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Advancing Sustainable Materials Management: Facts and Figures 2013

Assessing Trends in Material Generation, Recycling and Disposal in the United States

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EXECUTIVE SUMMARY

Introduction

U.S. Environmental Protection Agency (EPA) has collected and reported data on the generation and disposal of waste in the United States for more than 30 years. We use this information to measure the success of waste reduction and recycling programs across the country. These facts and figures are current through calendar year 2013.

Formerly called *Municipal Solid Waste in the United States: Facts and Figures*, this report's new name emphasizes the importance of Sustainable Materials Management (SMM). The new name also reflects continuing efforts to expand, improve, and enhance the report with new information on source reduction (waste prevention), historical landfill tipping fees for municipal solid waste (MSW), and construction and demolition (C&D) debris generation.

EPA's 2009 report, *Opportunities to Reduce Greenhouse Gas Emissions through Materials and Land Management Practices*, shows that approximately 42 percent of U.S. greenhouse gas (GHG) emissions are associated with materials management. This includes the extraction or harvest of materials and food, production and transport of goods, provision of services, and end of life management. These GHG emissions can be reduced through materials recovery. In 2013, the 87 million tons of MSW recycled and composted provided an annual reduction of 186 million tons of carbon dioxide equivalent emissions, comparable to the annual emissions from over 39 million passenger cars.

As the new name for our annual report suggests, EPA is thinking beyond waste. We are transitioning from focusing on waste management to focusing on Sustainable Materials Management. SMM refers to the use and reuse of materials in the most productive and sustainable way across their entire life cycle. SMM conserves resources, reduces waste, slows climate change, and minimizes the environmental impacts of the materials we use.

In an era of limitless business ingenuity but limited resources, the sustainable management of natural capital is increasingly at the forefront of international dialogue about how to achieve economic growth without compromising human health and the environment upon which that growth depends. By looking across the life cycle, businesses can find opportunities that enhance and sustain their value proposition and reduce risk through sustainably managing materials.

According to the UN Environment Programme (UNEP), "Humans are consuming resources and producing waste at a greater scale than ever before and per capita consumption levels are projected to increase with continued development." For every 1 percent increase in GDP, resource use has risen 0.4 percent.[1] Data indicate that global material resource use during the 20th century rose at about twice the rate of population. The growth rate in materials use was still lower than the pace of growth of the world economy. Despite some decoupling of economic growth and materials use, questions remain about the extent to which economic and environmental policies have impacted this decoupling.[2] Nevertheless, resource use is still on a steep rise and this decoupling is insufficient to overcome the even higher demands we face in the future given projections around future world population growth,

economic growth and energy and material consumption.[3] The United States consumed 46 percent more materials on a per capita basis in the year 2000 than in 1975 (see Figure ES-1). In the global context, the total volume of material resources extracted or harvested worldwide reached nearly 60 billion metric tons per year in 2007, with nonrenewable resource extraction accounting for 60 percent of global extraction.[4] According to the World Resources Institute, "one half to three quarters of annual resource inputs to industrial economies is returned to the environment as wastes within just one year."[5]

While EPA is currently updating the *U.S. Recycling Economic Information (REI) Study* which is due out later this year, our 2001 study showed we have domestic capacity to process 2 billion pounds of soda bottles, yet currently we only collect 1.4 billion annually. And there is growing demand for more recycled plastic. The aluminum industry is eager for more aluminum cans – yet in the U.S. we dispose of nearly half of our cans, which by the way are valued at nearly $1 billion.[6] Glass recycling capacity exceeds supply. Paper recycling is available to 96 percent of Americans.[7] The structure is in place for steel can recycling. All of the materials collected are used in recycling, and the forecast is for this demand to increase.

Overview of Municipal Solid Waste

In the United States, we generated 254 million tons (U.S. short tons unless specified) of MSW in 2013—3 million tons more than generated in 2012. MSW generation in 2013 increased to 4.40 pounds per person per day. This is an increase of less than 1 percent from 2012 to 2013.

About 87 million tons of MSW were recycled and composted. Excluding composting, 65 million tons of MSW were recycled, similar to the tons recycled in 2012. The tons of food and yard trimmings recovered for composting were 22 million tons in 2013, an increase of 1 million tons compared to 2012. The recovery rate for recycling (including composting) was 34.3 percent in 2013, slightly lower than the 34.5 percent in 2012. (See Table ES-1.) The recycling rate in 2013 (including composting) was 1.51 pounds per person per day. This is 1.12 pounds per person per day for recycling and 0.39 pounds per person per day for composting.

Three materials whose recycling rates rose from 2012 to 2013 are yard trimmings, selected consumer electronics, and food. In 2013, the rate of yard trimmings composting was 60.2 percent (20.60 million tons), up from 57.7 percent (19.59 million tons). This translates to 130 pounds per person per year of yard trimmings composted in 2013. In 2013, the rate of selected consumer electronics recovery was 40.4 percent (1.27 million tons) up from 30.6 percent in 2012 (1.00 million tons). This translates to 8 pounds per person per year recovered in 2013. In 2013, the rate of food recovery was 5.0 percent (1.84 million tons), up from 4.8 percent in 2012 (1.74 million tons). This translates to 12 pounds per person per year composted in 2013. Over the last few years, EPA has been heavily invested in these areas.

Figures ES-1 and ES-2 show a decrease in MSW generation and an increase in recycling from 2000 to 2013. The state of the economy has a strong impact on consumption and waste generation. Waste generation increases during times of strong economic growth and decreases during times of economic decline.

Table ES-1. Generation, Materials Recovery, Composting, Combustion with Energy Recovery, and Discards of Municipal Solid Waste, 1960 – 2013

(In thousands of tons and percent of total generation)

	Thousands of Tons									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Generation	88,120	121,060	151,640	208,270	243,450	253,730	244,600	250,540	251,040	254,110
Recovery for recycling	5,610	8,020	14,520	29,040	53,010	59,240	61,890	66,400	65,240	64,740
Recovery for composting*	Neg.	Neg.	Neg.	4,200	16,450	20,550	20,750	20,570	21,330	22,440
Total Materials Recovery	5,610	8,020	14,520	33,240	69,460	79,790	82,640	86,970	86,570	87,180
Discards after recovery	82,510	113,040	137,120	175,030	173,990	173,940	161,960	163,570	164,470	166,930
Combustion with energy recovery**	0	400	2,700	29,700	33,730	31,620	29,010	31,800	32,200	32,660
Discards to landfill, other disposal†	82,510	112,640	134,420	145,330	140,260	142,320	132,950	131,770	132,270	134,270
	Pounds per Person per Day									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Generation	2.68	3.25	3.66	4.57	4.74	4.69	4.37	4.41	4.38	4.40
Recovery for recycling	0.17	0.22	0.35	0.64	1.03	1.10	1.10	1.17	1.14	1.12
Recovery for composting*	Neg.	Neg.	Neg.	0.09	0.32	0.38	0.37	0.36	0.37	0.39
Total Materials Recovery	0.17	0.22	0.35	0.73	1.35	1.48	1.47	1.53	1.51	1.51
Discards after recovery	2.51	3.03	3.31	3.84	3.39	3.21	2.90	2.88	2.87	2.89
Combustion with energy recovery**	0.00	0.01	0.07	0.65	0.66	0.58	0.52	0.56	0.56	0.57
Discards to landfill, other disposal†	2.51	3.02	3.24	3.19	2.73	2.63	2.38	2.32	2.31	2.32
Population (thousands)	179,979	203,984	227,255	249,907	281,422	296,410	307,007	311,592	313,914	316,129

	Percent of Total Generation									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Generation	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Recovery for recycling	6.4%	6.6%	9.6%	14.0%	21.8%	23.3%	25.3%	26.5%	26.0%	25.5%
Recovery for composting*	Neg.	Neg.	Neg.	2.0%	6.7%	8.1%	8.5%	8.2%	8.5%	8.8%
Total Materials Recovery	6.4%	6.6%	9.6%	16.0%	28.5%	31.4%	33.8%	34.7%	34.5%	34.3%
Discards after recovery	93.6%	93.4%	90.4%	84.0%	71.5%	68.6%	66.2%	65.3%	65.5%	65.7%
Combustion with energy recovery**	0.0%	0.3%	1.8%	14.2%	13.9%	12.5%	11.9%	12.7%	12.8%	12.9%
Discards to landfill, other disposal†	93.6%	93.1%	88.6%	69.8%	57.6%	56.1%	54.4%	52.6%	52.7%	52.8%

* Composting of yard trimmings, food and other MSW organic material. Does not include backyard composting.

** Includes combustion of MSW in mass burn or refuse-derived fuel form, and combustion with energy recovery of source separated materials in MSW (e.g., wood pallets and tire-derived fuel). 2013 includes 29,500 MSW, 510 wood, and 2,650 tires (1,000 tons)

† Discards after recovery minus combustion with energy recovery. Discards include combustion without energy recovery.

Details may not add to totals due to rounding.

