMENT

This summary provides some perspective on historical and current municipal solid waste management practices in the U.S. The results are summarized in Table 29 and Figure 26.

Historically, municipal solid waste generation has grown relatively steadily from 88 million tons in 1960 to 229.9 million tons in 1999. In the 1960s and early 1970s, a large percentage of MSW was burned, with little recovery for recycling. Landfill disposal typically consisted of open dumping, often accompanied with open burning of the waste for volume reduction. Through the mid-1980s, incineration declined considerably landfills became difficult to site, and waste generation continued to increase. Materials recovery rates increased very slowly in this time period, and the burden on the nation's landfills grew dramatically.
As Figure 26 shows, discards of MSW to landfill or other disposal apparently peaked in the 1986-1987 period, then began to decline as materials recovery and combustion increased.

More recently, tons of waste landfilled have been growing again, to accommodate increased generation, while since 1997 combustion declined slightly and recycling rose slightly. Although there now are fewer MSW landfills, their average size has increased, and capacity at the national level does not appear to be a problem. It should be noted that there are fewer years of landfill capacity available than there were two years ago. Compared to two years ago, more states have less than a decade of capacity left. In addition, regional dislocations sometimes occur.

Recovery of products and yard trimmings increased steadily. Combustion has decreased slightly from 17 percent of generation in 1997 to 15 percent of generation in 1999. Although MSW discards to landfills have generally decreased in the 1990s, about 132 million tons of MSW were landfilled in 1999, up from 127 million tons in 1998. As a percentage of total MSW generation, landfilling has consistently decreased – from 83 percent of generation in 1986 to 57 percent in 1999.

Figure 26. Municipal solid waste management, 1960 to 1999

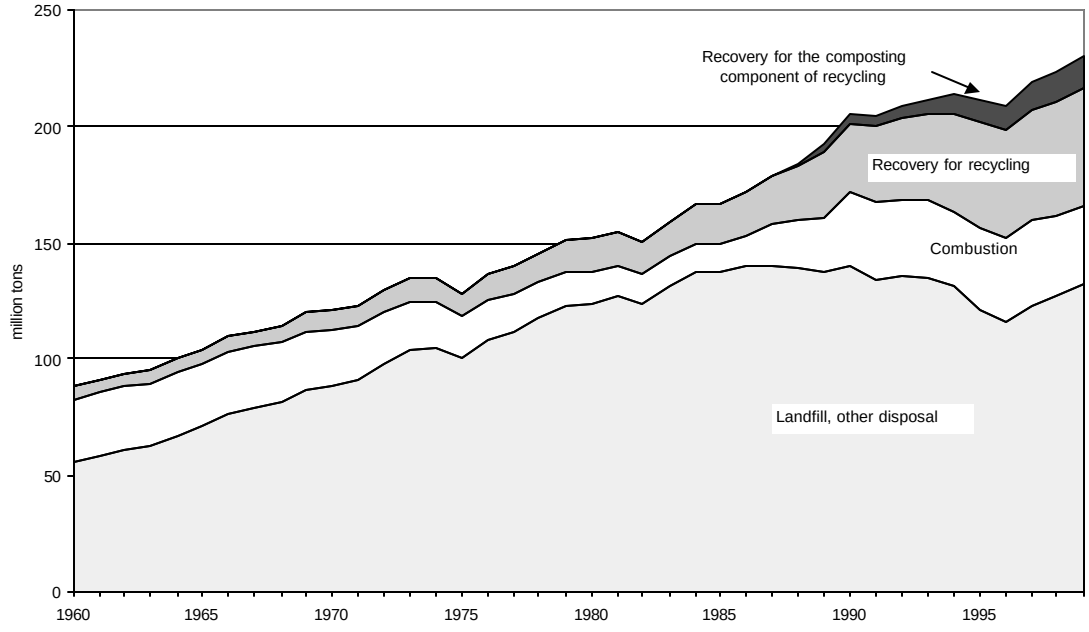


Table 29

GENERATION, MATERIALS RECOVERY, COMPOSTING, COMBUSTION, AND DISCARDS OF MUNICIPAL SOLID WASTE, 1960 TO 1999
(In thousands of tons and percent of total generation)

	Thousands of Tons								
	1960	**1970**	**1980**	**1990**	**1994**	**1995**	**1997**	**1998**	**1999**
Generation	88,120	121,060	151,640	205,210	214,360	211,360	219,140	223,040	229,850
Recovery for recycling	5,610	8,020	14,520	29,040	42,150	45,340	47,300	48,410	50,780
Recovery for composting*	Neg.	Neg.	Neg.	4,200	8,480	9,570	12,070	13,140	13,110
Total Materials Recovery	5,610	8,020	14,520	33,240	50,630	54,910	59,370	61,550	63,890
Discards after recovery	82,510	113,040	137,120	171,970	163,730	156,450	159,770	161,490	165,960
Combustion**	27,000	25,100	13,700	31,900	32,490	35,540	36,700	34,410	34,040
Discards to landfill, other disposal†	55,510	87,940	123,420	140,070	131,240	120,910	123,070	127,080	131,920

	Pounds per Person per Day								
	1960	**1970**	**1980**	**1990**	**1994**	**1995**	**1997**	**1998**	**1999**
Generation	2.68	3.25	3.66	4.50	4.51	4.40	4.49	4.52	4.62
Recovery for recycling	0.17	0.22	0.35	0.64	0.89	0.94	0.97	0.98	1.02
Recovery for composting*	Neg.	Neg.	Neg.	0.09	0.18	0.20	0.25	0.27	0.26
Total Materials Recovery	0.17	0.22	0.35	0.73	1.06	1.14	1.22	1.25	1.28
Discards after recovery	2.51	3.04	3.31	3.77	3.44	3.26	3.27	3.27	3.33
Combustion**	0.82	0.67	0.33	0.70	0.68	0.74	0.75	0.70	0.68
Discards to landfill, other disposal†	1.69	2.36	2.98	3.07	2.76	2.52	2.52	2.57	2.65
Population (thousands)	179,979	203,984	227,255	249,907	260,682	263,168	267,645	270,561	272,691

	Percent of Total Generation								
	1960	**1970**	**1980**	**1990**	**1994**	**1995**	**1997**	**1998**	**1999**
Generation	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Recovery for recycling	6.4%	6.6%	9.6%	14.2%	19.7%	21.5%	21.6%	21.7%	22.1%
Recovery for composting*	Neg.	Neg.	Neg.	2.0%	4.0%	4.5%	5.5%	5.9%	5.7%
Total Materials Recovery	6.4%	6.6%	9.6%	16.2%	23.6%	26.0%	27.1%	27.6%	27.8%
Discards after recovery	93.6%	93.4%	90.4%	83.8%	76.4%	74.0%	72.9%	72.4%	72.2%
Combustion**	30.6%	20.7%	9.0%	15.5%	15.2%	16.8%	16.7%	15.4%	14.8%
Discards to landfill, other disposal†	63.0%	72.6%	81.4%	68.3%	61.2%	57.2%	56.2%	57.0%	57.4%

* Composting of yard trimmings and food wastes. Does not include mixed MSW composting or backyard composting.
** Includes combustion of MSW in mass burn or refuse-derived fuel form, and combustion with energy recovery of source separated materials in MSW (e.g., wood pallets and tire-derived fuel).
† Discards after recovery minus combustion.
Details may not add to totals due to rounding.

