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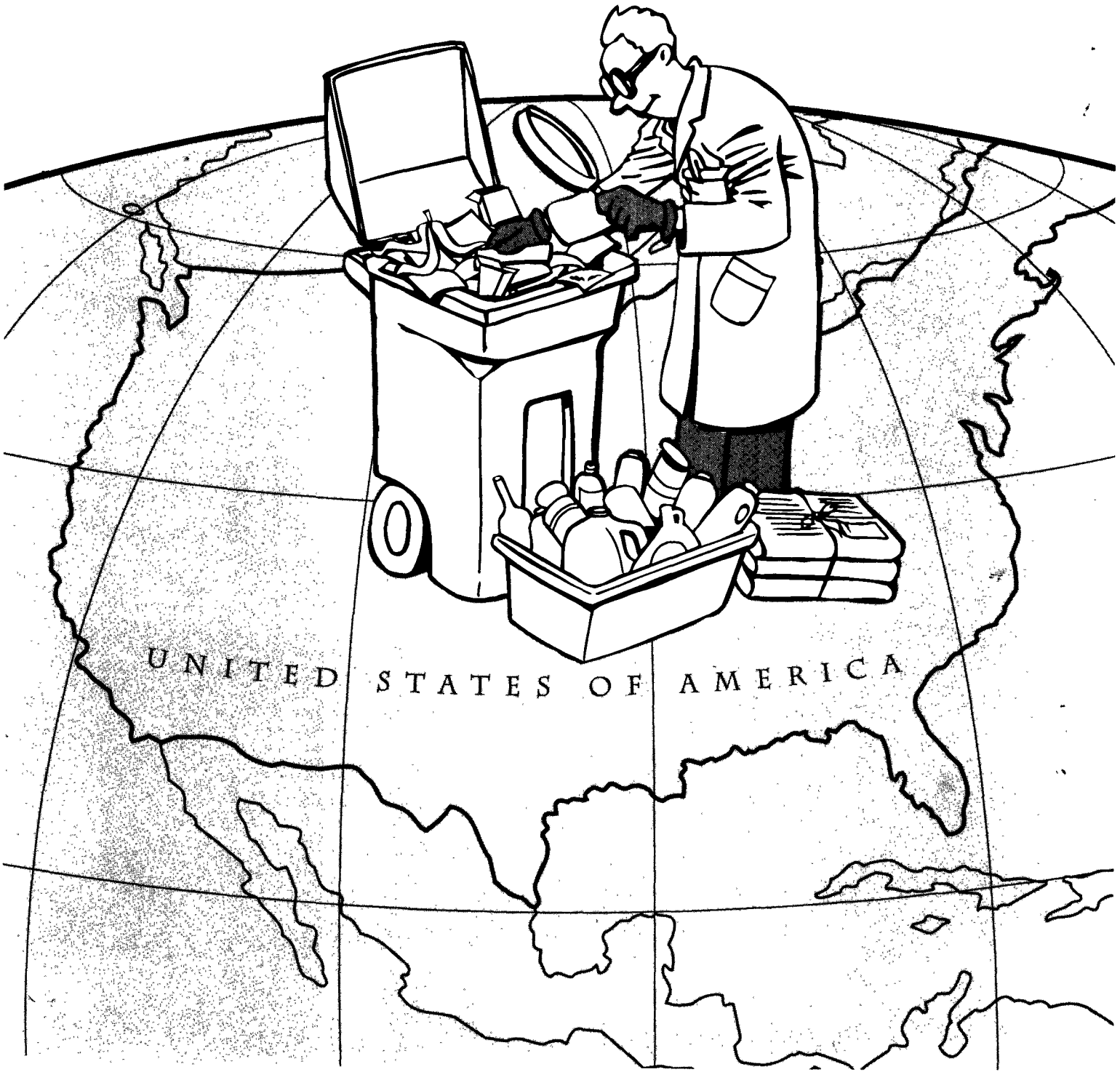
Characterization of Municipal Solid Waste in the United States: 1994 Update



CHARACTERIZATION OF MUNICIPAL SOLID WASTE IN THE UNITED STATES 1994 UPDATE

Prepared for

U.S. Environmental Protection Agency
Municipal and Industrial Solid Waste Division
Office of Solid Waste

November 15, 1994

CHARACTERIZATION OF MUNICIPAL SOLID WASTE IN THE UNITED STATES: 1994 UPDATE

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OMB Control Number 2010-0023

CHARACTERIZATION OF MSW IN THE U.S. CUSTOMER FEEDBACK FORM

The EPA Office of Solid Waste would like to hear from you about ways in which we can improve the information we bring to you in this report. Please answer the following questions and send or fax this form back to EPA. (The address and fax number are on the back of the form.) Thank you.

1. What in the report was most helpful to you?

2. What should we be adding that would be helpful to you?

3. Would you be interested in understanding more about the methodologies and calculations used to put together this report?

4. What other types of materials would you like to see characterized in the report?

5. Can you suggest alternative methods of estimating certain waste streams?

6. Are there particular areas that should be expanded or deemphasized?

7. Have you found this document to be a useful tool for planning or making projections regarding local waste management programs?

8. Have you found typographical/calculation errors that should be corrected?

Burden Statement: The average burden is estimated to be 5-10 minutes per respondent.

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CHARACTERIZATION OF MUNICIPAL SOLID WASTE IN THE UNITED STATES: 1994 UPDATE

Executive Summary

Management of the nation's municipal solid waste (MSW) continues to be a high priority issue for many communities as we near the turn of the century. Increasingly, the concept of integrated solid waste management—source reduction of wastes before they enter the waste stream, recovery of generated wastes for recycling and 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.

There are many regional variations that require each community to examine its own waste management needs. Such factors 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.

Identifying the components of the waste stream is an important step toward addressing the issues associated with the generation and management of municipal solid wastes. MSW characterizations, which analyze the quantity and composition of the municipal solid waste stream, involve estimating how much MSW is generated, recycled, combusted, and disposed of in landfills. By determining the makeup of the waste stream, waste characterizations also provide valuable data for setting waste management goals, tracking progress toward those goals, and supporting planning at the national, state, and local levels. For example, waste characterizations can be used to highlight opportunities for source reduction and recycling and provide information on any special management issues that should be considered.

Readers should note that this report characterizes the municipal solid waste stream of *the nation as a whole.* Local and regional variations are not addressed, but suggestions for use of the information in this report by local planners are included in Chapter 1.

FEATURES OF THIS REPORT

This report is the most recent in a series of reports released by the U.S. Environmental Protection Agency (EPA) to characterize MSW in the United States. It characterizes the national waste stream based on data through 1993 and includes:

- Information on MSW generation from 1960 to 1993
- Information on MSW management—recovery for recycling and composting, combustion, and landfilling—from 1960 to 1993
- A discussion of the role of source reduction in MSW management
- Information on the relationship of MSW generation to population and economic activity
- Information characterizing MSW by volume as well as by weight
- Projections for MSW generation to the year 2000
- Projections for MSW combustion through 2000
- Projections (presented in three recovery scenarios) for materials recovery for recycling and composting through 2000.

DEFINITIONS

Municipal solid waste 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. Examples of waste from these categories include appliances, automobile tires, newspapers, clothing, boxes, disposable tableware, office and classroom paper, wood pallets, and cafeteria wastes. MSW does not include wastes from other sources, such as construction and demolition wastes, automobile bodies, municipal sludges, combustion ash, and industrial process wastes that might also be disposed in municipal waste landfills or incinerators.

Source reduction activities reduce the amount or toxicity of wastes before they enter the municipal solid waste management system (see **Generation**). Reuse of products such as refillable glass bottles or refurbished wood pallets is counted as source reduction, not recovery for recycling.

Generation refers to the amount (weight, volume, or percentage of the overall waste stream) of materials and products as they enter the waste stream and before materials recovery, composting, or combustion takes place.

Recovery of materials includes materials or yard trimmings removed from the waste stream for the purpose of recycling or composting. Recovery for recycling as defined for this report includes purchases of postconsumer recovered materials plus exports of the materials. Recovery of yard trimmings includes those materials received at a composting facility. For some materials, recovery for uses such as highway construction or insulation is counted as recovery along with materials used in remanufacturing processes.

Combustion includes combustion of mixed MSW, fuel prepared from MSW, or a separated component of MSW (such as rubber tires), with or without energy recovery.

Discards include the municipal solid waste remaining after recovery for recycling and composting. These discards are usually combusted or disposed of in landfills, although some MSW is littered, stored, or disposed on site, particularly in rural areas.

By presenting three possible scenarios for recovery in the year 2000, this report illustrates how various recovery rates (25, 30, and 35 percent) could be achieved. States and local communities can set their own goals and recovery scenarios depending upon their local situations.

METHODOLOGY

There are two primary methods for conducting a waste characterization study. The first is a source-specific approach in which the individual components of the waste stream are sampled, sorted, and weighed. Although this method is useful for defining a local waste stream, extrapolating from a limited number of studies can produce a skewed or misleading picture if used for a nationwide characterization of waste. Any errors in the sample or atypical circumstances encountered during sampling would be greatly magnified when expanded to represent the nation's entire waste stream.

The second method, used in this report to estimate the waste stream on a nationwide basis, is called the "material flows methodology." EPA's Office of Solid Waste and its predecessors in the Public Health Service sponsored work in the 1960s and early 1970s to develop the material flows methodology. This methodology is based on production data (by weight) for the materials and products in the waste stream, with adjustments for imports, exports, and product lifetimes.

REPORT HIGHLIGHTS

This report demonstrates that the generation of municipal solid waste continues to increase steadily, both in overall tonnage and in pounds per capita. There is some evidence that source reduction measures, particularly efforts to keep yard trimmings out of the waste management system, are beginning to have an effect. Increasing recovery of materials in MSW for recycling and composting is leading to a decline in the percentage of MSW being sent to disposal facilities. Major findings include the following:

- **In 1993, 207 million tons, or 4.4 pounds per person per day, of MSW were generated.** After materials recovery for recycling and composting, discards were 3.4 pounds per person per day. Virtually all of these discards were combusted or sent to landfills.

- **For the first time, EPA projects that the per capita generation rate will decrease by the year 2000 to 4.3 pounds per person per day.** These projections are based in part on source reduction efforts, especially actions to divert yard trimmings from the solid waste management system through backyard composting and leaving grass clippings on lawns. States that include more than half of the U.S. population already have regulations leading to these actions. Other source

reduction activities, e.g., reduced packaging, are also contributing to this decrease.

- **Even with significant source reduction efforts, generation of MSW is projected to increase to 218 million tons in 2000. However, discards to combustion facilities or landfills are projected to decline from 162 million tons in 1993 to 152 million tons in 2000 assuming a 30 percent recovery rate for recycling and composting is achieved.**

- **Recovery of materials for recycling and composting was estimated to be 22 percent of MSW generated in 1993, up from 17 percent in 1990, continuing the impressive growth of recent years.** Combustion facilities managed 16 percent of total generation, and the remaining 62 percent of the municipal solid waste stream was sent to landfills or otherwise disposed.

- **Between 1990 and 1993, recovery of materials for recycling and composting increased from 38 million tons to 45 million tons, an increase of 18 percent.** Recovery of paper and paperboard accounted for over half of this increased tonnage. Yard trimmings for composting contributed the next largest increase in tonnage recovered.

- **The percentage of MSW discards continues to decline due to increased levels of recovery for recycling and composting.** In 1985, 83 percent of MSW was landfilled compared to 62 percent landfilled in 1993. Even with this reduction, landfilling continues to be the single most predominant waste management method into the year 2000.

MUNICIPAL SOLID WASTE IN 1993

Materials in MSW

In 1993, generation of municipal solid waste totaled 207 million tons. A breakdown by weight of the *materials* generated in MSW in 1993 is shown in Figure ES-1 and Table ES-1. Paper and paperboard products are the largest component of municipal solid waste by weight (38 percent of generation) and yard trimmings are the second largest component (16 percent of generation). Five of the remaining materials in MSW—glass, metals, plastics, wood and food wastes—range between 6 and 9 percent each by weight of total MSW generated. Other materials in MSW include rubber and leather, textiles, and small amounts of miscellaneous wastes, which each made up approximately 3 percent of MSW in 1993.

Figure ES-1. Materials generated in MSW by weight, 1993
(Total weight = 206.9 million tons)

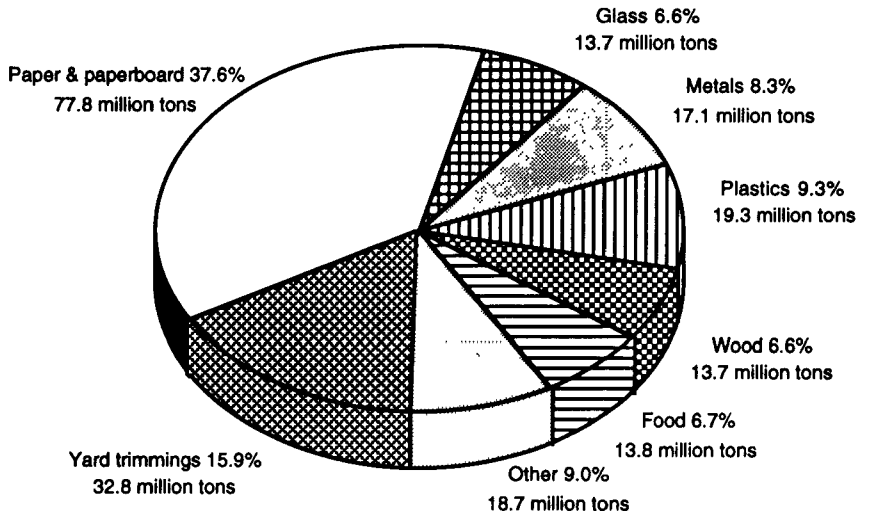


Table ES-1

GENERATION AND RECOVERY OF MATERIALS IN MSW, 1993
(In millions of tons and percent of generation of each material)

	Weight Generated	Weight Recovered	Percent of Generation
Paper and paperboard	77.8	26.5	34.0%
Glass	13.7	3.0	22.0%
Metals			
Ferrous metals	12.9	3.4	26.1%
Aluminum	3.0	1.1	35.4%
Other nonferrous metals	1.2	0.8	62.9%
Total metals	17.1	5.2	30.4%
Plastics	19.3	0.7	3.5%
Rubber and Leather	6.2	0.4	5.9%
Textiles	6.1	0.7	11.7%
Wood	13.7	1.3	9.6%
Other materials	3.3	0.7	22.1%
Total Materials in Products	157.3	38.5	24.5%
Other Wastes			
Food Wastes	13.8	Neg.	Neg.
Yard Trimmings	32.8	6.5	19.8%
Miscellaneous Inorganic Wastes	3.1	Neg.	Neg.
Total Other Wastes	49.7	6.5	13.1%
TOTAL MUNICIPAL SOLID WASTE	206.9	45.0	21.7%

Includes wastes from residential, commercial, and institutional sources.
Neg. = Less than 50,000 tons or 0.05 percent.
Numbers in this table have been rounded to the first decimal place.

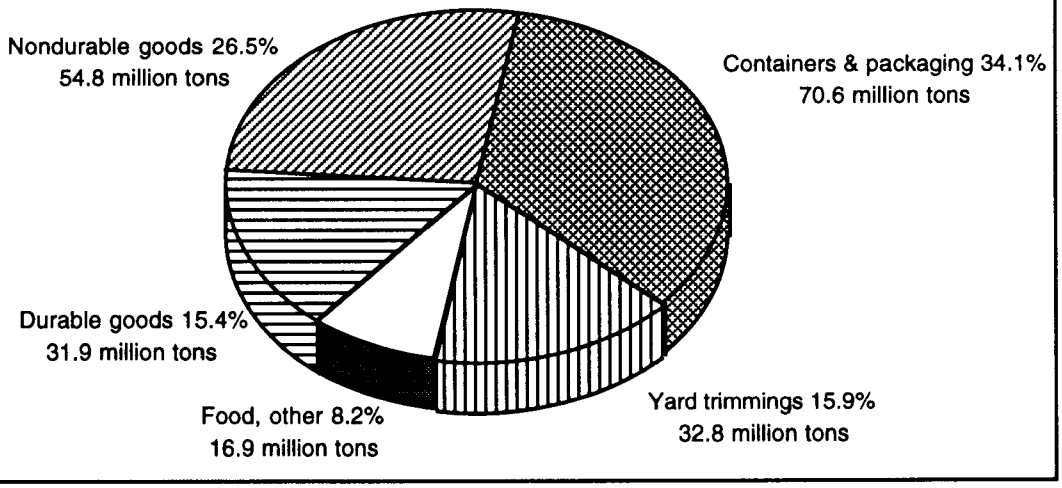
Most of the materials in MSW have some level of recovery for recycling or composting. This is illustrated for 1993 in Table ES-1. Since each material category (except for food wastes and yard trimmings) is made up of many different products, some of which may not be recovered at all, the overall recovery rate for any particular material will be lower than recovery rates for some products within the materials category.

The highest recovery rate shown in Table ES-1 is that for nonferrous metals other than aluminum (63 percent of generation). This is because the lead in lead-acid batteries is recovered at very high rates. Aluminum is recovered at approximately 35 percent of generation overall, even though aluminum cans are recovered at rates above 60 percent. Likewise, the overall recovery rate for paper and paperboard is 34 percent, even though corrugated containers are recovered at rates above 50 percent.

Products in MSW

The many products in MSW are grouped into three main categories: durable goods (for example, appliances), nondurable goods (for example, newspapers), and containers and packaging (Figure ES-2). The materials in MSW are generally made up of products from each category. There are exceptions, however. The durable goods category contains no paper and paperboard. The nondurable goods category includes only small amounts of metals and essentially no glass or wood. The containers and packaging category includes only very small amounts of rubber, leather, and textiles.

Figure ES-2. Products generated in MSW by weight, 1993 (Total weight = 206.9 million tons)



Generation and recovery of the product categories in MSW, broken down by materials within each category, are shown in Table ES-2. Overall, the materials in durable goods were recovered at a rate of approximately 13 percent in 1993. The non-ferrous metals were recovered at a rate of approximately 63 percent because of the high rate of recovery of lead-acid batteries. (The recovery of these batteries also accounts for the high rate of recovery of "other materials," which are the non-lead components of the batteries.) Considerable amounts of ferrous metals are recovered from appliances in the durables category, and some rubber is recovered from tires.

Overall recovery in the nondurable goods category was estimated to be 21 percent in 1993. In this category, large amounts of newspapers, office papers, and some other paper products are recovered.

Recovery from the containers and packaging category is the highest of these categories—33 percent of generation. Aluminum was recovered at over 53 percent in 1993 (mostly aluminum beverage cans), while steel (mostly cans) was recovered at over 46 percent. Paper and paperboard recovery was estimated at 44 percent overall in 1993, with corrugated containers accounting for most of that tonnage. Glass containers were estimated to have been recovered at 25 percent overall, while wood packaging (mostly pallets) was estimated to have been recovered at 14 percent of generation. Plastic containers and packaging were estimated to have been recovered at an overall rate of 6 percent in 1993, with most of the recovered plastics being soft drink bottles and milk and water bottles.

Management of MSW

The breakdown of how much waste went to recycling and composting, combustion, and landfills in 1993 is shown in Figure ES-3. Recovery of materials for recycling and composting was estimated to have been 45 million tons, or 22 percent of generation, in 1993. Combustion of MSW (nearly all with energy recovery) was estimated to have been 33 million tons, or 16 percent of generation, in 1993. The remainder, 129 million tons of MSW (62 percent of generation), was assumed to have been landfilled (although small amounts may have been littered or self-disposed, e.g., on farms).

Recovery for recycling remained at relatively low levels—9 to 10 percent of MSW generation—well into the decade of the 1980s. In the late 1980s, people nationwide realized that new approaches to solid waste management were needed, and recovery for recycling and composting began to increase. Recovery rates have increased from 13 percent in 1988 to 17 percent in 1990 to 22 percent in 1993 (Figure ES-4).

Table ES-2

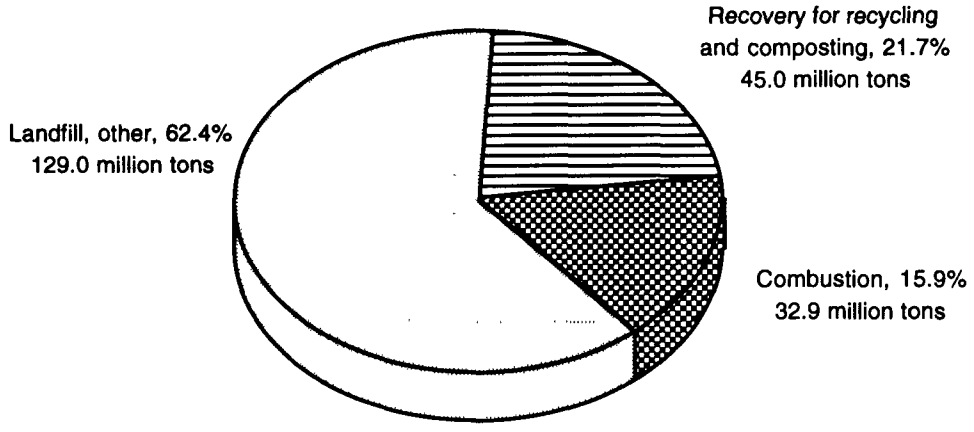
GENERATION AND RECOVERY OF PRODUCTS IN MSW BY MATERIAL, 1993

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

	Weight Generated	Weight Recovered	Percent of Generation
Durable goods			
Ferrous metals	10.0	2.0	20.0%
Aluminum	0.8	Neg.	Neg.
Other non-ferrous metals	1.2	0.8	62.9%
Total metals	12.0	2.8	23.1%
Glass	1.4	Neg.	Neg.
Plastics	6.3	0.2	2.4%
Rubber and leather	5.2	0.4	7.1%
Wood	4.2	Neg.	Neg.
Textiles	1.8	Neg.	1.7%
Other materials	1.0	0.7	76.0%
Total durable goods	31.9	4.1	12.7%
Nondurable goods			
Paper and paperboard	42.4	10.8	25.4%
Plastics	4.6	Neg.	<1%
Rubber and leather	1.0	Neg.	Neg.
Textiles	4.3	0.7	16.2%
Other materials	2.5	Neg.	Neg.
Total nondurable goods	54.8	11.5	21.0%
Containers and packaging			
Steel	3.0	1.4	46.3%
Aluminum	2.0	1.1	53.3%
Total metals	5.0	2.4	49.1%
Glass	12.2	3.0	24.6%
Paper and paperboard	35.4	15.7	44.2%
Plastics	8.4	0.5	6.1%
Wood	9.5	1.3	13.9%
Other materials	0.1	Neg.	Neg.
Total containers and packaging	70.6	22.9	32.5%
Other wastes			
Food wastes	13.8	Neg.	Neg.
Yard trimmings	32.8	6.5	19.8%
Miscellaneous inorganic wastes	3.1	Neg.	Neg.
Total other wastes	49.7	6.5	13.1%
TOTAL MUNICIPAL SOLID WASTE	206.9	45.0	21.7%

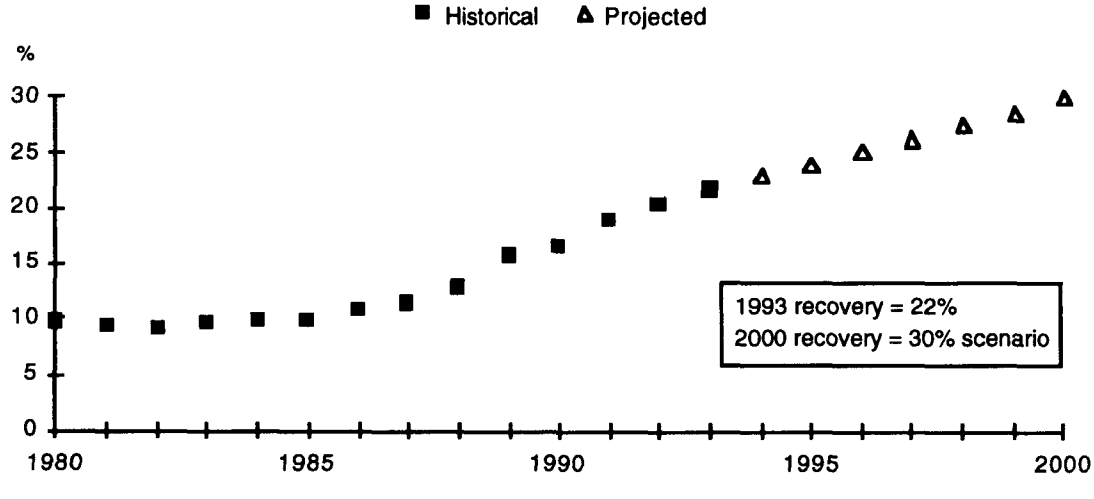
Includes wastes from residential, commercial, and institutional sources.
Neg. = less than 50,000 tons or 0.05 percent.
Numbers in this table have been rounded to the first decimal place.

Figure ES-3. Management of MSW in U.S., 1993
(Total weight = 206.9 million tons)



For this report, EPA looked at a range of recovery scenarios from 25 percent to 35 percent nationwide for the year 2000. A mid-range projected scenario of 30 percent in the year 2000 was used to illustrate the effects of recovery on future municipal solid waste management. To achieve this level of recovery, it was assumed that local, state, and federal agencies will continue to emphasize recycling and composting as a priority; that industries will continue

Figure ES-4. Recovery for recycling and composting
(in percent of total MSW generation)



to make the necessary investments in recovery and utilization of materials; that state and local governments will continue to expand programs designed to keep yard trimmings out of landfills; and that most U.S. citizens will have access to some sort of recovery program by the year 2000.

Source Reduction

Source reduction activities include the design, manufacture, purchase, or use of materials (such as products and packaging) to reduce the amount or toxicity of trash before it reaches the point of generation and enters the municipal solid waste management system. Source reduction activities include:

- Designing products or packages so as to reduce the quantity of materials or the toxicity of the materials used
- Reducing amounts of products or packages used through modification of current practices
- Reusing products or packages already manufactured
- Lengthening the life of products to postpone disposal
- Managing non-product organic wastes (food wastes, yard trimmings) through on-site composting or other alternatives to disposal.

While most source reduction activities were not quantified in this report, calculations were made showing that yard trimmings generation could be reduced 30 percent or more by the year 2000 if current and planned state and local programs to reduce disposal of yard trimmings are implemented.

MSW Volume Estimates

Although solid waste is usually characterized by weight, information about volume is important for such issues as determining how quickly landfill capacity is being filled and identifying the rates at which the volumes of various materials in the waste stream are changing.

Volume estimates of solid waste are, however, far more difficult to make than weight estimates. A pound of paper is a pound of paper whether it is in flat sheets, crumpled into a wad, or compacted into a bale, but the volume occupied in each case will be very different. The estimates presented here represent the relative volume of materials as they would typically be found if compacted individually in a landfill (a significant amount of compaction occurs in a landfill). These estimates are based largely on empirical data that are then used to estimate density factors (pounds per cubic yard) for components of solid waste

under simulated landfill conditions, with corroboration from actual landfill studies. It should be noted, however, that individual component density measurements serve only to compare component volume requirements, one to another. The component measurements should *not* be used to estimate landfill densities of mixed municipal solid waste.

Figure ES-5 shows the materials in MSW by volume as a percentage of total MSW discards (after recovery) in 1993. The paper and paperboard category ranks first in volume of MSW discarded (30 percent). Plastics rank second in volume, at 24 percent of the total, and yard trimmings are third, at 8 percent. Paper and plastics combined accounted for over one-half of the volume of MSW discarded in 1993.

Figure ES-5. Landfill volume of materials in MSW, 1993 (in percent of total)

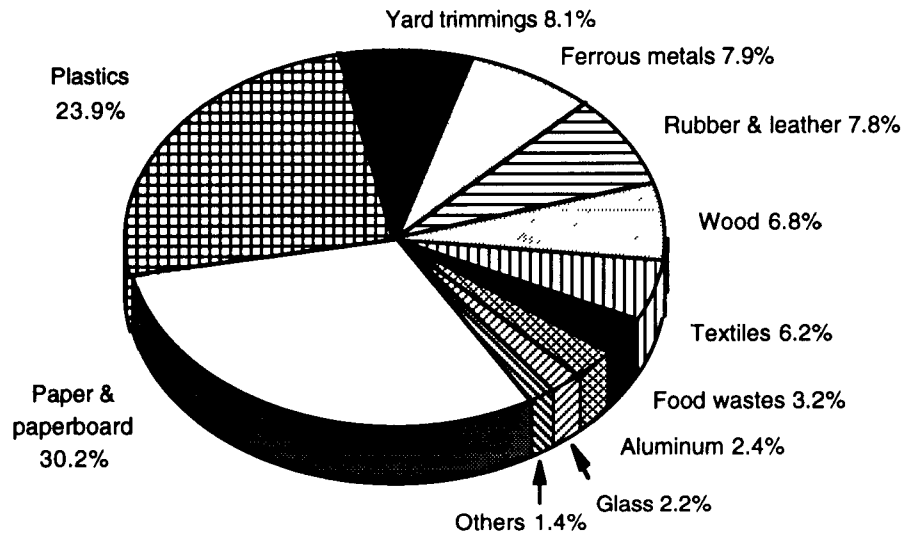
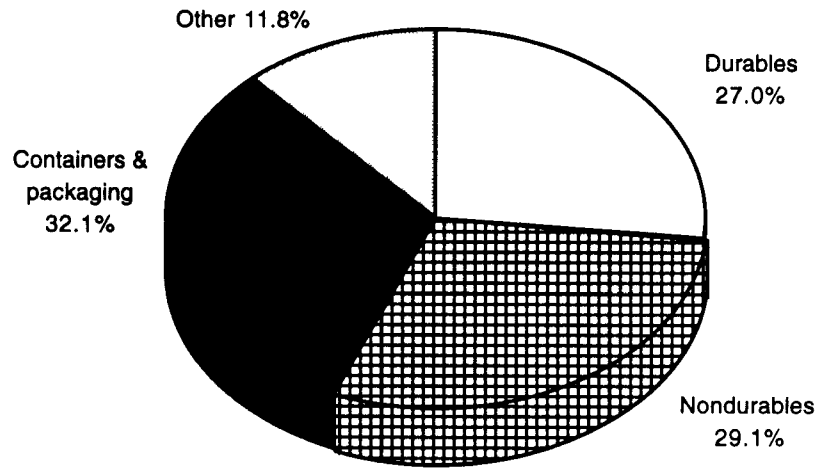


Figure ES-6 shows the product categories that made up MSW by volume of total discards in 1993. Containers and packaging were 32 percent of discards after recovery for recycling and composting, while nondurable goods were 29 percent of discards. Durable goods were an estimated 27 percent of MSW discards volume, while other materials (mostly yard trimmings and food wastes) were approximately 12 percent of discards by volume.

Figure ES-6. Landfill volume of products in MSW, 1993 (in percent of total)



ADDITIONAL PERSPECTIVES ON MSW

Per Capita Generation of MSW

Generation of MSW by individuals is an important parameter used by solid waste management planners. During the period 1960 to 1993, per capita generation of MSW increased steadily from 2.7 pounds per person per day to 4.4 pounds per person per day. During the period 1993 to 2000, per capita generation of products (including packaging) is projected to continue to increase if present trends continue. The per capita generation of yard trimmings is, however, projected to decline if current source reduction activities at the state and local levels continue. Overall, this could mean a decline in per capita generation from 4.4 pounds per person per day in 1993 to 4.3 pounds per person per day in 2000.

Residential and Commercial Sources of MSW

The sources of MSW as characterized in this report include both residential and commercial locations (commercial locations include institutions such as schools and some industrial sites where packaging is generated). The source where the MSW is generated is highly relevant to management techniques, including collection for disposal and collection for purposes of recycling or composting.

For this report, estimates of residential and commercial generation of MSW were made. Residential wastes (including wastes from multi-family

dwellings) are estimated to be 55 to 65 percent of total generation, with commercial wastes ranging between 35 and 45 percent of generation. Local and regional factors such as climate and level of commercial activity contribute to the variations.

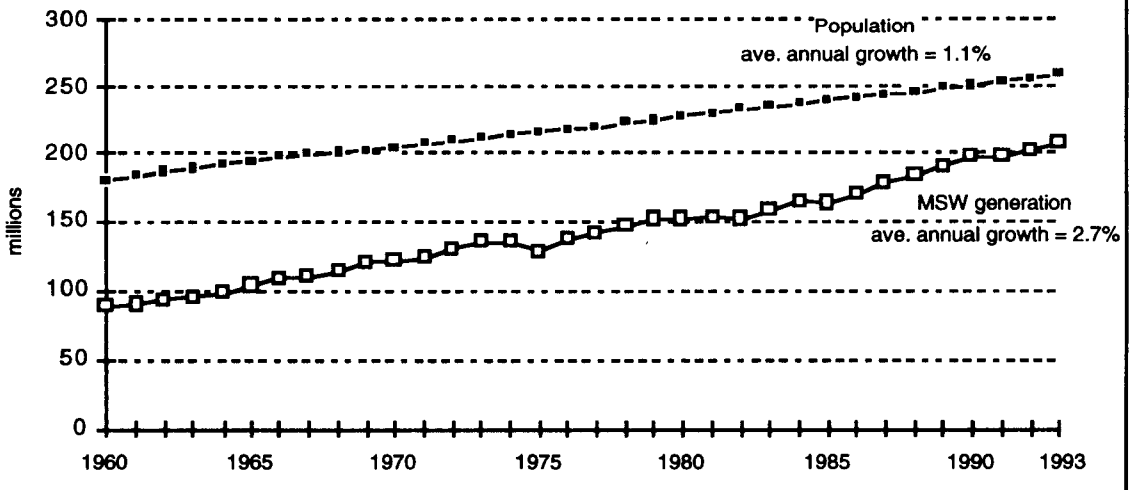
Factors Affecting MSW Generation

For the first time in this series of reports, the correlation of historical MSW generation with factors such as population and economic activity was analyzed. Increasing population clearly contributes to increasing generation of MSW. In statistical language, the correlation coefficient (r) between MSW generation and population from 1960 to 1993 is 0.99, a high degree of correlation.

Population is not the only factor leading to increased MSW generation; historical trends show that MSW generation has been increasing more rapidly than population (Figure ES-7). While average annual population growth over the 33-year period was 1.1 percent, average annual growth of MSW generation was 2.7 percent. In other words, per capita generation of MSW increased over the historical period.

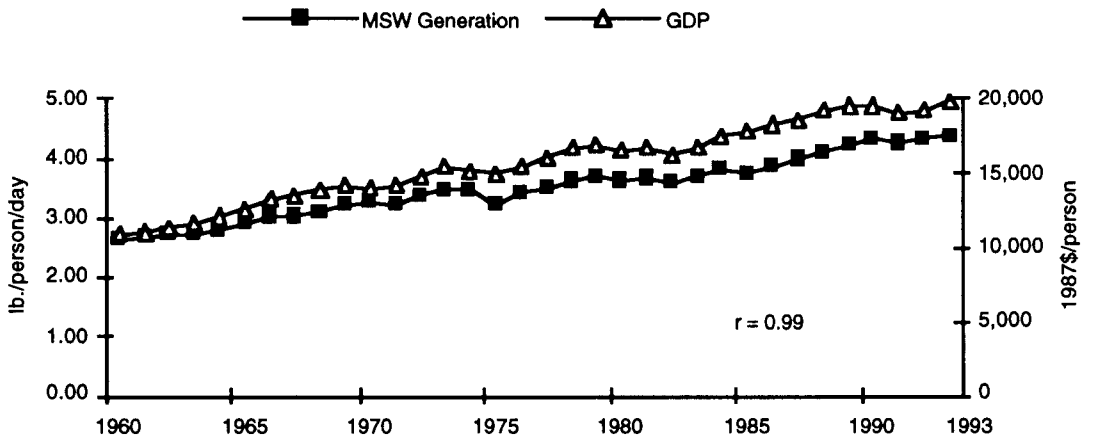
Many reasons have been suggested for the growth in per capita MSW generation, such as changes in lifestyles, more two-income wage earners in households, smaller households, and changes in the workplace (especially in offices). It seems clear that many of these reasons are related to changes in the level of economic activity, which has been generally upward except for

Figure ES-7. U.S. population and municipal solid waste generation, 1960 to 1993



occasional recessions. A plot of per capita MSW generation and economic activity as measured by Gross Domestic Product (GDP) (in 1987 dollars per capita) is shown in Figure ES-8. During the 33-year period, MSW per capita generation increased 65 percent, while GDP on a per capita basis increased 82 percent. The correlation coefficient (r) between per capita MSW generation and per capita GDP is 0.99, a strong positive correlation.

Figure ES-8. MSW generation and Gross Domestic Product, 1960 to 1993



On the basis of this preliminary analysis, it appears that population growth accounts for a portion of the increase in MSW generation, but that economic activity (and perhaps other factors such as household size) contributes to the increase over and above population growth.

TRENDS IN MSW GENERATION, RECOVERY, AND DISCARDS

Generation of municipal solid waste grew steadily between 1960 and 1993, from 88 million to 207 million tons per year. Per capita generation of MSW increased from 2.7 pounds per person per day in 1960 to 4.4 pounds per person per day in 1993. Projected per capita MSW generation in the year 2000 is 4.3 pounds per person per day (218 million tons). The projected decline in per capita generation rates is based in large part on a projected decrease in the tonnage of yard trimmings entering the municipal solid waste management system. Actually achieving the projected decline hinges on continued emphasis on source reduction of yard trimmings in particular, but also on other products in MSW.

Recovery for recycling and composting has increased from approximately 7 percent of MSW generated in 1960 to 22 percent by 1993, with much of the growth happening over the past five or six years. Projected scenarios for recovery are between 25 and 35 percent in 2000. To achieve these recovery rates, some products will have to be recovered at rates of 50 percent or more, and there will have to be substantial composting of yard trimmings.

Combustors handled an estimated 30 percent of MSW generated in 1960, mostly through incinerators with no energy recovery and no air pollution controls. In the 1960s and 1970s, combustion dropped steadily as the old incinerators were closed, reaching a low of less than 10 percent of MSW generated by 1980, then increasing to approximately 16 percent of MSW in 1990. Between 1990 and 1993, combustion remained around 16 percent of MSW generation. All major new facilities have energy recovery and are designed to meet air pollution standards.

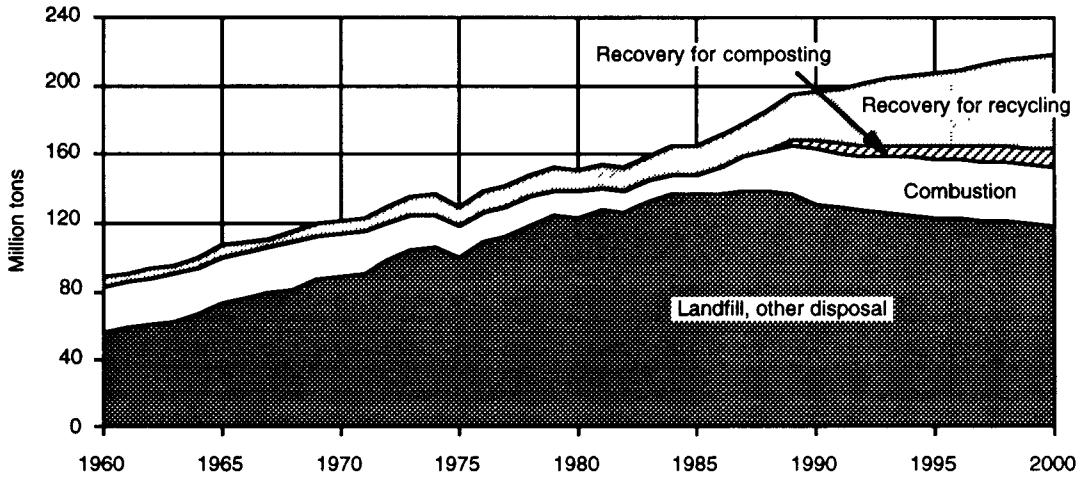
The report projects that tonnage of MSW combusted will increase only slightly by the year 2000—to 34 million tons, or less than 16 percent of generation. Estimates of combustion projections are based on an assumption that the facilities will operate at 85 percent of capacity.

Landfill use fluctuates with changes in the use of alternative solid waste management methods. For example, when the use of combustion for MSW management declined and recovery rates were low, the MSW percentage sent to landfills increased (Figure ES-9). Alternatively, when recovery and combustion of MSW increased, the percentage of MSW discarded to landfills declined. In 1960, approximately 62 percent of MSW was sent to landfills. This increased to 81 percent in 1980, then decreased to an estimated 62 percent in 1993 (the same percentage but much more tonnage than in 1960) due to changing trends in municipal solid waste management.

Recovery for recycling and composting at the 30 percent scenario in 2000 combined with projected source reduction efforts would reduce total national discards of MSW after recovery to 152 million tons compared to the 1993 level of 162 million tons. Adding projected combustion levels to recovery for recycling and composting would lower landfill tonnage to 118 million tons in 2000 compared to 129 million tons in 1993.