Figure ES-1. MSW Generation Rates, 1960 to 2013

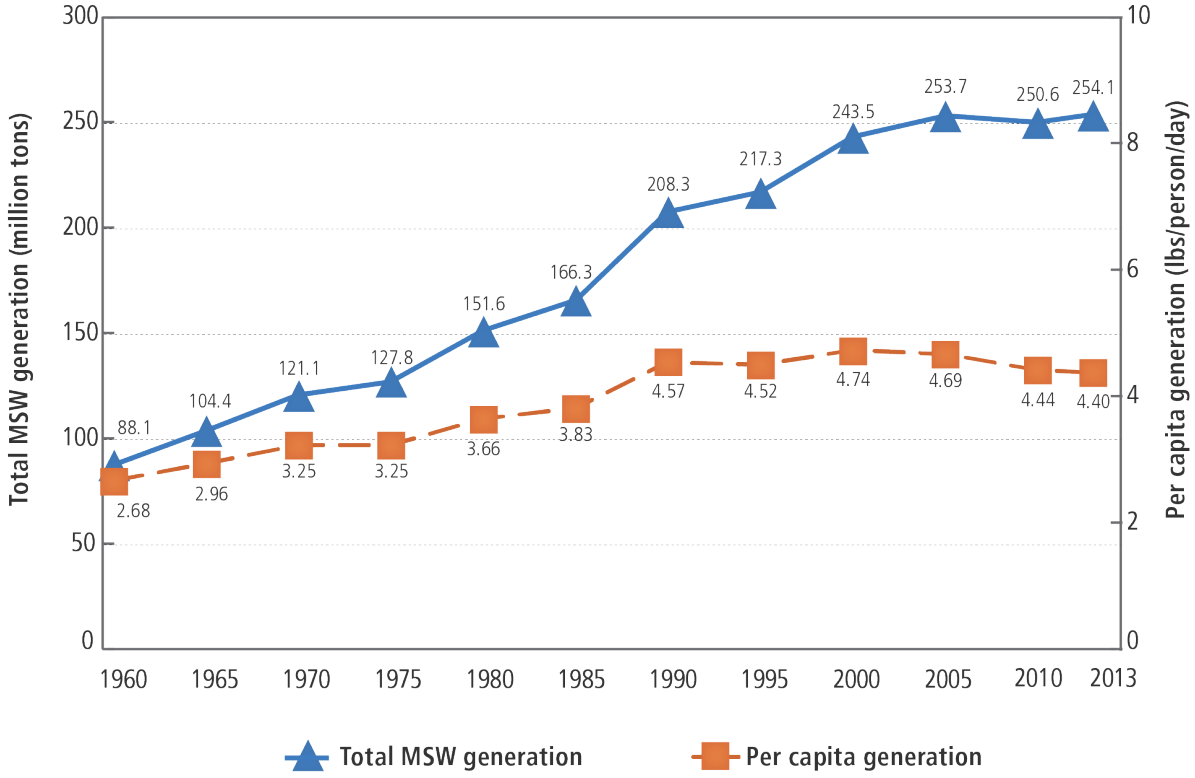
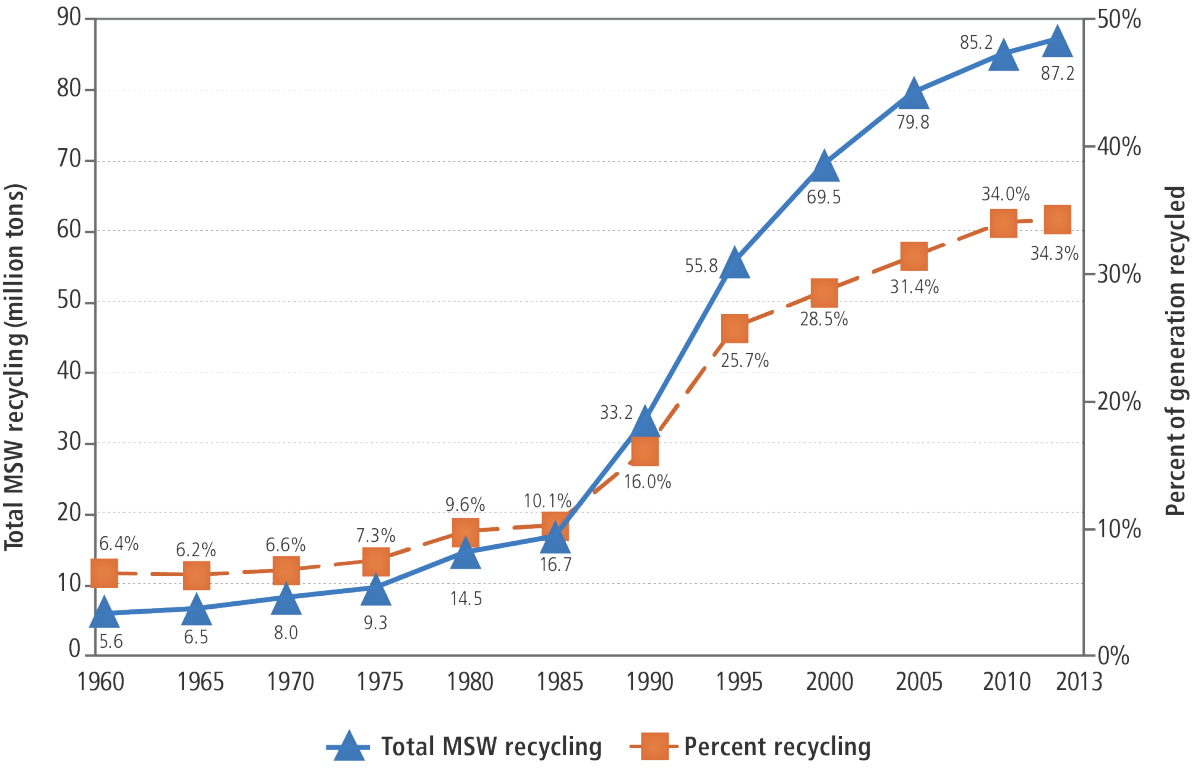


Figure ES-2. MSW Recycling Rates, 1960 to 2013



What is Included in Municipal Solid Waste?

Our trash, or MSW, is comprised of various items Americans commonly throw away after being used. These items include packaging, food, grass clippings, sofas, computers, tires, and refrigerators. Not included are materials that also may be disposed in landfills but are not generally considered MSW, such as C&D debris, municipal wastewater treatment sludges, and non-hazardous industrial wastes. New this year, information on C&D debris generation is included in this Executive Summary and Appendix B.

Municipal Solid Waste in Perspective

Trends Over Time

Over the last few decades, the generation, recycling, and disposal of MSW have changed substantially (see Table ES-1 and Figures ES-1 and ES-2). Annual MSW generation continued to increase from 1960, when it was 88 million tons, until 2005. After 2005, the tons of MSW generated started to decrease until 2009 when the tons of MSW generated started to increase. The generation rate in 1960 was just 2.68 pounds per person per day; it grew to 3.66 pounds per person per day in 1980, reached 4.74 pounds per person per day in 2000, and decreased to 4.69 pounds per person per day in 2005. The generation rate was 4.40 pounds per person per day in 2013 – one of the lowest generation rates since 1980. Over time, recycling rates have increased from just over 6 percent of MSW generated in 1960 to about 10 percent in 1980, to 16 percent in 1990, to about 29 percent in 2000, and to over 34 percent in 2013. Disposal of waste to landfills has decreased from 94 percent of the amount generated in 1960 to under 53 percent of the amount generated in 2013.

Municipal Solid Waste in 2013

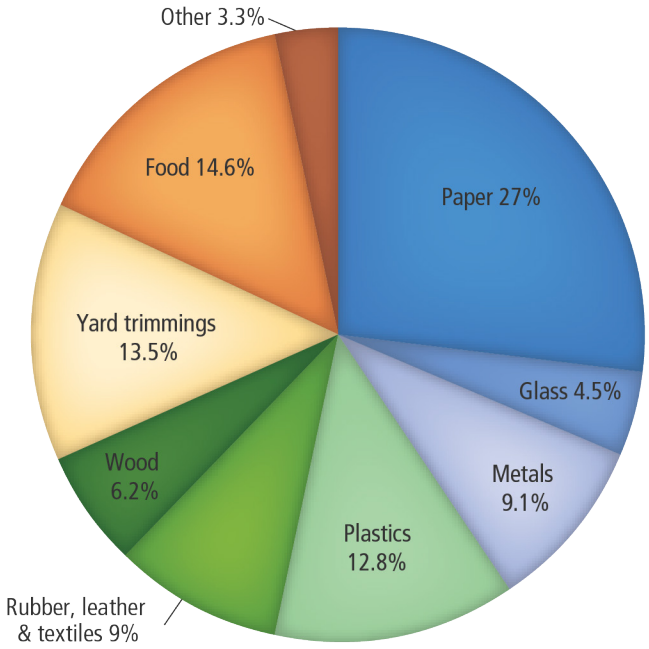
U.S. Environmental Protection Agency (EPA) uses two methods to characterize the 254 million tons of MSW generated in 2013. The first is by **material** (paper and paperboard, yard trimmings, food, plastics, metals, glass, wood, rubber, leather and textiles, and other); the second is by several major **product** categories. The product-based categories are containers and packaging; nondurable goods (e.g., newspapers); durable goods (e.g., appliances); food; yard trimmings; and other materials. See Figure 1-B in Chapter 1 for product category definitions.

Materials in MSW

A breakdown, by weight, of the MSW **materials** generated in 2013 is provided in Figure ES-3. Paper and paperboard made up the largest component of MSW generated (27.0 percent), food was the second-largest component (14.6 percent) and yard trimmings were the third largest (13.5 percent). Metals, plastics, and wood each constituted between 6 and 13 percent of the total MSW generated. Glass made up 4.5 percent, rubber, leather, and textiles combined made up 9.0 percent of MSW, while other miscellaneous wastes made up 3.3 percent of the MSW generated in 2013.

Figure ES-3. Materials Generation in MSW, 2013

254 Million Tons (before recycling)



A portion of each material category in MSW was recycled or composted in 2013. The highest rates of recovery were achieved with paper and paperboard, yard trimmings, and metals. Over 63 percent (43.4 million tons) of paper and paperboard was recovered for recycling in 2013. About 60 percent (20.6 million tons) of yard trimmings was recovered for composting or mulching in 2013. This represents almost a five-fold increase since 1990. Recycling paper and paperboard and yard trimmings alone diverted about 25 percent of municipal solid waste generated from landfills and combustion facilities. In addition, about 7.9 million tons, or 34.1 percent, of metals were recovered for recycling. Recycling rates for all materials categories in 2013 are listed in Table ES-2.

Figures ES-4 and ES-5 depict each material as a percent of total recovery and total discards, respectively. As a percent of total recovery, paper and paperboard made up over half of the materials recovered at 49.8 percent. Yard trimmings comprised the next largest portion of total materials recovery at 23.6 percent. All other materials accounted for less than 10 percent each of total recovery.

Food was the largest material in discards at 21.1 percent. Plastic was next largest at 17.7 percent followed by paper and paperboard at 15.1 percent and rubber, leather, and textiles at 11.6 percent. As a percent of total discards, the other materials accounted for less than 10 percent each.

Table ES-2. Generation, Recovery, and Discards of Materials in MSW, 2013

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

Material	Weight Generated	Weight Recovered	Recovery as Percent of Generation	Weight Discarded
Paper and paperboard	68.60	43.40	63.3%	25.20
Glass	11.54	3.15	27.3%	8.39
Metals				
Steel	17.55	5.80	33.0%	11.75
Aluminum	3.50	0.70	20.0%	2.80
Other nonferrous metals†	2.01	1.37	68.2%	0.64
Total metals	**23.06**	**7.87**	**34.1%**	**15.19**
Plastics	32.52	3.00	9.2%	29.52
Rubber and leather	7.72	1.24	16.1%	6.48
Textiles	15.13	2.30	15.2%	12.83
Wood	15.77	2.47	15.7%	13.30
Other materials	4.58	1.31	28.6%	3.27
Total materials in products	178.92	64.74	36.2%	114.18
Other wastes				
Food, other‡	37.06	1.84	5.0%	35.22
Yard trimmings	34.20	20.6	60.2%	13.60
Miscellaneous inorganic wastes	3.93	Negligible	Negligible	3.93
Total other wastes	**75.19**	**22.44**	**29.8%**	**52.75**
Total municipal solid waste	254.11	87.18	34.3%	166.93

* Includes waste from residential, commercial, and institutional sources.
† Includes lead from lead-acid batteries.
‡ Includes recovery of other MSW organics for composting.
Details might not add to totals due to rounding. Negligible = Less than 5,000 tons or 0.05 percent.