Source: Franklin Associates

Chapter 3

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Chapter 4

SOURCE REDUCTION OF MUNICIPAL SOLID WASTE

INTRODUCTION

During the past 40 years, the amount of waste each person creates has almost doubled, from 2.7 to 4.62 pounds per day. The most effective way to stop this trend is by preventing waste from being generated in the first place.

Source reduction, also known as "waste prevention," is the practice of designing, manufacturing, purchasing, or using materials (such as products and packaging) in ways that reduce the amount or toxicity of trash created. Reusing items is another way to stop waste at the source because it delays or avoids that item's entry into the waste collection and disposal system.

Source reduction means consuming and throwing away less. It includes things like purchasing durable, long-lasting goods and seeking products and packaging that are as free of excessive packaging and toxins as possible. It can be as complex as redesigning a product to use less raw material in production, have a longer life, or be used again after its original use is completed. Because source reduction actually prevents the generation of waste in the first place, it is the most preferable method of waste management and goes a long way toward protecting the environment.

MEASURING SOURCE REDUCTION

Although source reduction has been an increasingly important aspect of municipal solid waste programs since the late 1980s, the goal of actually measuring how much source reduction has taken place – how much waste prevention there has been – has proved elusive. Early attempts by localities and states often consisted of measuring a single waste stream in a single community. In time, additional research enabled proxy, or estimated values, to be developed for specific waste streams, to use on a statewide or national level. EPA's *Source Reduction Program Potential Manual* and planning packet, published in 1997 (EPA530-E-97-001) provides an example of this approach. Unlike recycling, where there are actual materials to weigh all through the process, measuring source reduction means trying to measure something that no longer exists.

As a reminder, in this chapter, as well as this report, MSW includes wastes such as durable goods, nondurable goods, containers and packaging, food scraps, yard trimmings, and miscellaneous inorganic wastes from residential, commercial, institutional, and industrial sources. MSW does not include sewage, hazardous wastes, nonhazardous industrial waste, construction and demolition debris, or automobile bodies.

To measure the absence of waste at the national level, a factor had to be found – something in the population or economy that has most closely followed the pattern of waste generation and disposal. Factors such as population increases or decreases of course have an impact, but EPA's study showed that population is not the best indicator of waste generation.

The Gross Domestic Product (GDP), which measures the value of goods and services produced in the U.S., had a relatively good correlation to waste generation. But, going all the way back to 1960, what ended up having the best relationship with waste generation was Personal Consumption Expenditures (PCE) – commonly referred to as "Consumer Spending." Fortunately, this makes perfect sense since consumer spending reflects the goods and products, including food, and their packaging, which are purchased, used, and ultimately discarded as municipal solid waste.

Over the last several decades, there has been a measured steep and steady increase in waste generation in the United States. If that same rate of generation remained constant through 1999, then almost 280 million tons of waste would have been generated. But in 1999, only 230 million tons of waste were actually generated. That's 50 million tons of waste that never made it to the waste stream. Source reduction is measured as the difference between the amount of MSW that was projected to be generated in 1999 and the actual amount of MSW that was generated in 1999.

The November 1999 *National Source Reduction Characterization Report for Municipal Solid Waste in the United States* (EPA530-R-99-034) explains the methodology that was used to generate the source reduction estimates presented in this report. Further detail on the chosen methodology, including an explanation of the significance of PCE as a predictor of waste is provided in that report. Please also note that updates to previously published data have been reflected in this report. These data adjustments are a result of recent revisions of national economic data and indicators from the U.S. Department of Commerce. Current and historical source reduction data have been adjusted to correctly reflect these updates.

SOURCE REDUCTION FACTS

More than 50 million tons of MSW were source reduced in the United States in 1999 – EPA estimates come to 50,042,000 tons.

Table 30 shows containers and packaging represent approximately 24 percent of the materials source reduced in 1999, in addition to nondurable goods (e.g., newspapers, clothing) at 18 percent, durable goods (e.g., appliances, furniture, tires) at 11 percent, and other MSW (e.g., yard trimmings, food scraps) at 47 percent.

Table 30: 1999 Source Reduction by Major Material Categories

Waste Stream	Tons Source Reduced	Percentage
Durable Goods (e.g. appliances, furniture)	**5,289,000**	**11%**
Nondurable Goods (e.g. newspapers & clothing)	**8,956,000**	**18%**
Containers & Packaging (e.g. bottles & boxes)	**12,004,000**	**24%**
Other MSW (e.g. yard trimmings & food scraps)	**23,793,000**	**47%**
Total Source Reduction (1990 baseline)	**50,042,000**	**100%**

Table 31 lists items that showed significant decreases (source reduction) and increases (source expansion) in waste generation in 1999. The top chart shows 7 major contributors to source reduction. These 7 accounted for 76 percent of the nation's entire 1999 waste reduction, while the bottom 4 account for 67 percent of the increases in waste generation. A detailed listing of individual MSW components can be found in Appendix B.

As a word of caution, individual materials should not necessarily be analyzed without giving careful consideration to other related materials that may have impacted either the reduction or increased use of that material. For example, as shown below, glass containers have contributed significantly to source reduction. However, it is clear that plastic containers may have been substituted for glass in many instances as reflected by the significant source expansion of plastic containers in this study. Therefore, there may not have been as much container packaging reduction as there was container material substitution – plastic for glass.

In order to better reflect the impact of this type of material substitution, Table 3 shows source reduction and expansion for "functional" categories so that individual materials are not taken out of context. For example, Table 32 shows that source reduction for "Bags and Sacks" is 1,230,000 tons. This is a result of the decrease in paper bags and sacks (1,638,000 tons) and the increase in plastic bags and sacks (408,000 tons).

Table 31: Significant Source Reduction and Source Expansion Within MSW (Thousands of Tons)

Waste Stream Showing Significant Source Reduction or Source Expansion	Source Reduction/Source Expansion
Significant Source Reduction	
Yard Trimmings	20,008
Glass Containers & Bottles	5,085
Newspapers	4,358
Wood Packaging	3,617
Food Scraps	3,210
Miscellaneous Durable Goods	3,028
Paper Bags & Sacks	1,638
Total	**39,306**
Significant Source Expansion	
Clothing and Footwear	(781)
Plastic Containers & Bottles	(971)
Plastic Wraps	(463)
Plastic Bags & Sacks	(408)
Total	**(2,623)**

Net source reduction is determined by subtracting total source expansion (4 million tons) from total source reduction (54 million tons).