As we approach the twenty-first century, integrated waste management with a focus on source reduction, recycling, and composting is clearly the solution to our growing waste management needs. Through source reduction, recycling, and composting, we can reduce generation and increase recovery, and, in turn, reduce the quantities of waste that must be managed by combustors and landfills.

Figure ES-9. Municipal solid waste management, 1960 to 2000



Chapter 1

INTRODUCTION AND METHODOLOGY

BACKGROUND

This report is the most recent in a 20-year 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 33-year characterization (by weight) of the materials and products in MSW, with projections through the year 2000.

HOW THIS REPORT CAN BE USED

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. However, the report is of equal or greater value as a solid waste management planning tool for state and local governments and private firms.

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 wastes, industrial process wastes, or a number of other wastes that may well go to a municipal waste landfill.

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, some reliable 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 check point against local MSW characterization data, any differences between local and national data should be examined carefully. There are many possible reasons for these differences, for example:

- Definitions of waste streams may differ. That is, a local landfill may be receiving construction and demolition wastes in addition to MSW, but this report addresses MSW only.

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

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

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

- Variations in climate and local waste management practices will greatly influence generation of yard trimmings. Yard trimmings also exhibit strong seasonal variations in most regions of the country.

- Generation and discards of other products will be affected by 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 can reasonably be expected to have typical/average 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 the following ways in local planning:

- to develop approximate estimates of total MSW generation in an area
- to check locally developed MSW data for accuracy and consistency
- to help estimate quantities of recyclables and other MSW components in an area
- to account for trends in total MSW generation and the generation of individual components.

NEW FEATURES OF THIS REPORT

In addition to the data series that have been previously published by EPA in these MSW characterization reports, the following information and features have been added:

- A separate line item has been added for small appliances; these products were formerly included with miscellaneous durable products.
- An estimate for groundwood inserts was added to the newsprint in newspapers.
- A discussion of source reduction was added to the chapter on MSW management.
- A discussion of the correlation of MSW generation with population, economic activity as measured by Gross Domestic Product, and number of persons in households was added to Chapter 5.

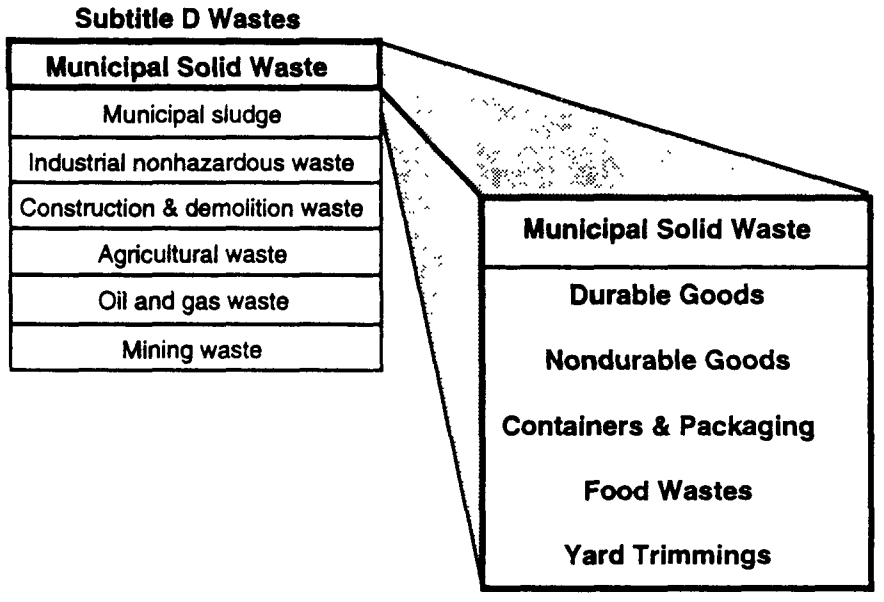
More information on the differences between this report and previous reports is included in Chapter 7.

MUNICIPAL SOLID WASTE IN PERSPECTIVE

Municipal Solid Waste Defined

Municipal solid waste includes durable goods, nondurable goods, containers and packaging, food wastes and yard trimmings, and miscellaneous inorganic wastes (Figure 1). EPA's 1989 Agenda for Action report states that municipal solid wastes come from residential, commercial, institutional, and industrial sources. Some examples of the types of MSW that come from each of the broad categories of sources are:

Figure 1. Municipal solid waste in the universe of Subtitle D wastes



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. (For this report, estimates were made of the residential/commercial distributions of MSW, but they were not made by the material flows methodology. See Chapter 5.)

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, fluff from automobile salvage operations, and construction and demolition wastes along with MSW, but these other kinds of wastes *are not included in the estimates presented in this report.*

The Solid Waste Management Hierarchy

EPA's 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 (preferably with energy recovery) and landfilling.

With the exception of source reduction, this updated characterization report includes estimates of the quantities of MSW managed by each practice in the hierarchy.

METHODOLOGIES FOR CHARACTERIZING MUNICIPAL SOLID WASTE

The Two Methodologies

There are two basic approaches to estimating quantities of municipal solid waste. The first method, which is site-specific, involves sampling, sorting, and weighing the individual components of the waste stream. 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 they are performed in a consistent manner over a long period of time.

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 over 20 years.

The material flows methodology is based on production data (by weight) for the materials and products in the waste stream. Adjustments are made for imports and exports and for diversions from MSW (e.g., for building materials made of paperboard). Adjustments are also made for the lifetimes of 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.

A more detailed description of the material flows methodology is included as Appendix 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 of products such as refillable glass bottles or refurbished wood pallets is counted as source reduction, not recovery for recycling.

Recovery of materials as estimated in this report includes products or yard trimmings removed from the waste stream for the purpose of recycling or composting. For most recovered products, recovery equals reported purchases of postconsumer recovered material (e.g., glass cullet, old newspapers) plus net exports (if any) of the material. Thus, 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. 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 and 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 amounts of MSW involved are presumed to be small.

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.

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, are also included among these product residues.

Certain other materials associated with products in MSW are often 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 plastic resins. 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 goods, but there is little documentation of these amounts.

PROJECTIONS

The projections of MSW generation to the year 2000 were not based on total quantities, but were aggregated from separate projections for each product and material. The projections are based on trend analysis of the 33-year historical database developed for each product, from information in government sources such as the ***Industrial Outlook*** published by the Department of Commerce, and, in some cases, best professional judgment. Based on the correlations of MSW generation with population and Gross Domestic Product (GDP) as described in Chapter 5, the projections for most products were kept higher than projected population growth but lower than projected GDP growth.

It should be emphasized that projections are not predictions. Projections are based on an assumption that there will be no unforeseen changes in current trends. Thus, the economy is assumed to remain stable and population trends are assumed to be as projected by the Bureau of the Census. Additional discussions of projection assumptions are included in Chapter 4.

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 1993 generation, recovery, and discards of products in each material category are included.

In Chapter 3 of the report, estimates of MSW management by the various alternatives are summarized. These include recovery for recycling and composting, combustion, and landfilling. A discussion of source reduction is also included in Chapter 3.

Projections of municipal solid waste generation and management to the year 2000 are included in Chapter 4. Projections are made by material and by

product. A discussion of assumptions and trends is included. In addition, there is a discussion of the potential effects of source reduction in this chapter.

Chapter 5 of the report provides some additional perspectives on MSW characterization. Information is included on per capita generation and management of MSW, on residential and commercial sources of MSW, and on organic and inorganic fractions of MSW. Also, there is a new section on the relationship of MSW generation to demographic and economic factors.

In Chapter 6, a characterization of MSW discards in 1993 by volume (cubic yards) is presented.

The final chapter of this report provides an overview comparison of the results of MSW characterization by the material flows methodology with the results of a number of field sampling studies. Also, the differences between the current update and previous material flows reports are explained.

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 study through 1993. The findings are presented in two ways: a breakdown of municipal solid waste (MSW) by material, and a breakdown by product (both by weight and by percentage of generation or discards). While some products, e.g., newspapers, are made up of a single material—paper—other products, e.g., rubber tires, contain more than one material, such as rubber, ferrous metals, and textiles. Thus the materials summary tables represent an aggregation of the materials that go into all the products in MSW. (Note that the totals for the materials and the products tables are the same.)

The summary tables and figures provide information on generation of each material and product, and recovery for recycling and composting (if any). Tables and figures displaying discards of materials and products after recovery for recycling and composting follow.

Recovery 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 (a MRF) or other waste processing facility are counted as generation, 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: paper, glass, metals, plastics, and rubber and leather.

MATERIALS IN MUNICIPAL SOLID WASTE

Generation, recovery, and discards of materials in MSW, by weight and by percentage of generation or discards, are summarized in Tables 1 through 3. Following these tables, each material is discussed in detail.

Table 1

MATERIALS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1993
(In thousands of tons and percent of total generation)

	Thousands of Tons						
Materials	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Paper and Paperboard	29,910	44,180	54,730	72,680	71,100	74,310	77,840
Glass	6,680	12,680	14,950	13,180	12,740	13,140	13,670
Metals							
Ferrous	9,950	12,590	11,580	12,440	12,560	12,880	12,930
Aluminum	360	850	1,760	2,860	2,980	2,910	2,970
Other Nonferrous	150	670	1,120	1,100	1,150	1,160	1,240
Total Metals	*10,460*	*14,110*	*14,460*	*16,400*	*16,690*	*16,950*	*17,140*
Plastics	400	3,060	7,870	16,820	17,230	18,520	19,300
Rubber and Leather	2,030	3,260	4,290	5,930	5,800	6,030	6,220
Textiles	1,750	2,030	2,610	6,450	6,100	6,420	6,130
Wood	3,010	3,980	6,760	12,310	12,610	12,860	13,690
Other	60	800	2,870	3,150	3,250	3,280	3,300
Total Materials in Products	54,300	84,100	108,540	146,920	145,520	151,510	157,290
Other Wastes							
Food Wastes	12,200	12,800	13,200	13,200	13,300	13,500	13,800
Yard Trimmings	20,000	23,200	27,500	35,000	35,000	35,000	32,800
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	2,950	3,000	3,050
Total Other Wastes	33,500	37,780	42,950	51,100	51,250	51,500	49,650
Total MSW Generated - Weight	87,800	121,880	151,490	198,020	196,770	203,010	206,940
	Percent of Total Generation						
Materials	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Paper and Paperboard	34.1%	36.2%	36.1%	36.7%	36.1%	36.6%	37.6%
Glass	7.6%	10.4%	9.9%	6.7%	6.5%	6.5%	6.6%
Metals							
Ferrous	11.3%	10.3%	7.6%	6.3%	6.4%	6.3%	6.2%
Aluminum	0.4%	0.7%	1.2%	1.4%	1.5%	1.4%	1.4%
Other Nonferrous	0.2%	0.5%	0.7%	0.6%	0.6%	0.6%	0.6%
Total Metals	*11.9%*	*11.6%*	*9.5%*	*8.3%*	*8.5%*	*8.3%*	*8.3%*
Plastics	0.5%	2.5%	5.2%	8.5%	8.8%	9.1%	9.3%
Rubber and Leather	2.3%	2.7%	2.8%	3.0%	2.9%	3.0%	3.0%
Textiles	2.0%	1.7%	1.7%	3.3%	3.1%	3.2%	3.0%
Wood	3.4%	3.3%	4.5%	6.2%	6.4%	6.3%	6.6%
Other	0.1%	0.7%	1.9%	1.6%	1.7%	1.6%	1.6%
Total Materials in Products	61.8%	69.0%	71.6%	74.2%	74.0%	74.6%	76.0%
Other Wastes							
Food Wastes	13.9%	10.5%	8.7%	6.7%	6.8%	6.6%	6.7%
Yard Trimmings	22.8%	19.0%	18.2%	17.7%	17.8%	17.2%	15.9%
Miscellaneous Inorganic Wastes	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
Total Other Wastes	38.2%	31.0%	28.4%	25.8%	26.0%	25.4%	24.0%
Total MSW Generated - %	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.

Source: Franklin Associates, Ltd.

Table 2

RECOVERY* OF MUNICIPAL SOLID WASTE, 1960 TO 1993
(In thousands of tons and percent of generation of each material)

	Thousands of Tons						
Materials	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Paper and Paperboard	5,360	7,420	11,850	20,250	22,510	24,480	26,460
Glass	100	160	750	2,630	2,560	2,890	3,010
Metals							
Ferrous	50	150	370	1,710	2,320	2,780	3,370
Aluminum	Neg.	10	340	1,010	1,040	1,110	1,050
Other Nonferrous	Neg.	330	540	730	740	720	780
Total Metals	*50*	*490*	*1,250*	*3,450*	*4,100*	*4,610*	*5,200*
Plastics	Neg.	Neg.	20	370	450	600	680
Rubber and Leather	330	250	130	330	350	360	370
Textiles	10	10	20	580	820	800	720
Wood	Neg.	Neg.	Neg.	390	810	1,070	1,320
Other**	Neg.	300	500	680	690	670	730
Total Materials in Products	5,850	8,630	14,520	28,680	32,290	35,480	38,490
Other Wastes							
Food Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Yard Trimmings	Neg.	Neg.	Neg.	4,200	5,000	6,000	6,500
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	4,200	5,000	6,000	6,500
Total MSW Recovered - Weight	5,850	8,630	14,520	32,880	37,290	41,480	44,990
	Percent of Generation of Each Material						
Materials	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Paper and Paperboard	17.9%	16.8%	21.7%	27.9%	31.7%	32.9%	34.0%
Glass	1.5%	1.3%	5.0%	20.0%	20.1%	22.0%	22.0%
Metals							
Ferrous	0.5%	1.2%	3.2%	13.7%	18.5%	21.6%	26.1%
Aluminum	Neg.	1.2%	19.3%	35.3%	34.9%	38.1%	35.4%
Other Nonferrous	Neg.	49.3%	48.2%	66.4%	64.3%	62.1%	62.9%
Total Metals	*0.5%*	*3.5%*	*8.6%*	*21.0%*	*24.6%*	*27.2%*	*30.3%*
Plastics	Neg.	Neg.	0.3%	2.2%	2.6%	3.2%	3.5%
Rubber and Leather	16.3%	7.7%	3.0%	5.6%	6.0%	6.0%	5.9%
Textiles	0.6%	0.5%	0.8%	9.0%	13.4%	12.5%	11.7%
Wood	Neg.	Neg.	Neg.	3.2%	6.4%	8.3%	9.6%
Other	Neg.	37.5%	17.4%	21.6%	21.2%	20.4%	22.1%
Total Materials in Products	10.8%	10.3%	13.4%	19.5%	22.2%	23.4%	24.5%
Other Wastes							
Food Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Yard Trimmings	Neg.	Neg.	Neg.	12.0%	14.3%	17.1%	19.8%
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	8.2%	9.8%	11.7%	13.1%
Total MSW Recovered - %	6.7%	7.1%	9.6%	16.6%	19.0%	20.4%	21.7%

* Recovery of postconsumer wastes for recycling and composting; does not include converting/fabrication scrap.

** Recovery of electrolytes in batteries; probably not recycled.

Neg. = Negligible.

Details may not add to totals due to rounding.

Source: Franklin Associates, Ltd.

Table 3

MATERIALS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1993
(In thousands of tons and percent of total discards)

	Thousands of Tons						
Materials	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Paper and Paperboard	24,550	36,760	42,880	52,430	48,590	49,830	51,380
Glass	6,580	12,520	14,200	10,550	10,180	10,250	10,660
Metals							
Ferrous	9,900	12,440	11,210	10,730	10,240	10,100	9,560
Aluminum	360	840	1,420	1,850	1,940	1,800	1,920
Other Nonferrous	150	340	580	370	410	440	460
Total Metals	*10,410*	*13,620*	*13,210*	*12,950*	*12,590*	*12,340*	*11,940*
Plastics	400	3,060	7,850	16,450	16,780	17,920	18,620
Rubber and Leather	1,700	3,010	4,160	5,600	5,450	5,670	5,850
Textiles	1,740	2,020	2,590	5,870	5,280	5,620	5,410
Wood	3,010	3,980	6,760	11,920	11,800	11,790	12,370
Other	60	500	2,370	2,470	2,560	2,610	2,570
Total Materials in Products	48,450	75,470	94,020	118,240	113,230	116,030	118,800
Other Wastes							
Food Wastes	12,200	12,800	13,200	13,200	13,300	13,500	13,800
Yard Trimmings	20,000	23,200	27,500	30,800	30,000	29,000	26,300
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	2,950	3,000	3,050
Total Other Wastes	33,500	37,780	42,950	46,900	46,250	45,500	43,150
Total MSW Discarded - Weight	81,950	113,250	136,970	165,140	159,480	161,530	161,950
	Percent of Total Discards						
Materials	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Paper and Paperboard	30.0%	32.5%	31.3%	31.7%	30.5%	30.8%	31.7%
Glass	8.0%	11.1%	10.4%	6.4%	6.4%	6.3%	6.6%
Metals							
Ferrous	12.1%	11.0%	8.2%	6.5%	6.4%	6.3%	5.9%
Aluminum	0.4%	0.7%	1.0%	1.1%	1.2%	1.1%	1.2%
Other Nonferrous	0.2%	0.3%	0.4%	0.2%	0.3%	0.3%	0.3%
Total Metals	*12.7%*	*12.0%*	*9.6%*	*7.8%*	*7.9%*	*7.6%*	*7.4%*
Plastics	0.5%	2.7%	5.7%	10.0%	10.5%	11.1%	11.5%
Rubber and Leather	2.1%	2.7%	3.0%	3.4%	3.4%	3.5%	3.6%
Textiles	2.1%	1.8%	1.9%	3.6%	3.3%	3.5%	3.3%
Wood	3.7%	3.5%	4.9%	7.2%	7.4%	7.3%	7.6%
Other	0.1%	0.4%	1.7%	1.5%	1.6%	1.6%	1.6%
Total Materials in Products	59.1%	66.6%	68.6%	71.6%	71.0%	71.8%	73.4%
Other Wastes							
Food Wastes	14.9%	11.3%	9.6%	8.0%	8.3%	8.4%	8.5%
Yard Trimmings	24.4%	20.5%	20.1%	18.7%	18.8%	18.0%	16.2%
Miscellaneous Inorganic Wastes	1.6%	1.6%	1.6%	1.8%	1.8%	1.9%	1.9%
Total Other Wastes	40.9%	33.4%	31.4%	28.4%	29.0%	28.2%	26.6%
Total MSW Discarded - %	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.
Source: Franklin Associates, Ltd.

Paper and Paperboard

By any measure, the many products made of paper and paperboard, taken collectively, are the largest component of MSW. 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.

Table 4

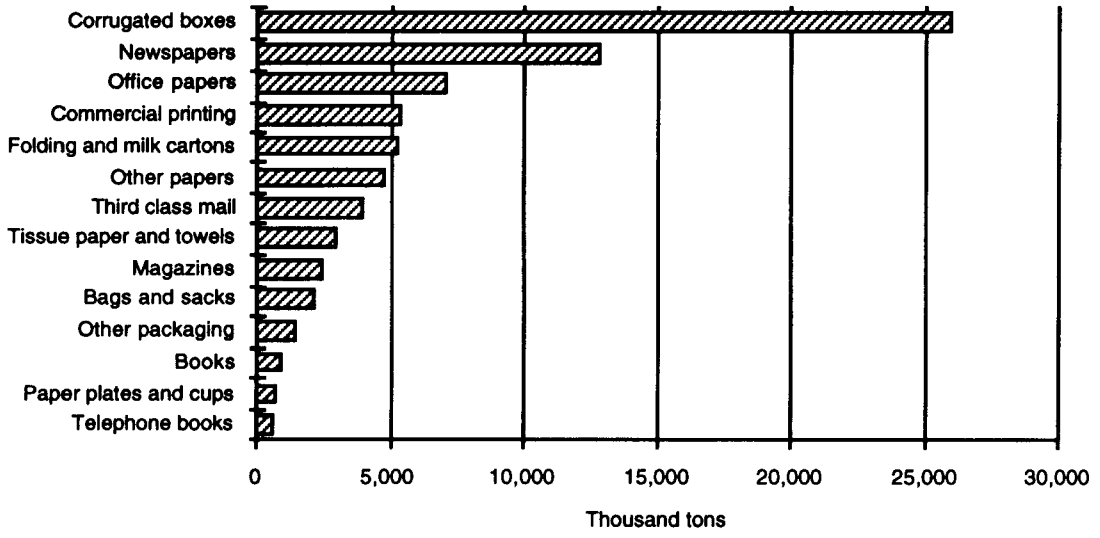
PAPER AND PAPERBOARD PRODUCTS IN MSW, 1993
(In thousands of tons and percent of generation)

Product Category	Generation (Thousands tons)	Recovery (Thousands tons)	Recovery (Percent of generation)	Discards (Thousands tons)
Nondurable Goods				
Newspapers				
Newsprint	10,620	4,970	46.8%	5,650
Groundwood inserts	2,320	950	40.9%	1,370
Total Newspapers	12,940	5,920	45.7%	7,020
Books	990	160	16.2%	830
Magazines	2,500	450	18.0%	2,050
Office Papers	7,120	2,600	36.5%	4,520
Telephone Books	740	60	8.1%	680
Third Class Mail	4,010	540	13.5%	3,470
Other Commercial Printing	5,440	1,060	19.5%	4,380
Tissue Paper and Towels	3,010	Neg.	Neg.	3,010
Paper Plates and Cups	830	Neg.	Neg.	830
Other Nonpackaging Paper*	4,830	Neg.	Neg.	4,830
Total Paper and Paperboard Nondurable Goods	42,410	10,790	25.4%	31,620
Containers and Packaging				
Corrugated Boxes	26,350	14,620	55.5%	11,730
Milk Cartons	470	Neg.	Neg.	470
Folding Cartons	4,940	700	14.2%	4,240
Other Paperboard Packaging	300	Neg.	Neg.	300
Bags and Sacks	2,200	350	15.9%	1,850
Wrapping Papers	70	Neg.	Neg.	70
Other Paper Packaging	1,100	Neg.	Neg.	1,100
Total Paper and Paperboard Containers and Packaging	35,430	15,670	44.2%	19,760
Total Paper and Paperboard	77,840	26,460	34.0%	51,380

* Includes tissue in disposable diapers, paper in games and novelties, cards, etc.
Neg. = Negligible.
Details may not add to totals due to rounding.

Source: Franklin Associates, Ltd.

Figure 2. Paper and paperboard products generated in MSW, 1993

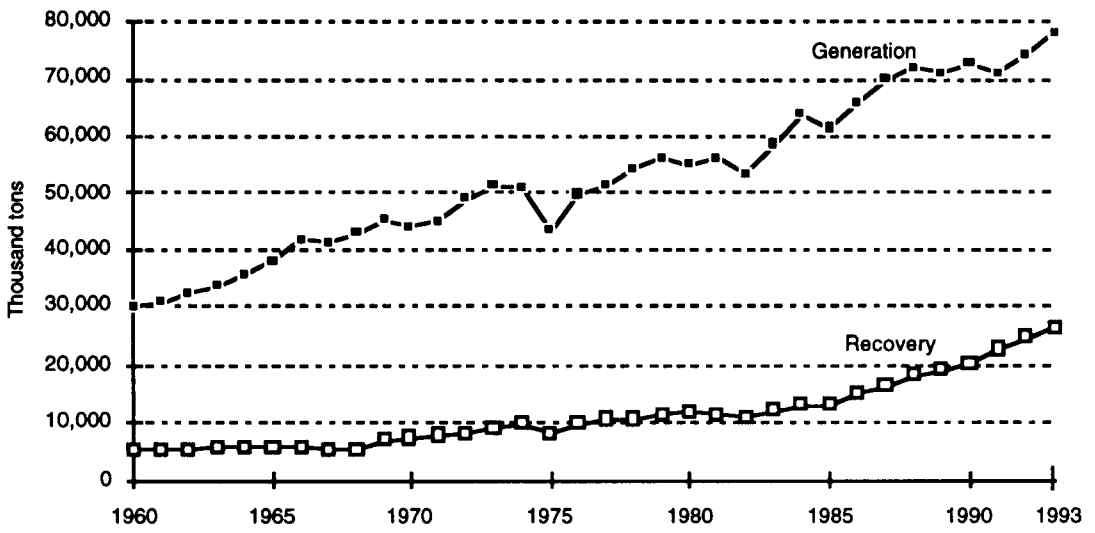


Total generation of paper and paperboard in MSW has grown steadily from 29.9 million tons in 1960 to 77.8 million tons in 1993 (Table 1). As a percentage of total MSW generation, paper represented 34.1 percent in 1960 (Table 1). The percentage has varied over time, but increased to 37.6 percent of total MSW generation in 1993.

(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.)

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, exports, and 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 deduct converting scrap, which is generated when sheets of paper or paperboard are cut 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. Various deductions are also made to account for products diverted out of municipal solid waste, such as gypsum wallboard facings or toilet tissue.

Figure 3. Paper generation and recovery, 1960 to 1993



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.

To estimate recovery of postconsumer paper products for this EPA report, estimates of recovery of converting scrap and returned overissue publications 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 this update, however, various converting scrap recovery rates ranging from 70 percent to 98 percent were applied to the estimates for 1990 through 1993. The converting scrap recovery rates were developed for a 1992 report for the Recycling Advisory Council. Because converting scrap is 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 all other materials in MSW. As Table 4 shows, 55.5 percent of all corrugated boxes were recovered for recycling in 1993. Newspapers were recovered at a rate of 45.7 percent, and office papers at 36.5 percent, with lesser percentages of other papers being recovered also. Approximately 26.5 million tons of postconsumer paper were recovered in 1993—34.0 percent of total generation.

Discards After Recovery. After recovery of paper and paperboard for recycling, discards were 51.4 million tons in 1993, or 31.7 percent of total MSW discards.

Glass

Glass is found in MSW primarily in the form of containers (Table 5 and Figures 4 and 5), but also in durable goods like furniture, appliances, and consumer electronics. In the container category, glass is found in beer and soft drink bottles, wine and liquor bottles, and 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 15.0 million tons in 1980 to 13.2 million tons in

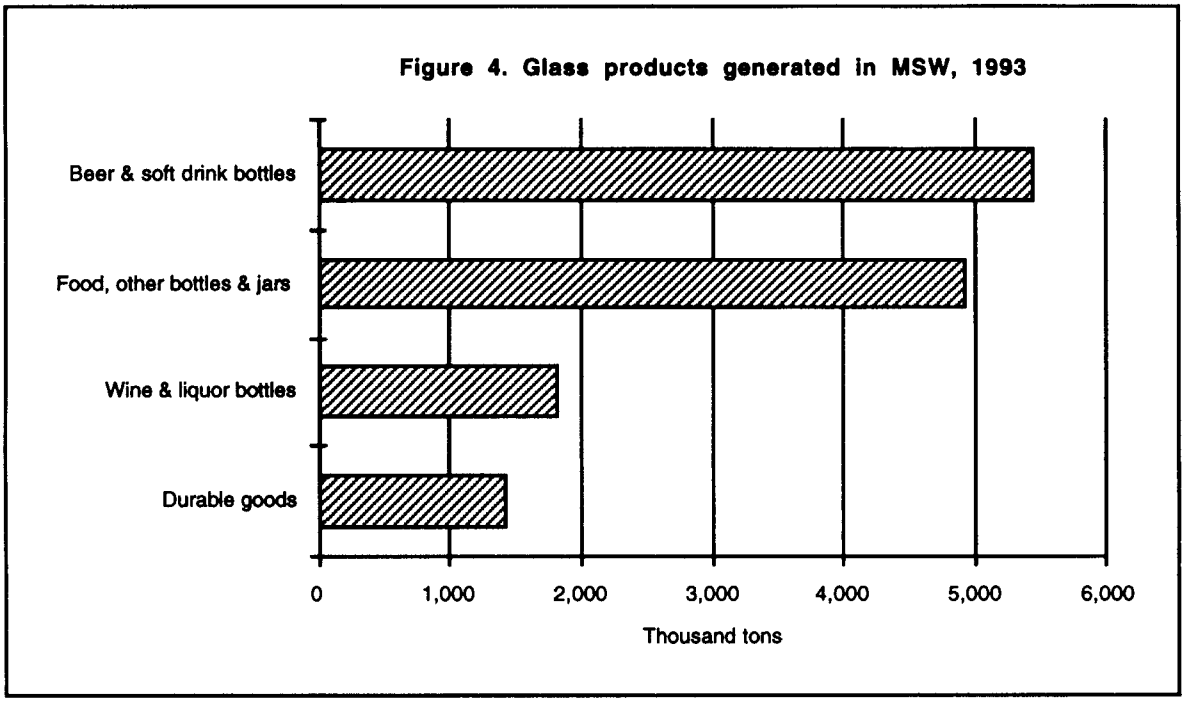
Table 5

GLASS PRODUCTS IN MSW, 1993
(In thousands of tons and percent of generation)

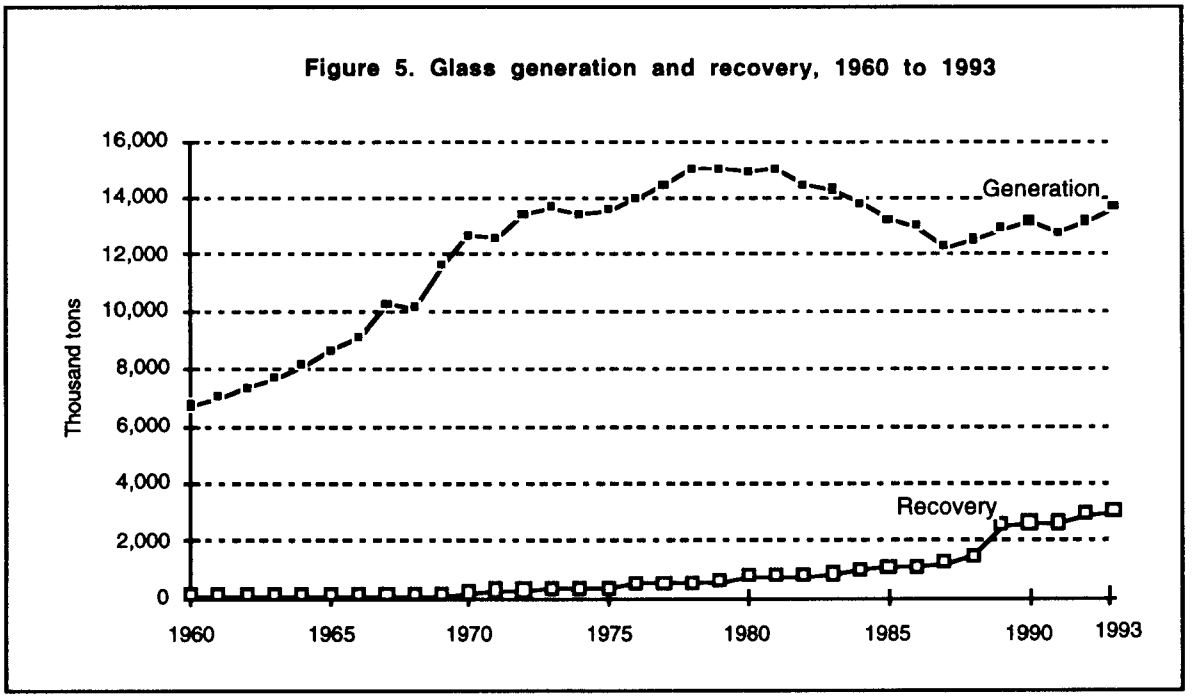
Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent of generation)	Discards (Thousand tons)
Durable Goods*	1,440	Neg.	Neg.	1,440
Containers and Packaging				
Beer and Soft Drink Bottles	5,440	1,600	29.4%	3,840
Wine and Liquor Bottles	1,850	450	24.3%	1,400
Food and Other Bottles and Jars	4,940	960	19.4%	3,980
Total Glass Containers	12,230	3,010	24.6%	9,220
Total Glass	13,670	3,010	22.0%	10,660

* Glass as a component of appliances, furniture, consumer electronics, etc.
Neg. = Negligible.
Details may not add to totals due to rounding.

Source: Franklin Associates, Ltd.



1985. Beginning about 1987, however, the decline in generation of glass containers reversed (Figure 5), and glass generation in 1993 was 13.7 million tons, about the same as the estimate for 1985. A decline in generation occurred in 1991, a recession year. Glass was 9.9 percent of MSW generation in 1980, declining to 6.6 percent in 1993.



Recovery. In 1993 an estimated 24.6 percent of glass containers was recovered for recycling, with a 22.0 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 highway construction. The Glass Packaging Institute reports a recovery rate of 35 percent for glass containers in 1993; this recovery rate includes an allowance for refilling of bottles. Since this EPA report considers refilling to be reuse (source reduction) rather than recovery for recycling, the recovery rate calculated for this report is 24.6 percent of glass containers.

Discards After Recovery. Recovery for recycling lowered discards of glass to 10.7 million tons in 1993 (6.6 percent of total MSW discards).

Ferrous Metals

By weight, ferrous metals 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, tires, and other miscellaneous durables. 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 are shown in Figure 7.

Figure 6. Metal products generated in MSW, 1993

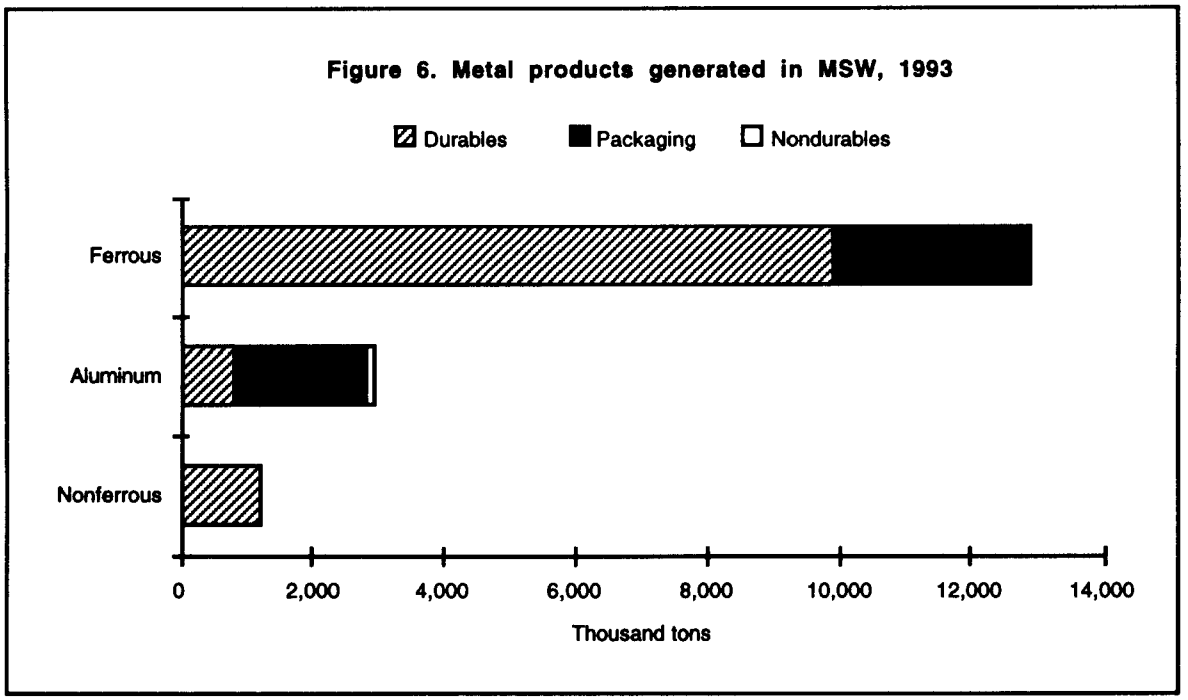


Table 6

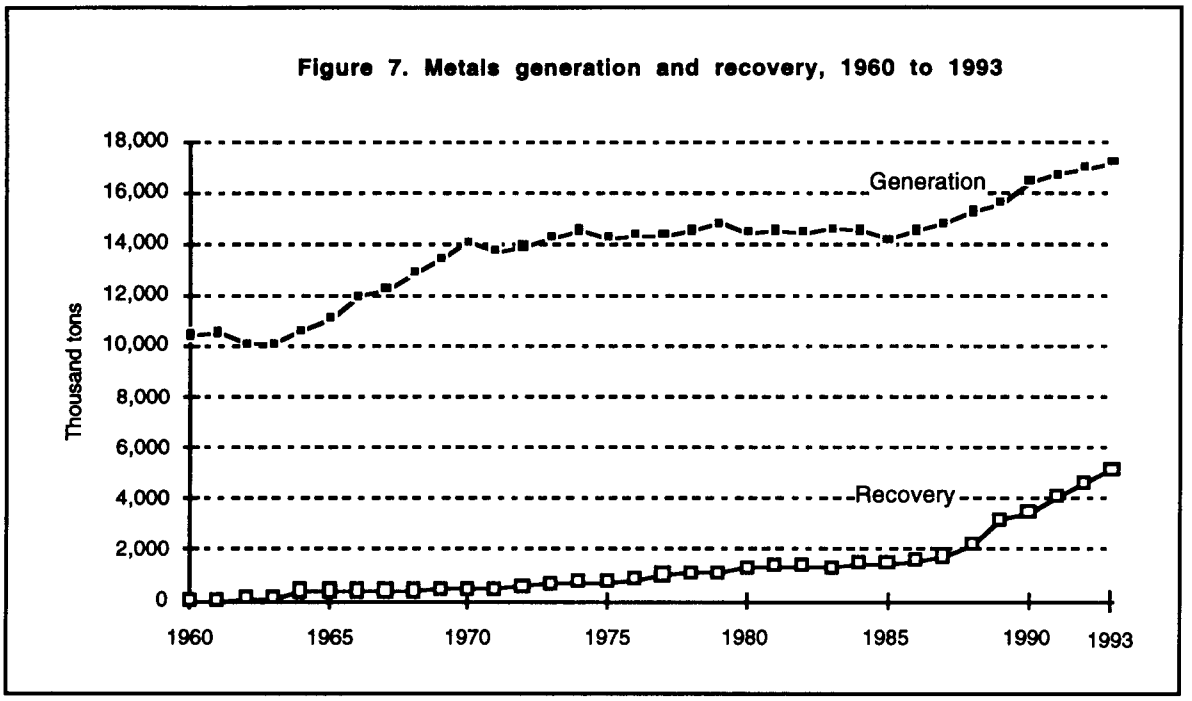
METAL PRODUCTS IN MSW, 1993
(In thousands of tons and percent of generation)

Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent of generation)	Discards (Thousand tons)
Durable Goods				
Ferrous metals*	9,950	1,990	20.0%	7,960
Aluminum**	810	Neg.	Neg.	810
Lead†	820	780	95.1%	40
Other nonferrous metals‡	420	Neg.	Neg.	420
Total Metals in Durable Goods	12,000	2,770	23.1%	9,230
Nondurable Goods				
Aluminum	180	Neg.	Neg.	180
Containers and Packaging				
Steel				
Beer and soft drink cans	70	40	24.7%	30
Food and other cans	2,720	1,300	47.8%	1,420
Other steel packaging	190	40	Neg.	150
Total Steel Packaging	2,980	1,380	46.3%	1,600
Aluminum				
Beer and soft drink cans	1,610	1,020	63.4%	590
Food and other cans	40	Neg.	Neg.	40
Foil and closures	330	30	Neg.	300
Total Aluminum Packaging	1,980	1,050	53.0%	930
Total Metals in Containers and Packaging	4,960	2,430	49.0%	2,530
Total Metals	17,140	5,200	30.3%	11,940
Ferrous	12,930	3,370	26.1%	9,560
Aluminum	2,970	1,050	35.4%	1,920
Other nonferrous	1,240	780	62.9%	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. = Negligible.
Details may not add to totals due to rounding.
Source: Franklin Associates, Ltd.

Generation. Approximately 10.0 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 12.9 million tons in 1993. The percentage of ferrous metals generation in MSW has declined from 11.3 percent in 1960 to 6.2 percent in 1993.

Recovery. Recovery of ferrous metals from MSW has generally not been well documented in the past. The renewed emphasis on recovery and recycling in recent years has, however, included ferrous metals. Recovery of ferrous



metals from appliances ("white goods") was estimated to be approximately 68.0 percent in 1993. Overall recovery of ferrous metals from durable goods (large and small appliances, furniture, and tires) was estimated to be 20.0 percent in 1993 (Table 6).

An estimated 24.7 percent of steel beverage cans was recovered in 1993, although the tonnage of these cans in MSW is not large. Food and other steel cans was estimated to be recovered at a rate of 47.8 percent in 1993.

Discards After Recovery. Discards of ferrous metals after recovery were 9.6 million tons in 1993, or 5.9 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 (almost one-third of generation) are found in durable and nondurable goods.

Generation. In 1993, approximately 2.0 million tons of aluminum were generated as containers and packaging, while a total of approximately 1.0 million tons was found in durable and nondurable goods. The total—3.0 million tons—represented 1.4 percent of total MSW generation in 1993. Aluminum generation was only 360,000 tons (0.4 percent of MSW generation) in 1960.