Figure ES-4. Materials Recovery in MSW, 2013
87 Million Tons

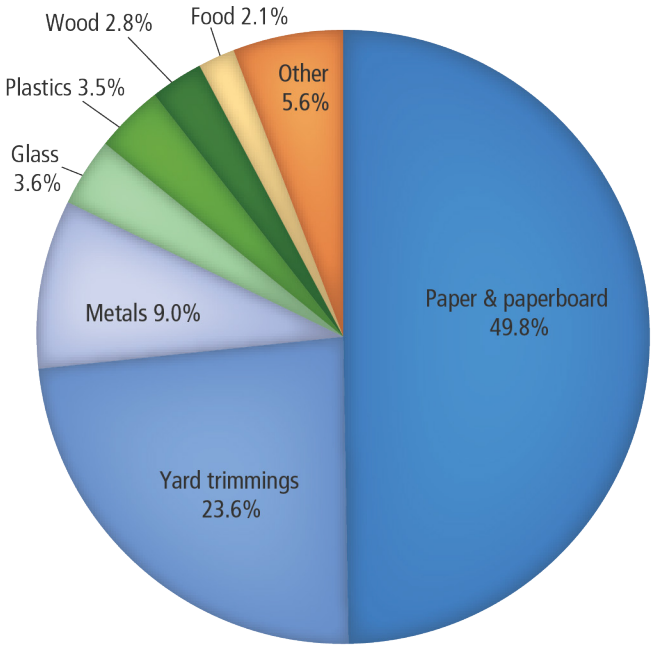
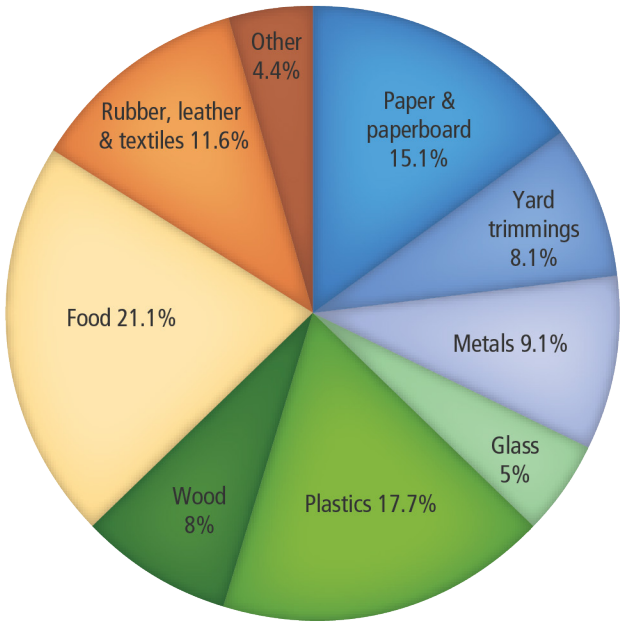


Figure ES-5. Material Discards* in MSW, 2013
167 Million Tons (after recycling and composting)



*Discards in this figure include combustion with energy recovery

Products in MSW

The breakdown of the 254 million tons of MSW generated in 2013 by product category follows. Containers and packaging comprised the largest portion of products generated in MSW, at 29.8 percent (75.8 million tons). Nondurable goods and durable goods each made up about 20.3 percent (over 51 million tons) each. Food made up 14.6 percent (37 million tons), yard trimmings made up 13.5 percent (34 million tons), and other wastes made up 1.5 percent (4 million tons).

The generation and recovery of the product categories in MSW in 2013 are shown in Table ES-3. Overall, *durable goods* were recovered at a rate of 18.0 percent in 2013. Nonferrous metals other than aluminum had one of the highest recovery rates, at 68.2 percent, due to the high rate of lead recovery from lead-acid batteries. Recovery of steel in all durable goods was 26.8 percent, with high rates of recovery from appliances. Durable goods textile recovery at 12.2 percent is mostly from tires and carpets and rugs.

Overall recovery of *nondurable goods* in MSW was 31.8 percent in 2013. Most of this recovery comes from paper products such as newspapers and high-grade office papers (e.g., white papers). Newspapers/mechanical papers constituted the largest portion of this recovery, with 67.0 percent of these paper products generated being recovered for recycling. Starting in 2010, newspapers (including newsprint and groundwood inserts) were expanded to include directories and other mechanical papers previously counted as Other Commercial Printing. An estimated 41.3 percent of other nondurable paper products were recovered in 2013. Total nondurable paper and paperboard product recovery is at 48.1 percent. The nondurable goods category also includes clothing and other textile products—almost 17 percent of these combined products were recovered for recycling or export in 2013.

Table ES-3 shows that recovery of containers and packaging was the highest of the three product categories—51.5 percent of containers and packaging generated in MSW in 2013 were recovered for recycling. Over 55 percent of all aluminum cans in MSW was recovered (38.9 percent of all aluminum packaging, including foil), while 72.5 percent of steel packaging (mostly cans) in MSW was recovered. Paper and paperboard containers and packaging were recovered at a rate of 75.1 percent; corrugated containers accounted for most of that amount.

Thirty-four percent of glass containers in MSW were recovered, while 26.1 percent of wood packaging (mostly wood pallets removed from service) was recovered for recycling. Over 14 percent of plastic containers and packaging in MSW were recovered—mostly bottles and jars.

Polyethylene terephthalate (PET) bottles and jars were recovered in 2013 at over 31 percent. Recovery of high density polyethylene (HDPE) natural (white translucent) bottles was estimated at over 28 percent.

The results of recovering containers and packaging are illustrated in Figures ES-6 and ES-7. Corrugated boxes accounted for 40 percent of total containers and packaging generation but, due to a high recovery rate, only accounted for nine percent of discards. Wood packaging made up 12 percent of containers and packaging generation and 19 percent of discards. Plastic bags, sacks, and wraps were five percent of generation and nine percent of discards. Although steel and aluminum containers and packaging had high recovery rates (see Table ES-3), each accounted for two to three percent of generation and discards. This is due to the relatively small amounts of these products generated.

One of the products with a very high recovery rate was lead-acid batteries, recovered at a rate of about 99 percent in 2013. Other products with particularly high recovery rates were corrugated boxes (88.5 percent), steel packaging (72.5 percent), newspapers/mechanical papers (67.0 percent), major appliances (58.6 percent), aluminum cans (55.1 percent), mixed paper (41.3 percent), and selected consumer electronics (40.4 percent). About 41 percent of rubber tires in MSW were recovered for recycling. (Other tires were retreaded, and shredded rubber tires were made into tire-derived fuel.) See Chapter 2 of this report for additional detail on product recovery rates.

Table ES-3. Generation, Recovery, and Discards of Products in MSW by Material, 2013

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

Products	Weight Generated	Weight Recovered	Recovery as Percent of Generation	Weight Discarded
Durable goods				
Steel	15.15	4.06	26.8%	11.09
Aluminum	1.51	Not Available	Not Available	1.51
Other non-ferrous metals†	2.01	1.37	68.2%	0.64
Glass	2.28	Negligible	Negligible	2.28
Plastics	12.07	0.83	6.9%	11.24
Rubber and leather	6.66	1.24	18.6%	5.42
Wood	6.31	Negligible	Negligible	6.31
Textiles	3.86	0.47	12.2%	3.39
Other materials	1.70	1.31	77.5%	0.39
Total durable goods	51.55	9.28	18.0%	42.27
Nondurable goods				
Paper and paperboard	30.03	14.45	48.1%	15.58
Plastics	6.47	0.13	2.0%	6.34
Rubber and leather	1.06	Negligible	Negligible	1.06
Textiles	10.96	1.83	16.7%	9.13
Other materials	3.08	Negligible	Negligible	3.08
Total nondurable goods	51.60	16.41	31.8%	35.19
Containers and packaging				
Steel	2.40	1.74	72.5%	0.66
Aluminum	1.80	0.70	38.9%	1.10
Glass	9.26	3.15	34.0%	6.11
Paper and paperboard	38.56	28.95	75.1%	9.61
Plastics	13.98	2.04	14.6%	11.94
Wood	9.46	2.47	26.1%	6.99
Other materials	0.31	Negligible	Negligible	0.31
Total containers and packaging	**75.77**	**39.05**	**51.5%**	**36.72**
Other wastes				
Food, other‡	37.06	1.84	5.0%	35.22
Yard trimmings	34.20	20.60	60.2%	13.60
Miscellaneous inorganic wastes	3.93	Negligible	Negligible	3.93
Total other wastes	75.19	22.44	29.8%	52.75
Total municipal solid waste	**254.11**	**87.18**	**34.3%**	**166.93**

Includes waste from residential, commercial, and institutional sources.

† Includes lead from lead-acid batteries.

‡ Includes recovery of other MSW organics for composting.

Details might not add to totals due to rounding. Negligible = less than 5,000 tons or 0.05 percent.

Figure ES-6. Containers and Packaging Generated in MSW, 2013

75.8 Million Tons (before recycling)

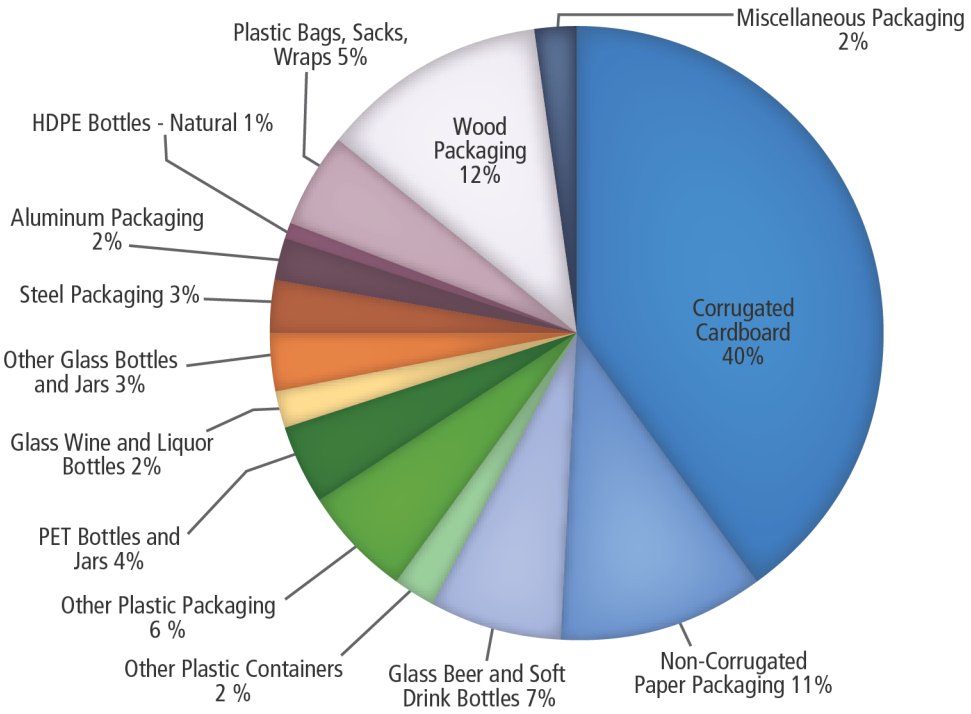
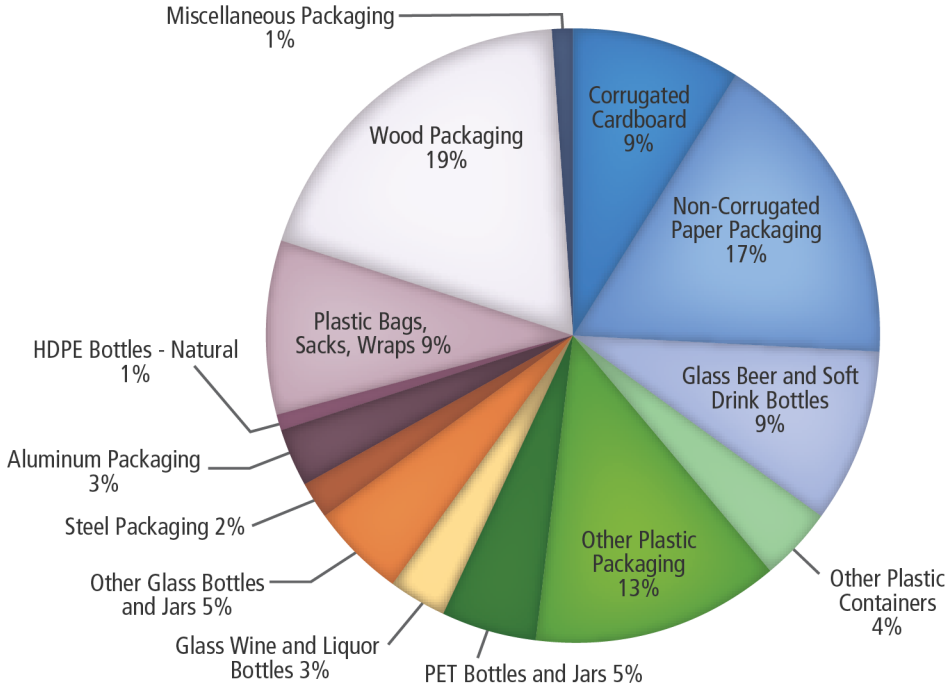