SOURCE REDUCTION BENEFITS

Source reduction, which includes material reuse, can help reduce waste disposal and handling costs, because it avoids the costs of recycling, municipal composting, landfilling, and combustion. Source reduction also conserves resources such as water and energy and reduces pollution, including greenhouse gases that contribute to global warming.

Source reduction saves natural resources. Waste is not just created when consumers throw items away. Throughout the life cycle of a product – from extraction of raw materials to transportation to processing and manufacturing facilities to manufacture and use – waste is generated. Reusing items or making them with less material decreases waste dramatically. Ultimately, less materials will need to be recycled or sent to landfills or waste combustion facilities.

Reduces toxicity of waste. Selecting nonhazardous or less hazardous items is another important component of source reduction. Using less hazardous alternatives for certain items (e.g., cleaning products and pesticides), sharing products that contain hazardous chemicals instead of throwing out leftovers, reading label directions carefully, and using the smallest amount necessary are ways to reduce waste toxicity.

Table 32: Source Reduction/(Expansion) for Functional Categories - 1999 (Thousands of Tons)

Product	Source Reduction/Expansion (based on consumer spending & change in waste generation rate)
Durables	
Miscellaneous Durables	3,028
Furniture/Furnishings	1,551
Major Appliances	835
Tires	274
Batteries, Lead Acid	120
Small Appliances	(313)
Carpets/Rugs	(206)
Subtotal	***5,289***

(*continued on next page*)

(*continued from previous page*)	
Non-Durables	
Publications	6,263
Office Paper	1,073
Tissue Paper/Towels	677
Miscellaneous Nondurables	826
Other Nonpackaging Paper	497
Towels, Sheets, Pillowcases	188
Trash Bags	114
Disposable Diapers	373
Third Class Mail	(350)
Plates and Cups	(67)
Clothing/Footwear	(781)
Other Commercial Printing	143
Subtotal	***8,956***
Packaging	
Wood Packaging	3,617
Beverage Containers	3,885
Food Containers	2,678
Bags and Sacks	1,230
Wrapping	(766)
Miscellaneous Packaging	(243)
Paper Boxes	1,603
Subtotal	***12,004***
Other MSW Wastes	
Yard Trimmings	20,008
Food Scraps	3,210
Miscellaneous Inorganics	575
Subtotal	***23,793***
Grand Total	**50,042**

* Parentheses denote negative numbers, or source expansion. Positive numbers indicate source reduction

Reduces costs. The benefits of preventing waste go beyond reducing reliance on other forms of waste disposal. Preventing waste also can mean economic savings for communities, businesses, schools, and individual consumers.

- **Communities.** When these households reduce waste at the source, they dispose of less trash, resulting in lower trash disposal fees and longer landfill life.

- **Businesses.** Industry also has an economic incentive to practice source reduction. When businesses manufacture their products with less packaging, they are buying less raw material. A decrease in manufacturing costs can mean a larger profit margin, with savings that can be passed on to the consumer. Add decreased waste disposal costs to this, and significant savings can be achieved.

- **Consumers.** Consumers also can share in the economic benefits of source reduction. Buying products in bulk, with less packaging, or that are reusable (not single-use) frequently means a cost savings. What is good for the environment can be good for the pocketbook as well.

FACTORS IMPACTING SOURCE REDUCTION

Since 1990, source reduction has continued to occur at an impressive rate in the United States – nearly doubling in the last three years alone. This is due, in large part, to the nation's continued economic prosperity the last half of this decade. That, combined with improvements in materials/resource management, has resulted in more than 50 million tons of waste prevented in 1999.

A fundamental business principal asserts that waste is an indicator of inefficiency. Therefore, when an organization becomes more efficient in their use of resources, they generate less waste. So it only makes sense that if a company were to look at eliminating, or at least reducing, the amount of waste they generate, they would, as a result, become more efficient. And in the business world, increased efficiency translates to increased profits. The recent prosperity that the United States has experienced has afforded many companies the opportunity to invest in operational efficiencies, thus generating less waste material. This can be seen in the reduction of wood packaging waste due to wooden pallets being reused multiple times instead of being sent to the landfill after just one use. Newspapers also have made large gains in waste reduction. They are being made lighter and slightly smaller than in prior years. It's also probably safe to say that the increased use of the Internet has contributed to the reduction in newspaper waste.

Unfortunately, economic prosperity does not necessarily translate to better waste management in residential applications. As a matter of fact, it looks to be just the opposite. It appears that as individuals are more prosperous and have greater discretionary spending, they become more wasteful. This can be seen in the data that is commonly attributed to home waste disposal such as clothing, footwear, disposable products, and packaging. There's also a significant increase in the use of plastic bags/sacks.

So the good news is that more products are being made with less waste and Americans are recycling more. The bad news is – we're also consuming more and generating more waste.

Appendix A

MATERIAL FLOWS METHODOLOGY

The material flows methodology is illustrated in Figures A-1 and A-2. The crucial first step is making estimates of the generation of the materials and products in MSW (Figure A-1).

DOMESTIC PRODUCTION

Data on domestic production of materials and products were compiled using published data series. U.S. Department of Commerce sources were used where available, but in several instances more detailed information on production of goods by end use is available from trade associations. The goal is to obtain a consistent historical data series for each product and/or material.

CONVERTING SCRAP

The domestic production numbers were then adjusted for converting or fabrication scrap generated in the production processes. Examples of these kinds of scrap would be clippings from plants that make boxes from paperboard, glass scrap (cullet) generated in a glass bottle plant, or plastic scrap from a fabricator of plastic consumer products. This scrap typically has a high value because it is clean and readily identifiable, and it is almost always recovered and recycled within the industry that generated it. Thus, converting/fabrication scrap is *not* counted as part of the post consumer recovery of waste.

ADJUSTMENTS FOR IMPORTS/EXPORTS

In some instances imports and exports of products are a significant part of MSW, and adjustments were made to account for this.

DIVERSION

Various adjustments were made to account for diversions from MSW. Some consumer products are permanently diverted from the municipal waste stream because of the way they are used. For example, some paperboard is used in building materials, which are not counted as MSW. Another example of diversion is toilet tissue, which is disposed in sewer systems rather than becoming MSW.

In other instances, products are temporarily diverted from the municipal waste stream. For example, textiles reused as rags are assumed to enter the waste stream the same year the textiles are initially discarded.

Figure A-1. Material flows methodology for estimating generation of products and materials in municipal solid waste.