Recovery. Aluminum beverage containers was recovered at a rate of 63.4 percent of generation in 1993, and 53.0 percent of all aluminum containers and packaging was recovered for recycling in 1993.

Discards After Recovery. In 1993, 1.9 million tons of aluminum were discarded in MSW after recovery, which was 1.2 percent of total discards.

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.

Generation. Generation of other nonferrous metals in MSW totaled 1.2 million tons in 1993. Lead in batteries accounted for 820,000 tons of this amount. Generation of these metals has increased slowly, from 150,000 tons in 1960. As a percentage of total generation, nonferrous metals have never exceeded one percent.

Recovery. Recovery of the other nonferrous metals was 780,000 tons in 1993, with most of this being lead recovered from batteries. It was estimated that 95 percent of battery lead was recovered in 1993.

Discards After Recovery. In 1993, 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. Plastics are found in durable and nondurable goods and in containers and packaging, with the latter being the largest category of plastics in MSW (Figure 8 and Table 7).

In durable goods, plastics are found in appliances, furniture, casings of lead-acid batteries, and other products. (Note that plastics in transportation products 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 such nondurable products as disposable diapers, trash bags, cups, eating utensils, shower curtains, etc. The plastic foodservice 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 are also 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. Data on plastics resin use in products is taken from the ***Modern Plastics*** annual statistical issue. The basic data are adjusted for fabrication losses and for net imports of plastic products to derive generation of plastics in the various products in MSW.

Plastics comprised an estimated 400,000 tons of MSW generation in 1960. The quantity grew steadily to 19.3 million tons in 1993 (Figure 9). As a percentage of MSW generation, plastics were 0.5 percent in 1960, increasing to 9.3 percent in 1993.

Recovery for Recycling. While overall recovery of plastics for recycling is relatively small—680,000 tons, or 3.5 percent of plastics generation in 1993 (Table 9)—recovery of some plastic containers is increasing. Plastic (polyethylene terephthalate) soft drink bottles and their base cups were recovered at a rate of 41.1 percent in 1993. Recovery of milk and water bottles (high-density polyethylene) was estimated at 23.6 percent in 1993. Significant recovery of plastics from lead-acid battery casings and from some other containers was also

Figure 8. Plastics products generated in MSW, 1993

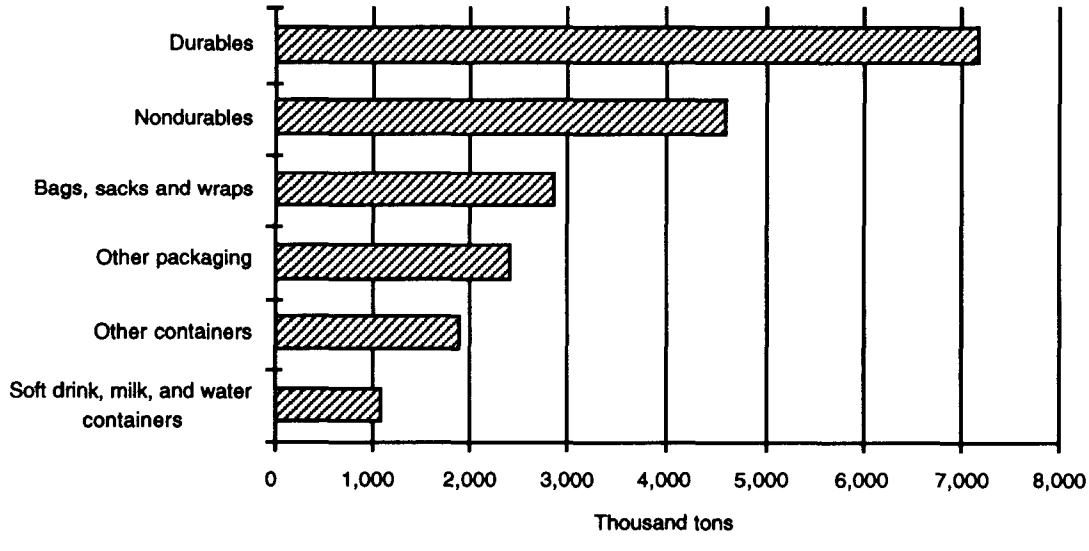


Table 7

PLASTICS IN PRODUCTS IN MSW, 1993
(In thousands of tons, and percent of generation by resin)

Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent)	Discards (Thousand tons)
Durable Goods				
PET	80	30		50
HDPE	800	10		790
PVC	700	Neg.		700
LDPE	1,250	10		1,240
PP	500	90		410
PS	1,040	Neg.		1,040
Other resins	1,940	10		1,930
Total Plastics in Durable Goods	6,310	150	2.4%	6,160
Nondurable Goods				
Plastic Plates & Cups				
PS	350	20		330
Trash Bags				
HDPE	150			150
LDPE	740			740
Subtotal Trash Bags	890			
All other nondurables*				
PET	80			80
HDPE	280			280
PVC	250			250
LDPE	1,170			1,170
PP	700			700
PS	460			460
Other resins	450			450
Subtotal All Other Nondurables	3,390			3,390
Total Plastics in Nondurable Goods, by resin				
PET	80			80
HDPE	430			430
PVC	250			250
LDPE	1,910			1,910
PP	700			700
PS	810	20		790
Other resins	450			450
Total Plastics in Nondurable Goods	4,630	20	0.4%	4,610
Plastic Containers & Packaging				
Soft drink bottles				
PET	500	210		290
HDPE	60	20		40
Subtotal Soft Drink Bottles	560	230	41.1%	330

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

Source: Franklin Associates, Ltd.

Table 7 (continued)

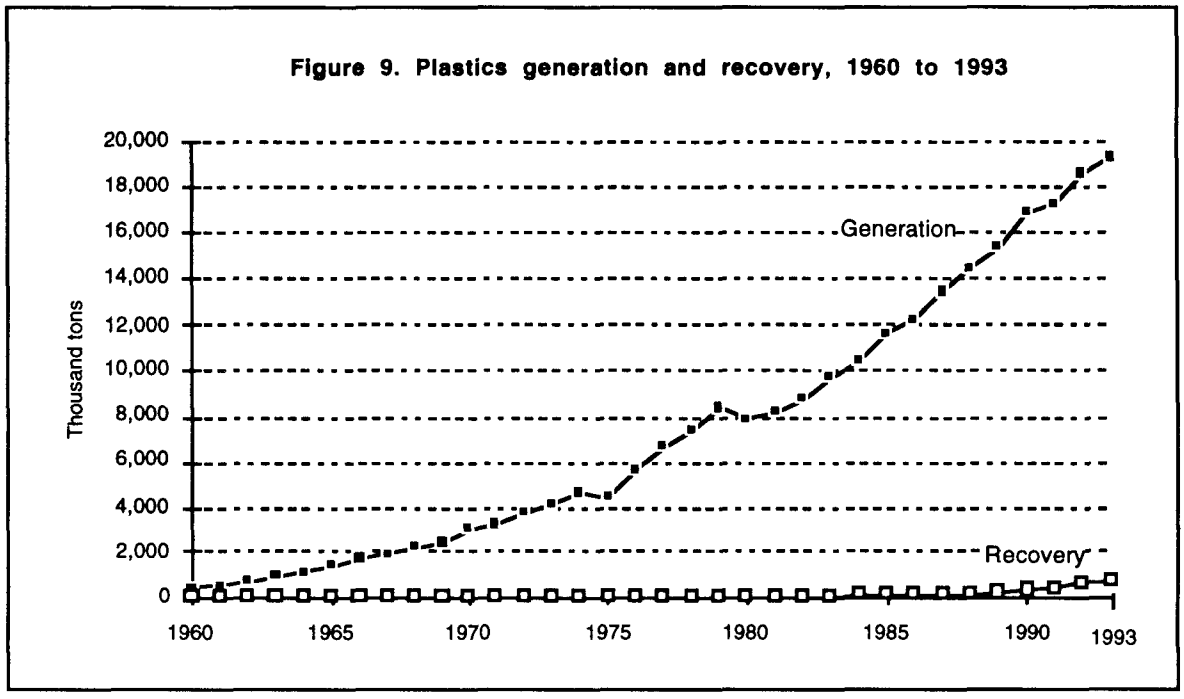
PLASTICS IN PRODUCTS IN MSW, 1993
(In thousands of tons, and percent of generation by resin)

Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent)	Discards (Thousand tons)
Plastic Containers & Packaging, cont.				
Milk and water bottles				
HDPE	550	130	23.6%	420
Other plastic containers				
PET	280	10		270
HDPE	930	70		860
PVC	90	Neg.		90
LDPE	180	Neg.		180
PP	160	Neg.		160
PS	220	Neg.		220
Other resins	70	10		60
Subtotal Other Containers	1,930	90	4.7%	1,840
Bags, sacks, & wraps				
HDPE	430	10		420
LDPE	2,440	40		2,400
Subtotal Bags, Sacks, & Wraps	2,870	50	1.7%	2,820
Other Plastics Packaging**				
PET	40	Neg.		40
HDPE	920	Neg.		920
PVC	190	Neg.		190
LDPE	450	Neg.		450
PP	330	10		320
PS	410	Neg.		410
Other resins	110	Neg.		110
Subtotal Other Packaging ***	2,450	10	0.4%	2,440
Total Plastics in Containers & Packaging, by resin				
PET	820	220		600
HDPE	2,890	230		2,660
PVC	280	Neg.		280
LDPE	3,070	40		3,030
PP	490	10		480
PS	630	Neg.		630
Other resins	180	10		170
Total Plastics in Containers & Packaging	8,360	510	6.1%	7,850
Total Plastics in MSW				
PET	980	250		730
HDPE	4,120	240		3,880
PVC	1,230	Neg.		1,230
LDPE	6,230	50		6,180
PP	1,690	100		1,590
PS	2,480	20		2,460
Other resins	2,570	20		2,550
Total Plastics	19,300	680	3.5%	18,620

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

* All other nondurables include plastics in disposable diapers, clothing, footwear, etc.
** Other plastic packaging includes coatings, closures, caps, trays, shapes, etc.
***Includes 80 thousand tons of plastics categorized as Other Miscellaneous Packaging.
Details may not add to totals due to rounding.

Source: Franklin Associates, Ltd.



reported. The primary source of data on plastics recovery is an annual survey conducted for the American Plastics Council.

Discards After Recovery. Discards of plastics in MSW after recovery were 18.6 million tons, or 11.5 percent of total discards.

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 2.0 million tons in 1960 to 6.2 million tons in 1993. One reason for the relatively slow rate of growth is that tires have been made smaller and longer-wearing than in past years.

As a percentage of total MSW generation, rubber and leather has ranged between 2.0 and 3.0 percent of the total over the historical period.

Recovery for Recycling. The only recovery for recycling identified in this category is rubber from tires, and that was estimated to be 370,000 tons (12.9 percent of rubber in tires in 1993) (Table 8). (This recovery estimate does not

Table 8

RUBBER AND LEATHER PRODUCTS IN MSW, 1993
(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 Tires*	2,870	370	12.9%	2,500
Other Durables**	2,350	Neg.	Neg.	2,350
Total Rubber & Leather Durable Goods	5,220	370	7.1%	4,850
Nondurable Goods				
Clothing and Footwear	730	Neg.	Neg.	730
Other Nondurables	260	Neg.	Neg.	260
Total Rubber & Leather Nondurable Goods	990	Neg.	Neg.	990
Containers and Packaging	10	Neg.	Neg.	10
Total Rubber & Leather	6,220	370	5.9%	5,850

* Does not include other materials in tires.
** Includes carpets and rugs and other miscellaneous durables.
Neg. = Negligible.
Details may not add to totals due to rounding.

Source: Franklin Associates, Ltd.

include tires retreaded or energy recovery from tires.) Overall, 5.9 percent of rubber and leather in MSW was recovered in 1993.

Discards After Recovery. Discards of rubber and leather after recovery were 5.9 million tons in 1993 (3.6 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.

Generation. An estimated 6.1 million tons of textiles were generated in 1993.

Recovery for Recycling and Discards. A significant amount of textiles is recovered for reuse, but 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 11.7 percent of

textiles in clothing and items such as sheets and pillowcases was recovered for export or reprocessing in 1993 (720,000 tons) leaving discards of 5.4 million tons of textiles in 1993.

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

Generation. Generation of wood in MSW was 13.7 million tons in 1993 (6.6 percent of total generation).

Recovery for Recycling and Discards. Recovery of wood pallets (usually by chipping) has been increasing along with recovery of other materials. It was estimated that 1.3 million tons of wood waste were recovered in 1993, leaving wood discards of 12.4 million tons (7.6 percent of total discards).

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

Food Wastes

Food wastes included here consist of uneaten food and food preparation wastes from residences, commercial establishments (restaurants, fast food establishments), institutional sources such as school cafeterias, and industrial sources such as factory lunchrooms.

Generation. As noted earlier, the only source of data on food wastes is on-site sampling studies. As many sampling studies as possible—representing a long time frame—were scrutinized. Sampling studies are generally performed on mixed wastes as received at a transfer station or landfill, and the results are reported by material as a percentage of the total sample. Therefore, the sampling study results for food wastes were integrated into the discards (after recovery) of the other materials in MSW. In addition, an adjustment was made for the moisture transfer that occurs when wastes are mixed prior to sampling.

Generation of food wastes was estimated to be 13.8 million tons in 1993. The use of garbage disposals, which send food wastes to wastewater treatment systems rather than MSW, and use of prepared foods both at home and in food service establishments, affect the amount of food waste in MSW. (When foods are prepared and packaged off site, food preparation wastes are categorized as industrial wastes rather than MSW.)

Recovery and Discards. While recovery of food wastes for composting or animal feed has been practiced in some locations, no significant recovery of food wastes was identified in 1993. Numerous composting pilot studies have been initiated for source-separated wet organics, such as food waste, from restaurants, grocery stores, institutions, and households. Also, some food wastes are used in backyard composting, which is classified as source reduction. (See the section on source reduction in Chapter 3.)

Yard Trimmings

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

Generation. Generation of yard trimmings was estimated in exactly the same manner described above for food wastes, based on sampling studies. (Generation is measured when the yard trimmings enter the solid waste management system and do not include grass clippings that are left on the lawn or yard trimmings composted.) As a percentage of the waste stream, yard trimmings have been exhibiting a decline. An estimated 32.8 million tons of yard trimmings were generated in MSW in 1993.

Recovery for Composting and Discards. Quantitative national information on composting of yard trimmings is difficult to obtain, but estimates were based on a literature search and telephone contacts with state agencies to determine state policies on removal of yard trimmings from MSW (e.g., by banning leaves from landfills), and estimates of the amounts of waste that might be affected. Removal of yard trimmings for composting was estimated to be 19.8 percent of generation in 1993 (6.5 million tons), leaving 26.3 million tons of yard trimmings to be discarded.

It should be noted that these estimates do not account for backyard composting by individuals or practices such as less bagging of grass wastes; since the yard trimming estimates are based on sampling studies at the landfill or transfer station, they are based on the quantities received there. These source reduction practices are discussed in Chapter 3.

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.

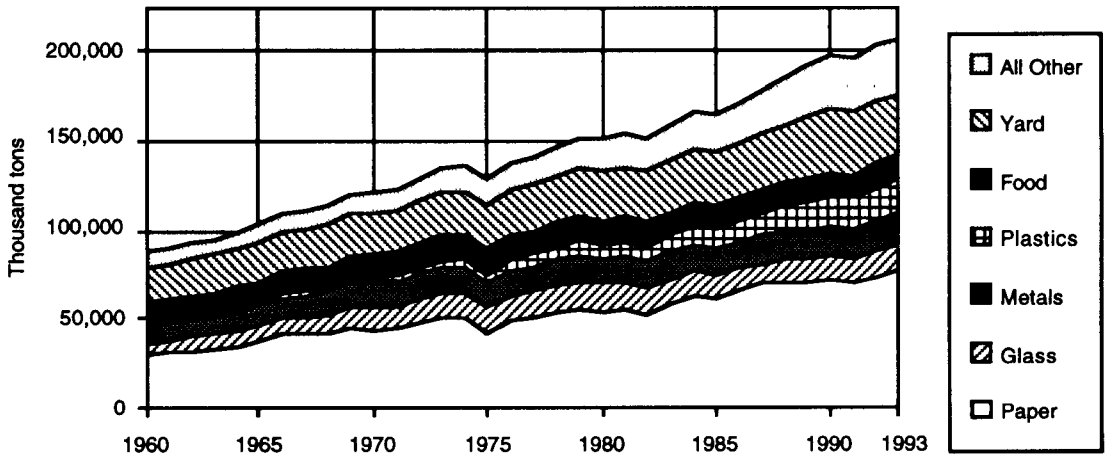
Generation. This category contributed an estimated 3.0 million tons of MSW in 1993.

Recovery and Discards. 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 steadily, from 87.8 million tons in 1960 to 206.9 million tons in 1993. Over the years, paper and paperboard has been the dominant material generated in MSW. Yard trimmings, the second largest component of MSW, have been declining as a percentage of MSW in recent years due to state and local legislated landfill bans and increased emphasis on backyard composting and other source reduction measures such as use of mulching mowers. Metals have remained fairly constant as a source of MSW, while glass increased until the 1980s and has since declined or shown a slower rate of increase. Food wastes have remained fairly constant in terms of MSW tonnage.

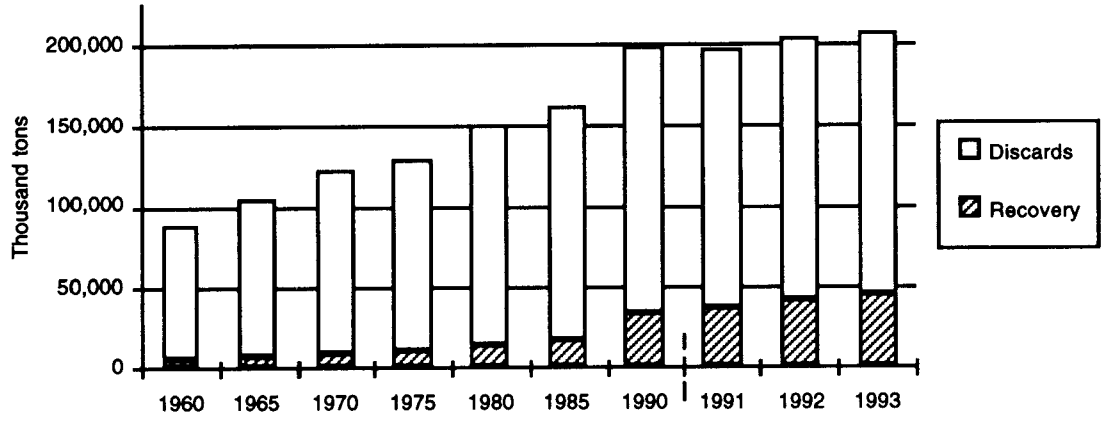
Figure 10. Generation of materials in MSW, 1960 to 1993



Plastics have been a rapidly growing component of MSW. In terms of tonnage contributed, they ranked third in 1993 (behind yard trimmings).

Recovery and Discards. The effect of recovery and composting on MSW discards is illustrated in Figure 11. Recovery of materials for recycling grew at a rather slow pace during most of the historical period covered by this data series, increasing only from 9.6 percent of generation in 1980 to 9.9 percent in 1985.

Figure 11. Materials recovery and discards of MSW, 1960 to 1993



Renewed interest in recycling and composting as solid waste management alternatives came about in the late 1980s, and the recovery rate in 1990 was estimated to be 16.6 percent of generation, increasing to 21.7 percent in 1993.

Estimated recovery and composting of materials are shown in Figure 12. In 1993, recovery of paper and paperboard dominated materials recovery at 58.8 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.

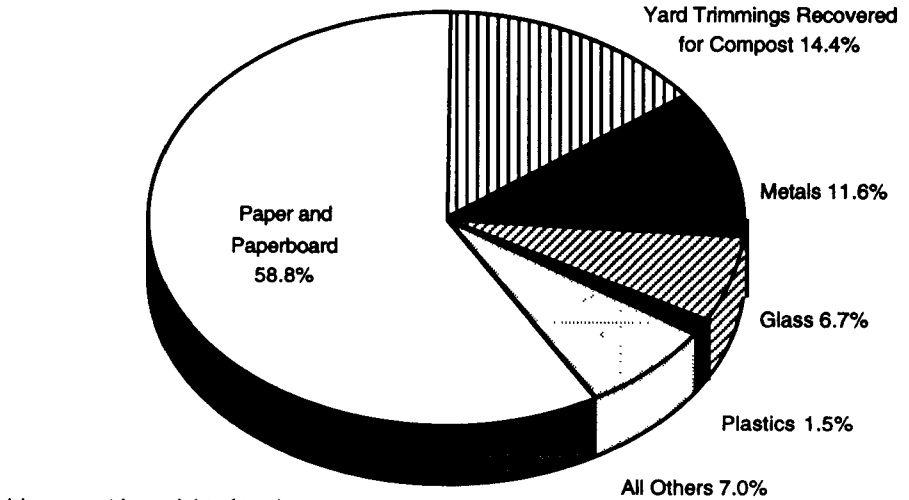
Figure 13 illustrates the effect of recovery of materials for recycling, including composting, on the composition of MSW discards. For example, paper and paperboard were 37.6 percent of MSW generated in 1993, but after recovery, paper and paperboard were 31.7 percent of discards.

Materials that have little or no recovery exhibit a larger percentage of MSW discards compared to generation. For instance, food wastes were 6.7 percent of MSW generation in 1993, but 8.5 percent of discards.

PRODUCTS IN MUNICIPAL SOLID WASTE

Generation, recovery, and discards of products in municipal solid waste are shown in a series of tables in this section. (Note that the totals for these tables are the same as the previous series of tables for materials in MSW.) The products in MSW are categorized as durable goods, nondurable goods, and containers and

Figure 12. Materials recovery*, 1993



* In percent by weight of total recovery.

packaging. Generation, recovery, and discards of these products are summarized in Tables 9 through 11. Each product category is discussed in more detail below, with detailed tables highlighting the products in each.

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 major appliances, furniture and furnishings, rubber tires, lead-acid automotive batteries, and miscellaneous durables (e.g., small appliances, 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 1993, these include: ferrous metals, plastics, rubber and leather, wood, textiles, glass, other nonferrous metals (e.g., lead, copper), and aluminum.

Generation of durable goods in MSW totaled 31.9 million tons in 1993 (15.4 percent of total MSW generation). After recovery for recycling, 27.9 million tons of durable goods remained as discards in 1993.

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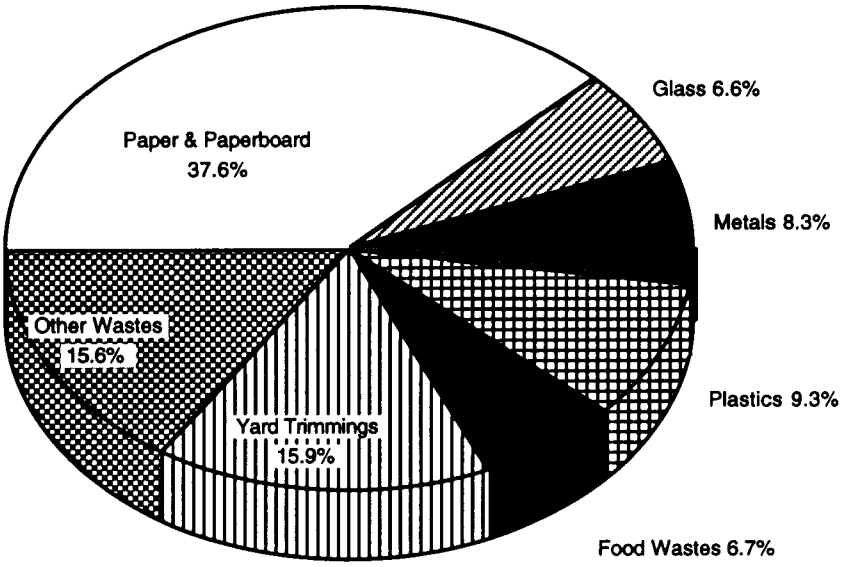
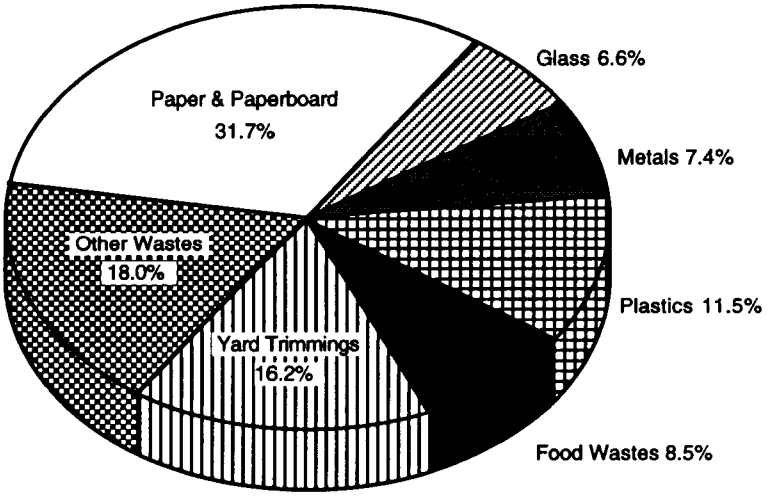
* Automobiles and other transportation equipment are not included in this report.

Figure 13. Materials generated and discarded in municipal solid waste, 1993
(in percent of total generation and discards)



Generation



Discards

Table 9

CATEGORIES OF PRODUCTS GENERATED*
IN THE MUNICIPAL WASTE STREAM, 1960 TO 1993
(In thousands of tons and percent of total generation)

	Thousands of Tons						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods *(Detail in Table 12)*	9,430	15,090	19,700	29,710	30,260	30,630	31,910
Nondurable Goods *(Detail in Table 15)*	17,550	25,540	36,490	52,450	50,000	52,750	54,800
Containers and Packaging *(Detail in Table 18)*	27,320	43,470	52,350	64,760	65,260	68,130	70,580
Total Product** Wastes	54,300	84,100	108,540	146,920	145,520	151,510	157,290
Other Wastes							
Food Wastes	12,200	12,800	13,200	13,200	13,300	13,500	13,800
Yard Trimmings	20,000	23,200	27,500	35,000	35,000	35,000	32,800
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	2,950	3,000	3,050
Total Other Wastes	33,500	37,780	42,950	51,100	51,250	51,500	49,650
Total MSW Generated - Weight	87,800	121,880	151,490	198,020	196,770	203,010	206,940
	Percent of Total Generation						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods *(Detail in Table 12)*	10.7%	12.4%	13.0%	15.0%	15.4%	15.1%	15.4%
Nondurable Goods *(Detail in Table 15)*	20.0%	21.0%	24.1%	26.5%	25.4%	26.0%	26.5%
Containers and Packaging *(Detail in Table 19)*	31.1%	35.7%	34.6%	32.7%	33.2%	33.6%	34.1%
Total Product** Wastes	61.8%	69.0%	71.6%	74.2%	74.0%	74.6%	76.0%
Other Wastes							
Food Wastes	13.9%	10.5%	8.7%	6.7%	6.8%	6.6%	6.7%
Yard Trimmings	22.8%	19.0%	18.2%	17.7%	17.8%	17.2%	15.9%
Miscellaneous Inorganic Wastes	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
Total Other Wastes	38.2%	31.0%	28.4%	25.8%	26.0%	25.4%	24.0%
Total MSW Generated - %	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, Ltd.

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 Appliance Manufacturer Annual Report. 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 are also made for the estimated lifetimes of the appliances, which range to 20 years.

Generation of these products in MSW has increased very slowly; it was estimated to be 3.4 million tons in 1993 (1.7 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 are also present.

Table 10

RECOVERY* OF MUNICIPAL SOLID WASTE, 1960 TO 1993
(In thousands of tons and percent of generation of each category)

	Thousands of Tons						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods *(Detail in Table 13)*	350	940	1,350	2,910	3,230	3,520	4,050
Nondurable Goods *(Detail in Table 16)*	2,380	3,790	4,810	8,620	10,300	10,920	11,500
Containers and Packaging *(Detail in Table 20)*	3,120	3,900	8,360	17,150	18,760	21,040	22,940
***Total Product** Wastes*	5,850	8,630	14,520	28,680	32,290	35,480	38,490
Other Wastes							
Food Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Yard Trimmings	Neg.	Neg.	Neg.	4,200	5,000	6,000	6,500
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	4,200	5,000	6,000	6,500
Total MSW Recovered - Weight	5,850	8,630	14,520	32,880	37,290	41,480	44,990
	Percent of Generation of Each Category						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods *(Detail in Table 13)*	3.7%	6.2%	6.9%	9.8%	10.7%	11.5%	12.7%
Nondurable Goods *(Detail in Table 16)*	13.6%	14.8%	13.2%	16.4%	20.6%	20.7%	21.0%
Containers and Packaging *(Detail in Table 21)*	11.4%	9.0%	16.0%	26.5%	28.7%	30.9%	32.5%
***Total Product** Wastes*	10.8%	10.3%	13.4%	19.5%	22.2%	23.4%	24.5%
Other Wastes							
Food Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Yard Trimmings	Neg.	Neg.	Neg.	12.0%	14.3%	17.1%	19.8%
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	8.2%	9.8%	11.7%	13.1%
Total MSW Recovered - %	6.7%	7.1%	9.6%	16.6%	19.0%	20.4%	21.7%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Other than food products.
Neg. = Negligible.
Details may not add to totals due to rounding.
Source: Franklin Associates, Ltd.

Data on recovery of ferrous metals from major appliances are from a survey conducted by the Steel Recycling Institute. Recovery of ferrous metals from shredded appliances was estimated to be 1.8 million tons in 1993, leaving 1.6 million tons of appliances to be discarded.

Small Appliances. For the first time, small appliances have been added as a separate line item for this report; previously they were counted as part of miscellaneous durable products. This category includes items such as toasters, hair dryers, electric coffeepots, and the like.

Information on shipments of small appliances was obtained from Department of Commerce data. Information on weights and materials

Table 11

CATEGORIES OF PRODUCTS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1993
(In thousands of tons and percent of total discards)

	Thousands of Tons						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods *(Detail in Table 14)*	9,080	14,150	18,350	26,800	27,030	27,110	27,860
Nondurable Goods *(Detail in Table 17)*	15,170	21,750	31,680	43,830	39,700	41,830	43,300
Containers and Packaging *(Detail in Table 22)*	24,200	39,570	43,990	47,610	46,500	47,090	47,640
Total Product** Wastes	48,450	75,470	94,020	118,240	113,230	116,030	118,800
Other Wastes							
Food Wastes	12,200	12,800	13,200	13,200	13,300	13,500	13,800
Yard Trimmings	20,000	23,200	27,500	30,800	30,000	29,000	26,300
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	2,950	3,000	3,050
Total Other Wastes	33,500	37,780	42,950	46,900	46,250	45,500	43,150
Total MSW Discarded - Weight	81,950	113,250	136,970	165,140	159,480	161,530	161,950
	Percent of Total Discards						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods *(Detail in Table 14)*	11.1%	12.5%	13.4%	16.2%	16.9%	16.8%	17.2%
Nondurable Goods *(Detail in Table 17)*	18.5%	19.2%	23.1%	26.5%	24.9%	25.9%	26.7%
Containers and Packaging *(Detail in Table 23)*	29.5%	34.9%	32.1%	28.8%	29.2%	29.2%	29.4%
Total Product** Wastes	59.1%	66.6%	68.6%	71.6%	71.0%	71.8%	73.4%
Other Wastes							
Food Wastes	14.9%	11.3%	9.6%	8.0%	8.3%	8.4%	8.5%
Yard Trimmings	24.4%	20.5%	20.1%	18.7%	18.8%	18.0%	16.2%
Miscellaneous Inorganic Wastes	1.6%	1.6%	1.6%	1.8%	1.8%	1.9%	1.9%
Total Other Wastes	40.9%	33.4%	31.4%	28.4%	29.0%	28.2%	26.6%
Total MSW Discarded - %	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, Ltd.

composition of small appliances was obtained through interviews. It was estimated that 530,000 tons of small appliances were generated in 1993. A small amount of ferrous metals in small appliances may be recovered through magnetic separation, but no specific data on recovery were found.

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 1993
(WITH DETAIL ON DURABLE GOODS)
(In thousands of tons and percent of total generation)

	Thousands of Tons						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods							
Major Appliances	1,500	2,670	2,830	2,830	3,100	3,220	3,430
Small Appliances**				520	590	600	530
Furniture and Furnishings	2,150	3,370	5,100	7,370	7,410	6,670	7,020
Carpets and Rugs**				1,750	1,840	1,970	2,130
Rubber Tires	1,120	1,890	2,560	3,280	3,190	3,280	3,410
Batteries, lead acid	Neg.	820	1,490	1,510	1,550	1,540	1,670
Miscellaneous Durables	4,660	6,340	7,720	12,450	12,580	13,350	13,720
Total Durable Goods	9,430	15,090	19,700	29,710	30,260	30,630	31,910
Nondurable Goods	17,550	25,540	36,490	52,450	50,000	52,750	54,800
(Detail in Table 15)							
Containers and Packaging	27,320	43,470	52,350	64,760	65,260	68,130	70,580
(Detail in Table 18)							
Total Product Wastes†	54,300	84,100	108,540	146,920	145,520	151,510	157,290
Other Wastes							
Food Wastes	12,200	12,800	13,200	13,200	13,300	13,500	13,800
Yard Trimmings	20,000	23,200	27,500	35,000	35,000	35,000	32,800
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	2,950	3,000	3,050
Total Other Wastes	33,500	37,780	42,950	51,100	51,250	51,500	49,650
Total MSW Generated - Weight	87,800	121,880	151,490	198,020	196,770	203,010	206,940
	Percent of Total Generation						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods							
Major Appliances	1.7%	2.2%	1.9%	1.4%	1.6%	1.6%	1.7%
Furniture and Furnishings	2.4%	2.8%	3.4%	3.7%	3.8%	3.3%	3.4%
Carpets and Rugs				0.9%	0.9%	1.0%	1.0%
Rubber Tires	1.3%	1.6%	1.7%	1.7%	1.6%	1.6%	1.6%
Batteries, Lead-Acid	Neg.	0.7%	1.0%	0.8%	0.8%	0.8%	0.8%
Miscellaneous Durables	5.3%	5.2%	5.1%	6.3%	6.4%	6.6%	6.6%
Total Durable Goods	10.7%	12.4%	13.0%	15.0%	15.4%	15.1%	15.4%
Nondurable Goods	20.0%	21.0%	24.1%	26.5%	25.4%	26.0%	26.5%
(Detail in Table 15)							
Containers and Packaging	31.1%	35.7%	34.6%	32.7%	33.2%	33.6%	34.1%
(Detail in Table 19)							
Total Product Wastes†	61.8%	69.0%	71.6%	74.2%	74.0%	74.6%	76.0%
Other Wastes							
Food Wastes	13.9%	10.5%	8.7%	6.7%	6.8%	6.6%	6.7%
Yard Trimmings	22.8%	19.0%	18.2%	17.7%	17.8%	17.2%	15.9%
Miscellaneous Inorganic Wastes	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
Total Other Wastes	38.2%	31.0%	28.4%	25.8%	26.0%	25.4%	24.0%
Total MSW Generated - %	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.
† Other than food products.
Source: Franklin Associates, Ltd.

Generation of furniture and furnishings in MSW has increased from 2.2 million tons in 1960 to 7.0 million tons in 1993 (3.4 percent of total MSW). No significant recovery of materials from furniture was identified.

Table 13

RECOVERY* OF PRODUCTS IN MUNICIPAL SOLID WASTE, 1960 TO 1993
(WITH DETAIL ON DURABLE GOODS)
(In thousands of tons and percent of generation of each product)

	Thousands of Tons						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods							
Major Appliances	10	50	130	910	1,180	1,470	1,840
Small Appliances**				Neg.	Neg.	Neg.	Neg.
Furniture and Furnishings	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Carpets and Rugs**				Neg.	10	10	10
Rubber Tires	330	250	140	400	410	430	440
Batteries, lead acid	Neg.	620	1,040	1,470	1,500	1,450	1,580
Miscellaneous Durables	10	20	40	130	130	160	180
Total Durable Goods	350	940	1,350	2,910	3,230	3,520	4,050
Nondurable Goods *(Detail in Table 16)*	2,380	3,790	4,810	8,620	10,300	10,920	11,500
Containers and Packaging *(Detail in Table 20)*	3,120	3,900	8,360	17,150	18,760	21,040	22,940
Total Product Wastes†	5,850	8,630	14,520	28,680	32,290	35,480	38,490
Other Wastes							
Food Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Yard Trimmings	Neg.	Neg.	Neg.	4,200	5,000	6,000	6,500
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	4,200	5,000	6,000	6,500
Total MSW Recovered - Weight	5,850	8,630	14,520	32,880	37,290	41,480	44,990
	Percent of Generation of Each Product						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods							
Major Appliances	Neg.	Neg.	Neg.	Neg.	38.1%	45.7%	53.6%
Furniture and Furnishings	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Carpets and Rugs					0.5%	0.5%	0.5%
Rubber Tires	29.5%	13.2%	5.5%	12.2%	12.9%	13.1%	12.9%
Batteries, Lead-Acid	Neg.	75.6%	69.8%	97.4%	96.8%	94.2%	94.6%
Miscellaneous Durables	Neg.	Neg.	Neg.	Neg.	1.0%	1.2%	1.3%
Total Durable Goods	3.7%	6.2%	6.9%	9.8%	10.7%	11.5%	12.7%
Nondurable Goods *(Detail in Table 16)*	13.6%	14.8%	13.2%	16.4%	20.6%	20.7%	21.0%
Containers and Packaging *(Detail in Table 21)*	11.4%	9.0%	16.0%	26.5%	28.7%	30.9%	32.5%
Total Product Wastes†	10.8%	10.3%	13.4%	19.5%	22.2%	23.4%	24.5%
Other Wastes							
Food Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Yard Trimmings	Neg.	Neg.	Neg.	12.0%	14.3%	17.1%	19.8%
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	8.2%	9.8%	11.7%	13.1%
Total MSW Recovered - %	6.7%	7.1%	9.6%	16.6%	19.0%	20.4%	21.7%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Not estimated separately prior to 1990.
† Other than food products.
Neg. = Negligible.
Source: Franklin Associates, Ltd.

Wood is the largest material category in furniture, with ferrous metals second. Plastics, glass, and other materials are also found in furniture.

Table 14

PRODUCTS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1993
(WITH DETAIL ON DURABLE GOODS)
(In thousands of tons and percent of total discards)

	Thousands of Tons						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods							
Major Appliances	1,490	2,620	2,700	1,920	1,920	1,750	1,590
Small Appliances**				520	590	600	530
Furniture and Furnishings	2,150	3,370	5,100	7,370	7,410	6,670	7,020
Carpets and Rugs**				1,750	1,830	1,960	2,120
Rubber Tires	790	1,640	2,420	2,880	2,780	2,850	2,970
Batteries, lead acid	Neg.	200	450	40	50	90	90
Miscellaneous Durables	4,650	6,320	7,680	12,320	12,450	13,190	13,540
Total Durable Goods	9,080	14,150	18,350	26,800	27,030	27,110	27,860
Nondurable Goods *(Detail in Table 17)*	15,170	21,750	31,680	43,830	39,700	41,830	43,300
Containers and Packaging *(Detail in Table 22)*	24,200	39,570	43,990	47,610	46,500	47,090	47,640
Total Product Wastes†	48,450	75,470	94,020	118,240	113,230	116,030	118,800
Other Wastes							
Food Wastes	12,200	12,800	13,200	13,200	13,300	13,500	13,800
Yard Trimmings	20,000	23,200	27,500	30,800	30,000	29,000	26,300
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	2,950	3,000	3,050
Total Other Wastes	33,500	37,780	42,950	46,900	46,250	45,500	43,150
Total MSW Discarded - Weight	81,950	113,250	136,970	165,140	159,480	161,530	161,950
	Percent of Total Discards						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods							
Major Appliances	1.8%	2.3%	2.0%	1.2%	1.2%	1.1%	1.0%
Furniture and Furnishings	2.6%	3.0%	3.7%	4.5%	4.6%	4.1%	4.3%
Carpets and Rugs	0.0%	0.0%	0.0%	1.1%	1.1%	1.2%	1.3%
Rubber Tires	1.0%	1.4%	1.8%	1.7%	1.7%	1.8%	1.8%
Batteries, Lead-Acid	Neg.	0.2%	0.3%	0.0%	0.0%	0.1%	Neg.
Miscellaneous Durables	5.7%	5.6%	5.6%	7.5%	7.8%	8.2%	8.4%
Total Durable Goods	11.1%	12.5%	13.4%	16.2%	16.9%	16.8%	17.2%
Nondurable Goods *(Detail in Table 17)*	18.5%	19.2%	23.1%	26.5%	24.9%	25.9%	26.7%
Containers and Packaging *(Detail in Table 23)*	29.5%	34.9%	32.1%	28.8%	29.2%	29.2%	29.4%
Total Product Wastes†	59.1%	66.6%	68.6%	71.6%	71.0%	71.8%	73.4%
Other Wastes							
Food Wastes	14.9%	11.3%	9.6%	8.0%	8.3%	8.4%	8.5%
Yard Trimmings	24.4%	20.5%	20.1%	18.7%	18.8%	18.0%	16.2%
Miscellaneous Inorganic Wastes	1.6%	1.6%	1.6%	1.8%	1.8%	1.9%	1.9%
Total Other Wastes	40.9%	33.4%	31.4%	28.4%	29.0%	28.2%	26.6%
Total MSW Discarded - %	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.