Figure ES-7. Containers and Packaging Discarded* in MSW, 2013

36.7 Million Tons (after recycling)



*Discards in this figure include combustion with energy recovery

Residential and Commercial Sources of MSW

Sources of MSW, as characterized in this report, include residential waste (including waste from apartment houses) and waste from commercial and institutional locations, such as businesses, schools, and hospitals.

Management of MSW

Overview

EPA's integrated waste management hierarchy, depicted below, includes the following four components:

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

Although we encourage the use of strategies that emphasize the top of the hierarchy whenever possible, all four components remain important within an integrated waste management system.

Source Reduction

Our waste management hierarchy emphasizes the importance of *reducing* the amount of waste created, reusing whenever possible, and then recycling whatever is left. When the amount of municipal solid waste generated is reduced or materials are reused rather than discarded, this is called "source reduction"—meaning the material never enters the waste stream.

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

- Redesigning products or packages so as to reduce the quantity of materials or the toxicity of the materials used, by substituting lighter materials for heavier ones and lengthening the life of products to postpone disposal.
- Removing unnecessary layers of packaging and using right-sized packaging.
- Using packaging that reduces the amount of damage or spoilage to the product.
- Reducing amounts of products or packages used through modification of current practices by processors and consumers.
- Reusing products or packages already manufactured.
- Managing non-product organic wastes (food, yard trimmings) through backyard composting or other on-site alternatives to disposal.

Realizing the value of our resources, both financial and material, we have continued in our efforts to reduce waste generation.

Recycling

The second component of our waste management hierarchy is recycling, including off-site (or community) composting. Residential and commercial recycling turns materials and products that would otherwise become waste into valuable resources. Materials like glass, metal, plastics, paper, and yard trimmings are collected, separated, and sent to facilities that can process them into new materials or products.

- Recycling (including community composting) recovered 34.3 percent (87.2 million tons) of MSW generation in 2013.
- About 3,560 community composting programs were documented in 2013, an increase from 3,227 in 2002.
- Over 2.7 million households were served with food composting collection programs in 2013.

Combustion with Energy Recovery

MSW combustion with energy recovery increased substantially between 1980 and 1990 (from 2.7 million tons in 1980 to 29.7 million tons in 1990). From 1990 to 2000, the quantity of MSW combusted with energy recovery increased over 13 percent to 33.7 million tons. After 2000, the quantity of MSW combusted with energy recovery has remained between 29.0 million tons and 32.7 million tons (12.9 percent of MSW generation in 2013). Discards sent for combustion with energy recovery were 0.57 pounds per person per day (see Table ES-1).

Disposal

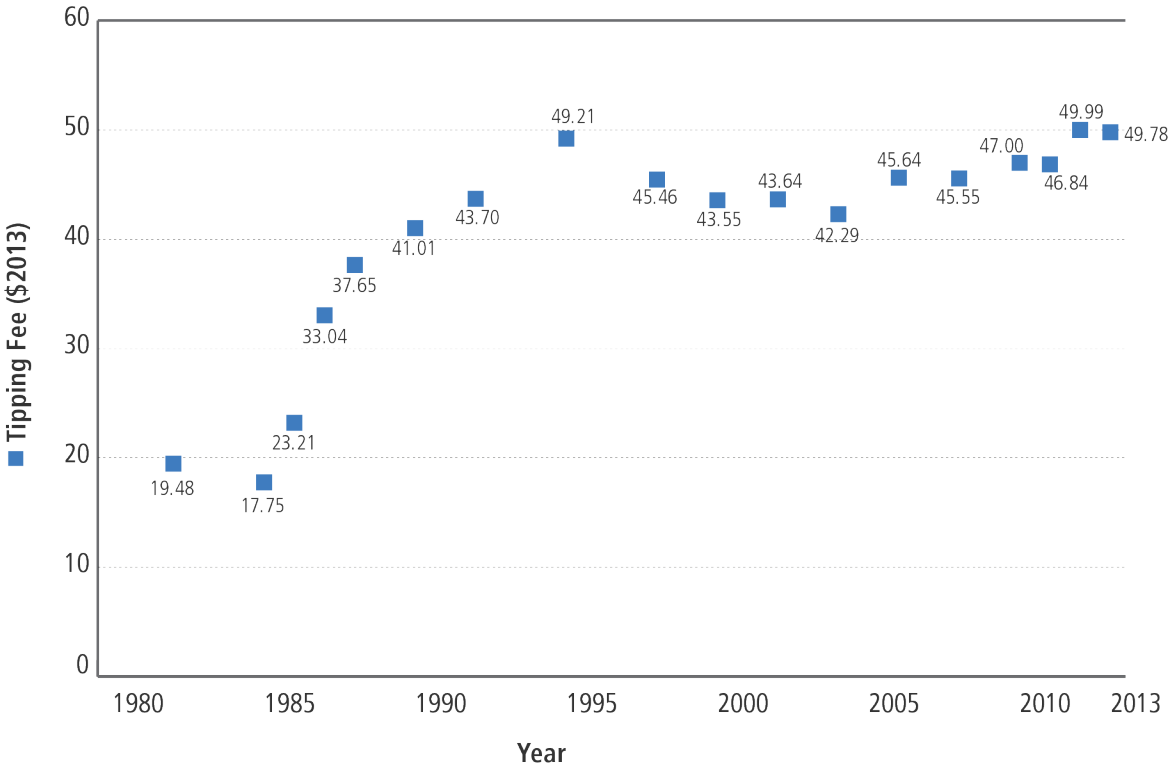
During 2013, 52.8 percent of MSW was landfilled, similar to the percentage landfilled in 2011 and 2012. At the national level, landfill capacity does not appear to be a problem, although regional dislocations sometimes occur.

- Over time, the tonnage of MSW landfilled has decreased. In 1990, 145.3 million tons of MSW were landfilled (see Table ES-1), decreasing to 140.3 million tons in 2000. The tonnage

increased to 142.3 million tons in 2005, then declined to 134.3 in 2013. The tonnage landfilled results from an interaction among generation, recycling, and combustion with energy recovery, which do not necessarily rise and fall at the same time. In general, as recovery increases, discards decrease.

- In 2013, the net per capita discard rate (after materials recovery and combustion with energy recovery) was 2.32 pounds per person per day. The net per capita discard rate has decreased since 1990. The 1990 rate was 3.19 pounds per person per day, the 2000 rate was 2.73 pounds per person per day, the 2005 rate was 2.63 pounds per person per day, and the 2013 rate was 2.32 pounds per person per day (Table ES-1).
- From 1985 to 1995 there was a rapid rise in the cost to manage MSW going to landfills followed by a steady decrease from 1995 to 2004. Since 2004, there has been a steady increase in landfill tipping fees (see Figure ES-8). The tipping fees are expressed in constant 2013 dollars.

Figure ES-8. National Landfill Tipping Fees, 1982-2013 ($2013 per ton)

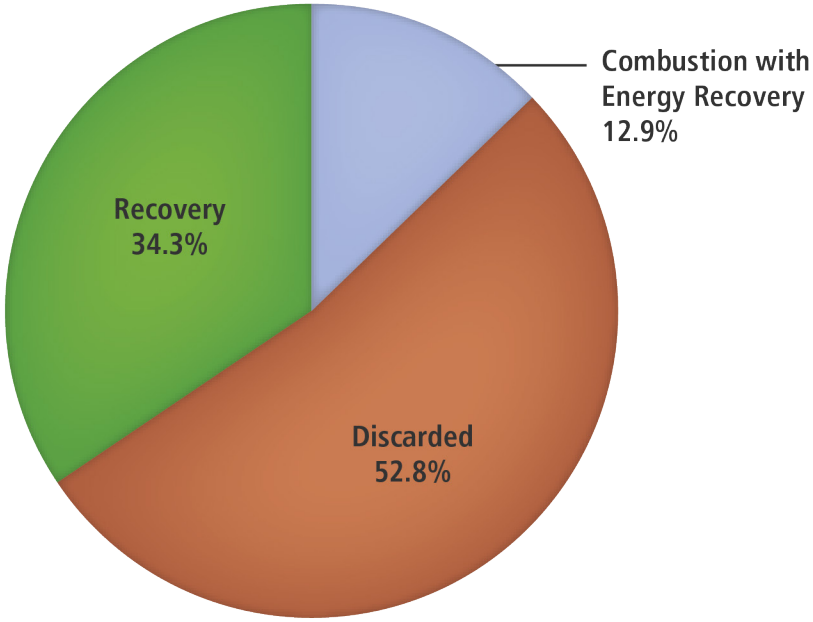


National mean annual landfill tipping fees normalized to constant $2013 using the consumer price index (CPI) from the Bureau of Labor Statistics to allow meaningful comparisons. This figure shows an average increase from 1985 to 1995 of $3.15 per year followed by a steady decrease of $0.77 per year followed by an increase of $0.83 from 2004 to 2013.
Sources: National Solid Wastes Management Association (NSWMA) Municipal Solid Waste Landfill Facts. October 2011. Data from 1985 to 2010. Waste & Recycling News, 2013 Landfill Tipping Fee Survey. Spring 2013. Data for 2012 and 2013.

MSW management through recovery for recycling (including composting), combustion with energy recovery, and discards to disposal in 2013 is shown in Figure ES-9. In 2013, 87.2 million tons (34.3 percent) of MSW were recycled, 32.7 million tons (12.9 percent) were combusted with energy recovery, and 134.3 million tons (52.8 percent) were landfilled or otherwise disposed. (Relatively small

amounts of this total undoubtedly were incinerated without energy recovery, littered, or illegally dumped rather than landfilled.)