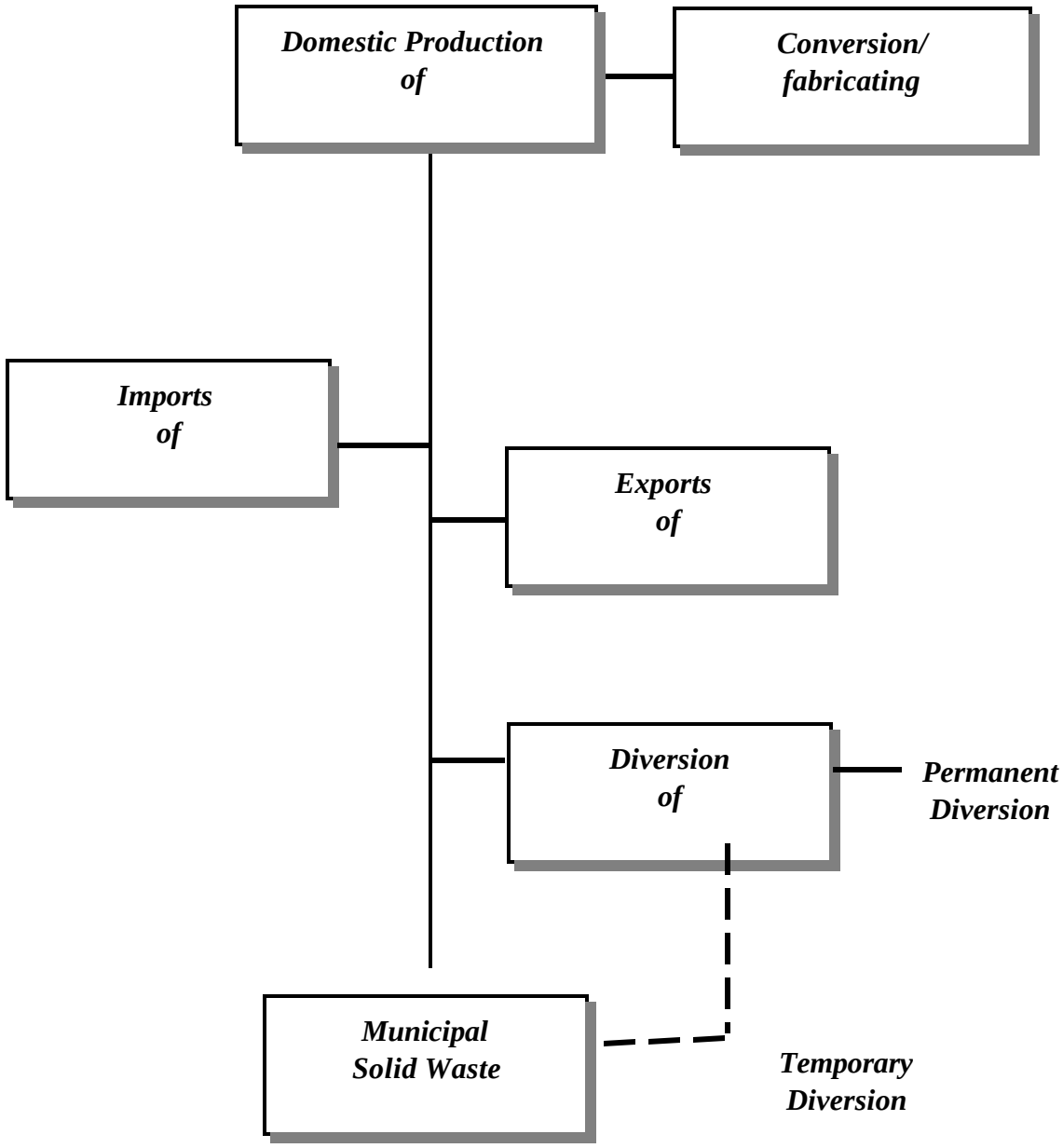
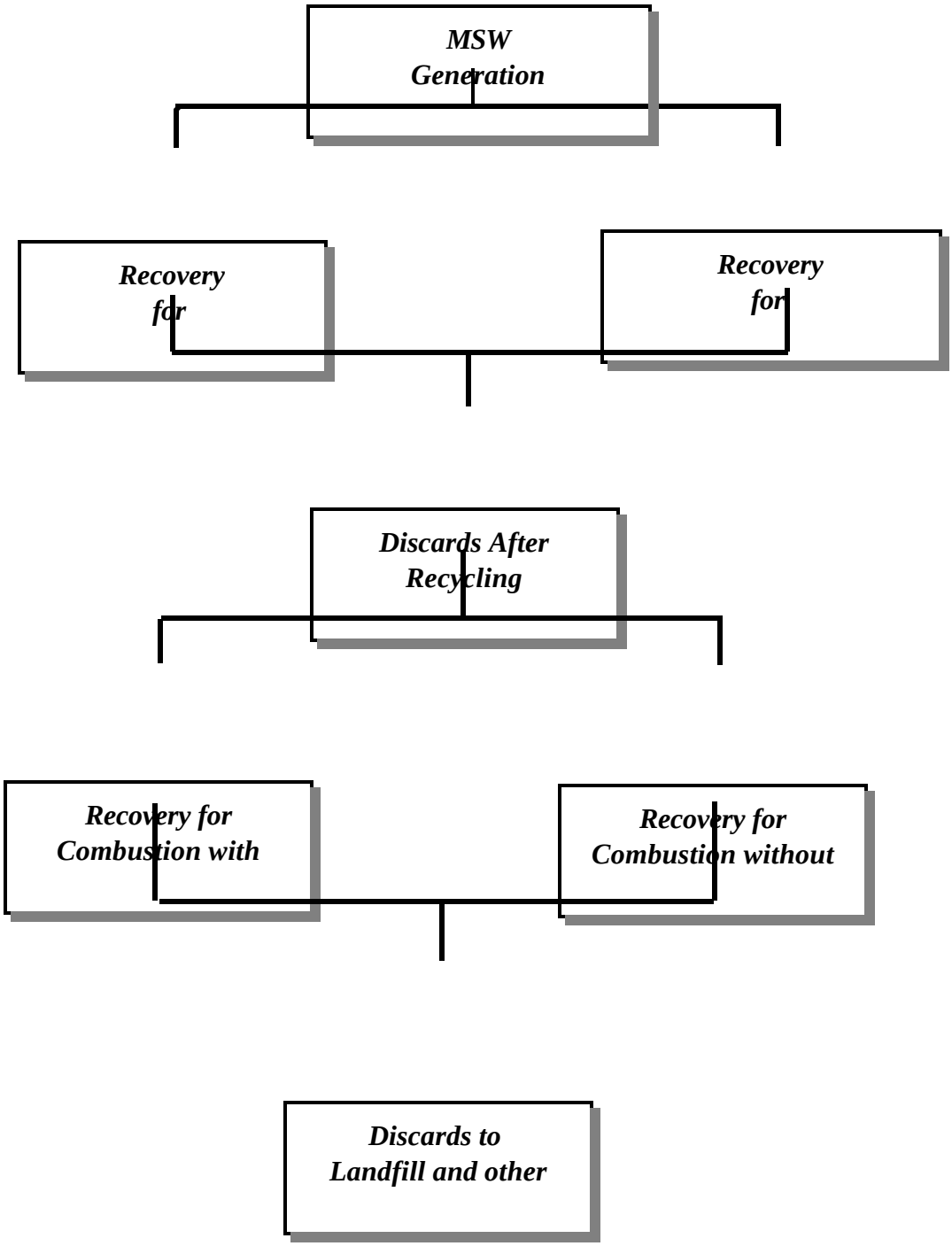


Figure A-2. Material flows methodology for estimating discards of products and materials in municipal solid waste.