† Other than food products.

Neg. = Negligible.

Source: Franklin Associates, Ltd.

Carpets and Rugs. An industry publication, *Carpet and Rug Industrial Review,* publishes data on carpet sales in square yards. These data are converted to tons using various factors developed for this report. An estimated 2.1 million

tons of carpets and rugs were generated in MSW in 1993, which was 1.0 percent of total generation.

A small amount of recycling of carpet fiber was identified—estimated to be 0.5 percent recovery in 1993.

Rubber Tires. The methodology for estimating generation of rubber tires for automobiles and trucks has been revised for this update; some of the data series used previously have been discontinued. The estimates are 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 3.4 million tons in 1993 (1.6 percent of total MSW).

Data on recovery of rubber tires are taken from an EPA scrap tire market study, updated with information from *Scrap Tire News*. Rubber recovery from tires has been small, but increasing in recent years. In 1993, an estimated 12.9 percent of tire rubber generated was recovered for recycling, leaving 3.0 million tons to be discarded. (Tires going to combustion facilities are included in the combustion estimates in Chapter 3.)

Lead-Acid Batteries. The methodology for estimating generation of lead-acid batteries has been changed for this report to be similar to the methodology for rubber tires as described above. An estimated 1.7 million tons of lead-acid batteries from automobiles, trucks, and motorcycles were generated in MSW in 1993 (0.8 percent of total generation).

Data on recovery of batteries are provided by the Battery Council International. Recovery of batteries for recycling has fluctuated between 60 percent and 95 percent or higher; recovery has increased since 1980 as a growing number of communities have restricted batteries from disposal at landfills or combustors. In 1993, 94.6 percent of the lead in these batteries was recovered for recycling as well as substantial quantities of the polypropylene battery casings; so discards after recycling of these batteries were decreased to 90,000 tons in 1993. (Some electrolytes and other materials in batteries are removed from the municipal solid waste stream along with recovered lead and polypropylene; these other materials are counted as "recovered" along with the recyclable materials.

Miscellaneous Durables. Miscellaneous durable goods include consumer electronics such as television sets, video cassette recorders, personal computers, luggage, sporting equipment, and the like. (Small appliances were included with miscellaneous durables in previous reports in this series, but are estimated separately in this report.) An estimated 13.7 million tons of these goods were generated in 1993, amounting to 6.6 percent of MSW generated. Small amounts of ferrous metals are estimated to be recovered from this category, decreasing discards to 13.5 million tons.

In addition to ferrous metals, this category includes plastics, glass, rubber, wood, and other metals.

Nondurable Goods

The Department of Commerce defines nondurable goods as those having a lifetime 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; and other miscellaneous products. (See Tables 15 through 17.)

Generation of nondurable goods in MSW was 54.8 million tons in 1993 (26.5 percent of total generation). Recovery of paper products in this category is quite significant, resulting in 11.5 million tons of nondurable goods recovered in 1993 (21.0 percent of generation). This means that 43.3 million tons of nondurable goods were discarded in 1993 (26.7 percent of 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 1993 was shown earlier in Table 4. 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 12.9 million tons generated in 1993 (6.3 percent of total MSW). In 1993, 45.7 percent of newspapers generated were recovered for recycling, leaving 7.0 million tons discarded (4.3 percent of total MSW discarded). For the first time in this series of reports, the estimates of newspaper generation are broken down into newsprint (the

Table 15

PRODUCTS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1993
(WITH DETAIL ON NONDURABLE GOODS)
(In thousands of tons and percent of total generation)

	Thousands of Tons						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods *(Detail in Table 12)*	9,430	15,090	19,700	29,710	30,260	30,630	31,910
Nondurable Goods							
Newspapers	7,110	9,500	11,040	13,270	12,330	12,770	12,940
Books and Magazines	1,920	2,470	3,390				
Books**				970	860	930	990
Magazines**				2,830	2,170	2,360	2,500
Office Papers	1,520	2,650	4,000	6,410	6,300	6,660	7,120
Telephone Books**				610	670	700	740
Third Class Mail**				3,820	3,690	3,560	4,010
Other Commercial Printing	1,260	2,130	3,110	4,560	4,800	5,340	5,440
Tissue Paper and Towels	1,090	2,060	2,300	2,970	2,700	2,750	3,010
Paper Plates and Cups	270	420	600	650	680	750	830
Plastic Plates and Cups†			190	320	300	340	350
Trash Bags**				780	770	840	890
Disposable Diapers	Neg.	370	2,310	2,640	2,720	2,750	2,700
Other Nonpackaging Paper	2,680	3,600	4,190	3,860	3,980	4,160	4,770
Clothing and Footwear	1,290	1,580	2,300	4,850	4,210	4,690	4,280
Towels, Sheets and Pillowcases**				710	750	770	720
Other Miscellaneous Nondurables	410	760	3,060	3,200	3,070	3,380	3,510
Total Nondurable Goods	17,550	25,540	36,490	52,450	50,000	52,750	54,800
Containers and Packaging *(Detail in Table 18)*	27,320	43,470	52,350	64,760	65,260	68,130	70,580
Total Product Wastes‡	54,300	84,100	108,540	146,920	145,520	151,510	157,290
Other Wastes	33,500	37,780	42,950	51,100	51,250	51,500	49,650
Total MSW Generated - Weight	87,800	121,880	151,490	198,020	196,770	203,010	206,940
	Percent of Total Generation						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods *(Detail in Table 12)*	10.7%	12.4%	13.0%	15.0%	15.4%	15.1%	15.4%
Nondurable Goods							
Newspapers	8.1%	7.8%	7.3%	6.4%	6.0%	6.2%	6.3%
Books and Magazines	2.2%	2.0%	2.2%				
Books**				0.5%	0.4%	0.4%	0.5%
Magazines**				1.4%	1.0%	1.1%	1.2%
Office Papers	1.7%	2.2%	2.6%	3.1%	3.0%	3.2%	3.4%
Telephone Books**				0.3%	0.3%	0.3%	0.4%
Third Class Mail**				1.8%	1.8%	1.7%	1.9%
Other Commercial Printing	1.4%	1.7%	2.1%	2.2%	2.3%	2.6%	2.6%
Tissue Paper and Towels	1.2%	1.7%	1.5%	1.4%	1.3%	1.3%	1.5%
Paper Plates and Cups	0.3%	0.3%	0.4%	0.3%	0.3%	0.4%	0.4%
Plastic Plates and Cups†			0.1%	0.2%	0.1%	0.2%	0.2%
Trash Bags**				0.4%	0.4%	0.4%	0.4%
Disposable Diapers	Neg.	Neg.	1.5%	1.3%	1.3%	1.3%	1.3%
Other Nonpackaging Paper	3.1%	3.0%	2.8%	1.9%	1.9%	2.0%	2.3%
Clothing and Footwear	1.5%	1.3%	1.5%	2.3%	2.0%	2.3%	2.1%
Towels, Sheets and Pillowcases**				0.3%	0.4%	0.4%	0.3%
Other Miscellaneous Nondurables	0.5%	0.6%	2.0%	1.5%	1.5%	1.6%	1.7%
Total Nondurables	20.0%	21.0%	24.1%	26.5%	25.4%	26.0%	26.5%
Containers and Packaging *(Detail in Table 19)*	31.1%	35.7%	34.6%	32.7%	33.2%	33.6%	34.1%
Total Product Wastes‡	61.8%	69.0%	71.6%	74.2%	74.0%	74.6%	76.0%
Other Wastes	38.2%	31.0%	28.4%	25.8%	26.0%	25.4%	24.0%
Total MSW Generated - %	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 1980.
‡ Other than food products.
Neg. = Negligible.
Source: Franklin Associates, Ltd.

Table 16

RECOVERY* OF PRODUCTS IN MUNICIPAL SOLID WASTE, 1960 TO 1993
(WITH DETAIL ON NONDURABLE GOODS)
(In thousands of tons and percent of generation of each product)

	Thousands of Tons						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods *(Detail in Table 13)*	350	940	1,350	2,910	3,230	3,520	4,050
Nondurable Goods							
Newspapers	1,820	2,320	3,000	4,520	5,260	5,470	5,920
Books and Magazines	90	260	350				
Books**				130	150	150	160
Magazines**				410	390	450	450
Office Papers	250	680	1,000	2,020	2,290	2,530	2,600
Telephone Books**				40	50	60	60
Third Class Mail**				270	440	510	540
Other Commercial Printing	130	340	440	670	910	960	1,060
Tissue Paper and Towels	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Paper Plates and Cups	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Plastic Plates and Cups†			Neg.	10	20	20	20
Trash Bags**				Neg.	Neg.	Neg.	Neg.
Disposable Diapers	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Other Nonpackaging Paper	80	180	0	Neg.	Neg.	Neg.	Neg.
Clothing and Footwear	10	10	20	430	660	640	570
Towels, Sheets and Pillowcases**				120	130	130	120
Other Miscellaneous Nondurables	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Nondurable Goods	2,380	3,790	4,810	8,620	10,300	10,920	11,500
Containers and Packaging *(Detail in Table 20)*	3,120	3,900	8,360	17,150	18,760	21,040	22,940
Total Product Wastes‡	5,850	8,630	14,520	28,680	32,290	35,480	38,490
Other Wastes	Neg.	Neg.	Neg.	4,200	5,000	6,000	6,500
Total MSW Recovered - Weight	5,850	8,630	14,520	32,880	37,290	41,480	44,990
	Percent of Generation of Each Product						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods *(Detail in Table 13)*	3.7%	6.2%	6.9%	9.8%	10.7%	11.5%	12.7%
Nondurable Goods							
Newspapers	25.6%	24.4%	27.2%	34.1%	42.7%	42.8%	45.7%
Books and Magazines	4.7%	10.5%	10.3%				
Books**				13.4%	17.4%	16.1%	16.2%
Magazines**				14.5%	18.0%	19.1%	18.0%
Office Papers	16.4%	25.7%	25.0%	31.5%	36.3%	38.0%	36.5%
Telephone Books**				6.6%	7.5%	8.6%	8.1%
Third Class Mail**				7.1%	11.9%	14.3%	13.5%
Other Commercial Printing	10.3%	16.0%	14.1%	14.7%	19.0%	18.0%	19.5%
Tissue Paper and Towels	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Paper Plates and Cups	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Plastic Plates and Cups†			Neg.	3.1%	6.7%	5.9%	5.7%
Trash Bags**				Neg.	Neg.	Neg.	Neg.
Disposable Diapers	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Other Nonpackaging Paper	3.0%	5.0%	0.0%	Neg.	Neg.	Neg.	Neg.
Clothing and Footwear	Neg.	Neg.	Neg.	8.9%	15.7%	13.6%	13.3%
Towels, Sheets and Pillowcases**				16.9%	17.3%	16.9%	16.7%
Other Miscellaneous Nondurables	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Nondurables	13.6%	14.8%	13.2%	16.4%	20.6%	20.7%	21.0%
Containers and Packaging *(Detail in Table 21)*	11.4%	9.0%	16.0%	26.5%	28.7%	30.9%	32.5%
Total Product Wastes‡	10.8%	10.3%	13.4%	19.5%	22.2%	23.4%	24.5%
Other Wastes	Neg.	Neg.	Neg.	8.2%	9.8%	11.7%	13.1%
Total MSW Recovered - %	6.7%	7.1%	9.6%	16.6%	19.0%	20.4%	21.7%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Not estimated separately prior to 1990.
† Not estimated separately prior to 1980.
‡ Other than food products.
Neg. = Negligible.
Source: Franklin Associates, Ltd.

Table 17

PRODUCTS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1993
(WITH DETAIL ON NONDURABLE GOODS)
(In thousands of tons and percent of total discards)

	Thousands of Tons						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods *(Detail in Table 14)*	9,080	14,150	18,350	26,800	27,030	27,110	27,860
Nondurable Goods							
Newspapers	5,290	7,180	8,040	8,750	7,070	7,300	7,020
Books and Magazines	1,830	2,210	3,040				
Books**				840	710	780	830
Magazines**				2,420	1,780	1,910	2,050
Office Papers	1,270	1,970	3,000	4,390	4,010	4,130	4,520
Telephone Books**				570	620	640	680
Third Class Mail**				3,550	3,250	3,050	3,470
Other Commercial Printing	1,130	1,790	2,670	3,890	3,890	4,380	4,380
Tissue Paper and Towels	1,090	2,060	2,300	2,970	2,700	2,750	3,010
Paper Plates and Cups	270	420	600	650	680	750	830
Plastic Plates and Cups†			190	310	280	320	330
Trash Bags**				780	770	840	890
Disposable Diapers	Neg.	370	2,310	2,640	2,720	2,750	2,700
Other Nonpackaging Paper	2,600	3,420	4,190	3,860	3,980	4,160	4,770
Clothing and Footwear	1,280	1,570	2,280	4,420	3,550	4,050	3,710
Towels, Sheets and Pillowcases**			0	590	620	640	600
Other Miscellaneous Nondurables	410	760	3,060	3,200	3,070	3,380	3,510
Total Nondurable Goods	15,170	21,750	31,680	43,830	39,700	41,830	43,300
Containers and Packaging *(Detail in Table 22)*	24,200	39,570	43,990	47,610	46,500	47,090	47,640
Total Product Wastes‡	48,450	75,470	94,020	118,240	113,230	116,030	118,800
Other Wastes	33,500	37,780	42,950	46,900	46,250	45,500	43,150
Total MSW Discarded - Weight	81,950	113,250	136,970	165,140	159,480	161,530	161,950
	Percent of Total Discards						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods *(Detail in Table 14)*	11.1%	12.5%	13.4%	16.2%	16.9%	16.7%	17.2%
Nondurable Goods							
Newspapers	6.5%	6.3%	5.9%	5.3%	4.4%	4.5%	4.3%
Books and Magazines	2.2%	2.0%	2.2%				
Books**				0.5%	0.4%	0.5%	0.5%
Magazines**				1.5%	1.1%	1.2%	1.3%
Office Papers	1.5%	1.7%	2.2%	2.7%	2.5%	2.6%	2.8%
Telephone Books**				0.3%	0.4%	0.4%	0.4%
Third Class Mail**				2.1%	2.0%	1.9%	2.1%
Other Commercial Printing	1.4%	1.6%	1.9%	2.4%	2.4%	2.7%	2.7%
Tissue Paper and Towels	1.3%	1.8%	1.7%	1.8%	1.7%	1.7%	1.9%
Paper Plates and Cups	0.3%	0.4%	0.4%	0.4%	0.4%	0.5%	0.5%
Plastic Plates and Cups†			0.1%	0.2%	0.2%	0.2%	0.2%
Trash Bags**				0.5%	0.5%	0.5%	0.5%
Disposable Diapers	Neg.	Neg.	1.7%	1.6%	1.7%	1.7%	1.7%
Other Nonpackaging Paper	3.2%	3.0%	3.1%	2.3%	2.5%	2.6%	2.9%
Clothing and Footwear	1.6%	1.4%	1.7%	2.7%	2.2%	2.5%	2.3%
Towels, Sheets and Pillowcases**				0.4%	0.4%	0.4%	0.4%
Other Miscellaneous Nondurables	0.5%	0.7%	2.2%	1.9%	1.9%	2.1%	2.2%
Total Nondurables	18.5%	19.2%	23.1%	26.5%	24.9%	25.9%	26.7%
Containers and Packaging *(Detail in Table 23)*	29.5%	34.9%	32.1%	28.8%	29.2%	29.2%	29.4%
Total Product Wastes‡	59.1%	66.6%	68.6%	71.6%	71.0%	71.8%	73.4%
Other Wastes	40.9%	33.4%	31.4%	28.4%	29.0%	28.2%	26.6%
Total MSW Discarded - %	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 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 1980.
‡ Other than food products.
Neg. = Negligible.
Source: Franklin Associates, Ltd.

majority of the weight of 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 1.0 million tons, or 0.5 percent of total MSW generation, in 1993. Recovery of books is not well documented, but it was estimated that approximately 160,000 tons of books were recovered in 1993. Books are made of both groundwood and chemical pulp.

- Magazines accounted for 2.5 million tons, or 1.2 percent of total MSW generation, in 1993. Like books, recovery of magazines is not well documented. It was estimated that 450,000 tons of magazines were recovered in 1993. 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. (7.1 million tons, or 3.4 percent of total MSW generation, in 1993). 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 2.6 million tons of office-type papers were recovered in 1993.

- Telephone books (directories) were estimated to generate 740,000 tons (0.4 percent of total MSW) in 1993. These directories are made of groundwood. It was estimated that 60,000 tons of directories were recovered in 1993.

- Third-class mail includes catalogs and other direct bulk mailings; these amounted to 4.0 million tons, or 1.9 percent of MSW generation, in 1993. Both groundwood and chemical pulps are used in these mailings. While recovery of third-class mail is not well documented, it was estimated that 540,000 tons were recovered in 1993. The U.S. Postal

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

Service has announced a program to increase recovery of bulk mail in the future.

- 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 5.4 million tons, or 2.6 percent of MSW generation, in 1993, with recovery at 1.1 million tons.

- Tissue paper and towels include facial and sanitary tissues and napkins, but not toilet tissue, which is nearly all diverted from MSW into the wastewater treatment system. Tissue products amounted to 3.0 million tons (1.5 percent of total MSW generation) in 1993. No significant recovery of tissue products was identified.

- 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 830,000 tons (0.4 percent of total MSW generation) in 1993. No significant recovery of these products was identified.

- Other nonpackaging papers—including posters, photographic papers, cards and games, etc.—accounted for 4.8 million tons (2.3 percent of total MSW generation) in 1993. No significant recovery of these papers was identified.

Overall, generation of paper and paperboard products in nondurable goods was 42.4 million tons in 1993 (Table 4). While newspapers were recovered at the highest rate, other paper products, such as books, magazines, and office papers, were also recovered for recycling, and the overall recovery rate for paper in nondurables was 25.4 percent in 1993. Thus 31.6 million tons of paper in nondurables were discarded in 1993.

Plastic Plates and Cups. This category includes plastic plates, cups, glasses, dishes and bowls, hinged containers, and other containers used in food service at home, in restaurants and other commercial establishments, and in institutional settings such as schools. These items are made of polystyrene resin. An estimated 350,000 tons of these products were generated in 1993, or 0.2 percent of total MSW (see Table 15). An estimated 20,000 tons of these products were recovered for recycling in 1993.

Disposable Diapers. 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 2.7 million tons of disposable diapers were generated in 1993, or 1.3

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.

There has been some investigation of recycling/composting of disposable diapers, but no significant recovery was identified for 1993.

Clothing and Footwear. Generation of clothing and footwear was estimated to be 4.3 million tons in 1993 (2.1 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 product included. Adjustments are made for net imports of these products based on Department of Commerce data.

The Council for Textile Recycling reports on recovery of textiles for exports, reprocessing, and reuse. Based on their data, it was estimated that 570,000 tons of textiles in clothing were recovered for export or recycling in 1993. (Reuse is not counted as recycling and is discussed in Chapter 3.)

Towels, Sheets, and Pillowcases. An estimated 0.7 million tons of towels, sheets, and pillowcases were generated in 1993. Generation was estimated using a methodology similar to that for clothing. An estimated 120,000 tons of these textiles were recovered in 1993.

Other Miscellaneous Nondurables. Generation of other miscellaneous nondurables was estimated to be 3.5 million tons in 1993 (1.7 percent of MSW). The primary material component of miscellaneous nondurables is plastics, although some aluminum, rubber, and textiles are also 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 70.6 million tons of generation in 1993 (34.1 percent of total generation). Generation, recovery, and discards of containers and packaging are shown in detail in Tables 18 through 23.

There is substantial recovery of many container and packaging products, especially corrugated containers. In 1993, 32.5 percent of containers and packaging generated was recovered for recycling. Because of this recovery, containers and packaging comprised 29.4 percent of total MSW discards in 1993.

Containers and packaging in MSW are made of several materials: paper and paperboard, glass, ferrous metals, aluminum, plastics, wood, and small amounts of other materials. Each materials category is discussed separately below.

Glass Containers. Glass containers include beer and soft drink bottles, 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 12.2 million tons in 1993, or 5.9 percent of MSW generation (Tables 18 and 19). Production of glass containers had been declining in the 1980s, but increased in recent years.

Recovery data for glass containers comes from the Glass Packaging Institute (GPI). The GPI figures include an estimate for use of refillable bottles. Since refilling is defined as reuse rather than recycling in this report, the refilled bottles are not counted as recovery in this report, although this has been the practice in earlier versions. An estimated 3.0 million tons of glass containers were recovered for recycling in 1993, or 24.6 percent of generation. After recovery for recycling, glass container discards were 9.2 million tons in 1993, or 5.7 percent of total discards.

Steel Containers and Packaging. Steel beer and soft drink cans, food and other cans, and other steel packaging (e.g., strapping), totaled 3.0 million tons in 1993 (1.4 percent of total generation), with most of that amount being "tin" cans for food (Tables 18 and 19). Generation estimates are based on data supplied by the Steel Recycling Institute (SRI), the American Iron and Steel Institute (AISI), and the Can Manufacturers Institute (CMI). Generation estimates include adjustments for imports and exports. Generation of steel containers and packaging had been declining in the 1970s and 1980s, but has been stable in recent years.

Recovery data for steel containers and packaging were provided by the Steel Recycling Institute. An estimated 1.4 million tons of steel packaging were recovered in 1993, or 46.3 percent of generation. The SRI estimates include both recovery from residential sources and magnetic separation of steel cans at waste-to-energy facilities.

Table 18

PRODUCTS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1993
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In thousands of tons)

	Thousands of Tons						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods *(Detail in Table 12)*	9,430	15,090	19,700	29,710	30,260	30,630	31,910
Nondurable Goods *(Detail in Table 15)*	17,550	25,540	36,490	52,450	50,000	52,750	54,800
Containers and Packaging							
Glass Packaging							
Beer and Soft Drink Bottles	1,400	5,580	6,750	5,700	5,280	5,410	5,440
Wine and Liquor Bottles	1,080	1,900	2,450	2,100	1,840	1,830	1,850
Food and Other Bottles & Jars	3,710	4,420	4,770	4,110	4,190	4,530	4,940
Total Glass Packaging	6,190	11,900	13,970	11,910	11,310	11,770	12,230
Steel Packaging							
Beer and Soft Drink Cans	640	1,570	520	150	90	80	70
Food and Other Cans	3,760	3,540	2,850	2,540	3,000	2,740	2,720
Other Steel Packaging	260	270	240	200	190	170	190
Total Steel Packaging	4,660	5,380	3,610	2,890	3,280	2,990	2,980
Aluminum Packaging							
Beer and Soft Drink Cans	60	270	920	1,550	1,640	1,590	1,610
Other Cans	Neg.	60	40	20	30	30	40
Foil and Closures	110	240	310	330	320	330	330
Total Aluminum Packaging	170	570	1,270	1,900	1,990	1,950	1,980
Paper & Paperboard Pkg							
Corrugated Boxes	7,280	12,680	16,980	24,010	24,100	25,400	26,350
Milk Cartons**			560	500	500	480	470
Folding Cartons**			3,710	4,300	4,600	4,600	4,940
Other Paperboard Packaging	3,840	4,830	320	290	270	280	300
Bags and Sacks**			3,370	2,440	2,280	2,320	2,200
Wrapping Papers**			200	110	80	80	70
Other Paper Packaging	2,940	3,810	850	1,020	1,050	1,120	1,100
Total Paper & Board Pkg	14,060	21,320	25,990	32,670	32,880	34,280	35,430
Plastics Packaging							
Soft Drink Bottles**			260	430	450	510	560
Milk Bottles**			230	530	490	520	550
Other Containers	60	910	890	1,660	1,740	1,860	1,930
Bags and Sacks**			390	940	930	970	1,050
Wraps**			840	1,530	1,700	1,820	1,820
Other Plastics Packaging	60	1,180	790	2,200	2,180	2,310	2,370
Total Plastics Packaging	120	2,090	3,400	7,290	7,490	7,990	8,280
Wood Packaging	2,000	2,070	3,940	7,890	8,100	8,930	9,460
Other Misc. Packaging	120	140	170	210	210	220	220
Total Containers & Pkg	27,320	43,470	52,350	64,760	65,260	68,130	70,580
Total Product Wastes†	54,300	84,100	108,540	146,920	145,520	151,510	157,290
Other Wastes							
Food Wastes	12,200	12,800	13,200	13,200	13,300	13,500	13,800
Yard Trimmings	20,000	23,200	27,500	35,000	35,000	35,000	32,800
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	2,950	3,000	3,050
Total Other Wastes	33,500	37,780	42,950	51,100	51,250	51,500	49,650
Total MSW Generated - Weight	87,800	121,880	151,490	198,020	196,770	203,010	206,940

* Generation before materials recovery or combustion.
Details may not add to totals due to rounding.
** Not estimated separately prior to 1980.
† Other than food products.
Neg. = Negligible.
Source: Franklin Associates, Ltd.

Table 19

PRODUCTS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1993
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In percent of total generation)

	Percent of Total Generation						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods *(Detail in Table 12)*	10.7%	12.4%	13.0%	15.0%	15.4%	15.1%	15.4%
Nondurable Goods *(Detail in Table 15)*	20.0%	21.0%	24.1%	26.5%	25.4%	26.0%	26.5%
Containers and Packaging							
Glass Packaging							
Beer and Soft Drink Bottles	1.6%	4.6%	4.5%	2.9%	2.7%	2.7%	2.6%
Wine and Liquor Bottles	1.2%	1.6%	1.6%	1.1%	0.9%	0.9%	0.9%
Food and Other Bottles & Jars	4.2%	3.6%	3.1%	2.1%	2.1%	2.2%	2.4%
Total Glass Packaging	7.1%	9.8%	9.2%	6.1%	5.7%	5.8%	5.9%
Steel Packaging							
Beer and Soft Drink Cans	0.7%	1.3%	0.3%	0.1%	0.0%	0.0%	0.0%
Food and Other Cans	4.3%	2.9%	1.9%	1.3%	1.5%	1.3%	1.3%
Other Steel Packaging	0.3%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%
Total Steel Packaging	5.3%	4.4%	2.4%	1.5%	1.7%	1.5%	1.4%
Aluminum Packaging							
Beer and Soft Drink Cans	0.1%	0.2%	0.6%	0.8%	0.8%	0.8%	0.8%
Other Cans	Neg.	Neg.	0.0%	Neg.	Neg.	Neg.	Neg.
Foil and Closures	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Total Aluminum Packaging	0.2%	0.5%	0.8%	1.0%	1.0%	1.0%	1.0%
Paper & Paperboard Pkg							
Corrugated Boxes	8.3%	10.4%	11.2%	12.2%	12.2%	12.5%	12.7%
Milk Cartons**			0.4%	0.3%	0.3%	0.2%	0.2%
Folding Cartons**			2.4%	2.2%	2.3%	2.3%	2.4%
Other Paperboard Packaging	4.4%	4.0%	0.2%	0.1%	0.1%	0.1%	0.1%
Bags and Sacks**			2.2%	1.2%	1.2%	1.1%	1.1%
Wrapping Papers**			0.1%	0.1%	0.0%	0.0%	0.0%
Other Paper Packaging	3.3%	3.1%	0.6%	0.5%	0.5%	0.6%	0.5%
Total Paper & Board Pkg	16.0%	17.5%	17.2%	16.6%	16.7%	16.9%	17.1%
Plastics Packaging							
Soft Drink Bottles**			0.2%	0.2%	0.2%	0.3%	0.3%
Milk Bottles**			0.2%	0.3%	0.2%	0.3%	0.3%
Other Containers	0.1%	0.7%	0.6%	0.8%	0.9%	0.9%	0.9%
Bags and Sacks**			0.3%	0.5%	0.5%	0.5%	0.5%
Wraps**			0.6%	0.8%	0.9%	0.9%	0.9%
Other Plastics Packaging	0.1%	1.0%	0.5%	1.1%	1.1%	1.1%	1.1%
Total Plastics Packaging	0.1%	1.7%	2.2%	3.7%	3.8%	3.9%	4.0%
Wood Packaging	2.3%	1.7%	2.6%	4.0%	4.1%	4.4%	4.6%
Other Misc. Packaging	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Total Containers & Pkg	31.1%	35.7%	34.6%	32.7%	33.2%	33.6%	34.1%
Total Product Wastes†	61.8%	69.0%	71.6%	74.2%	74.0%	74.6%	76.0%
Other Wastes							
Food Wastes	13.9%	10.5%	8.7%	6.7%	6.8%	6.6%	6.7%
Yard Trimmings	22.8%	19.0%	18.2%	17.7%	17.8%	17.2%	15.9%
Miscellaneous Inorganic Wastes	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
Total Other Wastes	38.2%	31.0%	28.4%	25.8%	26.0%	25.4%	24.0%
Total MSW Generated - %	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.
† Other than food products.
Neg. = Negligible.
Source: Franklin Associates, Ltd.

Table 20

RECOVERY* OF PRODUCTS IN MUNICIPAL SOLID WASTE, 1960 TO 1993
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In thousands of tons)

	Thousands of Tons						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods	350	940	1,350	2,910	3,230	3,520	4,050
(Detail in Table 13)							
Nondurable Goods	2,380	3,790	4,810	8,620	10,300	10,920	11,500
(Detail in Table 16)							
Containers and Packaging							
Glass Packaging							
Beer and Soft Drink Bottles	90	140	730	1,890	1,350	1,530	1,600
Wine and Liquor Bottles	10	10	20	210	380	430	450
Food and Other Bottles & Jars	Neg.	Neg.	Neg.	520	820	930	960
Total Glass Packaging	100	150	750	2,620	2,550	2,890	3,010
Steel Packaging							
Beer and Soft Drink Cans	10	20	50	40	40	40	40
Food and Other Cans	20	70	150	590	930	1,090	1,300
Other Steel Packaging	Neg.	Neg.	Neg.	50	40	40	40
Total Steel Packaging	30	90	200	680	1,010	1,170	1,380
Aluminum Packaging							
Beer and Soft Drink Cans	Neg.	10	340	980	1,020	1,080	1,020
Other Cans	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Foil and Closures	Neg.	Neg.	Neg.	30	20	30	30
Total Aluminum Pkg	Neg.	10	340	1,010	1,040	1,110	1,050
Paper & Paperboard Pkg							
Corrugated Boxes	2,470	2,700	6,250	11,530	12,110	13,310	14,620
Milk Cartons**			Neg.	Neg.	Neg.	Neg.	Neg.
Folding Cartons**			Neg.	430	600	690	700
Other Paperboard Packaging	300	530	500	Neg.	Neg.	Neg.	Neg.
Bags and Sacks**			Neg.	220	310	340	350
Wrapping Papers**			Neg.	Neg.	Neg.	Neg.	Neg.
Other Paper Packaging	220	420	310	Neg.	Neg.	Neg.	Neg.
Total Paper & Board Pkg	2,990	3,650	7,060	12,180	13,020	14,340	15,670
Plastics Packaging							
Soft Drink Bottles**			10	140	160	210	230
Milk Bottles**			Neg.	20	70	120	130
Other Containers	Neg.	Neg.	Neg.	20	70	80	90
Bags and Sacks**			Neg.	30	10	20	20
Wraps**			Neg.	30	10	20	30
Other Plastics Packaging	Neg.	Neg.	Neg.	20	10	10	10
Total Plastics Packaging	Neg.	Neg.	10	260	330	460	510
Wood Packaging	Neg.	Neg.	Neg.	400	810	1,070	1,320
Other Misc. Packaging	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Containers & Pkg	3,120	3,900	8,360	17,150	18,760	21,040	22,940
Total Product Wastes†	5,850	8,630	14,520	28,680	32,290	35,480	38,490
Other Wastes							
Food Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Yard Trimmings	Neg.	Neg.	Neg.	4,200	5,000	6,000	6,500
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	4,200	5,000	6,000	6,500
Total MSW Recovered - Weight	5,850	8,630	14,520	32,880	37,290	41,480	44,990

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Not estimated separately prior to 1980.
† Other than food products.
Details may not add to totals due to rounding.
Neg. = Negligible.
Source: Franklin Associates, Ltd.

Table 21

RECOVERY* OF PRODUCTS IN MUNICIPAL SOLID WASTE, 1960 TO 1993
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In percent of generation of each product)

	Percent of Generation of Each Product						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods *(Detail in Table 13)*	3.7%	6.2%	6.9%	9.8%	10.7%	11.5%	12.7%
Nondurable Goods *(Detail in Table 16)*	13.6%	14.8%	13.2%	16.4%	20.6%	20.7%	21.0%
Containers and Packaging							
Glass Packaging							
Beer and Soft Drink Bottles	6.4%	2.5%	10.8%	33.2%	25.6%	28.3%	29.4%
Wine and Liquor Bottles	Neg.	Neg.	Neg.	10.0%	20.7%	23.5%	24.3%
Food and Other Bottles & Jars	Neg.	Neg.	Neg.	12.7%	19.6%	20.5%	19.4%
Total Glass Packaging	1.6%	1.3%	5.4%	22.0%	22.5%	24.6%	24.6%
Steel Packaging							
Beer and Soft Drink Cans	Neg.	Neg.	Neg.	26.7%	44.4%	50.0%	57.1%
Food and Other Cans	Neg.	2.0%	5.3%	23.2%	31.0%	39.8%	47.8%
Other Steel Packaging	Neg.	Neg.	Neg.	25.0%	21.1%	23.5%	21.1%
Total Steel Packaging	Neg.	1.7%	5.5%	23.5%	30.8%	39.1%	46.3%
Aluminum Packaging							
Beer and Soft Drink Cans	Neg.	Neg.	Neg.	63.2%	62.2%	67.9%	63.4%
Other Cans	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Foil and Closures	Neg.	Neg.	Neg.	9.1%	6.3%	9.1%	9.1%
Total Aluminum Pkg	Neg.	Neg.	Neg.	53.2%	52.3%	56.9%	53.0%
Paper & Paperboard Pkg							
Corrugated Boxes	33.9%	21.3%	36.8%	48.0%	50.2%	52.4%	55.5%
Milk Cartons**			Neg.	Neg.	Neg.	Neg.	Neg.
Folding Cartons**			Neg.	Neg.	13.0%	15.0%	14.2%
Other Paperboard Packaging	7.8%	11.0%	Neg.	Neg.	Neg.	Neg.	Neg.
Bags and Sacks**			Neg.	Neg.	13.6%	14.7%	15.9%
Wrapping Papers**			Neg.	Neg.	Neg.	Neg.	Neg.
Other Paper Packaging	7.5%	11.0%	36.5%	Neg.	Neg.	Neg.	Neg.
Total Paper & Board Pkg	21.3%	17.1%	27.2%	37.3%	39.6%	41.8%	44.2%
Plastics Packaging							
Soft Drink Bottles**			3.8%	32.6%	35.6%	41.2%	41.1%
Milk Bottles**			Neg.	3.8%	14.3%	23.1%	23.6%
Other Containers	Neg.	Neg.	Neg.	1.2%	4.0%	4.3%	4.7%
Bags and Sacks**			Neg.	3.2%	1.1%	2.1%	1.9%
Wraps**			Neg.	2.0%	0.6%	1.1%	1.6%
Other Plastics Packaging	Neg.	Neg.	Neg.	0.9%	0.5%	0.4%	0.4%
Total Plastics Packaging	Neg.	Neg.	Neg.	3.6%	4.4%	5.8%	6.2%
Wood Packaging	Neg.	Neg.	Neg.	5.1%	10.0%	12.0%	14.0%
Other Misc. Packaging	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Containers & Pkg	11.4%	9.0%	16.0%	26.5%	28.7%	30.9%	32.5%
Total Product Wastes†	10.8%	10.3%	13.4%	19.5%	22.2%	23.4%	24.5%
Other Wastes							
Food Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Yard Trimmings	Neg.	Neg.	Neg.	12.0%	14.3%	17.1%	19.8%
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	8.2%	9.8%	11.7%	13.1%
Total MSW Recovered - %	6.7%	7.1%	9.6%	16.6%	19.0%	20.4%	21.7%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
** Not estimated separately prior to 1980.
† Other than food products.
Details may not add to totals due to rounding.
Neg. = Negligible.
Source: Franklin Associates, Ltd.

Table 22

PRODUCTS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1993
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In thousands of tons)

	Thousands of Tons						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods	9,080	14,150	18,350	26,800	27,030	27,110	27,860
(Detail in Table 14)							
Nondurable Goods	15,170	21,750	31,680	43,830	39,700	41,830	43,300
(Detail in Table 17)							
Containers and Packaging							
Glass Packaging							
Beer and Soft Drink Bottles	1,310	5,440	6,020	3,810	3,930	3,880	3,840
Wine and Liquor Bottles	1,080	1,900	2,450	1,890	1,460	1,400	1,400
Food and Other Bottles & Jars	3,710	4,420	4,770	3,590	3,370	3,600	3,980
Total Glass Packaging	6,090	11,750	13,220	9,290	8,760	8,880	9,220
Steel Packaging							
Beer and Soft Drink Cans	640	1,570	520	110	50	40	30
Food and Other Cans	3,760	3,470	2,700	1,950	2,070	1,650	1,420
Other Steel Packaging	260	270	240	150	150	130	150
Total Steel Packaging	4,660	5,290	3,410	2,210	2,270	1,820	1,600
Aluminum Packaging							
Beer and Soft Drink Cans	60	270	920	570	620	510	590
Other Cans	Neg.	60	40	20	30	30	40
Foil and Closures	110	240	310	300	300	300	300
Total Aluminum Pkg	170	570	1,270	890	950	840	930
Paper & Paperboard Pkg							
Corrugated Boxes	4,810	9,980	10,730	12,480	11,990	12,090	11,730
Milk Cartons**			560	500	500	480	470
Folding Cartons**			3,710	3,870	4,000	3,910	4,240
Other Paperboard Packaging	3,540	4,300	320	290	270	280	300
Bags and Sacks**			3,370	2,220	1,970	1,980	1,850
Wrapping Papers**			200	110	80	80	70
Other Paper Packaging	2,720	3,390	850	1,020	1,050	1,120	1,100
Total Paper & Board Pkg	11,070	17,670	18,930	20,490	19,860	19,940	19,760
Plastics Packaging							
Soft Drink Bottles**			250	290	290	300	330
Milk Bottles**			230	510	420	400	420
Other Containers	60	910	890	1,640	1,670	1,780	1,840
Bags and Sacks**			390	910	920	950	1,030
Wraps**			840	1,500	1,690	1,800	1,790
Other Plastics Packaging	60	1,180	790	2,180	2,170	2,300	2,360
Total Plastics Packaging	120	2,090	3,390	7,030	7,160	7,530	7,770
Wood Packaging	2,000	2,070	3,940	7,490	7,290	7,860	8,140
Other Misc. Packaging	120	140	170	210	210	220	220
Total Containers & Pkg	24,200	39,570	43,990	47,610	46,500	47,090	47,640
Total Product Wastes†	48,450	75,470	94,020	118,240	113,230	116,030	118,800
Other Wastes							
Food Wastes	12,200	12,800	13,200	13,200	13,300	13,500	13,800
Yard Trimmings	20,000	23,200	27,500	30,800	30,000	29,000	26,300
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	2,950	3,000	3,050
Total Other Wastes	33,500	37,780	42,950	46,900	46,250	45,500	43,150
Total MSW Discarded - Weight	81,950	113,250	136,970	165,140	159,480	161,530	161,950

* 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.

† Other than food products.

Neg. = Negligible.

Source: Franklin Associates, Ltd.