Figure ES-9. Management of MSW in the United States, 2013
254 Million Tons



The Benefits of Recycling

Recycling has environmental benefits at every stage in the life cycle of a consumer product—from the raw material with which it's made to its final method of disposal. By utilizing used, unwanted, or obsolete materials as industrial feedstocks or for new materials or products, Americans can each do their part to make recycling – including composting -- work. Aside from reducing GHG emissions, which contribute to global warming, recycling (including composting) also provides significant economic and job creation impacts.

The energy and GHG benefits of recycling and composting shown in Table ES-4 are calculated using the EPA's Waste Reduction Model (WARM). Please see: www.epa.gov/warm. WARM calculates and totals GHG emissions of baseline and alternative waste management practices including source reduction, recycling, composting, combustion, and landfilling. Paper and paperboard recovery at about 43 million tons resulted in a reduction of 149 million metric tons of carbon dioxide equivalent emissions in 2013. This is equivalent to removing 31 million cars from the road in one year.

In 2013, Americans recycled and composted over 87 million tons of MSW. This provides an annual reduction of more than 186 million metric tons of carbon dioxide equivalent emissions, comparable to removing the emissions from over 39 million passenger vehicles from the road in one year.

Table ES-4. Greenhouse Gas Benefits Associated with Recovery of Specific Materials, 2013

(In millions of tons, $MMTCO_2E$ and in numbers of cars taken off the road per year)*

Material	Weight Recovered (millions of tons)	GHG Benefits $MMTCO_2E$	Numbers of Cars Taken Off the Road per Year
Paper and paperboard	43	149	31 million
Glass	3.2	1	210 thousand
Metals			
Steel	5.8	9.5	2 million
Aluminum	0.7	6.4	1.3 million
Other nonferrous metals†	1.37	5.9	1.2 million
Total metals	**7.87**	**21.8**	**4.5 million**
Plastics	3	3.6	760 thousand
Rubber and leather‡	1.24	0.6	127 thousand
Textiles	2.3	5.8	1.2 million
Wood	2.47	3.8	798 thousand
Other wastes			
Food, other^	1.84	1.7	308 thousand
Yard trimmings	20.6	1.04	220 thousand

Includes materials from residential, commercial, and institutional sources.

These calculations do not include an additional 1.32 million tons of MSW recovered that could not be addressed in the WARM model. Recently WARM assumptions and data have been revised. $MMTCO_2E$ is million metric tons of carbon dioxide equivalent.

† Includes lead from lead-acid batteries. Other nonferrous metals calculated in WARM as mixed metals.

‡ Recovery only includes rubber from tires.

^ Includes recovery of other MSW organics for composting.

Source: WARM model (www.epa.gov/warm)

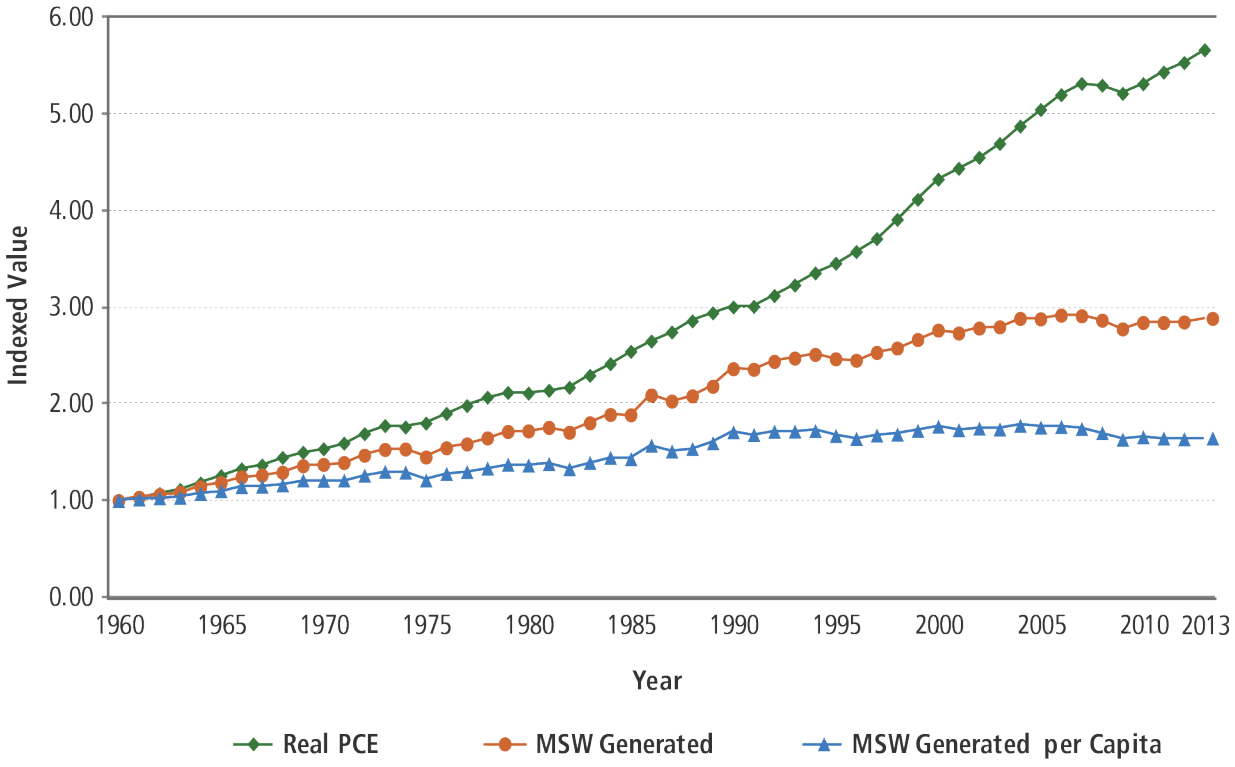
MSW Generation and Household Spending

Over the years, the change in the amount of MSW generated has typically imitated trends in how much money American households spend on goods and services. Personal Consumer Expenditures (PCE) measure U.S. household spending on goods and services such as food, clothing, vehicles, and recreation services. PCE accounts for approximately 70 percent of U.S. Gross Domestic Product, a key indicator of economic growth. PCE adjusted for inflation is referred to as real PCE. This is a more useful metric in making comparisons over time because it normalizes the value of a dollar by considering how much a dollar could purchase in the past versus today. Figure ES-10 explores the relationship between MSW generated and real PCE since 1960.

Figure ES-10 is an indexed graph showing the relative changes in real PCE, MSW generated, and MSW generated per capita over time. It is indexed to allow all three of these metrics to be shown on the same graph and compare their relative rates of change since 1960. The indexed value indicates the change in the value of the data since 1960. For example, if for a given year the value is three, then the data value for that year would be three times the 1960 value. In this case, if the 1960 value was 200 then the resulting year's value would be 600. The 2013 MSW per capita generation indexed value is 1.6, which means MSW per capita generation has increased by 60 percent since 1960.

Figure ES-10 shows that real PCE has increased at a faster rate than MSW generation, and the disparity has become even more distinct since the mid 1990s. This indicates the amount of MSW generated per dollar spent is falling. In other words, our economy has been able to enjoy dramatic increases in household spending on consumer goods and services without this being at the expense of the societal impact of similarly increasing MSW generation rates. This figure also shows that the MSW generated per capita leveled off in the early- to-mid-2000s and has since fallen. This is important because as population continues to grow, it will be necessary for MSW generated per capita to continue to fall to maintain or decrease the total amount of MSW generated as a country.

Figure ES-10. Indexed MSW Generated and Real PCE over Time (1960-2013)



C&D Debris Generation Results

C&D debris is a type of waste which is not included in MSW. Materials included in C&D are steel, wood products, drywall and plaster, brick, clay tile, asphalt shingles, asphalt concrete, and Portland cement concrete. These materials are used in building as well as road and bridge sectors. Our generation estimate represents C&D amounts from construction, renovation, and demolition activities for buildings, roads, and bridges.

In 2013, 530 million tons of C&D debris were generated. Figure ES-11 shows the 2013 generation composition for C&D. Portland cement concrete is the largest portion (67 percent), followed by asphalt concrete (18 percent). Wood products make up eight percent and the other products account for seven percent combined. The 2013 generation estimates are presented in more detail in Table ES-5. As shown in Figure ES-12, demolition represents over 90 percent of total C&D debris generation as opposed to construction which represents under 10 percent.

Figure ES-11. C&D Generation Composition by Material, 2013

530 Million Tons (before recycling)

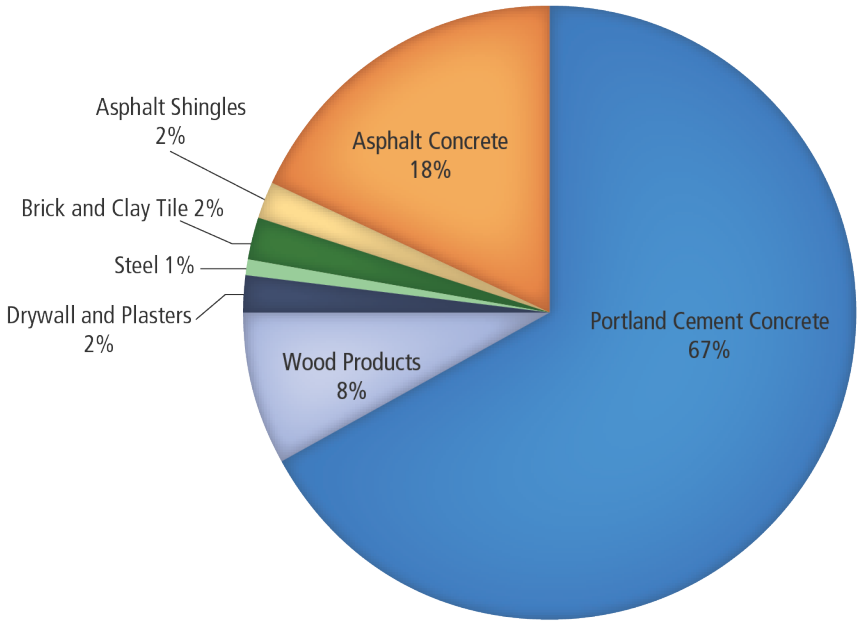


Table ES-5. C&D Debris Generation by Material and Activity (million tons)

	Waste During Construction	Demolition Debris	Total C&D Debris
	2013	2013	2013
Portland Cement Concrete	17.5	335.4	352.9
Wood Products	2.5	37.7	40.2
Drywall and Plasters	3.1	9.9	13.1
Steel[1]	0	4.3	4.3
Brick and Clay Tile	0.3	11.8	12.1
Asphalt Shingles	1.0	11.5	12.6
Asphalt Concrete	0	95.1	95.1
Total	***24.4***	***505.9***	***530.3***

1. Steel consumption in buildings also includes steel consumed for the construction of roads and bridges. Data were not available to allocate steel consumption across different sources.