ADJUSTMENTS FOR PRODUCT LIFETIME

Some products (e.g., newspapers and packaging) normally have a very short lifetime; these products are assumed to be discarded in the same year they are produced. In other instances (e.g., furniture and appliances), products have relatively long lifetimes. Data on average product lifetimes are used to adjust the data series to account for this.

MUNICIPAL SOLID WASTE GENERATION AND DISCARDS

The result of these estimates and calculations is a material-by-material and product-by-product estimate of MSW generation, recovery, and discards.

Appendix B

Table B-1 Source Reduction/Expansion for Individual Components of MSW - 1999 (Thousands of Tons)

Waste Stream by Commodity	Source Reduction / Expansion (based on consumer spending & change in waste generation rate)
Components	
Durable Goods	
Miscellaneous Durables	3,028
Furniture/Furnishings	1,551
Major Appliances	835
Tires	274
Batteries, Lead Acid	120
Small Appliances	(313)
Carpets/Rugs	(206)
Source Reduction Subtotal for Durable Goods	*5,808*
Source Expansion Subtotal for Durable Goods	*(519)*
Net Value Subtotal for Durable Goods	***5,289***
Nondurable Goods	
Newspapers	4,357
Magazines	1,550
Office Paper	1,073
Tissue Paper/Towels	677
Miscellaneous Nondurables	826
Other Nonpackaging Paper	497
Telephone Directories	152
Books	203
Towels, Sheets, Pillowcases	188
Trash Bags	114
Disposable Diapers	373
Plastic Plates/Cups	(23)
Third Class Mail	(350)
Paper Plates/Cups	(43)
Clothing/Footwear	(781)
Other Commercial Printing	143
Source Reduction Subtotal for Nondurable Goods	*10,153*
Source Expansion Subtotal for Nondurable Goods	*(1,197)*
Net Value Subtotal for Nondurable Goods	***8,956***

Containers and Packaging	
Wood Packaging	3,616
Glass Beer/Soft Drink Bottles	2,243
Glass Food/Other Bottles & Jars	1,904
Paper Bag/Sacks	1,638
Glass Wine/Liquor Bottles	939
Plastic-Other Containers	(690)
Aluminum Beer/Soft Drink Cans	574
Steel Beer/Soft Drink Cans	205
Milk Cartons	206
Other Paperboard Packaging	106
Wrapping Papers	150
Steel Food/Other Cans	774
Steel-Other Packaging	33
Other Misc. Packaging	(15)
Plastics-Other Packaging	102
Aluminum-Foils/Closure	70
Aluminum-Other Cans	(23)
Plastic Milk Bottles	33
Plastic Wraps	(463)
Other Paper Packaging	(279)
Plastic Soft Drink Bottles	(314)
Plastic Bags/Sacks	(408)
Folding Cartons	85
Corrugated Boxes	1,518
Source Reduction Subtotal for Containers & Packaging	14,196
Source Expansion Subtotal for Containers & Packaging	(2,192)
Net Value Subtotal for Containers and Packaging	**12,004**

Other Components of MSW Wastes	
Yard Trimmings	20,008
Food Scraps	3,210
Miscellaneous Inorganics	575
Source Reduction Subtotal for Other MSW Wastes	23,793
Source Expansion Subtotal for Other MSW Wastes	0
Net Value Subtotal for Other MSW Wastes	**23,793**
Source Reduction Total for MSW	53,950
Source Expansion Total for MSW	3,908
Net Value Total for MSW	**50,042**

Appendix C

CONSUMER ELECTRONICS IN MUNICIPAL SOLID WASTE

INTRODUCTION

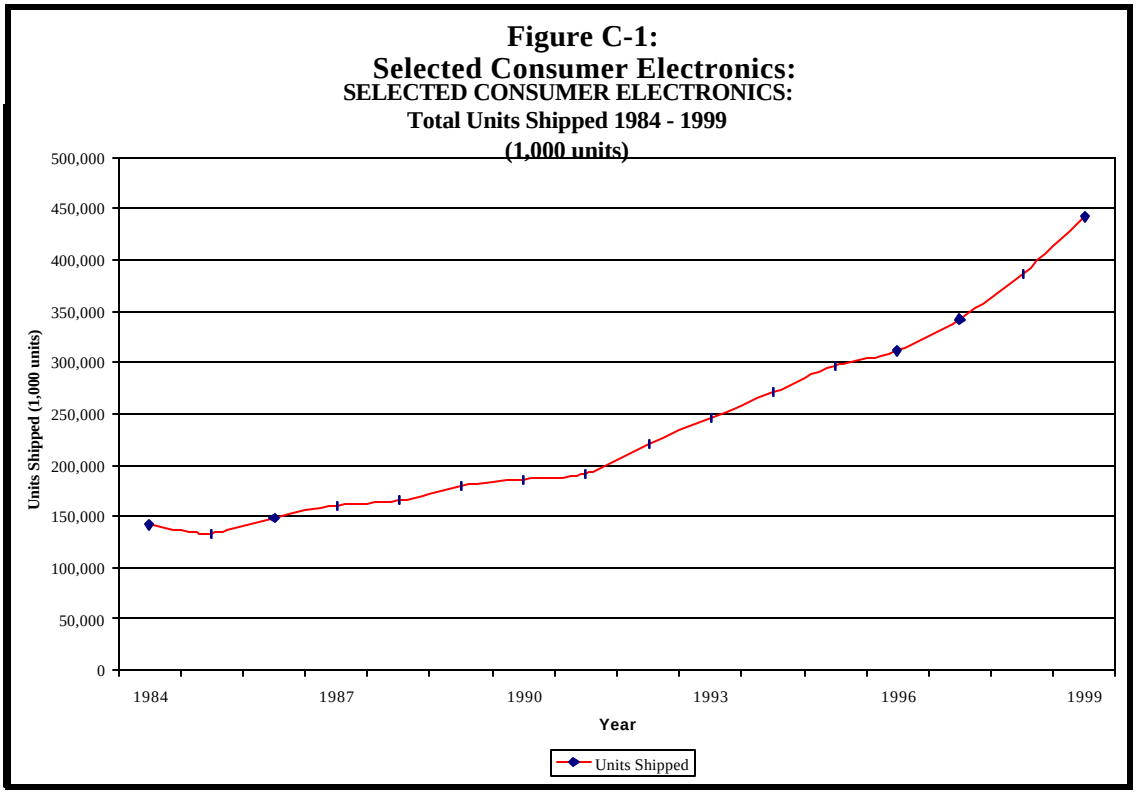
Consumer electronic products (electronics) are a fast growing segment of the municipal solid waste (MSW) waste stream, with increasing opportunities for recycling. Generation of these products is increasing from both residences and commercial establishments. This year, the U.S. Environmental Protection Agency (EPA) has studied consumer electronics to estimate generation, recovery and disposal of these products.