Table 23

PRODUCTS DISCARDED* IN THE MUNICIPAL WASTE STREAM, 1960 TO 1993
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In percent of total discards)

	Percent of Total Discards						
Products	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**
Durable Goods *(Detail in Table 14)*	11.1%	12.5%	13.4%	16.2%	16.9%	16.8%	17.2%
Nondurable Goods *(Detail in Table 17)*	18.5%	19.2%	23.1%	26.5%	24.9%	25.9%	26.7%
Containers and Packaging							
Glass Packaging							
Beer and Soft Drink Bottles	1.6%	4.8%	4.4%	2.3%	2.5%	2.4%	2.4%
Wine and Liquor Bottles	1.3%	1.7%	1.8%	1.1%	0.9%	0.9%	0.9%
Food and Other Bottles & Jars	4.5%	3.9%	3.5%	2.2%	2.1%	2.2%	2.5%
Total Glass Packaging	7.4%	10.4%	9.7%	5.6%	5.5%	5.5%	5.7%
Steel Packaging							
Beer and Soft Drink Cans	0.8%	1.4%	0.4%	0.1%	0.0%	0.0%	0.0%
Food and Other Cans	4.6%	3.1%	2.0%	1.2%	1.3%	1.0%	0.9%
Other Steel Packaging	0.3%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%
Total Steel Packaging	5.7%	4.7%	2.5%	1.3%	1.4%	1.1%	1.0%
Aluminum Packaging							
Beer and Soft Drink Cans	0.1%	0.2%	0.7%	0.3%	0.4%	0.3%	0.4%
Other Cans	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Foil and Closures	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Total Aluminum Pkg	0.2%	0.5%	0.9%	0.5%	0.6%	0.5%	0.6%
Paper & Paperboard Pkg							
Corrugated Boxes	5.9%	8.8%	7.8%	7.6%	7.5%	7.5%	7.2%
Milk Cartons**			0.4%	0.3%	0.3%	0.3%	0.3%
Folding Cartons**			2.7%	2.3%	2.5%	2.4%	2.6%
Other Paperboard Packaging	4.3%	3.8%	0.2%	0.2%	0.2%	0.2%	0.2%
Bags and Sacks**			2.5%	1.3%	1.2%	1.2%	1.1%
Wrapping Papers**			0.1%	0.1%	0.1%	0.0%	0.0%
Other Paper Packaging	3.3%	3.0%	0.6%	0.6%	0.7%	0.7%	0.7%
Total Paper & Board Pkg	13.5%	15.6%	13.8%	12.4%	12.5%	12.3%	12.2%
Plastics Packaging							
Soft Drink Bottles**			0.2%	0.2%	0.2%	0.2%	0.2%
Milk Bottles**			0.2%	0.3%	0.3%	0.2%	0.3%
Other Containers	0.1%	0.8%	0.6%	1.0%	1.0%	1.1%	1.1%
Bags and Sacks**			0.3%	0.6%	0.6%	0.6%	0.6%
Wraps**			0.6%	0.9%	1.1%	1.1%	1.1%
Other Plastics Packaging	0.1%	1.0%	0.6%	1.3%	1.4%	1.4%	1.5%
Total Plastics Packaging	0.1%	1.8%	2.5%	4.3%	4.5%	4.7%	4.8%
Wood Packaging	2.4%	1.8%	2.9%	4.5%	4.6%	4.9%	5.0%
Other Misc. Packaging	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Total Containers & Pkg	29.5%	34.9%	32.1%	28.8%	29.2%	29.2%	29.4%
Total Product Wastes†	59.1%	66.6%	68.6%	71.6%	71.0%	71.8%	73.4%
Other Wastes							
Food Wastes	14.9%	11.3%	9.6%	8.0%	8.3%	8.4%	8.5%
Yard Trimmings	24.4%	20.5%	20.1%	18.7%	18.8%	18.0%	16.2%
Miscellaneous Inorganic Wastes	1.6%	1.6%	1.6%	1.8%	1.8%	1.9%	1.9%
Total Other Wastes	40.9%	33.4%	31.4%	28.4%	29.0%	28.2%	26.6%
Total MSW Discarded - %	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.

† Other than food products.

Neg. = Negligible.

Source: Franklin Associates, Ltd.

Aluminum Containers and Packaging. Aluminum containers and packaging include beer and soft drink cans, other cans, and foil and closures. Aluminum can generation is estimated based on data from the Can Manufacturers Institute and the Aluminum Association, while data on other aluminum packaging is based on Department of Commerce data. Total aluminum container and packaging generation in 1993 was 2.0 million tons, or 1.0 percent of total generation.

Aluminum can recovery data comes from the Aluminum Association. Aluminum beer and soft drink cans were recovered at an estimated 63.4 percent rate in 1993. Recovery of all aluminum packaging was estimated to be 53.0 percent of total generation in 1993. After recovery for recycling, 930,000 tons of aluminum packaging were discarded in 1993. This represented 0.6 percent of MSW discards.

Paper and Paperboard Containers and Packaging. Corrugated boxes are the largest single product category of MSW at 26.4 million tons generated, or 12.7 percent of total generation, in 1993. Corrugated boxes also represent the largest single category of product recovery, at 14.6 million tons of recovery in 1993 (55.5 percent of boxes generated were recovered). After recovery, 11.7 million tons of corrugated boxes were discarded, or 7.2 percent of MSW discards in 1993.

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 35.4 million tons of MSW generation in 1993, or 17.1 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 1.1 million tons in 1993). The overall recovery rate for paper and paperboard packaging in 1993 was 44.2 percent. Recovery of other paper packaging like folding boxes and sacks is mostly in the form of mixed papers.

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—some with high-density polyethylene (HDPE) base cups, HDPE milk jugs, film products (including bags and sacks) made of low-density polyethylene (LDPE), and containers and other packaging (including coatings, closures, etc.) made of polyvinyl chloride, polystyrene, 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. Adjustments are made for imports and exports based on Department of Commerce data, and adjustments are made for the lifetimes of durable goods.

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 8.3 million tons in 1993 (4.0 percent of generation). (Note: plastic packaging 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 and base cups were estimated to have been recovered at a 41.1 percent rate in 1993. Recovery of plastic milk bottles was estimated to have been 23.6 percent of generation. Overall, recovery of plastic containers and packaging was estimated to be 6.2 percent in 1993. Discards of plastic containers and packaging were thus 7.8 million tons in 1993, or 4.8 percent of total discards.

Wood Packaging. Wood packaging includes wood crates and pallets. Data on production of wood packaging (in units) is obtained from the Wooden Pallet and Container Association, and converted to weight using converting factors for wood. In 1993, 9.5 million tons of wood packaging were estimated to have been generated. Wood packaging was thus 4.6 percent of total generation in 1993.

There is increasing recovery of wood pallets, mostly by chipping to make products like mulch. The Wooden Pallet and Container Association provides data on recovery of wood pallets. It was estimated that 1.3 million tons of wood were recovered in this manner in 1993, or 14 percent of generation. This left 8.1 million tons discarded in 1993, or 5.0 percent of total discards.

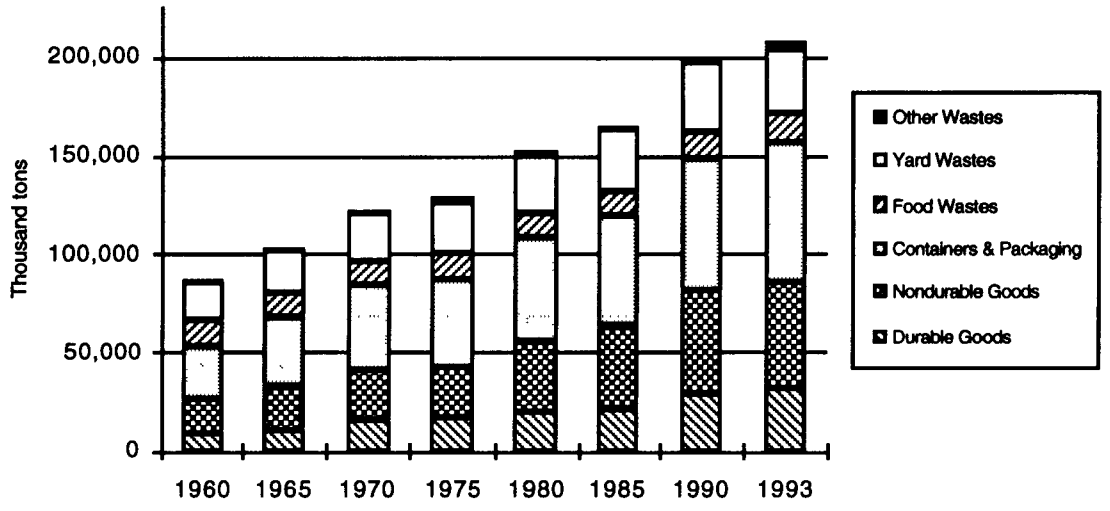
There is considerable reuse of wood pallets. Reuse was not counted as recycling in this chapter, but is discussed in the section on source reduction in Chapter 3.

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 1993.

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.

Figure 14. Generation of products in MSW, 1960 to 1993

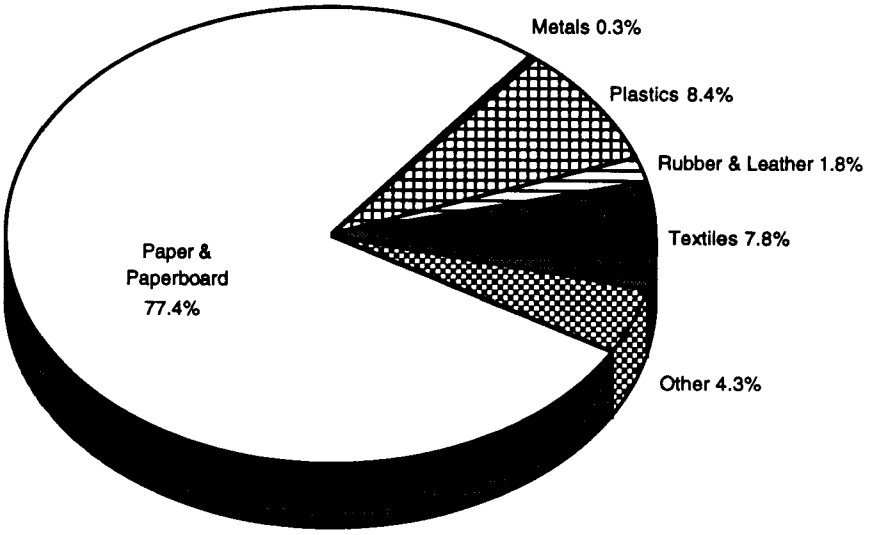


The materials composition of nondurable goods in 1993 is shown in Figure 15. Paper and paperboard made up 77.4 percent of nondurables in MSW generation, with plastics contributing 8.4 percent, and textiles 7.8 percent. Other materials contributed lesser percentages. After recovery for recycling, paper and paperboard were 73.0 percent of nondurable discards, with plastics being 10.6 percent, and textiles 8.2 percent.

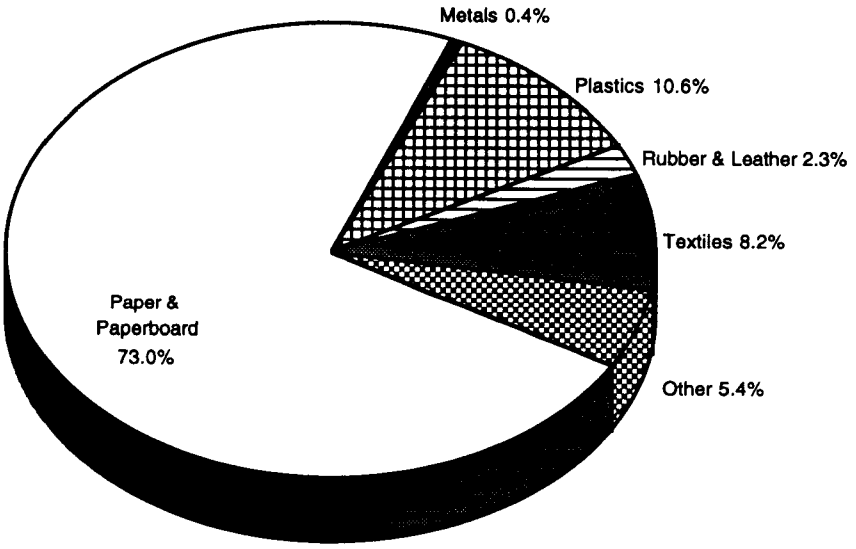
The materials composition of containers and packaging in MSW in 1993 is shown in Figure 16. Paper and paperboard products made up 50.2 percent of containers and packaging generation, with glass second at 17.3 percent of containers and packaging generation by weight. Recovery for recycling makes a significant change, with paper and paperboard being 41.4 percent of containers and packaging discards after recovery takes place. Glass was 19.4 percent of discards of containers and packaging, plastics comprised 16.5 percent, and other materials made up lesser amounts.

Some additional perspectives on products in municipal solid waste are included in other chapters of this report.

Figure 15. Nondurable goods generated and discarded in municipal solid waste, 1993
(in percent of total generation and discards)

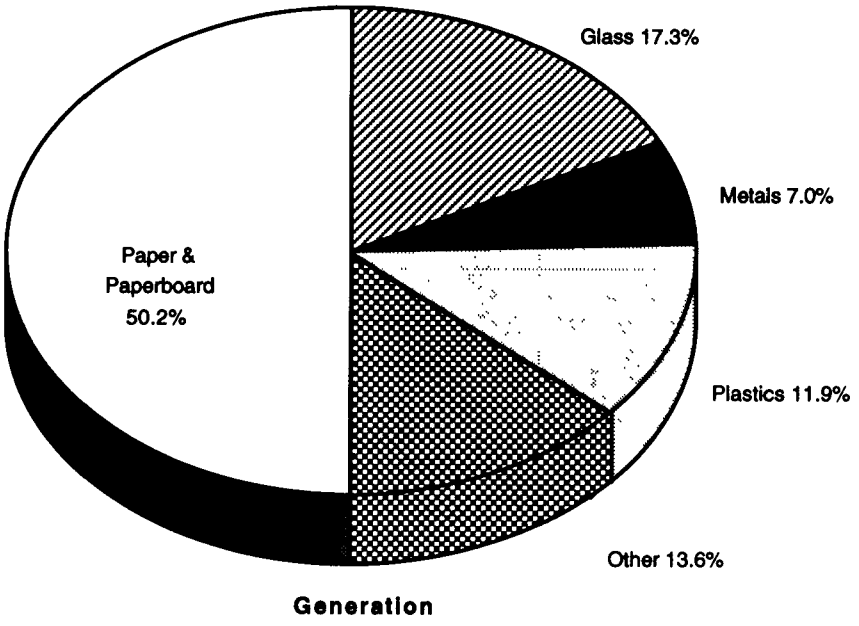


Generation

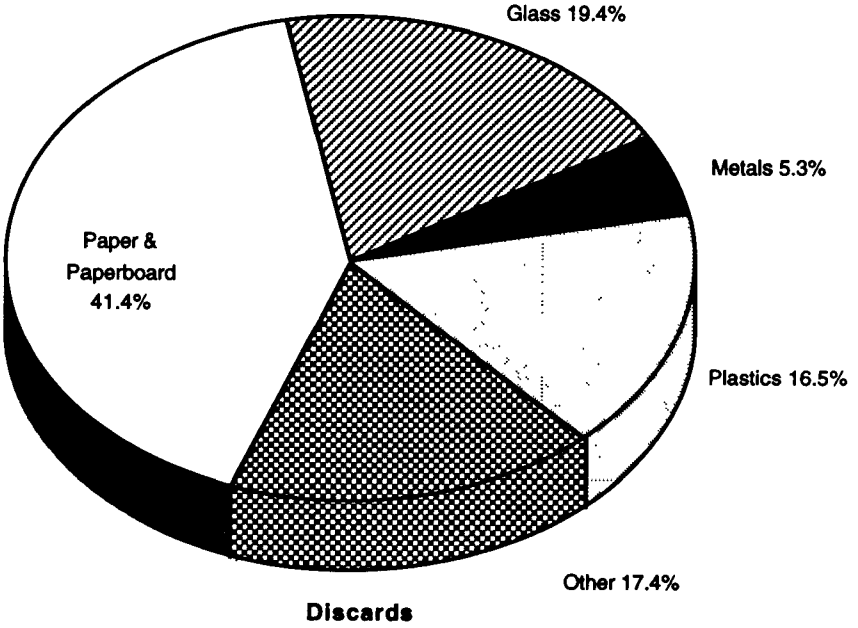


Discards

Figure 16. Containers and packaging generated and discarded in municipal solid waste, 1993
(In percent of total generation and discards)



Generation



Discards

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.

Characterization of historical municipal solid waste (MSW) management is a component of this report. Estimates of historical recovery of materials and yard trimmings for recycling and composting are presented in Chapter 2. Estimates of MSW combustion are presented in this chapter, and quantities of waste landfilled are estimated by subtracting combustion and recovery for recycling and composting from total MSW generation as estimated in Chapter 2.

While source reduction is not quantified as a line item in this report, a discussion of source reduction activities is included in this chapter. Source reduction activities have the effect of reducing MSW generation, while the other management alternatives deal with MSW once it is generated.

SOURCE REDUCTION

While the primary focus of this report is on generation of municipal solid waste and the ways in which the MSW is managed after it enters the waste stream, there is another aspect to waste management: source reduction. (Note that source reduction is often called "waste prevention.") EPA defines source reduction 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 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 disposal or other management alternative.

Many attempts have been made to measure and quantify source reduction activities. It is relatively easy to measure source reduction for a single product, such as a package, or for a specific location, such as an office. It is much more difficult to quantify source reduction on a national basis, and there is no

consensus at this time as to how this could be done. Some steps toward measuring source reduction have been identified; they include establishing a baseline, tracking that baseline, and accounting for major variables that impact generation rates. Variables that make accurate measurement difficult include economic factors, technical innovations, changing demographics, and climatic variations.

Source reduction measures encompass a very broad range of activities by private citizens, communities, commercial establishments, institutional agencies, and manufacturers and distributors. In general, source reduction activities include:

- Designing products or packages so as to reduce the quantity of materials or the toxicity of the materials used.
- Reducing amounts of products or packages used through modification of current practices.
- Reusing products or packages already manufactured.
- Lengthening the life of products to postpone disposal.
- Managing non-product organic wastes (food wastes, yard trimmings) through backyard composting or other on-site alternatives to disposal.

Product and Packaging Design for Source Reduction

Since source reduction of products and packages can save money through reducing materials and energy costs, manufacturers and packagers have been pursuing these activities for many years. Design for source reduction can take several approaches:

- A product or package can be reduced in size or made lighter. For example, soft drink packaging, regardless of material, has been reduced in weight over time (Table 24).

Table 24

REDUCTION IN WEIGHTS OF SOFT DRINK CONTAINERS, 1972 TO 1992
(in pounds per 100 containers)

	1972	1992	Percent Change
One-way glass bottle (16 fluid ounce)	75.7	48.04	- 36.5%
Steel can (12 fluid ounce)	10.5	7.19	- 31.5%
Aluminum can (12 fluid ounce)	4.5	3.51	- 22.0%
PET bottle (2 liter, one-piece)	14.6	11.95	-18.1%

Does not include weight of labels and caps. PET data for 1977 and 1992.
Source: Franklin Associates, Ltd.

- Materials substitution can make a product or package lighter. 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 may often be a flexible package (such as a bag) instead of a rigid package (such as a box). For example, a brick pack for coffee made of an aluminum foil/plastic laminate reduces packaging by 85 percent compared to a steel coffee can.

  Another illustration of source reduction by materials substitution is shown in Table 3-24a. This shows that over a 15-year period, weight of snack foods increased by over 42 percent, while weight of snack food packaging decreased by nearly 9 percent and pounds of packaging per 100 pounds of product decreased by over 36 percent. This decrease can be attributed primarily to a switch from rigid packaging (e.g., boxes) to flexible packaging (e.g., bags).

Table 3-24a

COMPARISON OF SNACK FOOD PACKAGING, 1972 AND 1987

	1972	1987	Percent Change
Millions pounds of product	11,028	15,731	+42.6%
Million pounds of packaging	1,243	1,134	- 8.8%
Pounds packaging/100 pounds of product	11.3	7.2	- 36.2%
Thousand cubic yards of packaging	1,536	1,391	- 9.4%

Does not include tertiary packaging (corrugated containers).
Source: Franklin Associates, Ltd.

- A product or package can be redesigned to reduce weight or volume. For example, a box used to package a tube or bottle can often be eliminated.

- 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. For example, vegetable-based inks are being substituted for petroleum-based inks.

Modifying Practices to Reduce Materials Use

Businesses and individuals can often 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).

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 can also 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

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. The recovery of products and materials for recycling and composting as characterized in Chapter 2 does *not* include reuse of products, but reuse is discussed below in this section.

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 donation to 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 can also reduce the number of products to be discarded ultimately. Except for tires, 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 are often 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 source reduction measure is use of washable plates, cups, napkins, towels, diapers, etc. instead of the disposable variety. (This will reduce solid waste but will have other 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 conveniently 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 Wood Pallet and Container Association estimates that over 50 percent of wood pallets produced are reusable; the pallets are reused about four times per year, on average.

Many other containers and packages can be recycled but are not often reused. Some refillable containers (e.g., for laundry softener) have been introduced; the original container can be refilled using concentrate in small packages. This practice can achieve a 75 percent 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, some parcel shippers will take back plastic packaging "peanuts" for reuse.

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

Lengthening Product Life. 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, consumers must demand the products and be willing to pay for them to make the goal work. Consumers must also be willing to care for and repair products.

Management of Organic Wastes. Food wastes and yard trimmings combined made up 22.6 percent of MSW generation in 1993, so source reduction measures aimed at these products can have an important effect on waste generation. Composting is the usual method for source reducing these organic

wastes. As defined in this report, composting of organic wastes after they are taken to a central composting facility is a waste management activity comparable to recovery for recycling. Estimates for these composting activities are included in this Chapter 3.

Composting or other reduction management measures that take place at the point of generation (e.g., the yard of a home or business) is source reduction. Backyard composting of yard trimmings and some food wastes is not a new practice, but in recent years publicity and education programs have encouraged more people to participate. There also is a trend toward leaving grass clippings on lawns, sometimes through the use of mulching mowers.

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 over 28 percent of the nation's population) had in effect legislation banning yard trimmings from landfills. By 1996, 23 states (amounting to over 50 percent of the nation's population) will have in effect legislation affecting disposal of yard trimmings. While data on amounts of yard trimmings received at disposal facilities is limited, there is considerable anecdotal evidence indicating that when these bans go into effect, people find ways to source reduce. This is discussed in more depth in Chapter 4.

SUMMARY OF HISTORICAL AND PROJECTED MSW MANAGEMENT

The data presented in this chapter and Chapter 2 make possible a comprehensive summary of historical municipal solid waste management. The study results are summarized in Table 25 and Figure 17. Municipal solid waste generation has grown steadily (except for occasional decreases during recession years) from 87.8 million tons in 1960 to 206.9 million tons in 1993.

Recovery for Recycling and Composting of Yard Trimmings

Recovery for recycling and composting had little effect on the total waste stream until the 1980s. Recovery was less than 10 percent of generation in the 1960s and 1970s. A strong emphasis on recovery for recycling, including composting, developed in the latter part of the 1980s, and total recovery reached an estimated 21.7 percent of generation in 1993.

Mixed MSW Composting

Composting of yard trimmings is well established in many communities and was found to be increasing rapidly due to state-wide bans of yard trimmings in landfills and other local initiatives. Composting of mixed municipal wastes (e.g., by in-vessel units) is a developing technology in the United States. It was estimated that less than 0.7 million tons of mixed MSW were recovered for

composting in 1993. Insufficient data were available to make projections for the future of this technology, however.

Combustion of Municipal Solid Waste

Most of the municipal solid waste combustion currently practiced in this country incorporates recovery of an energy product (generally steam or electricity); 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; recovery of energy started to become more prevalent in the 1970s.

Previous estimates of combustion with energy recovery were updated and expressed as a percentage of MSW generation (Table 25). Surveys by EPA and other organizations were used as references. In addition, a literature search updated lists of facilities that were operational, under construction, or in planning in 1993.

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 85 percent of rated capacity. While this is a conservative assumption, it has proven to be reasonably accurate over the years. (While new facilities are reporting operation at very high utilization rates, other facilities do not meet the same standards for annual throughput as compared to rated capacity.)

The surveys revealed that combustion of MSW increased rapidly between 1980 and 1990, with numerous new facilities coming into operation. The amount of MSW combusted has remained relatively constant since 1990. It was estimated that approximately 30.3 million tons of MSW were combusted with energy recovery in 1993. These estimates include facilities that mass burn mixed MSW with much pre-processing as well as those using fuel prepared from mixed MSW (usually called refuse-derived fuel).

To provide a complete picture of historical MSW management, updates of the estimates of combustion without energy recovery were also made. The estimates indicate that MSW combustion without energy recovery dropped steadily throughout the entire study period, to about 1.6 million tons in 1993.

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

Table 25

GENERATION, MATERIALS RECOVERY, COMPOSTING, COMBUSTION, AND DISCARDS OF MUNICIPAL SOLID WASTE, 1960 TO 1993
(In thousands of tons and percent of total generation)

	Thousands of Tons						
	1960	1970	1980	1990	1991	1992	1993
Generation	87,800	121,880	151,490	198,020	196,770	203,010	206,940
Recovery for recycling	5,850	8,630	14,520	28,680	32,290	35,480	38,490
Recovery for composting*	0.0	0.0	0.0	4,200	5,000	6,000	6,500
Total Materials Recovery	5,850	8,630	14,520	32,880	37,290	41,480	44,990
Discards after recovery	81,950	113,250	136,970	165,140	159,480	161,530	161,950
Combustion**	27,000	25,100	13,700	31,900	33,330	32,690	32,920
Discards to landfill, other disposal†	54,950	88,150	123,270	133,240	126,150	128,840	129,030

	Percent of Total Generation						
	1960	1970	1980	1990	1991	1992	1993
Generation	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Recovery for recycling	6.7%	7.1%	9.6%	14.5%	16.4%	17.5%	18.6%
Recovery for composting*	0.0%	0.0%	0.0%	2.1%	2.5%	3.0%	3.1%
Total Materials Recovery	6.7%	7.1%	9.6%	16.6%	19.0%	20.4%	21.7%
Discards after recovery	93.3%	92.9%	90.4%	83.4%	81.0%	79.6%	78.3%
Combustion**	30.8%	20.6%	9.0%	16.1%	16.9%	16.1%	15.9%
Discards to landfill, other disposal†	62.6%	72.3%	81.4%	67.3%	64.1%	63.5%	62.4%

* Composting of yard trimmings and food wastes. Does not include backyard composting.
** Includes combustion of MSW in mass burn or refuse-derived form, incineration without energy recovery, and combustion with energy recovery of source separated materials in MSW.
† Discards after recovery minus combustion.
Details may not add to totals due to rounding.
Source: Franklin Associates, Ltd.

estimated that about one million tons of MSW were combusted in this manner in 1993, with tires contributing a majority of the total.

The total of all MSW combustion was an estimated 32.9 million tons, or 16 percent of MSW generation, in 1993.

Residues from Waste Management Facilities

Whenever municipal wastes are processed, residues will remain. For the purposes of this report, it is assumed that these residues are landfilled (although residues from combustion processes (ash) are often managed separately from other MSW).

Materials processing facilities (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, 7 to 8 percent is

probably typical for a MRF. Residues from a MRF or compost facility are generally landfilled. Since the estimates of recovery in this report are based on purchases of recovered materials, not weight of materials received at the facilities, no further adjustments for residues were made.

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. 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.

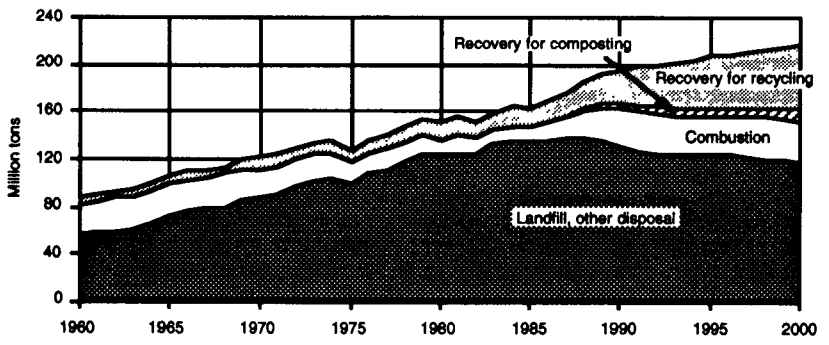
Historical Perspective

This summary provides some perspective on why a landfill capacity shortage developed in the 1980s. In the 1960s and early 1970s a large percentage of MSW was burned. The remainder was not usually landfilled as we define landfill in the 1990s; that is, it was not compacted and buried in cells with cover material added daily. In fact, much of this waste was "dumped" and often it was burned at the dump to reduce its volume.

As the old incinerators were closed down and landfills became more difficult and expensive to site, 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 17 graphically 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.

Generation of MSW declined in 1991 (a recession year), but then continued to increase in 1992 and 1993. Recovery of products and yard trimmings increased steadily, while combustion stayed nearly constant. As a result, discards to landfill were lower in 1993 than in 1990, but about the same as discards in 1992.

Figure 17. Municipal solid waste management, 1960 to 2000



Chapter 3

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Chapter 4

PROJECTIONS OF MSW GENERATION AND MANAGEMENT

INTRODUCTION

This chapter includes projections of municipal solid waste generation and management to the year 2000. It should be emphasized that these projections are not predictions. Recent efforts at source reduction are difficult to measure at a national level, but almost certainly are affecting MSW generation. No one can foresee with accuracy changes in the economy (e.g., booms and recessions), which also affect the municipal waste stream. In addition, it is difficult to predict which innovations and new products will affect the amounts and types of MSW discards. For example, there have long been predictions of the "paperless office" due to improvements in electronic communications, but in fact, facsimile machines, high-speed copiers, and personal computers have caused increasing amounts of paper to be generated in offices.

In spite of the limitations, it is useful to look at projections characterizing MSW based on past trends, since it is clear that the composition of the waste stream does change over time. New products (e.g., disposable products) are used, and materials are used in new ways (e.g., composite materials replace simpler products). Planners thus may choose to use different projections than those presented here, but anyone assuming that the current mix of materials in the waste stream will remain constant is disregarding the experience of the past.

OVERVIEW OF THIS CHAPTER

This chapter includes projections of municipal solid waste generation, recovery for recycling and composting, combustion, and landfill through the year 2000. Projections of total MSW recovery for recycling and composting are presented in three scenarios for the year 2000—25 percent, 30 percent, and 35 percent. In making these projections, it was assumed that overall, products in MSW would grow at a rate higher than population growth and lower than growth of Gross Domestic Product (GDP). (See Chapter 5 for an explanation of the correlation of MSW generation with these demographic and economic factors.)

It is important to note that the projections in this series of tables are also based on the assumption that there will be a considerable reduction in the generation of yard trimmings that enter the solid waste management system. These assumptions are explained later in this chapter. One result of this assumption is that the percentages of other products and materials in MSW are higher in 2000 than they would be if yard trimmings generation stayed constant or increased.

A summary table showing projected MSW generation, recovery at the mid-range scenario, and discards of MSW to combustion and landfill in 2000 is included at the end of the chapter.

MATERIALS GENERATION IN MUNICIPAL SOLID WASTE

Projections of materials generated in MSW (by weight) are summarized in Table 26 and Figure 18, and a discussion of each material category follows.

Table 26

PROJECTIONS OF MATERIALS GENERATED*
IN THE MUNICIPAL WASTE STREAM, 1993 AND 2000
(In thousands of tons and percent of total generation)

	Thousands of tons		% of total	
Materials	**1993**	**2000**	**1993**	**2000**
Paper and Paperboard	77,840	89,340	37.6%	41.0%
Glass	13,670	14,020	6.6%	6.4%
Metals				
Ferrous	12,930	14,220	6.2%	6.5%
Aluminum	2,970	3,425	1.4%	1.6%
Other Nonferrous	1,240	1,395	0.6%	0.6%
Total Metals	*17,140*	*19,040*	*8.3%*	*8.7%*
Plastics	19,300	22,490	9.3%	10.3%
Rubber and Leather	6,220	7,610	3.0%	3.5%
Textiles	6,130	6,200	3.0%	2.8%
Wood	13,690	16,010	6.6%	7.4%
Other	3,300	3,540	1.6%	1.6%
Total Materials in Products	157,290	178,250	76.0%	81.9%
Other Wastes				
Food Wastes	13,800	14,000	6.7%	6.4%
Yard Trimmings	32,800	22,200 **	15.9%	10.2%
Miscellaneous Inorganic Wastes	3,050	3,300	1.5%	1.5%
Total Other Wastes	49,650	39,500	24.0%	18.1%
Total MSW Generated	206,940	217,750	100.0%	100.0%

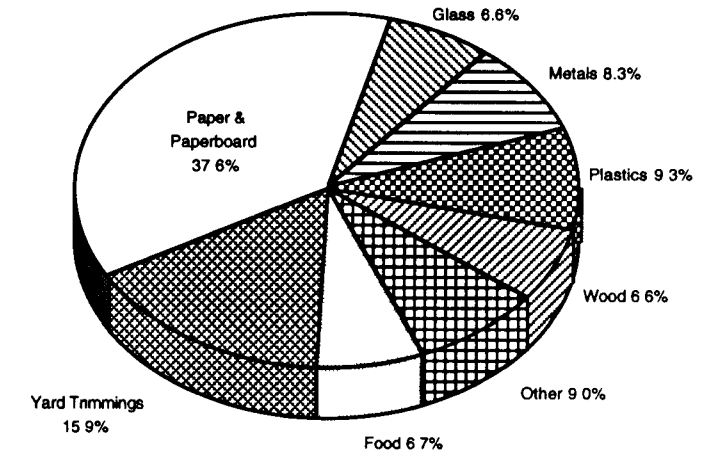
* Generation before materials recovery or combustion.

** This scenario assumes a 32.3% reduction of yard trimmings. See Table 32 for other scenarios.

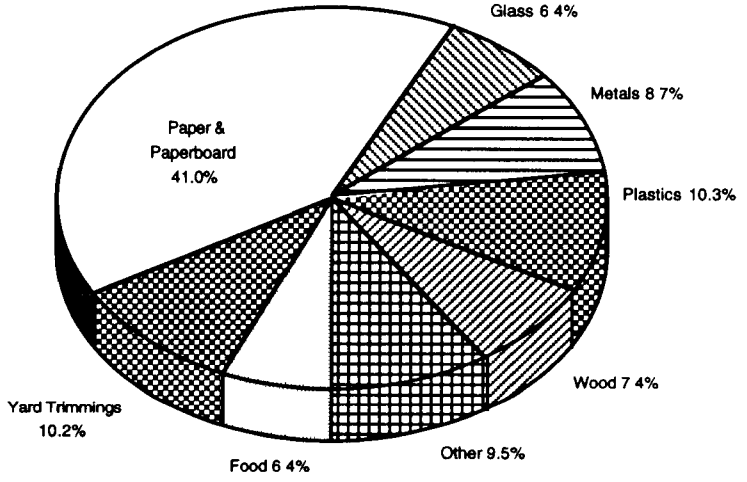
Details may not add to totals due to rounding.

Source: Franklin Associates, Ltd.

Figure 18. Materials generated in MSW, 1993 and 2000 (in percent of total generation)



1993



2000

Paper and Paperboard

Projections of paper and paperboard generation were based on past trends, with some slowing of growth projected for newsprint and paper packaging other than corrugated boxes. These grades of paper are showing the effects of decreased newspaper readership and some source reduction in packaging.

Paper and paperboard is projected to continue to be the dominant material in MSW, growing from a generation of 77.8 million tons in 1993 to 89.3 million tons in 2000. This would be 41.0 percent of MSW generation in 2000.

Glass

Glass products have been a declining percentage of municipal solid waste, and this trend is projected to continue, with tonnage of glass in MSW remaining fairly constant. Glass generation is projected to grow from 13.7 million tons in 1993 to 14.0 million tons in 2000, which is 6.4 percent of the projected total generation.

Ferrous Metals

Cans made of steel have been declining as a percentage of MSW. On the other hand, more ferrous metals enter MSW as a component of durable goods than as containers. Since durable goods are an increasing component of MSW, ferrous metals in MSW were projected to increase to 14.2 million tons in 2000. The percentage of ferrous metals in MSW is projected to increase slightly, from 6.2 percent of total generation to 6.5 percent in 2000.

Aluminum

Containers and packaging represent the primary source of aluminum in MSW, although some aluminum is present in durables and nondurables. Aluminum in MSW has grown rapidly, and the growth is projected to continue, to 3.4 million tons in 2000. Because of its light weight, aluminum represents a small percentage of MSW generation—1.4 percent in 1993 and a projected 1.6 percent in 2000.

Other Nonferrous Metals

Other nonferrous metals (e.g., lead, copper, and zinc) are found in durable goods like appliances, furniture, and batteries. Lead-acid (automotive) batteries comprise the majority of this category. Generation of lead-acid batteries is projected to continue to increase, along with small increases in other nonferrous metals. Other nonferrous metals were estimated to be 1.2 million tons in 1993 and are projected to be 1.4 million tons in 2000. These metals are expected to continue to be less than one percent of MSW generation.

Plastics

Generation of plastics in MSW has grown very rapidly in the past three decades. Plastics in MSW are projected to continue to increase both in tonnage (from 19.3 million tons in 1993 to 22.5 million tons in 2000) and in percentage of total generation (from 9.3 percent of total in 1993 to 10.3 percent in 2000).

Wood Wastes

Wood wastes (in furniture and other durables and in pallets and other packaging) have been increasing in MSW. The tonnage of wood wastes generated is projected to grow from 13.7 million tons in 1993 to 16.0 million tons in 2000. The percentage of wood wastes is projected to increase from 6.6 percent in 1993 to 7.4 percent of total in 2000.

Other Materials

Other materials in MSW—including rubber, leather, and textiles—are projected to have modest growth in tonnage and nearly "flat" percentages of total generation. Tonnage is projected to increase from 18.7 million tons in 1993 to 20.6 million tons in 2000.

Food Wastes

Sampling studies over a long period of time show food wastes to be a declining percentage of the waste stream. Per capita discards of food wastes have also been declining over time, which can be explained by the increased use of preprocessed food in homes, institutions, and restaurants, and by the increased use of garbage disposals, which put food wastes into wastewater systems rather than MSW. Therefore, the generation of food wastes was projected to grow at a slightly lower rate than population. The tonnage of food wastes is projected to increase from 13.8 million tons in 1993 to 14.0 million tons in 2000. The percentage of food wastes in total MSW would decline slightly, from 6.7 percent to 6.4 percent of total generation.

Yard Trimmings

In earlier versions of this report, generation of yard trimmings* was estimated based on sampling studies, which showed a more or less constant generation on a per capita basis. (The definition of generation used here is the amount of yard trimmings that enter the solid waste management system, e.g., they are placed at the curb for collection or taken to a drop-off site.) Projections were made on the same basis. This methodology has now been revised because of changing trends in the management of yard trimmings in many parts of the country.

Although not well documented, there is evidence that where communities have charged separately for pickup of yard trimmings, or where

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* 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.

disposal of yard trimmings in landfills has been banned, or other regulatory/educational measures have been taken, the amount of yard trimmings entering the system has greatly declined. In other words, source reduction at the site of generation (e.g., residences) has been accomplished through backyard composting, leaving grass clippings on the lawn, and the like.

Using data published by the Composting Council as updated from more recent sources, legislation affecting yard trimmings disposal in landfills was tabulated. In 1992, 12 states accounting for over 28 percent of the nation's population had in effect legislation banning yard trimmings from landfills. Also, data compiled by ***BioCycle*** magazine indicates that there were about 3,000 composting facilities for yard trimmings in 1992. Using these facts, it was estimated that the effect of this legislation was that there was no increase in yard trimmings generated (e.g., entering the waste management system) between 1990 and 1992, and that there was a 6 percent decline in yard trimmings generation between 1992 and 1993.

The tabulation of existing legislation also shows that by 1996, 23 states including more than 50 percent of the nation's population will have legislation banning yard trimmings from landfills. Additional states have enacted less stringent measures. Therefore, it was projected that yard trimmings generation would be reduced by half between 1992 and 1996 in the states having legislation—a 25 percent reduction overall. This is a rather conservative assumption, because yard trimmings may well be reduced by more than half in these states. Finally, it was assumed that some additional legislation affecting generation of yard trimmings would be enacted between 1996 and 2000, and that yard trimmings would decline by 15 percent between 1996 and 2000.

These assumptions yield a projection that generation of yard trimmings would decline from 32.8 million tons in 1993 to 22.2 million tons in 2000 (a 32 percent decrease compared to 1993).

Projected Growth Rates for Materials in MSW

Projected growth rates by decade for the various materials generated in MSW are shown in Table 27. Projected population growth rates (from the Bureau of the Census) are included as well; the Bureau of the Census forecasts an approximately one percent annual growth of population from 1990 to 2000. Paper and paperboard, plastics, metals, and wood are all projected to increase faster than population, while glass and food wastes are projected to increase more slowly than population. Food wastes are projected to show almost no increase, and yard trimmings are projected to decline. Overall, municipal solid waste generation is projected to increase at a rate of one percent annually between 1990 and 2000. (The rate would be higher if the projected decline in yard trimmings does not occur.)

Table 27

AVERAGE ANNUAL RATES OF INCREASE (OR DECREASE)* OF GENERATION OF MATERIALS IN MSW
(In annual percent by weight)

	1960-1970	1970-1980	1980-1990	1990-2000
Paper & Paperboard	4.0%	2.2%	2.9%	2.1%
Glass	6.6%	1.7%	-1.2%	0.6%
Metals	3.0%	0.2%	1.3%	1.5%
Plastics	22.5%	9.9%	8.4%	2.5%
Wood	2.8%	5.5%	6.2%	2.7%
All Other Materials**	4.3%	4.3%	3.9%	1.9%
Food Wastes	0.5%	0.3%	0.0%	0.6%
Yard Trimmings	1.5%	1.7%	2.4%	-4.5%
Total MSW	3.3%	2.2%	2.7%	1.0%
Population	1.2%	1.1%	1.0%	1.0%

* Annual rates of increase or decrease calculated on 10-year end points.
** Rubber and leather, textiles, electrolytes in batteries, wood pulp and moisture in disposable diapers, miscellaneous inorganics.
Source: Franklin Associates, Ltd.