Table ES-6 displays the amount of C&D debris generation from buildings, roads and bridges, and other structures for each material. The other structures category includes communication, power, transportation, sewer and waste disposal, water supply, conservation and development, and manufacturing infrastructure. In 2013 roads and bridges contributed significantly more to C&D debris generation than buildings and other structures, and Portland cement concrete makes up the largest share of C&D debris generation for all three categories.

Figure ES-12. Contribution of Construction and Demolition Phases to Total 2013 C&D Generation

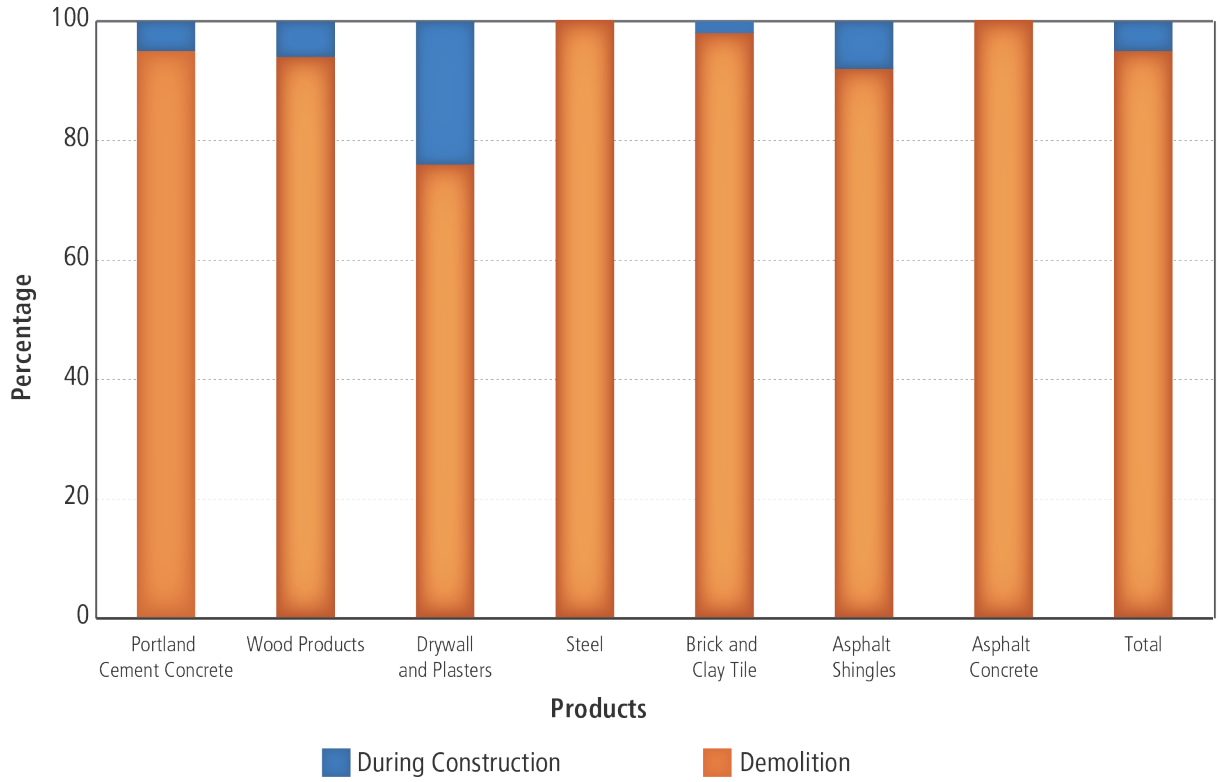


Table ES-6. C&D Debris Generation by Source (million tons)

	Buildings	Roads and Bridges	Other
	2013	2013	2013
Portland Cement Concrete	79.9	148.4	124.5
Wood Products	40.2		
Drywall and Plasters	13.1		
Steel[1]	4.3		
Brick and Clay Tile	12.1		
Asphalt Shingles	12.6		
Asphalt Concrete		95.1	
Total	***162.2***	***243.5***	***124.5***

1. Steel consumption in buildings also includes steel consumed for the construction of roads and bridges. Data were not available to allocate steel consumption across different sources.

Thinking Beyond Waste

EPA is helping change the way our society protects the environment and conserves resources for future generations by thinking beyond recycling, composting, and disposal. Building on the familiar concept of Reduce, Reuse, Recycle, the Agency is employing a systemic approach that seeks to reduce materials use and associated environmental impacts over their entire life cycle, called sustainable materials management (SMM). This starts with extraction of natural resources and material processing through product design and manufacturing then the product use stage followed by collection/processing and final end of life (disposal). By examining how materials are used throughout their life cycle, an SMM approach seeks to use materials in the most productive way with an emphasis on using less; reducing toxic chemicals and environmental impacts throughout the material life cycle; and assuring we have sufficient resources to meet today's needs and those of the future. Data on municipal solid waste generation, recycling and disposal is an important starting point for the full SMM approach. Viewing materials through an SMM lens changes how we think about our resources for a better tomorrow. Our policy is Reduce, Reuse, Recycle, Rethink.

Resources

The data summarized in this fact sheet characterizes the MSW stream as a whole by using a materials flow methodology that relies on a mass balance approach. For example, to determine the amounts of paper recycled, information is gathered on the amounts processed by paper mills and made into new paper on a national basis plus recycled paper exported, instead of counting paper collected for recycling on a state-by-state basis. Using data gathered from industry associations, businesses, and government sources, such as the U.S. Department of Commerce and the U.S. Census Bureau, we estimate tons of materials and products generated, recycled, and discarded. Other sources of data, such as waste characterization and research reports performed by governments, industry, or the press, supplement these data. The data on C&D debris generated summarized in this report is also developed using a materials flow methodology (see Appendix B).

The benefits of MSW recycling and composting, such as elimination of GHG emissions, are calculated using EPA's WARM methodology. WARM calculates and totals GHG emissions of baseline and alternative waste management practices including source reduction, recycling, composting, combustion, and landfilling. The model calculates emissions in metric tons of carbon equivalent (MTCE), metric tons of carbon dioxide equivalent ($MTCO_2E$), and energy units (million Btu) across a wide range of material types commonly found in MSW. EPA developed GHG emissions reduction factors through a life-cycle assessment methodology. Please see: www.epa.gov/warm.

For Further Information

This report and related additional data are available on the Internet at www.epa.gov/epawaste/nonhaz/municipal/msw99.htm.

Endnotes

1. *Circular Advantage: Innovative Business Models and Technologies to Create Value in a World without Limits to Growth*. Accenture (2014). http://www.accenture.com/us-en/Pages/insight-circular-advantage-innovative-business-models-value-growth.aspx
2. *Decoupling Natural Resource Use and Environmental Impacts from Economic Growth*. A Report of the Working Group on Decoupling to the International Resource Panel. Fischer-Kowalski, M., M. Swilling, E.U. von Weizsäcker, Y. Ren, Y. Moriguchi, W. Crane, F. Krausmann, N. Eisenmenger, S. Giljum, P. Hennicke, P. Romero Lankao, A. Siriban Manalang, S. Sewerin, S, United Nations Environment Programme (2011). http://www.unep.org/resourcepanel/decoupling/files/pdf/decoupling_report_english.pdf
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1. INTRODUCTION AND METHODOLOGY

Introduction

This report is the most recent in a series of reports sponsored by the U.S. Environmental Protection Agency to characterize municipal solid waste (MSW) in the United States. Together with the previous reports, this report provides a historical database for a 53-year characterization (by weight) of the materials and products in MSW.

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

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

Background

The Solid Waste Management Hierarchy

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

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

Although we encourage the use of strategies that emphasize the top of the hierarchy whenever possible, all four components remain important within an integrated waste management system. As done in previous versions of this report, combustion with energy recovery is shown as discards in the Chapter 2 tables and figures.

Overview of the Methodology

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

At the state or local level, recycling rates often are developed by counting and weighing all the recyclables collected, and then aggregating these data to yield a state or local recycling rate. At the national level, we use instead a *materials flow methodology*, which relies heavily on a mass balance approach. Using data gathered from industry associations, key businesses, and similar industry sources, and supported by government data from sources such as the Department of Commerce and the U.S. Census Bureau, we estimate tons of materials and products generated, recycled, or discarded. Other sources of data, such as waste characterizations and surveys performed by governments, industry, or the press, supplement these data.

To estimate MSW generation, production data are adjusted by imports and exports from the United States, where necessary. Allowances are made for the average lifespans of different products. Information on amounts of disposed MSW managed by combustion comes from industry sources and the press. MSW not managed by recycling (including composting) or combustion is assumed to be landfilled.

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

A common error in using this report is to assume that *all* nonhazardous wastes are included. As shown later in this chapter, municipal solid waste as defined here does *not* include construction and demolition debris (C&D), biosolids (sewage sludges), industrial process wastes, or a number of other wastes that, in some cases, may go to a municipal waste landfill. These materials, over time, have tended to be handled separately and are not included in the totals in this report. EPA has addressed several of these materials separately, for instance, in *Biosolids Generation, Use, and Disposal in the United States*, EPA530-R-99-009, September 1999, and *Estimating 2003 Building-Related Construction and Demolition Materials Amounts*, EPA530-R-09-002, March 2009. C&D debris generation is also addressed in Appendix B of this report. Recycling (including composting) is encouraged for these materials as well.

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

How This Report Can Be Used

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

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

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

While the national average data are useful as a checkpoint against local MSW characterization data, any differences between local and national data should be examined carefully. There are many regional variations that require each community to examine its own waste management needs. 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.

Specific reasons for regional differences may include:

- Variations in climate and local waste management practices, which greatly influence generation of yard trimmings. For instance, yard trimmings exhibit strong seasonal variations in most regions of the country. Also, the level of backyard composting in a community or region will affect generation of yard trimmings.
- Differences in the scope of waste streams. That is, a local landfill may be receiving other waste such as industrial non-hazardous process wastes in addition to MSW, but Chapters 1, 2, and 3 of this report address MSW only. Appendix B addresses C&D.
- Variance in the per capita generation of some products, such as newspapers and telephone directories, depending upon the average size of the publications. Typically, rural areas will generate less of these products on a per person basis than urban areas.
- Level of commercial activity in a community. This will influence the generation rate of some products, such as office paper, corrugated boxes, wood pallets, and food from restaurants.
- Variations in economic activity, which affect waste generation in both the residential and the commercial sectors.
- Local and state regulations and practices. Deposit laws, bans on landfilling of specific products, and variable rate pricing for waste collection are examples of practices that can influence a local waste stream.

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

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

- Develop approximate estimates of total MSW generation in an area.
- Check locally developed MSW data for accuracy and consistency.
- Account for trends in total MSW generation and the generation of individual components.
- Help set goals and measure progress in source reduction and recycling (including composting).

Characterization of Municipal Solid Waste: in Perspective

The Two Methodologies for Characterizing MSW: Site-Specific Versus Materials Flow

There are two basic approaches to estimating quantities of municipal solid waste at the local, state, or national levels—site-specific and materials flow. This report is based on the materials flow approach because site-specific approaches are problematic for national estimates.