In previous editions of the EPA report, *Characterization of Municipal Solid Waste in the United States*, EPA has included electronics under the category "Miscellaneous Durables," along with other products such as toys, toasters, dishes, and luggage. This year, EPA has broken out consumer electronic products as a separate subcategory under the miscellaneous durables category. The methodology EPA used to collect and analyze data for this appendix on electronics takes into account the lack of national information on this subject. Additionally, this appendix does not have information on all categories of electronic products because of data limitations. Those electronics that are not covered specifically in this appendix are included in the main body of this report in Chapter 2.

Consumer electronic products include electronic products used by residences and commercial establishments such as businesses and institutions. Consumer electronics include video and audio equipment and information age products. Video products are products such as standard televisions (TV), projection TV, high density TV, liquid crystal display TV, videocassette players, VCR decks, camcorders, laserdisc players, digital versatile disc players, TV/personal computer (PC), and video games. Audio products include rack audio systems, compact audio systems, portable compact discs (CD), portable headset audio, total CD players, and home radios. Information products include cordless/corded telephones, wireless telephones, telephone answering machines, facsimile (fax) machines, personal work processors, personal computers, computer printers, computer monitors, modems, and fax modems. Certain other electronics products such as separate audio components are not included because of data limitations.

The rapid growth of consumer electronic sales over the last 15 years, and the relatively short life of these products, has led to their increasing numbers in the waste stream. Management of these wastes is a concern to those governmental officials responsible for the safe handling of solid waste. Additionally, electronics contain valuable components which can be reused and valuable materials which can be recycled. To give an idea of the growth in electronics, Figure 1 depicts the growth of selected consumer electronic product sales since 1984 based on units shipped by manufacturers to retailers. In 1984, less than 150 million units were shipped. The number of units shipped increased to more than 400 million by 1999.

Figure C-1:
Selected Consumer Electronics:



The information on consumer electronics in this report is presented by: (1) material composition (metals, glass, plastic); (2) total generation; (3) total recovery; and (4) total discards for the year 1999. The generation findings are based on 1999 data on sales by manufacturers. As stated earlier, the consumer products quantified in this report include video, audio, and information products. Below, we list the specific electronic products included in this appendix, followed by a discussion of the methodology and data limitations.

CONSUMER ELECTRONICS PRODUCTS INCLUDED IN THIS REPORT

Although the category consumer electronics includes video, audio, and information products, only select electronic products from these categories were included in this appendix due to the limitations in the data. The specific products included in the consumer electronics designation for this appendix were chosen because we were able to obtain data on sales of these products by manufacturers to retailers and large quantity buyers. For example, pagers and radar detectors were not included because the data available were not complete. Some additional items excluded due to inadequate data were: separate audio components, home theater-in-a-box, digital cameras, electronic accessories, and electronic games. For those consumer electronics that are not listed separately within this Appendix, estimates are contained in the "Miscellaneous Durables category in the main body of this report, and in the subcategory, "Other Miscellaneous Durables." Tables 12 to 14 in Chapter 2 of the main report provide this information. Table C-1 below shows the selected consumer electronics addressed in this appendix.

Table C-1
Selected Consumer Electronics

Video Products
TVs
Projection TV
HDTV*
LCD TV
TV/VCR Combinations*
Videocassette Players
VCR Decks
Camcorders
Laserdiscs players
Digital Versatile Disc Players*
TV/PC Combinations*
Audio Products
Rack Audio Systems
Compact Audio Systems
Portable CD
Portable Headset Audio
Total CD Players
Home Radios
Information Products
Cordless/Corded Telephones
Wireless Telephones
Telephone Answering Machines
Fax Machines
Personal Word Processors
Personal Computers
Computer Printers
Computer Monitors
Modems/Fax Modems

*Items not expected to enter the municipal waste stream until after 1999.

METHODOLOGY

Research was conducted to develop a consistent method for estimating generation, recovery for recycling, and discards of consumer electronics on an annual basis. The method relies on data regarding shipments of consumer electronics from manufacturers (adjusted for imports and exports) to retail outlets. The number of units shipped is combined with estimated life span and the average weight of each product entering the municipal waste stream, to estimate generation. Average weights for consumer electronics were estimated after collecting information from catalogs, consumer electronic magazines, and weighing available items. This information was then compared to information from retail shops, repair shops, demanufacturers, recyclers, organizations, and governments to arrive at the figures for composition of the waste after retail sales, recovery for recycling, and discards.

Definition of Terms

The term *generation* as used in this appendix refers to the weight of products as they enter the waste management system from residential and commercial sources and before materials recovery takes place. Primary and secondary life (reuse) takes place ahead of generation. In other words, waste is generated only after the first and any subsequent users of the product are through using the equipment for its original purpose.

Recovery for recycling as estimated in this appendix includes products removed from the waste stream for the purpose of recycling. Product recovery for overseas markets is considered recovery for recycling.

Discards include those consumer electronics or their components that remain after the materials for recycling have been removed. These discards presumably would be incinerated or landfilled in MSW or hazardous waste facilities, although some products are placed into storage.

Data Collection and Research

In addition to the initial manufacturers' shipment data, information was collected regarding the weight, expected life span, and the composition for each type of consumer electronic product analyzed. Numerous research and case study reports were reviewed. Additional information sources included manufacturers, retailers, repair shops, demanufacturers, recyclers, industry organizations and governmental agencies. Table C-2 lists the types of information received from each of these entities.

Table C-2

Consumer Electronics Data Collection

	Information Requested
Manufacturers	Product weights, composition, and life span
Retail Shops	Product weights
Repair Shops	Product composition and life span
Demanufacturers	Product composition and life span
Recyclers	Product composition and life span
Organizations	Information on units shipped
Government	Product weights, composition, and life span

Source: Franklin Associates

Generation

The first step in estimating generation of consumer electronics is to combine the number of units shipped from the manufacturers to retailers, with the estimated life span and the average weight of each product entering the municipal waste stream. The retail sales for the years 1984 through 1999 were obtained from the Consumer Electronics Association (CEA). These data estimate the number of units shipped, adjusted for imports and exports, to U.S. retailers.

Note that the products shipped directly to large consumers from manufacturer or

manufacturers' representatives are not estimated in the CEA data. Therefore, the consumer electronic generation in this report may be underestimated for some products, such as telephones, fax machines, personal word processors, and modems used by large commercial establishments. Additional research *did* allow for an estimate of the direct sales to large commercial establishments of computers, printers, and monitors. As stated previously, consumer electronics not included in the consumer electronic subcategory have been accounted for in the miscellaneous durables category in the main body of this report, in Tables 12 to 14 in Chapter 2.