PRODUCT GENERATION IN MUNICIPAL SOLID WASTE

Projected generation of the products in municipal solid waste is summarized in Table 28 and Figure 19. All categories (except for yard trimmings) are projected to grow in tonnage. Containers and packaging are projected to remain the largest single category at 36.5 percent of generation, with nondurables being the second largest category of generation at 28.8 percent of total generation in 2000. More detailed observations on the projected growth in the individual product categories follow.

Durable Goods

Overall, durable goods are projected to increase in both tonnage and percent of total generation (Table 29). The trends in generation of major appliances, carpet and rugs, and furniture and furnishings are well established by production numbers, since lifetimes of up to 20 years are assumed. Generation of rubber tires, lead-acid batteries, and miscellaneous durables are projected based on historical trends, which are generally "flat" or exhibiting low rates of growth.

Substitution of relatively light materials like aluminum and plastics for heavier materials like steel has occurred in durables like appliances and furniture as well as other products. Also, cars have become smaller and tires have been made longer-wearing, which tends to reduce the rate of increase at which tires are generated. It was projected that these trends will continue.

Table 28

PROJECTIONS OF CATEGORIES OF PRODUCTS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1993 AND 2000
(In thousands of tons and percent of total generation)

Products	Thousands of tons		% of total	
	1993	2000	1993	2000
Durable Goods *(Detail in Table 29)*	31,910	36,110	15.4%	16.6%
Nondurable Goods *(Detail in Table 30)*	54,800	62,760	26.5%	28.8%
Containers and Packaging *(Detail in Table 31)*	70,580	79,380	34.1%	36.5%
Total Product Wastes **	157,290	178,250	76.0%	81.9%
Other Wastes				
Food Wastes	13,800	14,000	6.7%	6.4%
Yard Trimmings	32,800	22,200	15.9%	10.2%
Miscellaneous Inorganic Wastes	3,050	3,300	1.5%	1.5%
Total Other Wastes	49,650	39,500	24.0%	18.1%
Total MSW Generated	206,940	217,750	100.0%	100.0%

* Generation before materials recovery or combustion.
** Other than food products.
This scenario assumes a 32.3% reduction of yard trimmings. See Table 32 for other scenarios.
Details may not add to totals due to rounding.
Source: Franklin Associates, Ltd.

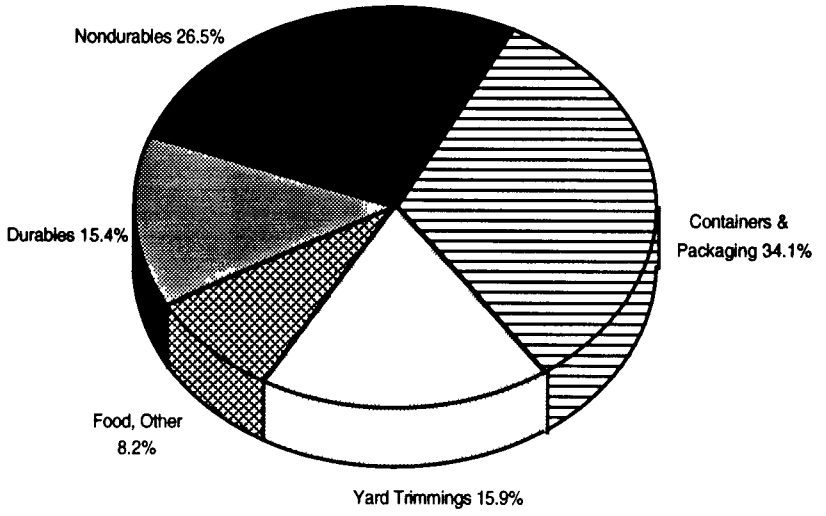
Nondurable Goods

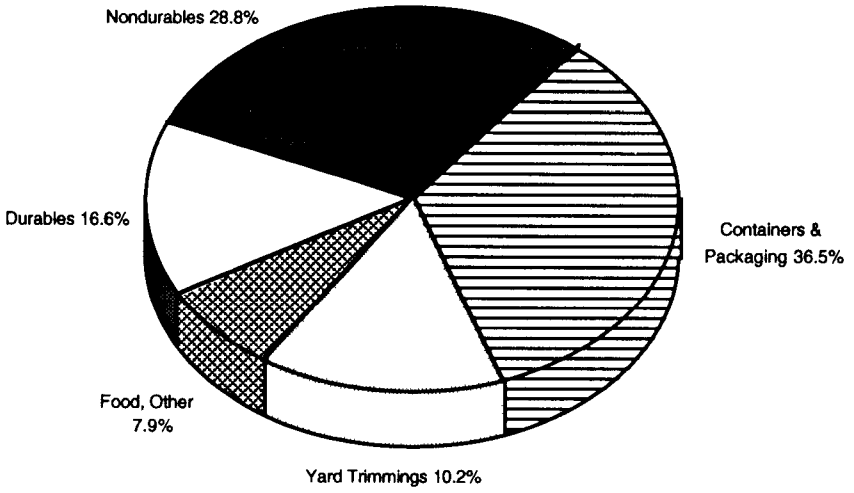
As noted above, generation of nondurable goods has been increasing rapidly, and this trend is projected to continue (Table 30). Generation of nondurable goods is projected to be 62.8 million tons in 2000, or 28.8 percent of total generation.

Most of the nondurable paper products are projected to continue to grow at rates higher than population growth. Based on historical trends, however, paper plates and cups were projected to show little increase in tonnage or percentage; plastic plates and cups were projected to show some growth in tonnage, although not much change in percentage of total generation. (The plates and cups categories include hinged containers and other foodservice items, and it was assumed that there will be no bans of disposable foodservice items.)

Plastic trash bags are projected to continue to grow in tonnage from 1993 to 2000. Clothing and footwear and other textiles also are projected to increase in tonnage.

Figure 19. Products generated in MSW, 1993 and 2000 (in percent of total generation)





Finally, other miscellaneous nondurables, which include many items made of plastics, have been growing historically and the growth is projected to continue, causing this category to continue to increase as a percentage of MSW generation.

Table 29

PROJECTIONS OF PRODUCTS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1993 AND 2000 (WITH DETAIL ON DURABLE GOODS)

(In thousands of tons and percent of total generation)

Products	Thousands of tons		% of total	
	1993	2000	1993	2000
Durable Goods				
Major Appliances	3,430	3,800	1.7%	1.7%
Small Appliances	530	610	0.3%	0.3%
Furniture and Furnishings	7,020	8,000	3.4%	3.7%
Carpets and Rugs	2,130	2,400	1.0%	1.1%
Rubber Tires	3,410	3,900	1.6%	1.8%
Batteries, Lead-Acid	1,670	1,900	0.8%	0.9%
Miscellaneous Durables	13,720	15,500	6.6%	7.1%
Total Durable Goods	31,910	36,110	15.4%	16.6%
Nondurable Goods *(Detail in Table 30)*	54,800	62,760	26.5%	28.8%
Containers and Packaging *(Detail in Table 31)*	70,580	79,380	34.1%	36.5%
Total Product Wastes**	157,290	178,250	76.0%	81.9%
Other Wastes				
Food Wastes	13,800	14,000	6.7%	6.4%
Yard Trimmings	32,800	22,200	15.9%	10.2%
Miscellaneous Inorganic Wastes	3,050	3,300	1.5%	1.5%
Total Other Wastes	49,650	39,500	24.0%	18.1%
Total MSW Generated	206,940	217,750	100.0%	100.0%

* Generation before materials recovery or combustion.

** Other than food products.

This scenario assumes a 32.3% reduction of yard trimmings. See Table 32 for other scenarios.

Details may not add to totals due to rounding.

Source: Franklin Associates, Ltd.

Table 30

PROJECTIONS OF PRODUCTS GENERATED* IN THE MUNICIPAL WASTE STREAM, 1993 AND 2000 (WITH DETAIL ON NONDURABLE GOODS)

(In thousands of tons and percent of total generation)

Products	Thousands of tons		% of total	
	1993	2000	1993	2000
Durable Goods *(Detail in Table 29)*	31,910	36,110	15.4%	16.6%
Nondurable Goods				
Newspapers	12,940	14,400	6.3%	6.6%
Books	990	1,180	0.5%	0.5%
Magazines	2,500	3,000	1.2%	1.4%
Office Papers	7,120	8,500	3.4%	3.9%
Telephone Books	740	870	0.4%	0.4%
Third Class Mail	4,010	4,700	1.9%	2.2%
Other Commercial Printing	5,440	6,400	2.6%	2.9%
Tissue Paper and Towels	3,010	3,500	1.5%	1.6%
Paper Plates and Cups	830	840	0.4%	0.4%
Plastic Plates and Cups	350	400	0.2%	0.2%
Trash Bags	890	1,020	0.4%	0.5%
Disposable Diapers	2,700	2,850	1.3%	1.3%
Other Nonpackaging Paper	4,770	5,400	2.3%	2.5%
Clothing and Footwear	4,280	4,800	2.1%	2.2%
Towels, Sheets, & Pillowcases	720	800	0.3%	0.4%
Other Misc. Nondurables	3,510	4,100	1.7%	1.9%
Total Nondurable Goods	54,800	62,760	26.5%	28.8%
Containers and Packaging *(Detail in Table 31)*	70,580	79,380	34.1%	36.5%
Total Product Wastes*	157,290	178,250	76.0%	81.9%
Other Wastes				
Food Wastes	13,800	14,000	6.7%	6.4%
Yard Trimmings	32,800	22,200	15.9%	10.2%
Miscellaneous Inorganic Wastes	3,050	3,300	1.5%	1.5%
Total Other Wastes	49,650	39,500	24.0%	18.1%
Total MSW Generated	206,940	217,750	100.0%	100.0%

* Generation before materials recovery or combustion.

** Other than food products.

This scenario assumes a 32.3% reduction of yard trimmings. See Table 32 for other scenarios.

Details may not add to totals due to rounding.

Source: Franklin Associates, Ltd.

Containers and Packaging

Containers and packaging is the largest single category of MSW, and this is projected to continue through the decade (Table 31). Generation was 70.6 million tons in 1993, with an increase to 79.4 million tons in 2000. In percentage of total MSW, containers and packaging were 34.1 percent in 1993, with a projected increase to 36.5 percent in 2000.

Tonnage of glass containers generated is projected to increase at a low rate. Glass containers are projected to continue to be a declining percentage of MSW generation (5.7 percent of total generation in 2000).

Steel packaging generation has been declining, but steel packaging generation is projected to be about constant to the year 2000. (In other words, the decline is projected to "flatten out.") As a percentage of MSW generation, steel packaging is projected to be constant at 1.4 percent of generation.

Tonnage of aluminum packaging has been increasing steadily over the historical period, and this trend is projected to continue. Tonnage of other materials also increases, however, so aluminum stays at one percent of total generation in the projections.

Like other paper and paperboard products, overall generation of paper and paperboard packaging has been increasing rapidly. The increase is almost all in corrugated boxes, which are mainly used for shipping other products. Continued increases in generation of corrugated boxes are projected; tonnage of these boxes is projected to be 31.0 million tons in 2000, or 14.2 percent of total MSW generation. Folding carton generation is also projected to increase. Other paper packaging is projected to remain about constant in tonnage. All paper and paperboard packaging is projected to be 18.6 percent of total generation in 2000.

Plastics packaging has exhibited rapid historical growth, and the trends are projected to continue. Soft drink bottles, milk bottles, other containers, bags and sacks, wraps, and other packaging are all projected to follow the increasing trends. Generation of all plastics packaging is projected to be 9.8 million tons in 2000, or 4.5 percent of total generation.

Table 31

PROJECTIONS OF PRODUCTS GENERATED*
IN THE MUNICIPAL WASTE STREAM, 1993 AND 2000
(WITH DETAIL ON CONTAINERS AND PACKAGING)
(In thousands of tons and percent of total generation)

Products	Thousands of tons		% of total	
	1993	2000	1993	2000
Durable Goods *(Detail in Table 29)*	31,910	36,110	15.4%	16.6%
Nondurable Goods *(Detail in Table 30)*	54,800	62,760	26.5%	28.8%
Containers and Packaging				
Glass Packaging				
Beer and Soft Drink Bottles	5,440	5,440	2.6%	2.5%
Wine and Liquor Bottles	1,850	1,950	0.9%	0.9%
Food and Other Bottles & Jars	4,940	5,010	2.4%	2.3%
Total Glass Packaging	12,230	12,400	5.9%	5.7%
Steel Packaging				
Beer and Soft Drink Cans	70		0.0%	
Food and Other Cans	2,720	2,780	1.3%	1.3%
Other Steel Packaging	190	220	0.1%	0.1%
Total Steel Packaging	2,980	3,000	1.4%	1.4%
Aluminum Packaging				
Beer and Soft Drink Cans	1,610	1,840	0.8%	0.8%
Other Cans	40	50	0.0%	0.0%
Foil and Closures	330	360	0.2%	0.2%
Total Aluminum Pkg	1,980	2,250	1.0%	1.0%
Paper & Paperboard Pkg				
Corrugated Boxes	26,350	31,000	12.7%	14.2%
Milk Cartons	470	400	0.2%	0.2%
Folding Cartons	4,940	5,340	2.4%	2.5%
Other Paperboard Packaging	300	300	0.1%	0.1%
Bags and Sacks	2,200	2,200	1.1%	1.0%
Wrapping Papers	70	80	0.0%	0.0%
Other Paper Packaging	1,100	1,170	0.5%	0.5%
Total Paper & Board Pkg	35,430	40,490	17.1%	18.6%
Plastics Packaging				
Soft Drink Bottles	560	617	0.3%	0.3%
Milk Bottles	550	600	0.3%	0.3%
Other Containers	1,930	3,184	0.9%	1.5%
Bags and Sacks	1,050	1,288	0.5%	0.6%
Wraps	1,820	1,840	0.9%	0.8%
Other Plastics Packaging	2,370	2,271	1.1%	1.0%
Total Plastics Packaging	8,280	9,800	4.0%	4.5%
Wood Packaging	9,460	11,200	4.6%	5.1%
Other Misc. Packaging	220	240	0.1%	0.1%
Total Containers & Pkg	70,580	79,380	34.1%	36.5%
Total Product Wastes**	157,290	178,250	76.0%	81.9%
Other Wastes				
Food Wastes	13,800	14,000	6.7%	6.4%
Yard Trimmings	32,800	22,200	15.9%	10.2%
Miscellaneous Inorganic Wastes	3,050	3,300	1.5%	1.5%
Total Other Wastes	49,650	39,500	24.0%	18.1%
Total MSW Generated	206,940	217,750	100.0%	100.0%

* Generation before materials recovery or combustion.

** Other than food products.

This scenario assumes a 32.3% reduction of yard trimmings. See Table 32 for other scenarios.

Details may not add to totals due to rounding.

Source: Franklin Associates, Ltd.

The Effects of Yard Trimmings Source Reduction

As discussed earlier in this chapter, the apparent trend toward lower generation of yard trimmings (that is, a lower tonnage of yard trimmings entering the waste management system to go to composting facilities, landfill, or combustion facilities) has a marked effect on projections of total generation of MSW. As discussed earlier, over half of the U.S. population will live in states having regulations affecting disposal of yard trimmings by 1996, and some additional legislation is projected between 1996 and 2000.

Since dramatic source reduction of yard trimmings is a comparatively new phenomenon, data to support these projections are limited, although the data that are available tend to support the assumptions used. Due to current lack of hard data, three different scenarios for yard trimmings projections are shown to present a range of possible outcomes (Table 32). The mid-range scenario (Scenario 2) is used for projections in this report.

Table 32

COMPARISON OF THREE SCENARIOS FOR SOURCE REDUCTION OF YARD TRIMMINGS, 2000
(In thousands of tons and percent of total generation)

	Thousand tons	Percent of total	Annual Increase Compared to 1993
Scenario 1: Yard trimmings constant since 1993			
Yard trimmings	32,800	14.4%	
Total MSW generation	228,350	100.0%	1.4%
Scenario 2: Yard trimmings reduced*			
Yard trimmings	22,200	10.2%	
Total MSW generation	217,750	100.0%	0.8%
Scenario 3: Yard trimmings reduced further**			
Yard trimmings	16,400	7.7%	
Total MSW generation	211,950	100.0%	0.4%

* Assumes a 32.3 percent reduction from 1993 generation. (See text for assumptions.)
** Assumes a 50 percent reduction from 1993 generation.
Source: Franklin Associates, Ltd.

For Scenario 1, it was assumed that there would be no further reduction in yard trimmings generation compared to generation in 1993. Scenario 2 was developed using the assumptions described earlier in this chapter. Assuming that generation of all other products and materials would not change from scenario to scenario, total projected MSW generation in 2000 would be 228.4

million tons under Scenario 1 compared to 217.8 million tons under Scenario 2. Yard trimmings would comprise 14.4 percent of total generation in Scenario 1, compared to 10.2 percent in Scenario 2.

For a more optimistic scenario for yard trimmings reduction in 2000, it was assumed that yard trimmings generation could be reduced by 50 percent between 1993 and 2000 (Scenario 3). Under this assumption, yard trimmings generation would be 16.4 million tons in 2000, and yard trimmings would be 7.7 percent of total MSW generation.

For another perspective, Table 32 also shows the annual rates of increase of MSW generation between 1993 and 2000 under the various scenarios. If yard trimmings do not decrease, MSW generation would increase an average of 1.4 percent annually. Under Scenario 2 for yard trimmings reduction, the average annual rate of increase in MSW generation would be 0.8 percent. (Population increase is projected at 1.0 percent annually.) Finally, under a 50 percent reduction in yard trimmings scenario, the increase in MSW generation would be 0.4 percent annually. (Each scenario assumes that generation of other materials would increase by the amount shown in Table 26.)

It should be noted that a marked reduction in yard trimmings causes the percentages of all other products in the MSW stream to increase, even if their tonnages remain constant or decrease modestly.

PROJECTIONS OF MSW RECOVERY

Prior to the 1980s, rates of recovery for recycling increased slowly and thus projections were relatively easy to make. At this time, however, there is a high level of interest in municipal solid waste management in general, and in recycling and composting in particular. Government agencies at all levels are seeking ways to stimulate materials recovery. Local communities are adding materials recovery and recycling programs rapidly, but there is no accurate nationwide accounting system. In response to the demand for more recovery and more markets for recovered products, industry associations and individual companies have invested large amounts of money and effort in developing new recycling programs and products containing recovered materials.

Because of the rapidly changing situation and uncertainty in the available data, projections of materials recovery were made in scenarios that could achieve different rates of recovery in 2000. Scenarios were developed for 25, 30, and 35 percent recovery rates (see Appendix B). These scenarios are based on recovery of postconsumer MSW and do not include industrial scrap. Also, composting of only yard trimmings is included in these scenarios; estimates of composting of mixed MSW were not made for this report.

The recovery scenarios developed for this report describe sets of conditions that could achieve the selected range of recovery rates. The scenarios are not intended to predict exact recovery rates for any particular material; there are many ways in which a targeted overall recovery rate could be achieved. Especially at the state and local levels, differing circumstances mean that recovery rates of a particular material could be higher or lower than those used to develop these scenarios.

Discussion of Assumptions

Some general assumptions and principles were used in making the recovery estimates:

- Recovery includes both recovery for recycling and for composting. Recovered materials are assumed to have been removed from the municipal waste stream.

- It was assumed that local, state, and federal agencies will continue to emphasize recycling and composting as MSW management alternatives.

- It was assumed that present state deposit laws will remain in place, but that no additional deposit legislation for containers would be enacted.

- It was assumed that affected industries will continue to emphasize recovery and recycling programs, and will make the necessary investments to achieve higher recycling rates.

- It was assumed that the current trend toward banning certain yard trimmings in landfills will continue, providing stimulus for composting programs and for source reduction of yard trimmings by citizens.

- Based on the preceding assumptions, most U.S. citizens will have access to recovery options before 2000, which will often, in fact, be mandated. These options will include curbside collection, drop-off and buy-back centers, and, in some instances, mixed waste processing facilities. Recovery will continue to increase as more recovery systems come on-line.

- In spite of the factors encouraging more recovery as enumerated above, many areas of the U.S. are thinly populated and/or remote from ready markets for recovered materials; many of these areas also have adequate landfill capacity. Therefore, the overall recovery rate for the entire country may not reflect the higher rates achieved in communities where conditions are favorable for recycling and composting.

Scenarios for 2000

The range of projected recovery rates for materials in MSW under three recovery scenarios in the year 2000 is shown in Table 33. (Details of the assumptions for individual products in MSW are in Appendix B.) Continued increases in recovery in every category will be required to reach the scenarios shown. To reach a recovery rate of 35 percent nationwide in 2000, 47 percent of all paper and paperboard, 37 percent of all glass, nearly 50 percent of metals, and over 11 percent of all plastics in MSW would be recovered under this scenario. Fifty-five percent of all yard trimmings would be recovered for composting under this scenario (not including backyard composting and other source reduction measures).

Table 33

PROJECTED GENERATION AND RANGES OF RECOVERY,* 2000
(In thousands of tons and percent of generation of each material)

		Recovery						1993
		Thousand tons			% of generation			Recovery
Materials	Generation	25%	30%	35%	25%	30%	35%	%***
Paper and Paperboard	89,340	31,680	37,480	41,915	35.5%	42.0%	46.9%	34.0%
Glass	14,020	3,845	4,340	5,210	27.4%	31.0%	37.2%	22.0%
Metals								
Ferrous	14,220	3,900	5,135	6,800	27.4%	36.1%	47.8%	26.1%
Aluminum	3,425	1,465	1,575	1,620	42.8%	46.0%	47.3%	35.4%
Other Nonferrous**	1,400	890	920	920	63.6%	65.7%	65.7%	62.9%
Total Metals	19,045	6,255	7,630	9,340	32.8%	40.1%	49.0%	30.3%
Plastics	22,490	1,530	1,975	2,660	6.8%	8.8%	11.8%	3.5%
Rubber & Leather	7,605	490	660	820	6.4%	8.7%	10.8%	5.9%
Clothing, Other Textiles	6,200	240	480	720	3.9%	7.7%	11.6%	11.7%
Wood	16,010	1,570	1,680	2,015	9.8%	10.5%	12.6%	9.6%
Yard Trimmings†	22,200	8,880	10,655	12,210	40.0%	48.0%	55.0%	19.8%
Food Wastes	14,000	15	520	1,385	0.1%	3.7%	9.9%	Neg.
Other Materials‡	6,840	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Totals	217,750	54,505	65,420	76,275	25.0%	30.0%	35.0%	21.7%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.
Does not include recovery for mixed MSW composting.
** Includes some nonferrous metals other than battery lead.
† Yard trimmings generation reduced by 32.3% in this scenario (Table 32).
‡ Miscellaneous inorganic wastes, electrolytes in batteries, other miscellaneous.
*** From Table 2.
Neg. = Negligible (less than 50,000 tons or 0.05%.
Details may not add to totals due to rounding.
Source: Franklin Associates, Ltd.

PROJECTIONS OF MSW DISCARDS AFTER RECOVERY

Discards of municipal solid waste as defined for this report are those wastes remaining after recovery of materials for recycling and composting of yard trimmings. The remaining discards must be managed by combustion, landfilling, or some other means such as mixed waste composting or preparation of fuel products. The effects of projected recovery rates on the amounts and characteristics of municipal solid waste discards are illustrated in Table 34. (A 30 percent recovery scenario for 2000 is shown as an example.)

This projected scenario of discards, which is based on substantial source reduction of yard trimmings and a 30 percent recovery rate for materials and products generated in 2000, shows a 5.9 percent decrease in MSW discards in 2000 as compared to 1993.

Table 34

PROJECTIONS OF MATERIALS DISCARDED* IN MSW, 1993 AND 2000
(AT A 30 PERCENT RECOVERY SCENARIO IN 2000)
(In thousands of tons and percent of total discards)

	Thousand tons		% of discards	
Materials	**1993**	**2000****	**1993**	**2000**
Paper and Paperboard	51,380	51,860	31.7%	34.0%
Glass	10,660	9,680	6.6%	6.4%
Metals				
Ferrous	9,560	9,085	5.9%	6.0%
Aluminum	1,920	1,850	1.2%	1.2%
Other Nonferrous	460	480	0.3%	0.3%
Total Metals	*11,940*	*11,415*	*7.4%*	*7.5%*
Plastics	18,620	20,515	11.5%	13.5%
Rubber & Leather	5,850	6,945	3.6%	4.6%
Clothing, Other Textiles	5,410	5,720	3.3%	3.8%
Wood	12,370	14,330	7.6%	9.4%
Yard Trimmings†	26,300	11,545	16.2%	7.6%
Food Wastes	13,800	13,480	8.5%	8.8%
Other Materials‡	5,620	6,840	3.5%	4.5%
Totals	161,950	152,330	100.0%	100.0%

* Discards after recovery for recycling and composting of yard trimmings.
** Recovery scenario at 30 percent (Table 33).
† Yard trimmings generation reduced in this scenario (Table 32).
‡ Miscellaneous inorganic wastes, electrolytes in batteries, other miscellaneous.
Details may not add to totals due to rounding.
Source: Franklin Associates, Ltd.

The materials composition of MSW discards is quite different from the materials composition of MSW generation, especially for materials that are recovered at higher rates. For example, paper and paperboard are projected to comprise 41.0 percent of MSW generation, but 34.0 percent of MSW discards, in 2000. Yard trimmings would decline from 10.2 percent of MSW generation to 7.6 percent of discards under this scenario. The percentages of other materials discards would likewise increase or decrease, depending upon their projected recovery rates.

PROJECTIONS OF MSW COMBUSTION

Making projections of MSW combustion is somewhat difficult at this time because there are many uncertainties affecting construction of new facilities. New rulings and regulations affecting air emissions control, ash management, and flow control of MSW were all causing uncertainty at the time this report was prepared. Since several years are required to site and obtain permits for construction of new MSW combustion facilities, it was assumed that there will be almost no new net MSW combustion capacity coming on-line between 1993 and 2000 (Table 35).

While substantial amounts of MSW were burned without energy recovery in past years, most of these older facilities have been closed due to the costs of implementing air pollution requirements. It is projected that all major facilities for combustion of MSW will have energy recovery in the future.

Since there is increasing interest in combustion of certain source-separated components of MSW—especially tires, but also wood pallets, paper, and plastics—it was assumed that combustion of these materials would double between 1993 and 2000. This is probably a very conservative assumption.

SUMMARY OF PROJECTED MSW MANAGEMENT

A summary of the projections is presented, with similar figures for 1993 included for contrast (Table 35). For the summary, a mid-range recovery scenario of 30 percent in 2000 was used.

From 1993 to 2000, generation of MSW is projected to increase by 0.7 percent per year compared to 2.7 percent per year between 1980 and 1990. As described earlier, source reduction of yard trimmings accounts for most of the decrease under the selected scenario.

The effect of the mid-range scenario for materials recovery for recycling and yard trimmings composting causes the discards of MSW to decline between 1993 and 2000, from 162.0 million tons in 1993 to 152.3 million tons in 2000. After deductions for combustion, discards to landfill and other disposal were 129.0 million tons in 1993, declining to 118.3 million tons in 2000.

A graphical illustration of the long-term trends is shown in Figure 20.

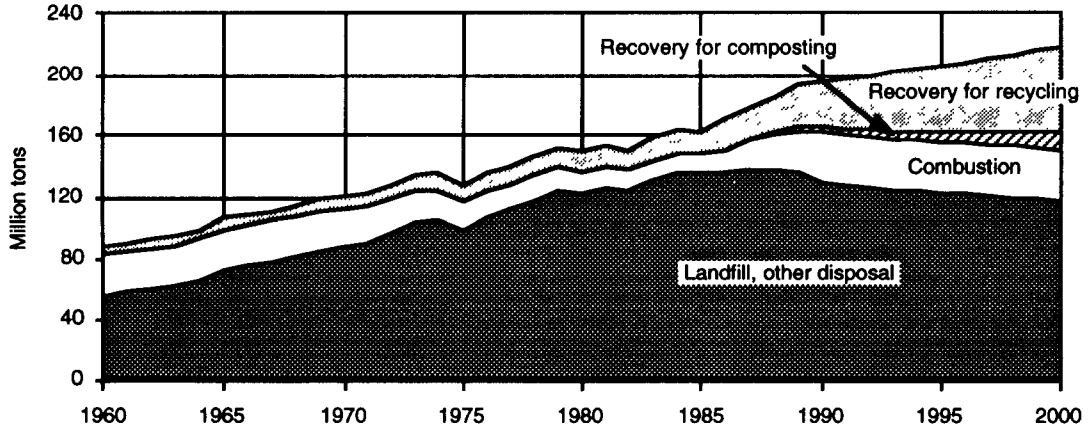
Table 35

GENERATION, RECOVERY, COMBUSTION, AND DISPOSAL OF MUNICIPAL SOLID WASTE, 1993 AND 2000 (AT A 30 PERCENT RECOVERY SCENARIO IN 2000) (In thousands of tons and percent of total generation)

	Thousands of tons		% of generation	
	1993	2000	1993	2000
Generation	206,940	217,750	100.0%	100.0%
Recovery for recycling	38,490	54,245	18.6%	24.9%
Recovery for composting*	6,500	11,175	3.1%	5.1%
Total materials recovery	44,990	65,420	21.7%	30.0%
Discards after recovery	161,950	152,330	78.3%	70.0%
Combustion**	32,920	34,000	15.9%	15.6%
Landfill, other disposal	129,030	118,330	62.4%	54.3%

* Composting of yard trimmings and food wastes. Does not include backyard composting.
** Combustion of MSW in mass burn or refuse derived form, incineration without energy recovery, and combustion with energy recovery of source separated materials in MSW.
Details may not add to totals due to rounding.
Source: Franklin Associates, Ltd.

Figure 20. Municipal solid waste management, 1960 to 2000



Chapter 4

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Chapter 5

ADDITIONAL PERSPECTIVES ON MUNICIPAL SOLID WASTE

INTRODUCTION

In this chapter, the municipal solid waste (MSW) characterization data summarized in the previous chapters are presented again from different perspectives. These are:

- Historical and projected MSW generation and management on a pounds per person per day basis
- Historical and projected MSW generation by material on a pounds per person per day basis
- A classification of 1993 MSW generation into residential and commercial components
- Historical and projected discards of MSW classified into organic and inorganic fractions
- A table ranking products and materials in MSW by tonnage generated in 1993
- A discussion of some of the demographic and economic factors that appear to affect MSW generation.

GENERATION AND DISCARDS BY INDIVIDUALS

Municipal solid waste planners often think in terms of generation and discards on a per capita (per person) basis. Data on historical and projected MSW generation and management are presented on the basis of pounds per person per day in Table 36. The top line shows a steady increase in per capita generation of MSW, from 2.7 pounds per person per day in 1960 to 4.4 pounds per person per day in 1993, with a projection of 4.3 pounds per person per day in 2000. (The primary reason for the projected decline in MSW generation is a decrease in yard trimmings entering the MSW management system. See Chapter 4 for a discussion of the assumptions used in making the projections.)

The per capita discards represent the amount remaining after recovery for recycling and composting. Discards after recovery for recycling and composting grew from 2.5 pounds per person per day in 1960 to 3.6 pounds per person per day in 1990. Between 1990 and 1993, discards declined to 3.4 pounds per person per day due to increased recovery for recycling and composting. Under a 30 percent

Table 36

PER CAPITA GENERATION, MATERIALS RECOVERY, COMBUSTION, AND DISCARDS OF MUNICIPAL SOLID WASTE, 1960 TO 2000
(In pounds per person per day; population in thousands)

	1960	1970	1980	1990	1993	2000
Generation	2.66	3.27	3.65	4.35	4.39	4.32
Recovery for recycling & composting	0.18	0.23	0.35	0.72	0.96	1.30
Discards after recovery	2.48	3.04	3.30	3.63	3.44	3.02
Combustion	0.82	0.67	0.33	0.70	0.70	0.67
Discards to landfill, other disposal	1.67	2.37	2.97	2.93	2.74	2.35
Population (thousands)	180,671	203,984	227,255	249,399	257,908	276,241

The year 2000 scenario assumes substantial reduction of yard trimmings generation, a 30% recovery scenario, and virtually no increase in net combustion of MSW.
Details may not add to totals due to rounding.
Population figures from Bureau of the Census, Current Population Reports.
Source: Franklin Associates, Ltd.

recovery scenario for 2000, this decline is projected to continue, to 3.0 pounds per person per day.

In 1993, an estimated 0.7 pounds per person per day of discards were managed through combustion, while the remainder—2.7 pounds per person per day—went to landfill or other disposal. The projection for 2000 is that 0.7 pounds per person per day would be combusted, and 2.4 pounds per person per day would be landfilled.

In Table 37, per capita generation of each material category characterized in this study is shown. Paper, plastics, rubber and leather, and wood in MSW have grown on a per capita basis throughout the 33-year historical period, and this growth is projected to continue. Glass generation grew on a per capita basis during the earlier decades, but declined in the 1980s. Generation in the 1990s was lower on a per capita basis, and is projected to decline slightly. Generation of metals and textiles on a per capita basis also grew, then declined somewhat. Some growth in metals generation is projected to 2000, while textiles generation is projected to be declining slightly.

Generation of food wastes has declined on a per capita basis due to increased processing of food before it enters the residential or commercial waste streams. This trend is projected to continue. Generation of yard trimmings on a per capita basis increased over a 30-year period, but has begun to decline for reasons discussed elsewhere in this report.

Table 37

PER CAPITA GENERATION* OF MUNICIPAL SOLID WASTE, BY MATERIAL, 1960 TO 2000
(In pounds per person per day)

Materials	1960	1970	1980	1990	1993	2000
Paper and paperboard	0.91	1.19	1.32	1.60	1.65	1.77
Glass	0.20	0.34	0.36	0.29	0.29	0.28
Metals	0.32	0.38	0.35	0.36	0.36	0.38
Plastics	0.01	0.08	0.19	0.39	0.43	0.47
Rubber and leather	0.06	0.09	0.10	0.13	0.13	0.15
Textiles	0.05	0.05	0.06	0.13	0.11	0.10
Wood	0.09	0.11	0.16	0.27	0.29	0.32
Other	0.00	0.02	0.07	0.07	0.07	0.07
Total Nonfood Products	1.65	2.26	2.62	3.23	3.34	3.54
Food wastes	0.37	0.34	0.32	0.29	0.29	0.28
Yard trimmings	0.61	0.62	0.66	0.77	0.70	0.44
Miscellaneous inorganic wastes	0.04	0.05	0.05	0.06	0.06	0.07
Total MSW Generated	2.66	3.27	3.65	4.35	4.39	4.32

* Generation before materials or energy recovery.
Details may not add to totals due to rounding.
Source: Tables 1 and 33. Population figures from the Bureau of the Census.

Overall, per capita generation of MSW increased throughout the 33-year study period. A decline is, however, projected primarily because of the projected source reduction of yard trimmings.

RESIDENTIAL AND COMMERCIAL GENERATION OF MSW

The sources of MSW generation are of considerable interest to management planners. The material flows methodology does not lend itself well to a distinction as to sources of the materials because the data used are national in scope. However, a classification of products and materials by residential and commercial sources was first made for the 1992 update of this series of reports.

For purposes of this classification, residential waste was considered to come from both single family and multi-family residences. This is somewhat contrary to a common practice in MSW management to classify wastes collected from apartment buildings as commercial. The rationale used for this report is that the nature of residential waste is basically the same whether it is generated in a single or multi-family residence. (Yard trimmings are probably the primary exception, and this was taken into account.) Because of this approach, the

percentage of residential waste shown here is higher than that often reported by waste haulers.

Commercial wastes for the purpose of this classification include MSW from retail and wholesale establishments; hotels; office buildings; airports and train stations; hospitals, schools, and other institutions; and similar sources. No industrial process wastes are included, but normal MSW such as packaging, cafeteria and washroom wastes, and office wastes from industrial sources are included. As is the case for the data in Chapter 2, construction and demolition wastes, sludges, ashes, automobile bodies, and other non-MSW wastes are not included.

The classification of MSW generation into residential and commercial fractions was made on a product-by-product basis, as shown in Appendix C. The 1993 tonnage generation of each product was allocated to residential or commercial sources on a "best judgment" basis; then the totals were aggregated. These are estimates for the nation as a whole, and should not be taken as representative of any particular region of the country.

A few revisions to the 1993 methodology were made for the current report based on estimates made in a recent report for Keep America Beautiful, which was extensively reviewed by public and private sector experts in municipal solid waste management. Discards of major appliances and rubber tires were reassigned to the commercial sector rather than the residential sector because, while these products may be used in a residential setting, they tend to be collected and managed through the commercial sector.

Based on this analysis, a reasonable range for residential wastes would be 55 to 65 percent of total MSW generation, while commercial wastes probably range between 35 to 45 percent of total generation (Table 38).

Table 38

CLASSIFICATION OF MSW GENERATION INTO RESIDENTIAL AND COMMERCIAL FRACTIONS, 1993
(In thousands of tons and percent of total)

	Thousand tons	Percent of total
Residential Wastes	113,820 – 134,510	55.0% – 65.0%
Commercial Wastes	72,430 – 93,120	35.0% – 45.0%

Estimates are presented as a range because of wide variations across the country.
Source: Franklin Associates, Ltd. (Appendix C).

ORGANIC/INORGANIC FRACTIONS OF MSW

The composition of MSW in terms of organic and inorganic fractions is of interest to planners of waste management facilities and others working with MSW. This characterization of MSW discards is shown in Table 39. (Discards were used instead of generation because discards enter the solid waste management system after recovery for recycling and composting.) The organic fraction of MSW has been increasing steadily since 1970, from 75 percent organics in 1970 to 84 percent in 1993.

It is interesting to note, however, that the percentage of MSW that is organics began to "level off" after 1992 because of the projected decline in yard trimmings discarded. This trend is projected to continue, with organics declining to 83.3 percent of total MSW discards in 2000. Other than yard trimmings, other organic components of MSW, such as paper, are tending to increase.

Table 39

COMPOSITION OF MSW DISCARDS* BY ORGANIC AND INORGANIC FRACTIONS, 1960 TO 2000
(In percent of total discards)

Year	Organics**	Inorganics†
1960	77.6	22.4
1965	78.4	21.6
1970	75.2	24.8
1975	75.5	24.5
1980	78.1	21.9
1985	81.3	18.7
1990	83.9	16.1
1991	83.8	16.2
1992	84.2	15.8
1993	84.2	15.8
2000	83.3	16.7

* Discards after materials recovery has taken place, and before combustion.
** Includes paper, plastics, rubber and leather, textiles, wood, food wastes, and yard trimmings.
† Includes glass, metals, and miscellaneous inorganics. Details may not add to totals due to rounding.

Source: Tables 3 and 34.

RANKING OF PRODUCTS IN MSW BY WEIGHT

About 50 categories of products and materials are characterized as line items in the tables in Chapter 2. It is difficult when examining that set of tables to see in perspective the relative tonnages generated or discarded by the different items. Therefore, Tables 40 and 40a were developed to illustrate this point.

In Table 40, the various products and materials are arranged in descending order by weight generated in 1993. Subtotals in the right-hand column group categories together for further illustration. For example, only yard trimmings and corrugated boxes stand at the top of the list, with each generating over 12 percent of total MSW. Together these two items totaled 28.6 percent of MSW generated in 1993. The next six categories totaled 31 percent of total generation. Together these eight categories made up almost 60 percent of total MSW generated. The 19 items at the bottom of the list each amounted to less than one percent of generation in 1993; together they amounted to only 8.0 percent of total generation.

A different perspective is provided in Table 40a, which ranks products in MSW by weight discarded after recovery for recycling and composting. This table illustrates how recovery alters the products' rankings. For example, corrugated boxes, which ranked second highest in generation, ranked fourth in discards in 1993.

Discards of three categories—yard trimmings, food wastes, and miscellaneous durables—were 33.1 percent of all discards in 1993. The next four categories—corrugated boxes, wood packaging, newspapers, and furniture and furnishings—made up 20.9 percent of total discards. Together these seven categories made up over 50 percent of MSW discards in 1993. Eighteen categories of discards were each less than one percent of the total; together these items totaled less than 7 percent of 1993 discards.

FACTORS AFFECTING MUNICIPAL SOLID WASTE GENERATION

Data on municipal solid waste (MSW) generation presented elsewhere in this report show steady growth in most years. Many reasons have been suggested for this growth: increasing population, changing population demographics, growing economic activity, and changes in lifestyles and the nature of the workplace. In this section, the 33-year data series on MSW generation is correlated with data on U.S. population, economic activity as measured by Gross Domestic Product, and household size to illustrate factors contributing to growth in MSW generation.