Site-specific studies. In the first methodology, which is site-specific, sampling, sorting, and weighing the individual components of the waste stream could be used. This methodology 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 other factors. In addition, quantities of MSW components such as yard trimmings and food can only be estimated through sampling and weighing studies.

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

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

Materials flow. The second approach to quantifying and characterizing the municipal solid waste stream–the methodology used for this report–utilizes a materials flow 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 30 years.

The materials flow methodology is based on production data (by weight) for the materials and products in the waste stream. To estimate generation data, specific adjustments are made to the production data for each material and product category. Adjustments are made for imports and exports and for diversions from MSW (e.g., for building materials made of plastic and paperboard that become C&D debris.) Adjustments are also made for the lifetimes of products. Finally, food, yard

trimmings, and a small amount of miscellaneous inorganic wastes are accounted for by compiling data from a variety of waste sampling studies.

One problem with the materials flow 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, and dried paint in a can. Some household hazardous wastes, (e.g., pesticide left in a can) are also included among these product residues.

Municipal Solid Waste Defined in Greater Detail

As stated earlier, EPA includes those materials that historically have been handled in the municipal solid waste stream–those materials from municipal sources, sent to municipal landfills. In this report, MSW includes wastes such as product packaging, newspapers, office and classroom paper, bottles and cans, boxes, wood pallets, food, grass clippings, clothing, furniture, appliances, automobile tires, consumer electronics, and lead-acid batteries. For purposes of analysis, these products and materials are often grouped in this report into the following categories: durable goods, nondurable goods, containers and packaging, yard trimmings, food, and miscellaneous inorganic wastes.

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

The materials flow methodology used in this report does not readily lend itself to the quantification of wastes according to their sources. For example, corrugated boxes may be unpacked and discarded from residences, commercial establishments such as grocery stores and offices, institutions such as schools, or factories. Similarly, office papers are mostly generated in offices, but they also are generated in residences and institutions. The methodology estimates only the total quantity of products generated, not their places of disposal or recovery for recycling.

Sources and Examples	Example Products
Residential (single-and multi-family homes)	▪ Newspapers, clothing, disposable tableware, food packaging, cans and bottles, food, yard trimmings
Commercial (office buildings, retail and wholesale establishments, restaurants)	▪ Corrugated boxes, food, 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.

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-A, however, RCRA Subtitle D includes many kinds of wastes. It has been common practice to landfill wastes such as municipal sludges, nonhazardous industrial wastes, residue from automobile salvage operations, and C&D debris

along with MSW, but these other kinds of wastes are not included in the MSW estimates presented in Chapters 1, 2, and 3 of this report. Information on C&D debris generation is presented in the Executive Summary and Appendix B of this report.

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

Subtitle D Wastes

The Subtitle D Waste included in this report is Municipal Solid Waste, which includes:

- Containers and packaging such as soft drink bottles and corrugated boxes
- Durable goods such as furniture and appliances
- Nondurable goods such as newspapers, trash bags, and clothing
- Other wastes such as food and yard trimmings.

Subtitle D Wastes not included in this report are:

- Municipal sludges
- Industrial nonhazardous process wastes
- Construction and demolition debris (except as noted above)
- Land clearing debris
- Transportation parts and equipment
- Agricultural wastes
- Oil and gas wastes
- Mining wastes
- Auto bodies
- Fats, grease, and oils

Figure 1-B. Definition of Terms

The materials flow methodology produces an estimate of total municipal solid waste generation in the United States, by material categories and by product categories.

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

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

Recovery of materials as estimated in this report includes products and yard trimmings removed from the waste stream for the purpose of recycling (including composting). For recovered products, recovery equals reported purchases of postconsumer recovered material (e.g., glass cullet, old newspapers) plus net exports (if any) of the material. 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. Imported secondary materials are also not counted in recovery estimates in this report. For some materials, additional uses, such as glass used for highway construction or newspapers used to make insulation, are added into the recovery totals.

Combustion of MSW with energy recovery, often called "waste-to-energy," is estimated in Chapter 3 of this report. Combustion of separated materials–wood and rubber from tires–is included in the estimates of combustion with energy recovery in this report.

Discards include MSW remaining after recovery for recycling (including composting). These discards presumably would be combusted without energy recovery or landfilled, although some MSW is littered, stored or disposed onsite, or burned onsite, particularly in rural areas. No good estimates for these other disposal practices are available, but the total amounts of MSW involved are presumed to be small.

For the analysis of municipal solid waste, products are divided into three basic categories: durable goods, nondurable goods, and containers and packaging. The durable goods and nondurable goods categories generally follow the definitions of the U.S. Department of Commerce.

Durable goods are those products that last 3 years or more. Products in this category include major and small appliances, furniture and furnishings, carpets and rugs, tires, lead-acid batteries, consumer electronics, and other miscellaneous durables.

Nondurable goods are those products that last less than 3 years. Products in this category include newspapers, books, magazines, office papers, directories, mail, other commercial printing, tissue paper and towels, paper and plastic plates and cups, trash bags, disposable diapers, clothing and footwear, towels, sheets and pillowcases, other nonpackaging paper, and other miscellaneous nondurables.

Containers and packaging are assumed to be discarded the same year the products they contain are purchased. Products in this category include bottles, containers, corrugated boxes, milk cartons, folding cartons, bags, sacks, and wraps, wood packaging, and other miscellaneous packaging.

Materials and Products Not Included in the MSW Estimates

As noted earlier, other Subtitle D wastes (illustrated in Figure 1-A) are not included in the MSW 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 parts and equipment (including automobiles and trucks) are not included in the wastes characterized in this report.

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 packaging materials. Considerable additional research would be required to estimate these materials, which constitute a relatively small percentage of the waste stream.

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

Overview of This Report

Following this introductory chapter, Chapter 2 presents the results of the municipal solid waste characterization (by weight). Estimates of MSW generation, recovery, and discards are presented in a series of tables, with discussion. Detailed tables and figures summarizing 2013 MSW 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. Summaries of the infrastructure currently available for each waste management alternative are also included in Chapter 3.

A brief discussion of the materials flow methodology for estimating generation, recycling, and disposal is presented in Appendix A. C&D debris generation estimates are detailed in Appendix B.

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2. CHARACTERIZATION OF MUNICIPAL SOLID WASTE BY WEIGHT

Introduction

The tables and figures in this chapter present the results of the update of EPA's municipal solid waste characterization report through 2013. The data presented also incorporate some revisions to previously reported data for 2009 through 2012. The revisions are generally due to improvements in the data available from data sources used in developing this report.

This chapter discusses how much municipal solid waste (MSW) is generated, recovered, and disposed. First, an overview presents this information for the most recent years, and for selected years back to 1960. This information is summarized in Tables 1 to 3 and Figures 10 to 13. Then, throughout the remainder of the chapter, MSW is characterized in more detail. Findings are presented in two basic ways: the first portion of the chapter presents data by *material type*. Some material types of most use to planners (paper and paperboard, glass, metals, plastics, and rubber and leather) are presented in detail in Tables 4 to 8 and Figures 2 to 9, while data on other materials also are summarized in Figures 12 and 13.

The second portion of the chapter presents data by *product type*. This information is presented in Tables 9 to 23 and Figures 14 to 17. Products are classified into durable goods (e.g., appliances, furniture, tires); nondurable goods (e.g., newspapers, office-type papers, trash bags, clothing); and containers and packaging (e.g., bottles, cans, corrugated boxes). A fourth major category includes other wastes—yard trimmings, food, and miscellaneous inorganic wastes. These wastes are not manufactured products, but to provide complete information in each table, they are included in both the product and the material tables.

This chapter provides data on generation, recovery, and discards of MSW. (See Figure 1-B in Chapter 1 for definitions of these terms.) Recovery, in this report, means that the materials have been removed from the municipal solid waste stream. Recovery of materials in products means that the materials are reported to have been purchased by an end user or have been exported from the United States. For yard trimmings and food, recovery includes estimates of the material delivered to a composting facility (not backyard composting).

Under these definitions, residues from a materials recovery facility (MRF) or other waste processing facility are counted as generation (and, of course, discards), since they are not purchased by an end user. Residues from an end user facility (e.g., sludges from a paper deinking mill) are considered to be industrial process wastes that are no longer part of the municipal solid waste stream.

Municipal Solid Waste: Characterized by Material Type

Generation, recovery, and discards of materials in MSW, by weight and by percentage of generation and discards, are summarized in Tables 1 through 3. Figures 10 and 11 (later in this chapter) illustrate these data over time. A snapshot, by material, for 2013 is provided in Figures 12 and 13. In the following sections, each material is discussed in detail.

Table 1. Materials Generated* in the Municipal Waste Stream, 1960 to 2013

(In thousands of tons and percent of total generation)

Materials	Thousands of Tons									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Paper and Paperboard	29,990	44,310	55,160	72,730	87,740	84,840	68,430	69,950	68,620	68,600
Glass	6,720	12,740	15,130	13,100	12,770	12,540	11,780	11,490	11,590	11,540
Metals										
Ferrous	10,300	12,360	12,620	12,640	14,150	15,210	15,900	16,540	16,800	17,550
Aluminum	340	800	1,730	2,810	3,190	3,330	3,440	3,520	3,510	3,500
Other Nonferrous	180	670	1,160	1,100	1,600	1,860	1,930	2,020	1,980	2,010
Total Metals	*10,820*	*13,830*	*15,510*	*16,550*	*18,940*	*20,400*	*21,270*	*22,080*	*22,290*	*23,060*
Plastics	390	2,900	6,830	17,130	25,550	29,380	30,070	31,970	31,940	32,520
Rubber and Leather	1,840	2,970	4,200	5,790	6,670	7,290	7,500	7,600	7,570	7,720
Textiles	1,760	2,040	2,530	5,810	9,480	11,510	12,990	13,130	14,340	15,130
Wood	3,030	3,720	7,010	12,210	13,570	14,790	15,590	15,780	15,820	15,770
Other **	70	770	2,520	3,190	4,000	4,290	4,680	4,650	4,580	4,580
Total Materials in Products	54,620	83,280	108,890	146,510	178,720	185,040	172,310	176,650	176,750	178,920
Other Wastes										
Food	12,200	12,800	13,000	23,860	30,700	32,930	35,270	36,310	36,430	37,060
Yard Trimmings	20,000	23,200	27,500	35,000	30,530	32,070	33,200	33,710	33,960	34,200
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,500	3,690	3,820	3,870	3,900	3,930
Total Other Wastes	33,500	37,780	42,750	61,760	64,730	68,690	72,290	73,890	74,290	75,190
Total MSW Generated - Weight	88,120	121,060	151,640	208,270	243,450	253,730	244,600	250,540	251,040	254,110