All consumer electronics included in this study have an estimated life span. This estimate includes primary and when applicable, secondary use of the product. Reuse of consumer electronic products is taken into account in the methodology and is referred to as secondary use of the product. Consumer electronics repair shops provided estimates on life span of all audio and video products. Telephone repair shops provided estimates for cordless/corded telephones and wireless telephones.

Computer and computer monitor life spans were taken from the estimates found in the *Electronic Product Recovery and Recycling Baseline Report* of the National Safety Council. EPA estimated life spans for all other computer peripherals such as personal work processors, printers, and fax/fax modems, based on data gathered from trade associations and businesses.

Table C-3 shows the various life span ranges for the selected consumer electronics. Televisions have the longest expected life span of 13 to 15 years. Wireless telephones have the shortest life span, estimated from two to four years. The methodology for this report assumed an average life span, which was arrived at by taking an average of the range of life expectancy given by manufacturers over a number of years for the number of units shipped and their average weights.

Consumer electronics are categorized as durable products. Consumer electronic life expectancies vary from two years for wireless telephones to 15 years for televisions. In the material flows methodology, generation of consumer electronics is based on shipment data, adjusted for the individual life span of individual products. For example, assuming a 13 to 15 year life expectancy for televisions, 1985 to 1987 shipment data are the basis for 1999 generation of televisions into the waste stream. The generation estimate is based on the average number of shipments recorded in those three years. The generation of other consumer electronics is estimated similarly based on the expected life of the individual products. Generation of consumer electronics in the waste stream is the summation of the individual product estimates.

The ranges shown in Table C-3 represent both the primary and secondary uses of the products. As previously described, the secondary life or reuse of a product takes place before a product enters the solid waste stream.

Table C-3

Estimated Life Of Selected Consumer Electronics
(in years)

	Range of Primary and Secondary Use (Reuse) Life Expectancy
Video Products	
Direct View Color TV	13 to 15
Projection TV	13 to 15
LCD Color TV	13 to 15
Videocassette Players	7 to 10
VCR Decks	7 to 10
Camcorders	7 to 10
Laserdisc Players	7 to 10
Audio Products	
Rack Audio System	3 to 15
Compact Audio System	3 to 15
Portable CD	3 to 15
Portable Headset Audio	3 to 15
Total CD Players	3 to 15
Home Radios	3 to 15
Information Products	
Cordless/Corded Telephones	3 to 6
Wireless Telephones	2 to 4
Telephone Answering Machines	3 to 6
Fax Machines	3 to 6
Personal Word Processors	3 to 6
Personal Computers	3 to 6
Computer Printers	3 to 5
Computer Monitors	6 to 7
Modem/Fax Modems	3 to 6

Source: Franklin Associates

The average weights for the selected consumer electronics were estimated for the years 1984 through 1999. This series was developed to account for those products with a life span of 15 years. Since consumer electronics sold in 1999 do not represent the consumer electronics currently entering the waste stream, a time series must be developed based on expected life spans.

Average weights for consumer electronics were estimated after collecting information from catalogs, consumer electronic magazines, and weighing available items. If weights for a specific product and year were not found, average weights were extrapolated from existing estimates. For example, camcorder weights were found for the years 1985, 1990, 1995, and 1998. Camcorder weights for the other years were estimated from these weights.

The average weights for 1999 were based on information from retail outlets and retail manufacturers' Web sites.

Retail sources also provided national market data on the number of each size of television sold. Due to the wide range of sizes, a weighted average was developed from retail sources for televisions using weight information for each size of television adjusted for market share.

All other average weights were estimated after collecting as many weights as possible from the sources listed above for each size and style of product. Market share data were not available for the other products.

Data received from the various information sources were combined to estimate the material composition of the selected consumer electronic products. The primary sources used to estimate composition data included:

- *The Recycling and Demanufacturing of Computers and Electronic Equipment in Pasco County, Florida;*
- *End-of-Life Electronic Equipment Pilot Program Summary Report* - Alachua County, Florida;
- Information provided by the Minnesota Office of Environmental Assistance;
- *Analysis of Five Community Consumer/Residential Collections End-Of-Life Electronic and Electrical Equipment;*
- Information provided by the National Recycling Coalition; and
- Discussions with repair shop personnel, recyclers, and demanufacturers.

Information on composition for the selected consumer electronics included products from several different years. Since the composition estimates were developed from recovery data, it was assumed that the data represented a mix of products from various years. Therefore the composition for each specific consumer electronic product was assumed to be the same for the entire data series.

Recovered for Recycling

Once consumer electronics have gone through their primary use and secondary use (reuse), they can be recovered through a collection program and transported to a demanufacturer to be dismantled in order to retrieve their reusable components to be recycled into new products. Figure C-2 is a flow chart of electronics from use through recycling. Recovery may occur through a local collection program, such as a one-day collection event or ongoing collection at a permanent site. Some generators may have the option of taking consumer electronics directly to a demanufacturer or a private recycler. Other consumer electronic products are left at repair shops or traded for new products through retailers or manufacturers. Repair shops will typically remove any usable parts before recycling and/or discarding. Demanufacturers recycle the products into raw material and into salvaged parts for repair. Those parts that cannot be recycled are to be disposed of by the demanufacturer in accordance with federal, state, and local environmental laws and regulations.

Table C-4
Total Generation of Consumer Electronics by Material
In the Municipal Waste Stream
(%)

Type of Consumer Electronics	Steel	Copper & Brass	Alumi-num	Lead	Other Metals	Glass	Wood	Plastic	Other
Video Products	22%	3%	0%	7%	10%	27%	20%	11%	0%
Audio Products	21%	0%	0%	0%	30%	0%	3%	46%	0%
Information Products	29%	5%	5%	2%	5%	7%	0%	45%	2%
Total	25%	3%	2%	4%	11%	14%	9%	31%	1%

Source: Franklin Associates

According to System Service Industry, a demanufacturer in Illinois, 95 to 100 percent of the consumer electronics collected could be recycled. However, it is contended that in order for this high recovery to be cost effective, 40 to 50 percent of the products, including low-grade material and plastics, must be sent overseas for further processing, due to lower labor costs overseas. All recycling operations could occur in the United States but at a higher cost.

Although there has been an increase in collection programs throughout the country that divert old and outdated consumer electronics from disposal, there is no central repository and no systematic collection of recovery data. The recovery estimates in this appendix are therefore first-cut estimates. In this appendix, recovery estimates rely upon the information in the National Safety Council's *Electronic Product Recovery and Recycling Baseline Report; Recycling of Selected Electronic Products in the United States* for TVs, computers, and monitors. For these products, as well as for word processors and printers, data from written reports is supplemented by personal communication with state government experts, representatives of trade associations, and representatives of businesses, for word processors and printers.