Table 40

GENERATION OF MUNICIPAL SOLID WASTE, 1993
ARRANGED IN DESCENDING ORDER BY WEIGHT
(In thousands of tons)

	Thousand tons	Percent of total	Subtotals
Yard trimmings	32,800	15.9%	
Corrugated boxes	26,350	12.7%	28.6% (over 12%)
Food wastes	13,800	6.7%	
Miscellaneous durables	13,720	6.6%	
Newspapers	12,940	6.3%	
Wood packaging	9,460	4.6%	
Office-type papers	7,120	3.4%	
Furniture and furnishings	7,020	3.4%	31.0% (3 to 7%)
Glass beer & soft drink bottles	5,440	2.6%	
Other commercial printing	5,440	2.6%	
Glass food & other bottles	4,940	2.4%	
Paper folding cartons	4,940	2.4%	
Other nonpackaging paper	4,770	2.3%	
Clothing and footwear	4,280	2.1%	14.4% (2 to 3%)
Third class mail	4,010	1.9%	
Miscellaneous nondurables	3,510	1.7%	
Major appliances	3,430	1.7%	
Rubber tires	3,410	1.6%	
Miscellaneous inorganic wastes	3,050	1.5%	
Tissue paper and towels	3,010	1.5%	
Steel cans and other packaging	2,980	1.4%	
Disposable diapers	2,700	1.3%	
Magazines	2,500	1.2%	
Other plastic packaging	2,370	1.1%	
Paper bags and sacks	2,200	1.1%	
Carpets and rugs	2,130	1.0%	
Aluminum cans and other packaging	1,980	1.0%	18.0% (1 to 2%)
Plastic other containers	1,930	0.9%	
Glass wine & liquor bottles	1,850	0.9%	
Plastic wraps	1,820	0.9%	
Lead-acid batteries	1,670	0.8%	
Other paper packaging	1,100	0.5%	
Plastic bags and sacks	1,050	0.5%	
Books	990	0.5%	
Trash bags	890	0.4%	
Paper plates and cups	830	0.4%	
Telephone books	740	0.4%	
Towels, sheets, and pillowcases	720	0.3%	
Plastic soft drink bottles	560	0.3%	
Plastic milk bottles	550	0.3%	
Small appliances	530	0.3%	
Paper milk cartons	470	0.2%	
Plastic plates and cups	350	0.2%	
Other paperboard packaging	300	0.1%	
Other miscellaneous packaging	220	0.1%	
Paper wraps	70	0.0%	8.0% (0 to 1%)
Total	206,940	100.0%	100.0%

Source: Chapter 2.

Table 40a

DISCARDS OF MUNICIPAL SOLID WASTE, 1993
ARRANGED IN DESCENDING ORDER BY WEIGHT
(In thousands of tons)

	Thousand tons	Percent of total	Subtotals
Yard trimmings	26,300	16.2%	
Food wastes	13,800	8.5%	
Miscellaneous durables	13,540	8.4%	33.1% (over 8%)
Corrugated boxes	11,730	7.2%	
Wood packaging	8,140	5.0%	
Newspapers	7,020	4.3%	
Furniture and furnishings	7,020	4.3%	20.9% (3 to 8%)
Other nonpackaging paper	4,770	2.9%	
Office-type papers	4,520	2.8%	
Other commercial printing	4,380	2.7%	
Paper folding cartons	4,240	2.6%	
Glass food & other bottles	3,980	2.5%	
Glass beer & soft drink bottles	3,840	2.4%	
Clothing and footwear	3,710	2.3%	
Miscellaneous nondurables	3,510	2.2%	
Third class mail	3,470	2.1%	22.5% (2 to 3%)
Miscellaneous inorganic wastes	3,050	1.9%	
Tissue paper and towels	3,010	1.9%	
Rubber tires	2,970	1.8%	
Disposable diapers	2,700	1.7%	
Other plastic packaging	2,360	1.5%	
Carpets and rugs	2,120	1.3%	
Magazines	2,050	1.3%	
Paper bags and sacks	1,850	1.1%	
Plastic other containers	1,840	1.1%	
Plastic wraps	1,790	1.1%	
Steel cans and other packaging	1,600	1.0%	
Major appliances	1,590	1.0%	16.6% (1 to 2%)
Glass wine & liquor bottles	1,400	0.9%	
Other paper packaging	1,100	0.7%	
Plastic bags and sacks	1,030	0.6%	
Aluminum cans and other packaging	930	0.6%	
Trash bags	890	0.5%	
Books	830	0.5%	
Paper plates and cups	830	0.5%	
Telephone books	680	0.4%	
Towels, sheets, and pillowcases	600	0.4%	
Small appliances	530	0.3%	
Paper milk cartons	470	0.3%	
Plastic milk bottles	420	0.3%	
Plastic soft drink bottles	330	0.2%	
Plastic plates and cups	330	0.2%	
Other paperboard packaging	300	0.2%	
Other miscellaneous packaging	220	0.1%	
Lead-acid batteries	90	0.1%	
Paper wraps	70	0.0%	6.8% (0 to 1%)
Totals	161,950	100.0%	100.0%

Source: Chapter 2.

STATISTICAL TERMS USED IN THIS SECTION

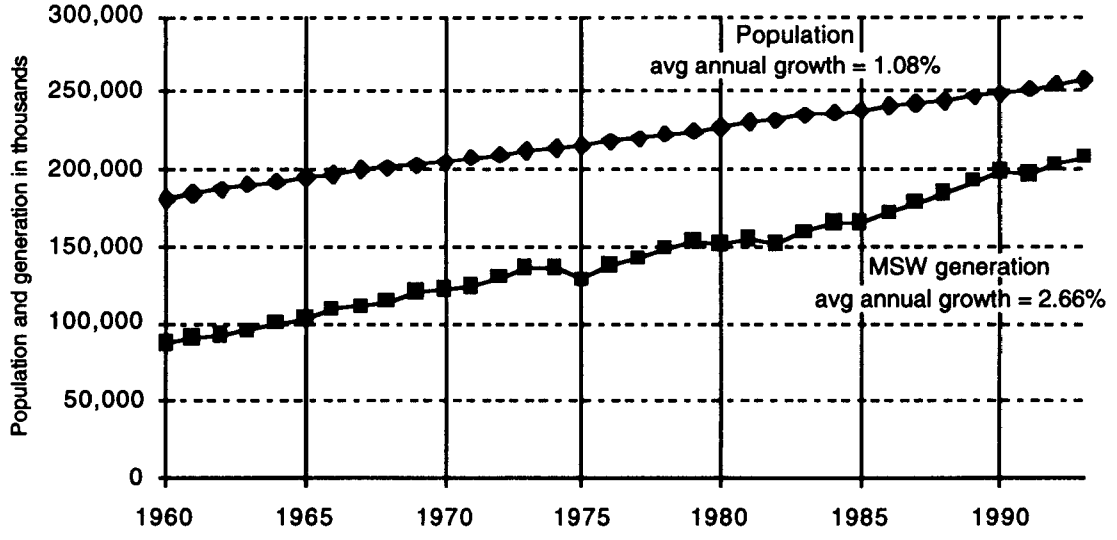
The correlation coefficient (r) is a standardized measure of the linear relationship between two variables. The value of the correlation coefficient varies from +1 to -1, with the positive numbers indicating that the two variables increase and decrease together, and negative correlations indicating one variable increases as the other decreases. Thus the best-fit line of the two variables on an X-Y graph has a negative slope when the correlation coefficient is negative. A correlation coefficient of zero means the two variables are not linearly related, and the best-fit line is horizontal (parallel to the X axis). In mathematical terms, the correlation coefficient is the covariance of two variables divided by the product of their standard deviations.

Correlation is often presented in squared form (r^2), which is known as the coefficient of determination. R^2 is always positive and ranges between zero and one. For the MSW vs. population analysis, r^2 represents the proportion of the variance in MSW generation that can be explained by the population. For example, an r^2 of 0.98 between MSW generation and population means that 98 percent of the variance (which is the standard deviation squared) of MSW generation can be explained by the changes in population.

Population Growth

The most basic observation about MSW generation is that people generate wastes in their daily lives at home, at work, and at other sites such as schools, restaurants, retail stores, and the like. Therefore, increasing population means more MSW will be generated. However, growing MSW generation is only partially explained by population growth, because MSW generation is growing faster than the population (Figure 21).

Figure 21. U.S. population and MSW generation

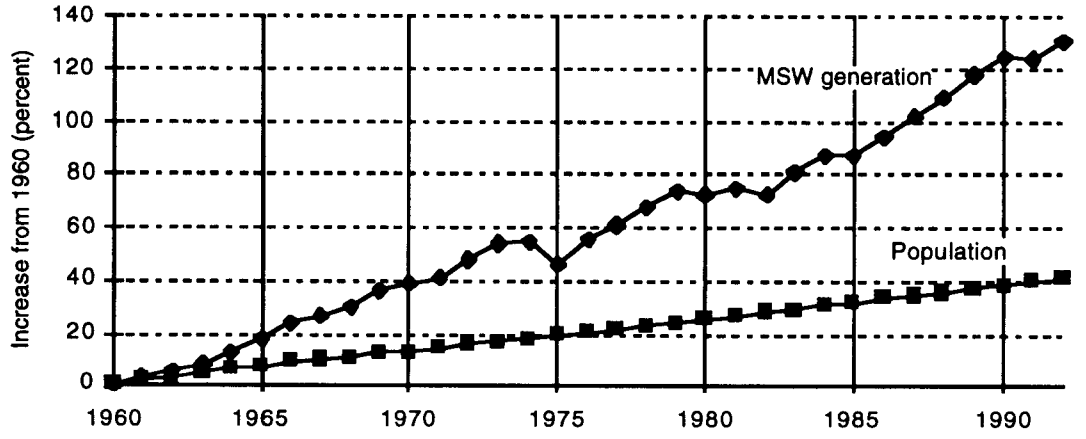


During the 33-year time period from 1960 to 1993, the population grew from 180.7 million to 257.9 million for a 43 percent total increase, compared to a 135 percent increase in MSW generated. Therefore, the population growth alone explains about one-third of the growth in MSW.

Figure 22 shows the annual growth rates for population and for MSW generation from 1960 to 1993. The average population growth is 1.08 percent per year. The annual percentage increase in MSW generation shows greater variations from year to year, with an average growth of 2.66 percent.

The correlation coefficient (r) between total MSW generation and population from 1960 to 1993 is 0.99, and the coefficient of determination (r^2) is 0.98.

Figure 22. Growth of U.S. population and municipal solid waste generation



Economic Activity

Consumption can be measured using Gross Domestic Product (GDP); these figures are published regularly by the U.S. Department of Commerce. GDP is the output of all goods and services produced. To examine the correlation of MSW generation with GDP in the U.S., MSW generation is expressed as pounds per capita per day. This removes the element of MSW growth explained by population changes, and considers only the remaining portion of growth. GDP can be expressed in constant dollars (1987 dollars per capita) to remove the effects of inflation.

During the 33-year period, MSW generation grew from 2.7 pounds per person per day to 4.4 pounds per person per day, an increase of 65 percent. During the same period, the Gross Domestic Product rose from $10,922 per person to $19,908 per person, an increase of 82 percent. Plots of MSW generation per person and GDP in constant dollars per person are shown in Figure 23. The correlation coefficient (r) for the two data series is 0.99.

Figure 23. MSW generation and Gross Domestic Product, 1960 to 1993

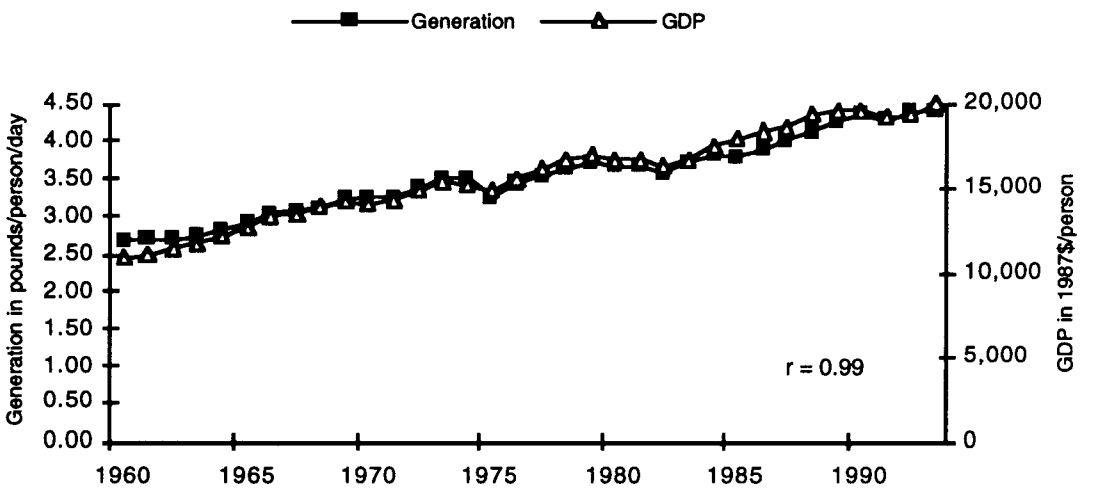


Figure 24 is a scatter plot showing the nearly linear relationship of MSW generation and Gross Domestic Product since 1960. The correlation coefficient (r) is 0.99, showing a very strong positive correlation.

Generation of Product Categories

Generation of the major categories of MSW, which are durable goods, nondurable goods, and containers and packaging, is plotted in Figure 25 along with GDP. Generation is expressed in pounds per person per day and GDP in 1987 dollars per person to eliminate the effects of population growth and inflation. Correlation coefficients are shown for each MSW category.

Because of their long life spans, durable goods—e.g., furniture and appliances—are not as sensitive to the single year dips in GDP of 1975, 1982, and 1991 as are nondurable goods and containers and packaging. However, the calculated correlation coefficient for each category is quite high, ranging from 0.96 for containers and packaging to 0.98 for nondurable goods.

Figure 24. MSW generation and Gross Domestic Product

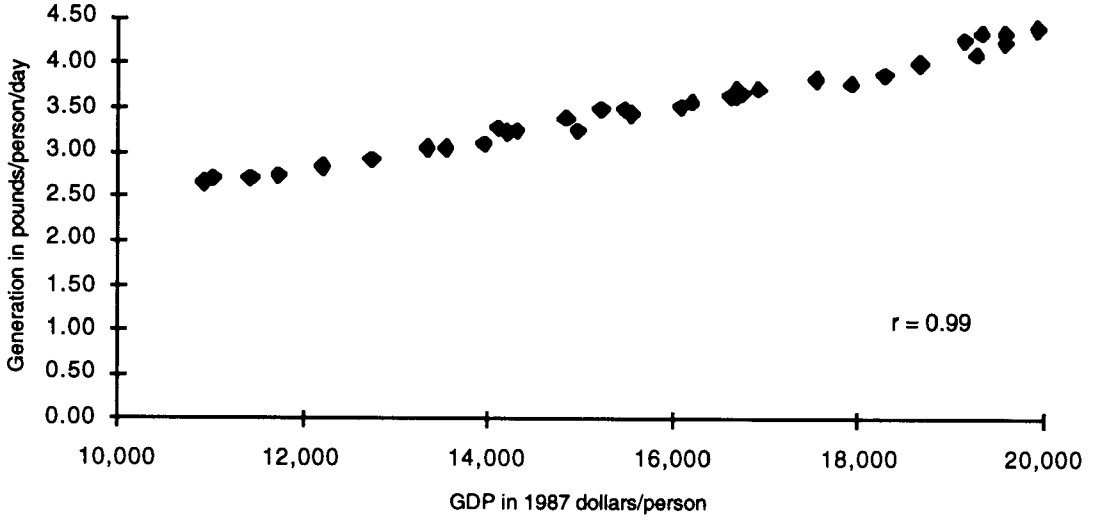
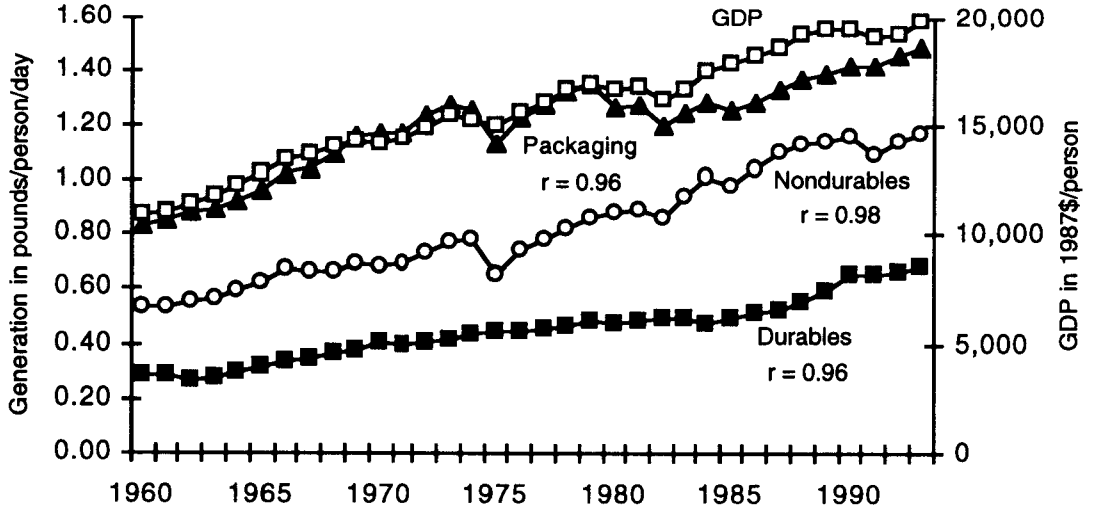


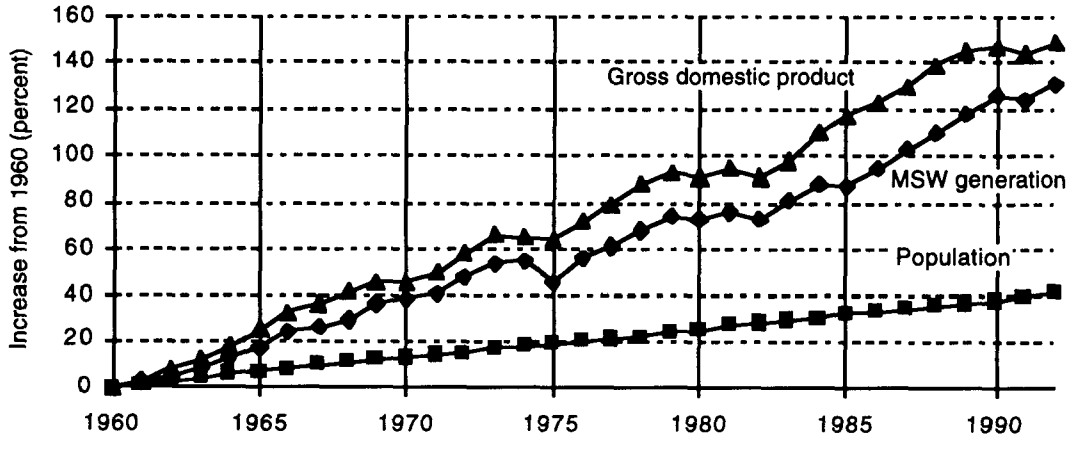
Figure 25. MSW product categories and Gross Domestic Product



Comparison of MSW Generation, Population, and GDP

Comparative growth rates of MSW generation, population, and Gross Domestic Product are shown in Figure 26. For each parameter, 1960 is taken as the base year, with percentage increase over 1960 plotted. If per capita generation of MSW were constant, the population and generation plots would be the same. As can be seen, however, MSW generation correlates more closely with GDP than with population. GDP grew an average of 2.94 percent per year from 1960 to 1993; population grew 1.08 percent per year; and MSW generation grew 2.66 percent per year.

Figure 26. Growth of U.S. population, MSW generation, and gross domestic product



Household Size

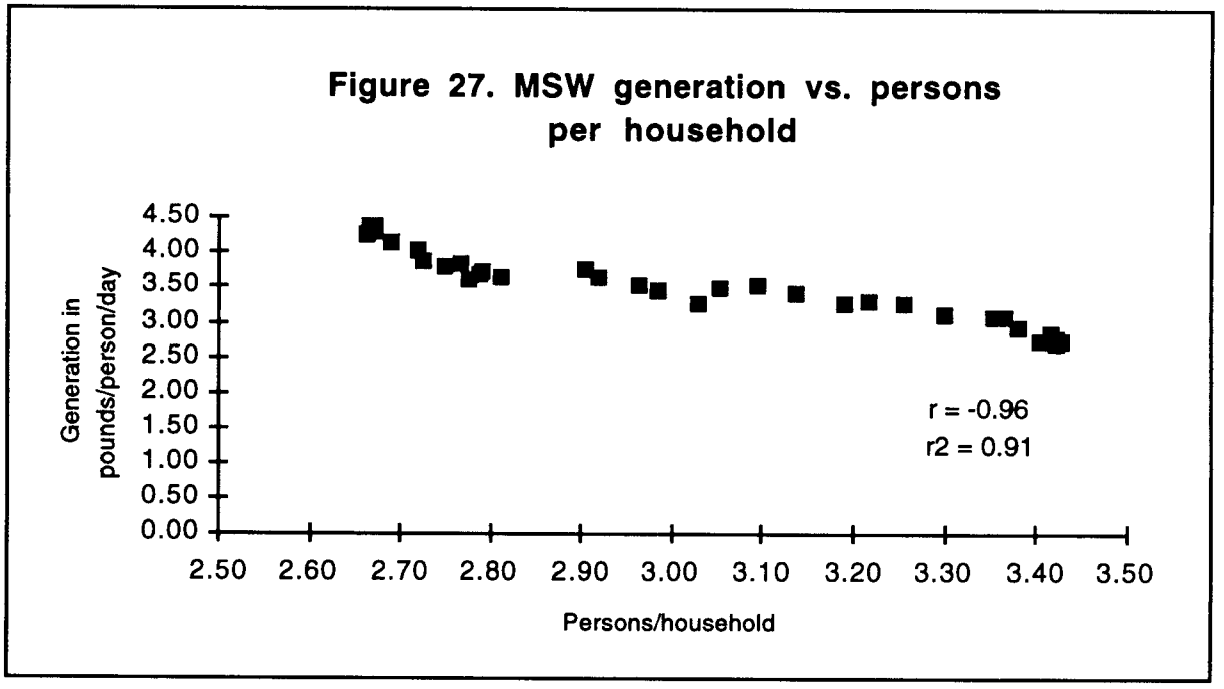
For a variety of reasons, the average size of households has decreased more than 20 percent in the last 33 years, from 3.42 persons in 1960 to 2.67 persons in 1993. The Bureau of the Census and *American Demographics* project that the average household size will continue to drop to 2.4 by 2000, before starting to increase again.* Bureau of the Census data on household size was correlated with data on per capita MSW generation from this report to illustrate the possible effects of household size on generation.

The smaller households have resulted in higher per capita consumption rates for several products that end up in the waste stream. Certain items of the waste stream, such as newspapers, appliances, furniture, and yard trimmings

* *American Demographics*. August 1994.

would be expected to relate more closely to the number of households than to population. For example, households with one or two persons generally read the same newspapers and have the same number of appliances as larger households.

Figure 27 shows how the per capita MSW generation decreases with increasing household size. The correlation coefficient is -0.955 (r^2 = 0.91). Generation and average household size are shown as a function of time in Figure 28. As expected, per capita generation is seen to rise as household size decreases. Figure 29 shows that in spite of the decreasing household size, the amount of MSW generated per household has continued to increase, but not as rapidly as per capita generation. (The correlation between generation in pounds per household per day and persons per household is weaker than the correlation between generation in pounds per person per day and persons per household.)



These data appear to indicate that household size is one factor leading to increased per capita generation of MSW. Many other factors have been suggested, such as increased use of paper in offices, more kinds of products available to consumers, and changes in workforce patterns, but correlations for these and other factors were not attempted for this report.

Figure 28. MSW generation per person and household size

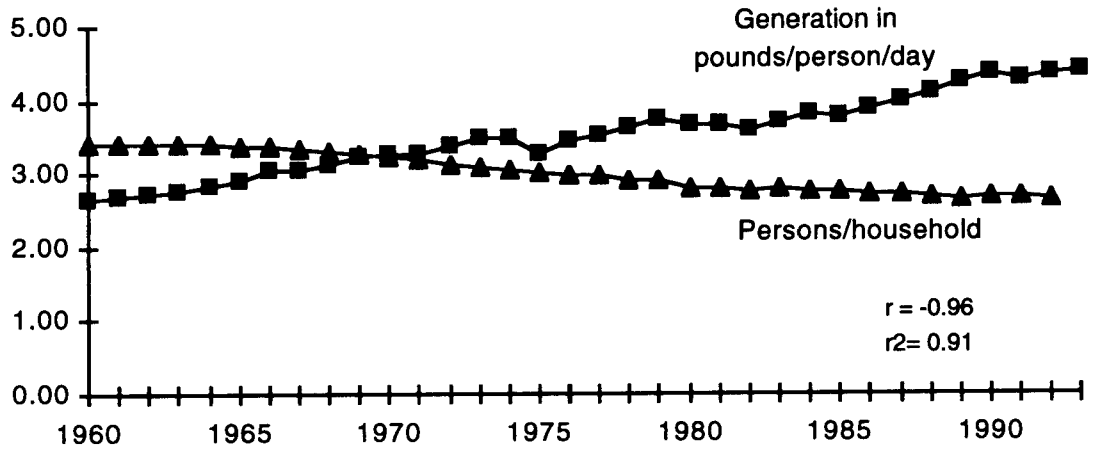
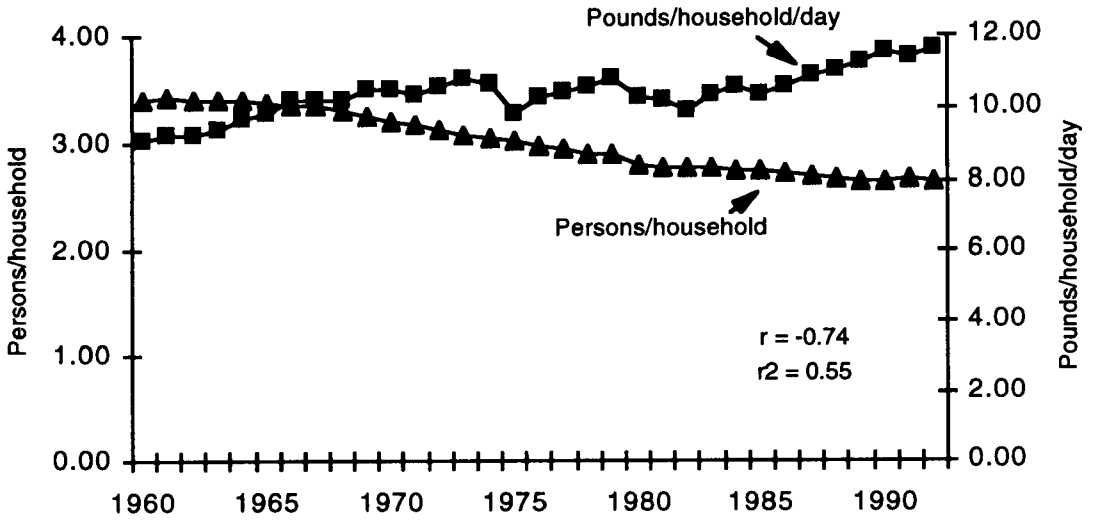


Figure 29. MSW generation per household and household size



Chapter 6

CHARACTERIZATION OF MUNICIPAL SOLID WASTE BY VOLUME

INTRODUCTION

Solid waste is generally characterized by weight, either in pounds or tons. Most statistics are compiled by weight. Landfill and combustion facility operators generally charge fees by weight, and estimates of quantities are stated in tons. The remainder of this report uses tons or thousands of tons to specify the quantity of municipal solid waste (MSW). Weight can be readily and rapidly measured with a set of scales. People agree that properly calibrated scales will accurately measure weight, but there is no agreed-upon method for measuring volume.

It has been realized for many years, however, that the space occupied by waste is also important. Landfills do not get overweight; instead, their space fills up. It is useful to quantify MSW by cubic yards of space occupied, but volume measurements are far more complex to make than weight measurements. Volume measurements are very contextual. A pound of paper is a pound of paper no matter whether it is in flat sheets, crumpled into a wad, or compacted into a bale. However, the *volume* occupied will be very different in each case. Perhaps the one-pound wad of paper will occupy as much as ten times the volume of a pound of baled paper.

Another problem with volume measurement of MSW is the difficulty in establishing a typical set of environmental conditions to serve as a basis for comparison. We may agree that volumes of MSW in landfills are of interest, but the difficulty arises as to how to define typical landfill conditions. Every waste management system treats waste differently, and achieves different levels of compaction and therefore different volumes for different materials. The waste also degrades with time. As waste remains in a landfill, biochemical reactions occur and many of the organic materials are converted to gases. The moisture conditions will also change with time. This makes it extremely difficult to devise a set of standard environmental conditions to serve as a basis for volume measures.

To begin the process of determining a scientific basis for decision-making, a set of volume factors for MSW was developed. While it is difficult to attain a high degree of accuracy in volume measurements because of the complexity of the problem, a reasonable approach can shed light on the volume issue.

Because of the desirability of establishing a national consensus on solid waste volumes, a series of measurements were taken in 1989 to present for the first time a methodology for measuring volumes and to generate a preliminary

set of data (1). This chapter is based in part on the results reported in that reference.

METHODOLOGY AND EXPERIMENTAL PROGRAM

As described in the 1990 EPA MSW characterization report (2), the basic approach was to set up an experimental program to develop a set of landfill density factors for solid waste components, measured in pounds per cubic yard. The MSW weight data reported in thousands of tons (from Chapter 2 of this report) were converted to thousands of pounds, and the MSW volume in thousands of cubic yards was calculated by dividing the weight values by the density (in pounds per cubic yard).

The experimental program was developed in cooperation with The Garbage Project, administered as a part of the Department of Anthropology, Bureau of Applied Research in Anthropology, The University of Arizona, located in Tucson. They are experienced in landfill sampling and in volume measurement. They use a specially constructed machine that can compact MSW samples so as to replicate landfill conditions.

For purposes of conducting experiments, paper was separated into four broad categories based on similarities of compaction behavior. Plastics were also separated into four categories, with another category for composite mixtures of paper and plastics. The nine categories are listed below (no other materials categories were segregated):

- Nonpackaging paper (paper plates, tissues, towels, mail, newspapers, magazines, books, forms, greeting cards, etc.)
- Corrugated boxes
- Paperboard boxes (food boxes, detergent boxes, milk cartons, six-pack wraps, etc.)
- Other paper and paperboard packaging (bags, wrapping paper, towel rolls, molded pulp egg cartons, cups, hinged fast food containers, cigarette wrappers, etc.)
- Plastic film packaging (bags, wrappers, food wrap films, wet-wipes packs, bubble packaging, condiment packs, etc.)
- Plastic rigid containers (bottles, jars, tubs and lids, microwave trays, hard cosmetic cases, bottle basecups, etc.)
- Other plastic packaging (cookie trays, six-pack ring holders, flexible tubes, polystyrene foam packaging, etc.)

- Nonpackaging plastic (cups, tumblers, eating utensils, pens, razors, toys, food serving trays, hangers, sponges, etc.)

- Composite mixtures of paper and plastic (blister packs, juice concentrate containers, composite cans, diapers, etc.)

A central part of the methodology was to retrieve materials from landfills after they had experienced the actual conditions of the solid waste system. Landfill excavations were made at the Los Reales landfill in Tucson in June 1989. Samples were sorted and compressed, and density measurements were recorded by The Garbage Project staff. The results of these experiments and analysis of the data resulted in a set of density factors for the paper and plastic products.

DENSITY FACTORS FOR LANDFILLED MATERIALS

Data Sources

Best estimates of the density of 24 important categories of waste, reported in pounds per cubic yard as compacted in landfills, are summarized in Table 41. The paper and plastic densities are the result of the experimental efforts described above. The values for other materials are based on prior work by The Garbage Project, other literature sources, and other experiments performed at Franklin Associates. In some cases, estimates were made based on behavior of similar materials. References for the origins of each density value are included in Table 41.

Uncertainties in Density Factor Estimates

Problems With Experimental Values. Measuring densities of various waste products under conditions designed to simulate those in a landfill can result in data that may be useful but, at the same time, potentially misleading. As previously mentioned, conditions in different landfills vary significantly including the equipment and techniques used in compaction, refuse depths, and other factors. Of perhaps greatest concern, however, is the fact that experimentally derived densities are based on compaction of individual waste materials. In a landfill, wastes are mixed together and the materials become intermingled. This intermingling tends to reduce void space that may be present with a single material. For example, fine materials will, at least partially, fill the voids between cans and bottles and other waste products that are not completely flattened in a landfill. As a result, the relative landfill space occupied by these products is less than would be indicated by densities determined from compaction tests. The aforementioned compaction tests on rigid plastic containers, for instance, would have led to density calculations that included all void space between the containers. Since some of these voids would be filled with other materials in a landfill, the landfill density of plastic containers would be higher than indicated by the tests (assuming equal compaction characteristics).

Accordingly, the landfill space occupied by the containers would be less than calculated from the compaction tests density.

Durable Goods. Densities of durable goods present a particular problem, since no experimental values are available. Where it was necessary to include densities of durable products, they were assigned the average density of nondurable products that have the same densities (e.g., metals, plastics). A composite density is shown in Table 41.

Table 41

SUMMARY OF ESTIMATED DENSITY FACTORS FOR LANDFILLED MATERIALS

	Density (lb/cu yd)	References*
DURABLE GOODS**	475	12
NONDURABLE GOODS		
Nondurable paper	800	1
Nondurable plastic	315	1
Disposable diapers†		
Diaper materials	795	4
Urine and feces	1,350	13
Rubber	345	5
Textiles	435	6
Misc. nondurables (mostly plastics)	390	11
PACKAGING		
Glass containers		
Beer & soft drink bottles	2,800	5, 9
Other containers	2,800	5, 9
Steel Containers		
Beer & soft drink cans	560	5
Food cans	560	5
Other packaging	560	5
Aluminum		
Beer & soft drink cans	250	9, 10
Other packaging	550	9
Paper and Paperboard		
Corrugated	750	1
Other paperboard	820	1
Paper packaging	740	1
Plastics		
Film	670	1
Rigid containers	355	1
Other packaging	185	1, 11
Wood packaging	800	6
Other miscellaneous packaging	1,015	3
FOOD WASTES	2,000	5
YARD TRIMMINGS	1,500	7, 8

* References are listed at the end of this chapter.

** No measurements were taken for durable goods or plastic coatings.

Plastic Coatings. Plastic coatings applied to packaging and other products present another special case. These coatings do not act as materials in their own right, but take on the characteristics of the products on which they are applied. Their density was also assumed to be the same as the average density of other products.

VOLUME OF PRODUCTS DISCARDED

The estimated volume of product discards in cubic yards (Table 42) was derived from Chapter 2 and Table 41. (It is necessary to characterize the volume of MSW *discards* rather than generation because the weight discard estimates most closely match the wastes received at a landfill, where the experimental data were derived. Discards include the waste left after materials recovery and composting and before combustion, landfilling, or other disposal.) The weight values from Tables 14, 17, and 22 are shown in the first column of Table 42, with the volumes being calculated by taking the weight values, converting to pounds, and dividing by the density (in pounds per cubic yard) from Table 41. The results are reported in Table 42 as volume in thousands of cubic yards of waste on a landfill volume basis for the individual products. The data in Table 42 are summarized by product categories in Figure 30 and Table 43.

The data in Table 42 may be useful in comparing the relative volumes of products in a landfill. However, the volumes shown for several products may be too high for the reasons indicated previously. The landfill density shown for total MSW discards is below those usually achieved in landfills receiving MSW, as demonstrated later in this chapter. This is further evidence that at least some of the product densities shown in Table 42 are too low and corresponding volume estimates too high.

Total landfill volume shown in Table 42 for 1993 MSW discards is judged to be higher than actual for two reasons. First, not all MSW discards were landfilled (e.g., some were combusted) and, second, total MSW densities in landfills appear to be higher than shown. (When estimating landfill volumes, however, cover material requirements must be considered as well.)

Table 42

ESTIMATED VOLUME OF PRODUCTS DISCARDED IN MSW, 1993

	1993 Discards* (thousand tons)	Weight (% of total)	Landfill Density** (lb/cu yd)	Landfill Volume*** (thousand cu yd)	Volume (% of total)
DURABLE GOODS	27,860	17.2%	475	117,305	27.0%
NONDURABLE GOODS					
Newspapers	7,020	4.3%	800	17,550	4.0%
Books	830	0.5%	800	2,075	0.5%
Magazines	2,050	1.3%	800	5,125	1.2%
Office papers	4,520	2.8%	800	11,300	2.6%
Telephone books	680	0.4%	800	1,700	0.4%
Third class mail	3,470	2.1%	800	8,675	2.0%
Other commercial printing	4,380	2.7%	800	10,950	2.5%
Tissue paper and towels	3,010	1.9%	800	7,525	1.7%
Paper plates and cups	830	0.5%	800	2,075	0.5%
Plastic plates and cups	330	0.2%	355	1,859	0.4%
Trash bags	890	0.5%	670	2,657	0.6%
Disposable diapers					
Diaper materials	934	0.6%	795	2,350	0.5%
Urine and feces	1,766	1.1%	1,350	2,616	0.6%
Subtotal diapers	2,700	1.7%	—	4,966	1.1%
Other nonpackaging paper	4,770	2.9%	800	11,925	2.7%
Clothing and footwear	3,710	2.3%	435	17,057	3.9%
Towels, sheets & pillowcases	600	0.4%	435	2,759	0.6%
Other misc. nondurables	3,510	2.2%	390	18,000	4.1%
Total Nondurable Goods	43,300	26.7%	686	126,198	29.1%
CONTAINERS AND PACKAGING					
Glass Packaging					
Beer and soft drink	3,840	2.4%	2,800	2,743	0.6%
Wine and liquor	1,400	0.9%	2,800	1,000	0.2%
Food and other bottles & jars	3,980	2.5%	2,800	2,843	0.7%
Total Glass Packaging	9,220	5.7%	2,800	6,586	1.5%
Steel Packaging					
Beer and soft drink cans	30	0.02%	560	107	0.0%
Food and other cans	1,420	0.9%	560	5,071	1.2%
Other steel packaging	150	0.1%	560	536	0.1%
Total Steel Packaging	1,600	1.0%	560	5,714	1.3%
Aluminum Packaging					
Beer and soft drink cans	590	0.4%	250	4,720	1.1%
Other cans	40	0.02%	250	320	0.1%
Foil and closures	300	0.2%	550	1,091	0.3%
Total Aluminum Pkg	930	0.6%	303	6,131	1.4%
Paper & Paperboard Pkg					
Corrugated boxes	11,730	7.2%	750	31,280	7.2%
Milk cartons	470	0.3%	820	1,146	0.3%
Folding cartons	4,240	2.6%	820	10,341	2.4%
Other paperboard packaging	300	0.2%	820	732	0.2%
Bags and sacks	1,850	1.1%	740	5,000	1.2%
Wrapping paper	70	0.04%	800	175	0.0%
Other paper packaging	1,100	0.7%	740	2,973	0.7%
Total Paper & Board Pkg	19,760	12.2%	765	51,647	11.9%

(continued on next page)

Table 42 (continued)

ESTIMATED VOLUME OF PRODUCTS DISCARDED IN MSW, 1993

	1993 Discards* (thousand tons)	Weight (% of total)	Landfill Density** (lb/cu yd)	Landfill Volume*** (thousand cu yd)	Volume (% of total)
Plastics Packaging					
Soft drink bottles	330	0.2%	355	1,859	0.4%
Milk bottles	420	0.3%	355	2,366	0.5%
Other containers	1,840	1.1%	355	10,366	2.4%
Bags and sacks	1,030	0.6%	670	3,075	0.7%
Wraps	1,790	1.1%	670	5,343	1.2%
Other plastics packaging	2,360	1.5%	185	25,514	5.9%
Total Plastics Packaging	7,770	4.8%	320	48,523	11.2%
Wood packaging	8,140	5.0%	800	20,350	4.7%
Other misc. packaging	220	0.1%	1,015	433	0.1%
Total Containers & Packaging	47,640	29.4%	684	139,385	32.1%
Total Product Waste†	118,800	73.4%	621	382,888	88.2%
Other Wastes					
Food wastes	13,800	8.5%	2,000	13,800	3.2%
Yard trimmings	26,300	16.2%	1,500	35,067	8.1%
Miscellaneous inorganics	3,050	1.9%	2,500	2,440	0.6%
Total Other Wastes	43,150	26.6%	1,682	51,307	11.8%
TOTAL MSW DISCARDED	161,950	100%	746 ‡	434,195 ‡	100%

* From Tables 14, 17, and 22. Discards after materials recovery and composting, before combustion and landfilling.

** From Table 41.

*** This assumes that all waste discards are landfilled, but some are combusted.

† Other than food products.

‡ This density factor and volume are derived by adding the individual factors. Actual landfill density and densities of certain products may be considerably higher than shown (see discussion in text).

Source: Franklin Associates, Ltd.

Figure 30. Landfill volume of MSW product categories, 1993 (In percent of total)

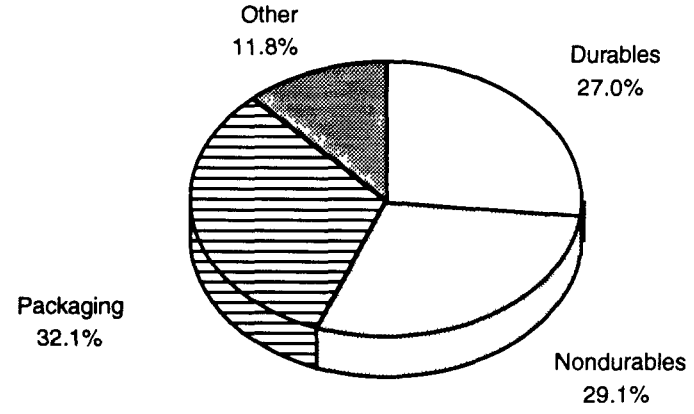


Table 43

SUMMARY OF ESTIMATED VOLUME OF PRODUCTS DISCARDED* IN MSW, 1993
(In percent of total)

	Percent by Weight*	Percent by Volume**
Durable Goods	17.2%	27.0%
Nondurable Goods	26.7%	29.1%
Containers and Packaging	29.4%	32.1%
Food Wastes	8.5%	3.2%
Yard Trimmings	16.2%	8.1%
Miscellaneous Inorganics	1.9%	0.6%
Total Discards	100%	100%

* Discards after materials recovery and composting, before combustion and landfilling.
** From Table 42.
Details may not add to totals due to rounding.
Source: Franklin Associates, Ltd.

VOLUME OF MATERIALS

These same data are reported by material rather than by product in Table 44 and Figure 31. The values are ranked by estimated landfill volume occupied, with the most voluminous materials listed first. Paper is shown to occupy the most volume, at about 30 percent of the total. This is followed by plastics, at 24 percent of the total.

The right-hand column of Table 44 presents the ratio of volume percent to weight percent for each material category. A ratio of 1.0 means that the material occupies the same proportion of volume as weight. Values greater than 1.0 mean that a larger proportion of volume is occupied than weight. Four materials stand out as having ratios of approximately 2.0 or greater: plastics, rubber and leather, textiles, and aluminum. On the other hand, yard trimmings, food, and glass each have ratios of 0.5 or less, illustrating that these materials are quite dense and occupy proportionately less volume in landfills.

Estimated landfill volumes by material are compared for 1990 and 1993 MSW discards in Table 45. Plastics are shown to be increasing in percentage of landfill volume occupied while certain other materials such as yard trimmings are declining.

Again, caution is advised when using the data in Tables 44 and 45 and Figure 31. In particular, the volume estimates shown for the experiment-determined low density materials should be considered questionable. The landfill volume of these materials relative to other MSW discards is probably lower than shown.

Table 44

ESTIMATED VOLUME OF MATERIALS DISCARDED IN MSW, 1993

	1993 Discards* (thousand tons)	Weight* (% of MSW total)	Landfill Density** (lb/cu yd)	Landfill Volume*** (thousand cu yd)	Volume (% of MSW total)	Ratio (vol %/ wt%)
Paper & Paperboard	51,380	31.7	784	131,071	30.2	1.0
Plastics	18,620	11.5	359	103,733	23.9	2.1
Yard Trimmings	26,300	16.2	1,500	35,067	8.1	0.5
Ferrous Metals	9,560	5.9	560	34,143	7.9	1.3
Rubber & Leather	5,850	3.6	346	33,815	7.8	2.2
Wood	12,370	7.6	840	29,452	6.8	0.9
Textiles	5,410	3.3	400	27,050	6.2	1.9
Food Wastes	13,800	8.5	2,000	13,800	3.2	0.4
Aluminum	1,920	1.2	366	10,492	2.4	2.0
Glass	10,660	6.6	2,268	9,400	2.2	0.3
Other†	6,080	3.8	2,000	6,080	1.4	0.4
Totals	161,950	100.0	746 ‡	434,103 ‡	100.0	1.0

* From Table 3. Discards after materials recovery.

** Composite factors derived by Franklin Associates, Ltd.

*** This assumes that all waste discards are landfilled, but some are combusted.

† Found by difference to obtain total to match products table. Note: Results in this table and Table 42 are not identical due to rounding differences.

‡ This density factor and volume are derived by adding the individual factors. Actual landfill density and densities of certain materials may be considerably higher than shown (see discussion in text).

Source: Franklin Associates, Ltd.

Figure 31. Landfill volume of materials in MSW, 1993 (In percent of total)

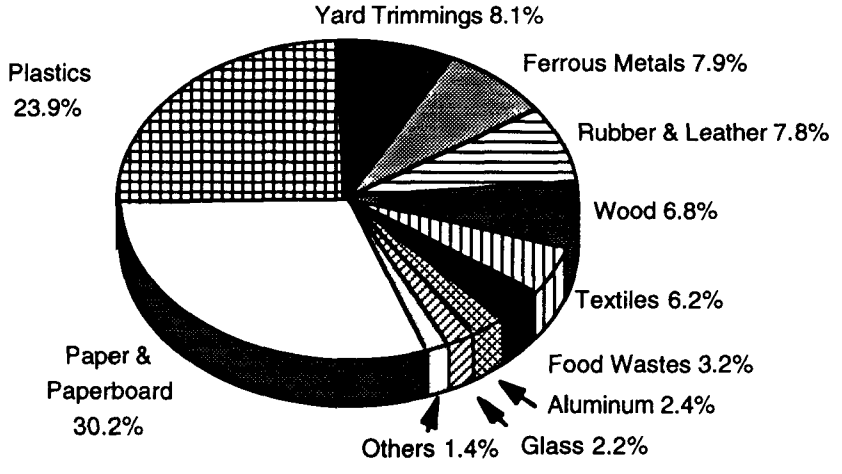


Table 45

ESTIMATED WEIGHT AND VOLUME OF MATERIALS DISCARDED IN MSW, 1990 AND 1993

(in percent of total)

	1990		1993	
	Weight* (% of MSW total)	Volume** (% of MSW total)	Weight* (% of MSW total)	Volume** (% of MSW total)
Paper & Paperboard	31.7	30.9	31.7	30.2
Plastics	10.0	21.2	11.5	23.9
Yard Trimmings	18.7	9.5	16.2	8.1
Ferrous Metals	6.5	8.8	5.9	7.9
Rubber & Leather	3.4	7.5	3.6	7.8
Wood	7.2	6.6	7.6	6.8
Textiles	3.6	6.8	3.3	6.2
Food Wastes	8.0	3.0	8.5	3.2
Aluminum	1.1	2.3	1.2	2.4
Glass	6.4	2.1	6.6	2.2
Other†	3.5	1.3	3.8	1.4
Totals	100.0	100.0	100.0	100.0

* From Table 3. Discards after materials recovery.

** Volume estimates based on MSW weights and densities shown in previous tables.

† Found by difference to obtain total to match products table.

Source: Franklin Associates, Ltd.

VALIDITY OF RESULTS

As previously indicated, the density and volume data presented in this chapter are of questionable accuracy. The density values in Table 41 are based on sorted MSW materials. Later tests conducted by The Garbage Project indicated that mixing wastes results in higher composite densities than those attained with sorted waste materials. The intermingling of different materials with different characteristics, as occurs in a landfill, results in filling more air space than if the materials were landfilled individually (or apart from each other). For example, mixing one cubic yard of paper with one cubic yard of plastic results in less than two cubic yards of material.

The mixing effect is believed to have a more pronounced impact on measured densities and volumes of cans, plastic containers and a few other waste products. In a landfill, more finely divided materials will tend to fill the voids between these items. Thus, the occupied volume of these items in a landfill will be less than would be measured through an individual material/product compaction test.

At best, the data in the tables and figures in this chapter may provide an indication of the relative order of densities and volumes of the various waste components in a landfill. However, it is anticipated that the spread between the higher and lower density components will be less than indicated. In particular, the materials shown to have the highest ratios of volume to weight probably use less landfill space than indicated.

REPORTED LANDFILL DENSITIES

Densities achieved in landfills that accept MSW are reported to vary between 700 and 1,600 pounds per cubic yard (14). A minimum initial compaction density of 1,000 pounds per cubic yard is sometimes recommended in landfill operator training courses (14). As landfill depth increases, the density of the waste increases. The maximum density of solid waste in a landfill under overburden pressure is reported to vary from 1,750 to 2,150 pounds per cubic yard (15).

The calculated landfill densities shown in Tables 42 and 44 for total MSW discards are about 740 pounds per cubic yard. Higher densities are found in other solid wastes disposed in landfills including industrial process wastes and construction and demolition debris. However, quantities of other wastes in landfills accepting MSW are usually small by comparison. The MSW discards density would, therefore, need to be higher than shown here in order to achieve the landfill densities generally reported today.

Chapter 6

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Chapter 7

COMPARISON OF MSW ESTIMATES

INTRODUCTION

As explained in Chapter 1, there are two basic methodologies for estimating quantities and composition of MSW:

- The material flows approach used in this report
- Sampling, sorting, and weighing of waste on-site.

Both methodologies have validity; both must be used with care if they are to be effective for solid waste management purposes.

This chapter compares the MSW estimates in this report with other estimates from two perspectives. First, the estimates in the current report are compared with previous material flows estimates. Second, the estimates in the current report are compared with some of the estimates made by on-site sampling studies.

COMPARISON WITH PREVIOUS MATERIAL FLOWS STUDIES

The material flows methodology has been evolving for about 20 years. Over the years increasing levels of detail have been added as new data became available and as new funding from public and private sources allowed more complete analyses of the materials and products in MSW. For example, generation of some products—e.g., disposable diapers—was insignificant in the early 1970s when the methodology was first being developed. Many new types of packaging also have come into common use in the past two decades, and the current estimates include more detailed information on paper and plastic packaging than was available previously.

When changes have been made in the database, e.g., to account for additional products, the changes were generally—to the extent data were available—carried backward in the data series as well as being added to the recent years. This has been done to preserve the integrity of the data series by avoiding discontinuities in the database. (There are, however, some discontinuities introduced by the information sources.)

The last year for which MSW was characterized in the 1992 update was 1990. To highlight changes that have been made in this 1994 update, Table 46 was prepared. Overall, the estimate of MSW generation in 1990 has been increased by 1.2 percent, from 195.7 million tons of MSW to 198 million tons. A change in the

Table 46

COMPARISON OF THE 1992 AND THE 1994 ESTIMATES FOR 1990 MATERIALS GENERATION*
(In thousands of tons and percent)

Materials	Previous Estimate**	Current Estimate***	Percent Difference	Comments
Paper and paperboard	73,325	72,681	-0.9%	Revisions in data source. Changes in methodology.
Glass	13,182	13,184	0.0%	
Metals				
Ferrous	12,302	12,437	1.1%	Changes in tires methodology.
Aluminum	2,660	2,860	7.5%	Addition of small appliances.
Other nonferrous	1,209	1,103	-8.8%	Changes in battery methodology. Addition of small appliances.
Plastics	16,244	16,822	3.6%	Revisions in data series.
Rubber and leather	4,640	5,928	27.8%	Changes in tires methodology.
Textiles	5,584	6,450	15.5%	Revisions in data series.
Wood	12,313	12,313	0.0%	
Other†	3,173	3,147	-0.8%	Changes in battery methodology.
Total Nonfood Product Waste	144,632	146,925	1.6%	
Food wastes	13,200	13,200	0.0%	
Yard trimmings	35,000	35,000	0.0%	
Miscellaneous inorganic wastes	2,900	2,900	0.0%	
Total MSW Generated	195,732	198,025	1.2%	
Pounds per Person per Day	4.3	4.4	1.2%	

* Generation before recovery for recycling and composting.
** From worksheets for the July 1992 EPA MSW characterization report.
*** From worksheets prepared for this report.
† Includes part of materials in disposable diapers and lead-acid batteries.
Details may not add to totals due to rounding.
Source: Franklin Associates, Ltd.

methodology for estimating generation of rubber tires accounted for some of the increase, although there were adjustments in some other categories, as explained below.

As discussed in earlier chapters of this report, projections of MSW generation are done on a material-by-material and product-by-product basis. The projections are made using trend analysis, available reports from government (usually Department of Commerce) sources, industry sources, and in some instances, best professional judgment on the industries involved. Projections were updated for this 1994 report based on an additional three years of historical data.

A comparison of projections of MSW generation for the year 2000 as made for the 1992 update and for this report is shown in Table 47, with results discussed below.

Table 47

COMPARISON OF THE 1992 AND THE 1994 PROJECTIONS OF MATERIALS GENERATION IN 2000*
(In thousands of tons and percent)

Materials	Previous Estimate**	Current Estimate***	Percent Difference	Comments
Paper and paperboard	84,720	89,340	5.5%	More growth in paper products than anticipated.
Glass	13,484	14,022	4.0%	Previous decline in container generation reversed.
Metals				
Ferrous	12,050	14,220	18.0%	Change in tires methodology puts more steel in 1993 base.
Aluminum	3,572	3,426	-4.1%	
Other nonferrous	1,498	1,396	-6.8%	Addition of small appliances puts less metals in 1993 base.
Plastics	24,768	22,492	-9.2%	Trends reevaluated.
Rubber and leather	6,466	7,606	17.6%	Change in tires methodology puts more rubber in 1993 base.
Textiles	6,659	6,197	-6.9%	Trends reevaluated.
Wood	16,015	16,011	0.0%	
Other†	3,655	3,538	-3.2%	Change in battery methodology puts less electrolytes in 1993 base.
Total Nonfood Product Waste	172,887	178,248	3.1%	
Food wastes	13,200	14,000	6.1%	Trends reevaluated.
Yard trimmings	32,900	22,200	-32.5%	Source reduction practices.
Miscellaneous inorganic wastes	3,100	3,300	6.5%	Trends reevaluated.
Total MSW Generated	222,087	217,748	-2.0%	
Pounds per Person per Day	4.5	4.4	-2.0%	

* Generation before any materials recovery.
** From worksheets for the July 1992 EPA MSW characterization report.
*** From worksheets prepared for this report.
† Includes part of materials in disposable diapers and lead-acid batteries.
Details may not add to totals due to rounding.
Source: Franklin Associates, Ltd.

Paper and Paperboard

The methodology for estimating generation and recovery of paper and paperboard products was revised to better account for generation and recovery of converting scrap (preconsumer waste). In earlier versions of this report, it was assumed that all converting scrap was recovered. For this report, converting scrap recovery rates as developed for the Recycling Advisory Council were used. These rates range from 70 percent to 98 percent of converting scrap. The recovered converting scrap was subtracted from total recovered paper to obtain postconsumer recovery. The unrecovered converting scrap was added to MSW generation of the appropriate paper grades. This has the effect of increasing generation of paper and paperboard in MSW.

In spite of these adjustments, estimates of generation of paper and paperboard in 1990 declined. This is because the data source for new supply (production plus imports minus exports) of paper grades (the American Forest & Paper Association) revised its estimates for 1990 downward.

At the time projections for paper and paperboard generation in 2000 were made in 1992, it was thought that some decreases in growth rates due to source reduction would occur. At this time, however, production of the corrugated and printing-writing grades (the two grades with the most significant production) continues to increase rapidly. Therefore, the projections of paper and paperboard generation in 2000 were increased compared to the projections made in 1992.

Metals

Some significant changes were made affecting metals generation. The methodology for estimating rubber tires was revised, with the result that estimates of rubber tire generation in 1990 were increased. Since there is steel in rubber tires, this had the effect of increasing the estimates of ferrous metals in MSW. Also, small appliances were added as a line item, which caused a recalculation of the materials allocation in the remaining miscellaneous durable goods. This had the effect of increasing estimates of aluminum in MSW. The methodology for estimating generation of lead-acid batteries was also revised; this had the effect of lowering estimates of other nonferrous metals (lead).

The projections of these metals were revised to account for these changes in estimates of metals generation.

Glass

Generation of glass had been declining when the 1992 update was completed. This trend has reversed itself somewhat since 1992, with production of glass containers increasing again. Therefore, glass generation for 2000 was projected to increase slightly rather than declining.

Plastics

Plastics generation continues to grow, but based on recent trends, the rate of growth for plastics between 1993 and 2000 was decreased somewhat compared to the estimates made in 1992.

Rubber and Leather

The methodology for estimating generation of rubber tires was revised because the Department of Commerce database used previously was discontinued. A methodology based on sales of replacement tires and deregistrations of automobiles was substituted. This had the effect of increasing

the estimated generation of rubber tires (and rubber) significantly. Projections of generation of rubber and leather were adjusted accordingly.

Textiles

The statistics used for estimating textiles generation in clothing and other products tend to fluctuate widely. This caused estimates of textiles generation in 1990 to be increased.

Food Wastes

Generation of food wastes in 2000 was projected to be somewhat higher than that projected in 1992. The per capita generation of food wastes (including some allowance for composting at home) is projected to be lower than per capita generation in 1990.

Yard Trimmings

As discussed in other chapters of this report, the projection of yard trimmings generation was reduced substantially.

COMPARISON WITH ESTIMATES MADE BY SAMPLING STUDIES

Comparison of estimates made by the material flows methodology with estimates made by sampling and weighing MSW are of interest, but must be approached with caution. For one thing, the waste stream sampled in any particular study may not be comparable to the mix of products included in the material flows methodology. For example, industrial waste is often included in waste received and sampled at a landfill or transfer station. Seasonal variations in the waste stream may also affect the results of a sampling study.

Another important factor to consider when comparing results is moisture transfer among materials in wastes as they are collected. The material flows methodology characterizes wastes in their as-generated condition. That is, moisture in disposable diapers is accounted for, and estimates of food wastes and yard trimmings have been adjusted to include the moisture inherent in the discards. Wastes as sampled, however, have been mixed together prior to sampling, and the moisture in the wastes has been transferred among products. For example, paper products in MSW absorb large quantities of moisture from food wastes and yard trimmings, and the latter wastes thus contain less moisture than they did in their as-generated condition. This moisture transfer may significantly affect the relative weight percentages of the materials in MSW.

Municipal solid waste composition estimated by the material flows methodology is compared with composition estimated by sampling studies in Table 48. The sampling study results are presented in ranges; the first set represents the results of 16 studies as compiled by Franklin Associates, the second

Table 48

COMPARISON OF MSW DISCARDS BY MATERIAL FLOWS AND SAMPLING METHODOLOGIES
(In percent of total by weight)

Material	1993 Material Flows Estimate*	Range of 16 Sampling Studies**	Range of 9 Sampling Studies***	Range of 8 Sampling Studies†
Paper and paperboard	31.7	14.4 - 54.2	29.9 - 45.9	29.1 - 43.8
Glass	6.6	2.8 - 19.9	3.6 - 12.9	3.3 - 5.9
Metals	7.4	4.3 - 11.5	1.5 - 9.4	4.4 - 8.8
Plastics	11.5	4.9 - 9.7	5.3 - 12.6	6.3 - 10.2
Rubber, leather, textiles	6.9	1.9 - 5.9	1.1 - 7.2	3.2 - 5.6
Wood	7.6	0.8 - 12.9	0.7 - 8.2	4.5 - 15.1
Food wastes	8.5	5.1 - 19.3	1.3 - 28.8	6.5 - 9.8
Yard trimmings	16.2	3.5 - 30.9	0.0 - 39.7	5.1 - 19.8
Other	3.5	NA NA	3.8 - 16.6	NA NA

* Discards after recovery for recycling and composting.
** Compiled by Franklin Associates from a variety of sources. 1984-1988 time frame.
*** Office of Technology Assessment.
† Compiled by Franklin Associates from a variety of sources. 1987-1990 time frame.
NA - Not available.

set is taken from a recent Office of Technology Assessment report on MSW, and the third set is a more recent compilation made by Franklin Associates. For each material category, the percentage estimated by the material flows methodology falls within the range found in the sampling studies. (The sole exception is an "other" category, which is not well defined.)

It seems clear that both the material flows and sampling methodologies have valid uses in estimating municipal solid waste generation and discards. Whatever methodology is used, it is most important to be very clear as to what wastes are being measured and at what point in the solid waste management system the measurements are being taken.

Chapter 7

REFERENCES

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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 for 1970 through 1993, 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 postconsumer 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.

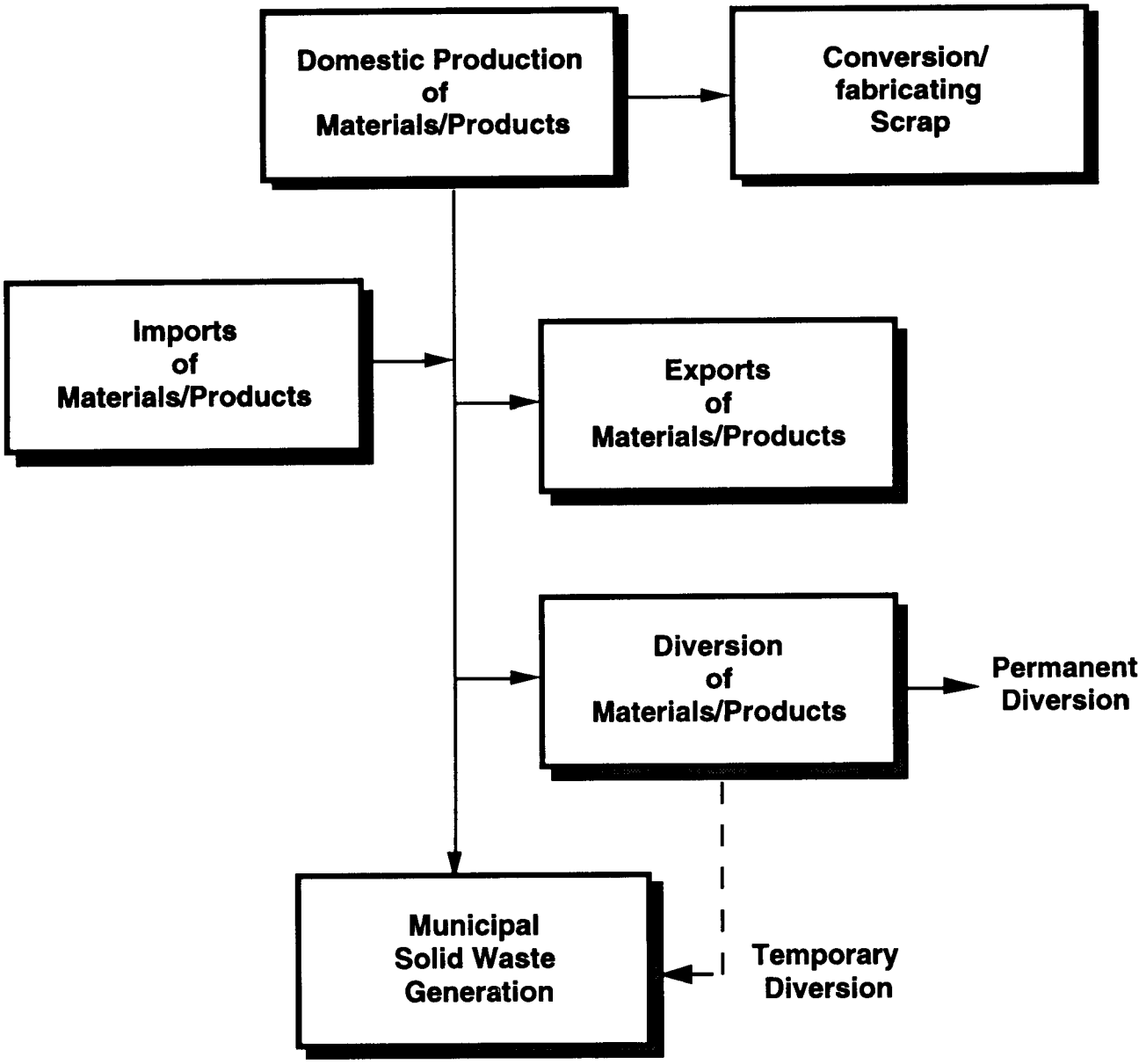

Figure A-1. Material flows methodology for estimating generation of products and materials in municipal solid waste.

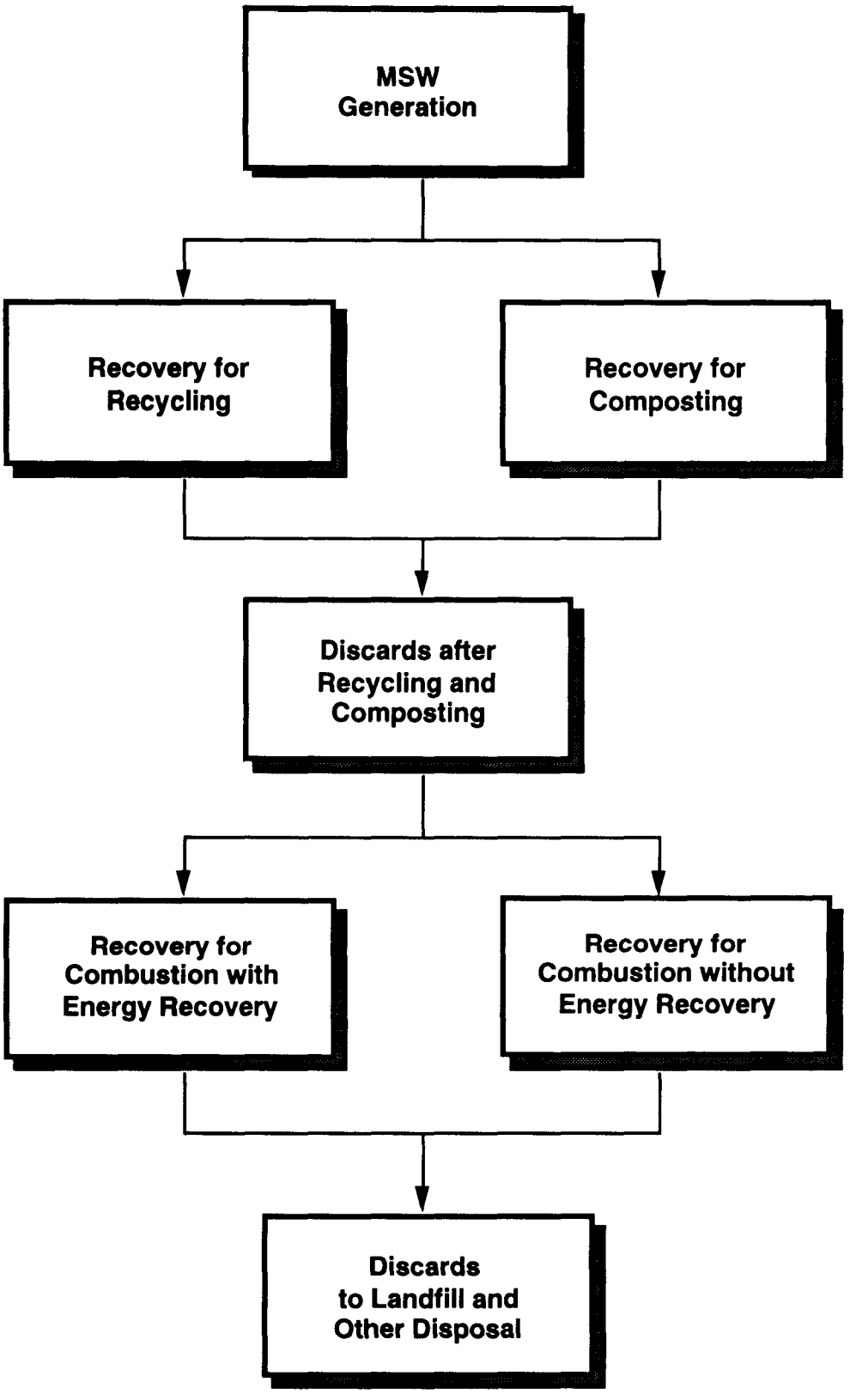

Figure A-2. Material flows methodology for estimating recovery and discards of municipal solid waste.

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

RECOVERY SCENARIOS FOR 2000

Because of the rapidly changing situation and uncertainty in the available data, projections of materials recovery were made in scenarios that could achieve different rates of recovery in 2000. Scenarios were developed for total MSW recovery rates of 25, 30, and 35 percent recovery rates in 2000. These scenarios are based on recovery of postconsumer MSW and do not include industrial scrap. Also, estimates for composting of food wastes and yard trimmings are including in these scenarios.

The recovery scenarios developed for this report describe sets of conditions that could achieve the selected range of recovery rates. The scenarios are not intended to predict exact recovery rates for any particular material; there are many ways in which a selected overall recovery rate could be achieved.

Discussion of Assumptions

Some general assumptions and principles were used in making the recovery estimates:

- Recovery includes both recovery for recycling and for composting.
- It was assumed that local, state, and federal agencies will continue to emphasize recycling and composting as MSW management alternatives.
- It was assumed that there will be no new deposit laws for beverage containers, but that the present state deposit laws will remain in place.
- It was assumed that affected industries will continue to emphasize recovery and recycling programs, and will make the necessary investments to achieve higher recycling rates.
- It was assumed that the current trend toward banning certain yard trimmings in landfills will continue, providing stimulus for composting programs and for source reduction of yard trimmings by citizens.
- Based on the preceding assumptions, most U.S. citizens will have access to recovery options in 2000, which will often, in fact, be mandated. These options will include curbside collection, drop-off and buy-back centers, and composting facilities. Recovery will continue to increase as more recovery systems come on-line.

- In spite of the factors encouraging more recovery as enumerated above, many areas of the U.S. are thinly populated and/or remote from ready markets for recovered materials; many of these areas also have adequate landfill capacity. Therefore, the overall recovery rate for the entire country may not reflect the rates achieved in communities where conditions are favorable for recycling and composting.

The ranges of projected recovery assumptions for the various materials in MSW are shown in Table B-1. Assumed recovery rates for 2000 were based on existing recovery rates in 1993, with projected growth that seemed reasonably achievable nationwide. Projections for each product in MSW were made separately, and the results were aggregated, with some minor adjustments to achieve the three selected scenarios for each year. Assumptions as to the projected recovery rates for specific products and materials were made in ranges. It is certainly possible (indeed, probable) that any given material will be recovered at higher or lower rates than those given here, but the scenarios illustrate how the selected recovery rates could be reached.

Table B-1

SCENARIOS FOR RECOVERY* OF MSW, 2000
(In thousands of tons and percent of generation)

Products	Generation	25% Recovery		30% Recovery		35% Recovery	
		Tons	%	Tons	%	Tons	%
Durable Goods							
Major Appliances (ferrous metals only)	3,036	1,518	50.0%	1,822	60.0%	2,125	70.0%
Rubber Tires (rubber only)	3,289	493	15.0%	658	20.0%	822	25.0%
Batteries, lead acid							
Nonferrous metals	938	891	95.0%	919	98.0%	919	98.0%
Plastics	88	79	90.0%	79	90.0%	84	95.0%
Misc. Durables (ferrous metals only)	5,135	411	8.0%	719	14.0%	924	18.0%
Other Durables	23,624	472	2.0%	945	4.0%	1,654	7.0%
Total Durable Goods	36,110	3,865	10.7%	5,142	14.2%	6,528	18.1%
Nondurable Goods							
Newspapers	14,400	7,488	52.0%	8,640	60.0%	9,360	65.0%
Books	1,180	236	20.0%	295	25.0%	354	30.0%
Magazines	3,000	840	28.0%	1,050	35.0%	1,200	40.0%
Office- type Papers	8,500	2,975	35.0%	3,825	45.0%	4,675	55.0%
Directories	870	131	15.0%	174	20.0%	218	25.0%
Third Class Mail	4,700	705	15.0%	940	20.0%	1,175	25.0%
Other Commercial Printing	6,400	1,280	20.0%	1,792	28.0%	2,240	35.0%
Textiles, Footwear	4,800	240	5.0%	480	10.0%	720	15.0%
Other Nondurables	18,910	95	0.5%	189	1.0%	378	2.0%
Total Nondurable Goods	62,760	13,989	22.3%	17,385	27.7%	20,320	32.4%
Containers and Packaging							
Glass Containers	12,400	3,844	31.0%	4,340	35.0%	5,208	42.0%
Steel Containers Pkg	3,000	1,500	50.0%	1,650	55.0%	2,100	70.0%
Aluminum Packaging	2,250	1,463	65.0%	1,575	70.0%	1,620	72.0%
Paper & Paperboard Packaging							
Corrugated Containers	31,000	17,360	56.0%	19,530	63.0%	21,080	68.0%
Other Packaging	9,490	664	7.0%	1,234	13.0%	1,613	17.0%
Total Paper & Board Pkg	40,490	18,024	44.5%	20,764	51.3%	22,693	56.0%
Plastics Packaging							
Soft Drink Bottles	617	278	45.0%	309	50.0%	339	55.0%
Milk Bottles	600	180	30.0%	210	35.0%	240	40.0%
Other Containers	3,184	796	25.0%	955	30.0%	1,114	35.0%
Other Plastics Packaging	5,399	135	2.5%	270	5.0%	540	10.0%
Total Plastics Packaging	9,800	1,389	14.2%	1,744	17.8%	2,234	22.8%
Wood Packaging	11,200	1,568	14.0%	1,680	15.0%	2,016	18.0%
Other Misc. Packaging	240	0	0.0%	0	0.0%	0	0.0%
Total Containers & Packaging	79,380	27,787	35.0%	31,752	40.0%	35,871	45.2%
Total Product Waste*	178,250	45,641	25.6%	54,279	30.5%	62,719	35.2%
Other Wastes							
Yard Trimmings†	22,200	8,880	40.0%	10,656	48.0%	12,210	55.0%
Food, Other	17,300	17	0.1%	519	3.0%	1,384	8.0%
TOTAL MSW	217,750	54,539	25.0%	65,454	30.1%	76,313	35.0%

* Does not include recovery for mixed waste composting.

** Other than food products.

† Yard trimmings substantially reduced in this scenario.

Details may not add to totals due to rounding.

Source: Franklin Associates, Ltd.

Appendix C

RESIDENTIAL/COMMERCIAL FRACTIONS OF MUNICIPAL SOLID WASTE

The material flows methodology does not lend itself well to a distinction as to sources of the materials because the data used are national in scope. For the 1992 MSW characterization update, a preliminary classification was made based on the best knowledge available at the time. For this 1994 update, some refinements were made to these estimates based on a recent report for Keep America Beautiful, which was extensively peer reviewed by representatives of both public and private organizations.

For purposes of this classification, residential waste was considered to come from both single family and multi-family residences. This is somewhat contrary to a common practice in MSW management to classify wastes collected from apartment buildings as commercial. The rationale used for this report is that the nature of residential waste is basically the same whether it is generated in a single or multi-family residence. (Yard trimmings are probably the primary exception, and this was taken into account.) Thus, the percentage of residential waste shown here is higher than that often reported by waste haulers.

Commercial wastes for the purpose of this classification include MSW from retail and wholesale establishments; hotels; office buildings; airports and train stations; hospitals, schools, and other institutions; and similar sources. No industrial process wastes are included, but normal MSW such as packaging, cafeteria and washroom wastes, and office wastes from industrial sources are included. Construction and demolition wastes, sludges, ashes, automobile bodies, and other wastes that may be landfilled along with MSW are not included.

The classification of MSW generation into residential and commercial fractions was made on a product-by-product basis, as shown in Table C-1. The 1993 tonnage generation of each product (from Chapter 2) was allocated to residential or commercial sources on a "best judgment" basis; then the totals were aggregated. Sampling studies were consulted where applicable, although available data on residential/commercial sorting of waste are limited. These are estimates for the nation as a whole, and should not be taken as representative of any particular region of the country.

While this appendix contains estimates for each component of MSW by source, there is substantial uncertainty associated with the individual estimates. For this reason, the report provides final estimates for commercial and residential MSW in a range, and encourages the use of this range rather than a point estimate. A reasonable range for residential wastes would be 55 to 65 percent of total MSW generation, while commercial wastes probably range between 35 to 45 percent of total generation.

Table C-1
WORKSHEET FOR ESTIMATES OF
RESIDENTIAL/COMMERCIAL FRACTIONS OF MSW, 1993

	1993 Generation	Residential		Commercial	
	Thousand tons	Percent	Tons	Percent	Tons
Durable Goods					
Major Appliances	3,430	10	343	90	3,087
Small Appliances	530	95	504	5	27
Furniture and Furnishings	7,020	80	5,616	20	1,404
Carpets and Rugs	2,130	80	1,704	20	426
Rubber Tires	3,410	5	171	95	3,240
Batteries, lead acid	1,670	5	84	95	1,587
Miscellaneous Durables	13,720	80	10,976	20	2,744
Total Durable Goods	**31,910**		19,397		12,514
Nondurable Goods					
Newspapers	12,940	85	10,999	15	1,941
Books	990	80	792	20	198
Magazines	2,500	65	1,625	35	875
Office Papers	7,120	25	1,780	75	5,340
Telephone Books	740	60	444	40	296
Third Class Mail	4,010	65	2,607	35	1,404
Other Commercial Printing	5,440	65	3,536	35	1,904
Tissue Paper and Towels	3,010	60	1,806	40	1,204
Paper Plates and Cups	830	20	166	80	664
Plastic Plates and Cups	350	20	70	80	280
Trash Bags	890	95	846	5	45
Disposable Diapers	2,700	90	2,430	10	270
Other Nonpackaging Paper	4,770	50	2,385	50	2,385
Clothing and Footwear	4,280	60	2,568	40	1,712
Towels, Sheets and Pillowcases	720	90	648	10	72
Other Miscellaneous Nondurables	3,510	50	1,755	50	1,755
Total Nondurable Goods	**54,800**		34,456		20,344
Containers and Packaging					
Glass Packaging					
Beer and Soft Drink Bottles	5,440	80	4,352	20	1,088
Wine and Liquor Bottles	1,850	80	1,480	20	370
Food and Other Bottles & Jars	4,940	85	4,199	15	741
Total Glass Packaging	**12,230**		10,031		2,199
Steel Packaging					
Beer and Soft Drink Cans	70	80	56	20	14
Food and Other Cans	2,720	85	2,312	15	408
Other Steel Packaging	190	5	10	95	181
Total Steel Packaging	**2,980**		2,378		603
Aluminum Packaging					
Beer and Soft Drink Cans	1,610	80	1,288	20	322
Other Cans	40	50	20	50	20
Foil and Closures	330	90	297	10	33
Total Aluminum Packaging	**1,980**		1,605		375

(continued on next page)

Table C-1 (continued)
WORKSHEET FOR ESTIMATES OF
RESIDENTIAL/COMMERCIAL FRACTIONS OF MSW, 1993

	1993 Generation	Residential		Commercial	
	Thousand tons	Percent	Tons	Percent	Tons
Paper & Paperboard Pkg					
Corrugated Boxes	26,350	10	2,635	90	23,715
Milk Cartons	470	50	235	50	235
Folding Cartons	4,940	60	2,964	40	1,976
Other Paperboard Packaging	300	50	150	50	150
Bags and Sacks	2,200	90	1,980	10	220
Wrapping Papers	70	90	63	10	7
Other Paper Packaging	1,100	70	770	30	330
Total Paper & Board Pkg	**35,430**		8,797		26,633
Plastics Packaging					
Soft Drink Bottles	560	80	448	20	112
Milk Bottles	550	95	523	5	28
Other Containers	1,930	80	1,544	20	386
Bags and Sacks	1,050	90	945	10	105
Wraps	1,820	80	1,456	20	364
Other Plastics Packaging	2,370	80	1,896	20	474
Total Plastics Packaging	**8,280**		6,812		1,469
Wood Packaging	9,460	0	0	100	9,460
Other Misc. Packaging	220	70	154	30	66
Total Containers & Pkg	**70,580**		29,776		40,804
Total Product Wastes	**157,290**		83,629		73,662
Other Wastes					
Food Wastes	13,800	50	6,900	50	6,900
Yard Trimmings	32,800	90	29,520	10	3,280
Miscellaneous Inorganic Wastes	3,050	50	1,525	50	1,525
Total Other Wastes	**49,650**		37,945		11,705
Total MSW Generated	**206,940**	59	**121,574**	41	**85,367**
Range		55 – 65		35 – 45	

Source: Franklin Associates, Ltd.

REFERENCES

Franklin Associates, Ltd. *The Role of Recycling in Integrated Solid Waste Management to the Year 2000.* Keep America Beautiful, Inc. September 1994.

U.S. Environmental Protection Agency. *Characterization of Municipal Solid Waste in the United States: 1992 Update.* EPA 530-R-92-019. July 1992.

United States
Environmental Protection
Agency

EPA530-R-94-042
November 1994

ERRATA SHEET

Characterization of Municipal Solid Waste in the United States: 1994 Update

Full Report

Page 4, third bullet, change to read:

Between 1990 and 1993, recovery of materials for recycling and composting increased from 33 million tons to 45 million tons, an increase of 37 percent.

Page 38, Table 6, under ***Containers and Packaging****, change to read:*

Beer and soft drink cans	70	40	57%	30

EPA

Solid Waste and
Emergency Response
(5305)