Discards After Recovery

Since recycling of consumer electronics is in its infancy, the majority of the consumer electronic waste generated will be discarded to landfills and incinerators. Some electronics, however, at least temporarily are placed into storage in warehouses, closets, basements, and garages. Storage of consumer electronics is something that exists but is difficult to quantify. This storage could affect the final discard figures. This methodology assumes consumer electronics are leaving storage at the same rate they are entering storage. Discard estimates in this analysis are derived by subtracting the recovery rates from the generation rates.

RESULTS

Composition of Consumer Electronic Products

The composition by material of the selected consumer electronic products generated is summarized in Table C-4.

Video Products: Video products are composed of 21 percent steel, 27 percent glass, and 23 percent plastic. Televisions make up a large portion of this category. The Cathode Ray Tube (CRT) is the major source of the glass and steel. Plastic is the major component in the frame housings of video products. Lead, which accounts for 8 percent of the material generated from video products, comes from the CRTs. The source of the remaining material is from the circuit board, wiring and other small miscellaneous items.

Audio Products: Audio products contain 50 percent steel and other metals, 35 percent plastic, and 15 percent wood. Usually, the audio products are cased in plastic frame housings that contain the steel and other metals.

Information Products: About 45 percent of the plastic in information products is in the frame housings; however, in many cases, this percentage can be much higher. For example corded/cordless telephones, wireless phones, and answering machines were reported to composed primarily of plastic. Steel is estimated at 29 percent of the information products. Steel plus all of the other metals except lead equals 44 percent. Lead, from the computer monitors, makes up 2 percent of total generation.

Total selected consumer electronic products: have an estimated composition of 24 percent steel, 21 percent other metals, 14 percent glass, 6 percent wood, 34 percent plastic, and 1 percent other material.

Table C-5 summarizes total generation, recovery for recycling and discards of video, audio, and information products. Here are the highlights:

Figure C-2: Life Cycle for Consumer Electronics

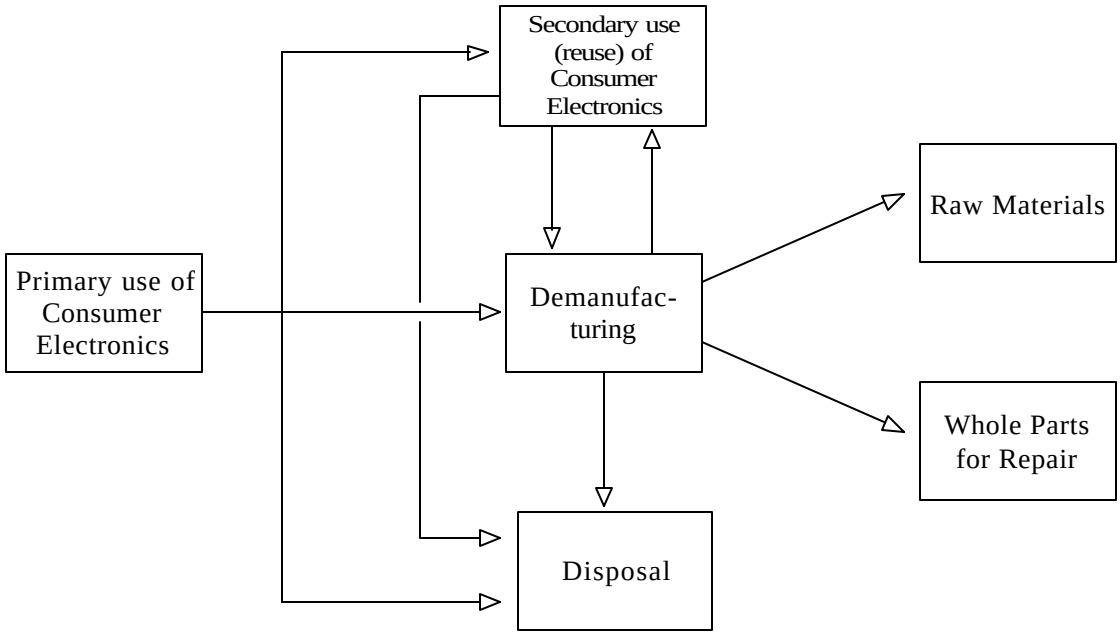


Table C-5

Generation, Recovery, And Discards Of Consumer Electronics In The Municipal Waste Stream 1999

(in tons)

Type of Consumer Electronics	Total Generation	Total Recovery	% Recovered	Total Discards
Video Products	725,400	1,050	0.1%	724,350
Audio Products	302,000	Neg.	Neg.	302,000
Information Products	730,700	156,300	21%	574,400
Total	1,758,100	157,350	9%	1,600,750

Source: Franklin Associates

Generation: In 1999, it is estimated that 1,758,100 tons of these selected consumer electronic products were generated. Included in this total are 725,400 tons of video products, 302,000 tons of audio products, and 730,700 tons of information products.

Recovery: Table C-5 shows that recovery for recycling is estimated to be 1,050 tons of video products and 156,300 tons of information products. Less than one percent of the video products is estimated to be recovered. The information products recovery is estimated at 21 percent of generation. Recovery of audio products is assumed to be negligible. Total recovery of the selected consumer electronic products is estimated at 157,350 tons or nine percent of total generation.

Discards: Final discards of the three categories is 1,600,750 tons or 91 percent of generation.

The EPA report *Characterization of Municipal Solid Waste in the United States: 1998 Update* and earlier editions have included consumer electronics as part of the larger category "Miscellaneous Durables." Table C-6 separates the selected consumer electronic product category from the miscellaneous durables category. Generation of the selected consumer electronics is estimated at 13 percent of total miscellaneous durables generation, 20 percent of the recovery for recycling and 12 percent of the discards.

Generation of selected consumer electronic products is estimated at less than one percent of total MW generation and less than one half of one percent of recovery. Selected consumer electronics is estimated to be 1 percent of total MSW discards.

Although the weight of the selected consumer electronics that enter the waste stream is only estimated at 1 percent of total MSW discards, some of these products do present a problem. Television CRTs and monitors, which contain lead, are, for the most part, discarded into U.S. landfills. Besides lead, other hazardous materials that may be found in consumer electronics include cadmium, hexavalent chromium, mercury and brominated flame-retardant materials.

Table C-6
Selected Consumer Electronics
As a Percentage of Total Miscellaneous Dureable Goods
and Total MSW, 1999
(1,000 Tons)

	Generation	Recovery	Recovery % of Generation	Discards
Selected Consumer Electronics	1,760	160	9%	1,600
Miscellaneous Durable Goods	12,220	650	5%	11,570
Total Miscellaneous Durable Goods	13,9890	810	6%	13,170
Consumer Electronics as % of Misc. Durable Goods	13%	20%		12%
Total MSW	229,850	63,890	28%	165,960
Consumer Electronics as % of Total MSW	0.8%	0.3%		1.0%

Source: Franklin Associates

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