Materials	Percent of Total Generation									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Paper and Paperboard	34.0%	36.6%	36.4%	34.9%	36.0%	33.4%	28.0%	27.9%	27.3%	27.0%
Glass	7.6%	10.5%	10.0%	6.3%	5.2%	4.9%	4.8%	4.6%	4.6%	4.5%
Metals										
Ferrous	11.7%	10.2%	8.3%	6.1%	5.8%	6.0%	6.5%	6.6%	6.7%	6.9%
Aluminum	0.4%	0.7%	1.1%	1.3%	1.3%	1.3%	1.4%	1.4%	1.4%	1.4%
Other Nonferrous	0.2%	0.6%	0.8%	0.5%	0.7%	0.7%	0.8%	0.8%	0.8%	0.8%
Total Metals	*12.3%*	*11.4%*	*10.2%*	*7.9%*	*7.8%*	*8.0%*	*8.7%*	*8.8%*	*8.9%*	*9.1%*
Plastics	0.4%	2.4%	4.5%	8.2%	10.5%	11.6%	12.3%	12.8%	12.7%	12.8%
Rubber and Leather	2.1%	2.5%	2.8%	2.8%	2.7%	2.9%	3.1%	3.0%	3.0%	3.0%
Textiles	2.0%	1.7%	1.7%	2.8%	3.9%	4.5%	5.3%	5.2%	5.7%	6.0%
Wood	3.4%	3.1%	4.6%	5.9%	5.6%	5.8%	6.4%	6.3%	6.3%	6.2%
Other **	0.1%	0.6%	1.7%	1.5%	1.6%	1.7%	1.9%	1.9%	1.8%	1.8%
Total Materials in Products	62.0%	68.8%	71.8%	70.3%	73.4%	72.9%	70.4%	70.5%	70.4%	70.4%
Other Wastes										
Food	13.8%	10.6%	8.6%	11.5%	12.6%	13.0%	14.4%	14.5%	14.5%	14.6%
Yard Trimmings	22.7%	19.2%	18.1%	16.8%	12.5%	12.6%	13.6%	13.5%	13.5%	13.5%
Miscellaneous Inorganic Wastes	1.5%	1.5%	1.5%	1.4%	1.4%	1.5%	1.6%	1.5%	1.6%	1.5%
Total Other Wastes	38.0%	31.2%	28.2%	29.7%	26.6%	27.1%	29.6%	29.5%	29.6%	29.6%
Total MSW Generated - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

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

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

Details may not add to totals due to rounding.

Table 2. Recovery* of Municipal Solid Waste, 1960 to 2013

(In thousands of tons and percent of generation of each material)

Materials	Thousands of Tons									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Paper and Paperboard	5,080	6,770	11,740	20,230	37,560	41,960	42,500	45,900	44,360	43,400
Glass	100	160	750	2,630	2,880	2,590	3,000	3,180	3,210	3,150
Metals										
Ferrous	50	150	370	2,230	4,680	5,020	5,330	5,450	5,530	5,800
Aluminum	Neg.	10	310	1,010	860	690	690	720	710	700
Other Nonferrous	Neg.	320	540	730	1,060	1,280	1,380	1,430	1,390	1,370
Total Metals	*50*	*480*	*1,220*	*3,970*	*6,600*	*6,990*	*7,400*	*7,600*	*7,630*	*7,870*
Plastics	Neg.	Neg.	20	370	1,480	1,780	2,130	2,660	2,800	3,000
Rubber and Leather	330	250	130	370	820	1,050	1,370	1,330	1,270	1,240
Textiles	50	60	160	660	1,320	1,830	1,980	2,010	2,230	2,300
Wood	Neg.	Neg.	Neg.	130	1,370	1,830	2,200	2,350	2,410	2,470
Other **	Neg.	300	500	680	980	1,210	1,310	1,370	1,330	1,310
Total Materials in Products	5,610	8,020	14,520	29,040	53,010	59,240	61,890	66,400	65,240	64,740
Other Wastes										
Food	Neg.	Neg.	Neg.	Neg.	680	690	850	1,270	1,740	1,840
Yard Trimmings	Neg.	Neg.	Neg.	4,200	15,770	19,860	19,900	19,300	19,590	20,600
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	4,200	16,450	20,550	20,750	20,570	21,330	22,440
Total MSW Recovered - Weight	5,610	8,020	14,520	33,240	69,460	79,790	82,640	86,970	86,570	87,180

Materials	Percent of Generation of Each Material									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Paper and Paperboard	16.9%	15.3%	21.3%	27.8%	42.8%	49.5%	62.1%	65.6%	64.6%	63.3%
Glass	1.5%	1.3%	5.0%	20.1%	22.6%	20.7%	25.5%	27.7%	27.7%	27.3%
Metals										
Ferrous	0.5%	1.2%	2.9%	17.6%	33.1%	33.0%	33.5%	33.0%	32.9%	33.0%
Aluminum	Neg.	1.3%	17.9%	35.9%	27.0%	20.7%	20.1%	20.5%	20.2%	20.0%
Other Nonferrous	Neg.	47.8%	46.6%	66.4%	66.3%	68.8%	71.5%	70.8%	70.2%	68.2%
Total Metals	*0.5%*	*3.5%*	*7.9%*	*24.0%*	*34.8%*	*34.3%*	*34.8%*	*34.4%*	*34.2%*	*34.1%*
Plastics	Neg.	Neg.	0.3%	2.2%	5.8%	6.1%	7.1%	8.3%	8.8%	9.2%
Rubber and Leather	17.9%	8.4%	3.1%	6.4%	12.3%	14.4%	18.3%	17.5%	16.8%	16.1%
Textiles	2.8%	2.9%	6.3%	11.4%	13.9%	15.9%	15.2%	15.3%	15.6%	15.2%
Wood	Neg.	Neg.	Neg.	1.1%	10.1%	12.4%	14.1%	14.9%	15.2%	15.7%
Other **	Neg.	39.0%	19.8%	21.3%	24.5%	28.2%	28.0%	29.5%	29.0%	28.6%
Total Materials in Products	10.3%	9.6%	13.3%	19.8%	29.7%	32.0%	35.9%	37.6%	36.9%	36.2%
Other Wastes										
Food, Other^	Neg.	Neg.	Neg.	Neg.	2.2%	2.1%	2.4%	3.5%	4.8%	5.0%
Yard Trimmings	Neg.	Neg.	Neg.	12.0%	51.7%	61.9%	59.9%	57.3%	57.7%	60.2%
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	6.8%	25.4%	29.9%	28.7%	27.8%	28.7%	29.8%
Total MSW Recovered - %	6.4%	6.6%	9.6%	16.0%	28.5%	31.4%	33.8%	34.7%	34.5%	34.3%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.

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

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

^ Includes recovery of paper and mixed MSW for composting.

Details may not add to totals due to rounding.

Table 3. Materials Discarded* in the Municipal Waste Stream, 1960 to 2013

(In thousands of tons and percent of total discards)

Materials	Thousands of Tons									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Paper and Paperboard	24,910	37,540	43,420	52,500	50,180	42,880	25,930	24,050	24,260	25,200
Glass	6,620	12,580	14,380	10,470	9,890	9,950	8,780	8,310	8,380	8,390
Metals										
Ferrous	10,250	12,210	12,250	10,410	9,470	10,190	10,570	11,090	11,270	11,750
Aluminum	340	790	1,420	1,800	2,330	2,640	2,750	2,800	2,800	2,800
Other Nonferrous	180	350	620	370	540	580	550	590	590	640
Total Metals	*10,770*	*13,350*	*14,290*	*12,580*	*12,340*	*13,410*	13,870	*14,480*	*14,660*	*15,190*
Plastics	390	2,900	6,810	16,760	24,070	27,600	27,940	29,310	29,140	29,520
Rubber and Leather	1,510	2,720	4,070	5,420	5,850	6,240	6,130	6,270	6,300	6,480
Textiles	1,710	1,980	2,370	5,150	8,160	9,680	11,010	11,120	12,110	12,830
Wood	3,030	3,720	7,010	12,080	12,200	12,960	13,390	13,430	13,410	13,300
Other **	70	470	2,020	2,510	3,020	3,080	3,370	3,280	3,250	3,270
Total Materials in Products	49,010	75,260	94,370	117,470	125,710	125,800	110,420	110,250	111,510	114,180
Other Wastes										
Food	12,200	12,800	13,000	23,860	30,020	32,240	34,420	35,040	34,690	35,220
Yard Trimmings	20,000	23,200	27,500	30,800	14,760	12,210	13,300	14,410	14,370	13,600
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,500	3,690	3,820	3,870	3,900	3,930
Total Other Wastes	33,500	37,780	42,750	57,560	48,280	48,140	51,540	53,320	52,960	52,750
Total MSW Discarded - Weight	82,510	113,040	137,120	175,030	173,990	173,940	161,960	163,570	164,470	166,930
Materials	**Percent of Total Discards**									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Paper and Paperboard	30.2%	33.2%	31.7%	30.0%	28.8%	24.7%	16.0%	14.7%	14.8%	15.1%
Glass	8.0%	11.1%	10.5%	6.0%	5.7%	5.7%	5.4%	5.1%	5.1%	5.0%
Metals										
Ferrous	12.4%	10.8%	8.9%	5.9%	5.4%	5.9%	6.5%	6.8%	6.9%	7.0%
Aluminum	0.4%	0.7%	1.0%	1.0%	1.3%	1.5%	1.7%	1.7%	1.7%	1.7%
Other Nonferrous	0.2%	0.3%	0.5%	0.2%	0.3%	0.3%	0.3%	0.4%	0.4%	0.4%
Total Metals	*13.1%*	*11.8%*	*10.4%*	*7.2%*	*7.1%*	*7.7%*	*8.6%*	*8.9%*	*8.9%*	*9.1%*
Plastics	0.5%	2.6%	5.0%	9.6%	13.8%	15.9%	17.3%	17.9%	17.7%	17.7%
Rubber and Leather	1.8%	2.4%	3.0%	3.1%	3.4%	3.6%	3.8%	3.8%	3.8%	3.9%
Textiles	2.1%	1.8%	1.7%	2.9%	4.7%	5.6%	6.8%	6.8%	7.4%	7.7%
Wood	3.7%	3.3%	5.1%	6.9%	7.0%	7.5%	8.3%	8.2%	8.2%	8.0%
Other **	0.1%	0.4%	1.5%	1.4%	1.7%	1.8%	2.1%	2.0%	2.0%	2.0%
Total Materials in Products	59.4%	66.6%	68.8%	67.1%	72.3%	72.3%	68.2%	67.4%	67.8%	68.4%
Other Wastes										
Food	14.8%	11.3%	9.5%	13.6%	17.3%	18.5%	21.3%	21.4%	21.1%	21.1%
Yard Trimmings	24.2%	20.5%	20.1%	17.6%	8.5%	7.0%	8.2%	8.8%	8.7%	8.1%
Miscellaneous Inorganic Wastes	1.6%	1.6%	1.6%	1.7%	2.0%	2.1%	2.4%	2.4%	2.4%	2.4%
Total Other Wastes	40.6%	33.4%	31.2%	32.9%	27.7%	27.7%	31.8%	32.6%	32.2%	31.6%
Total MSW Discarded - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Discards after materials and compost recovery. In this table, discards include combustion with energy recovery. Does not include construction & demolition debris, industrial process wastes, or certain other wastes.

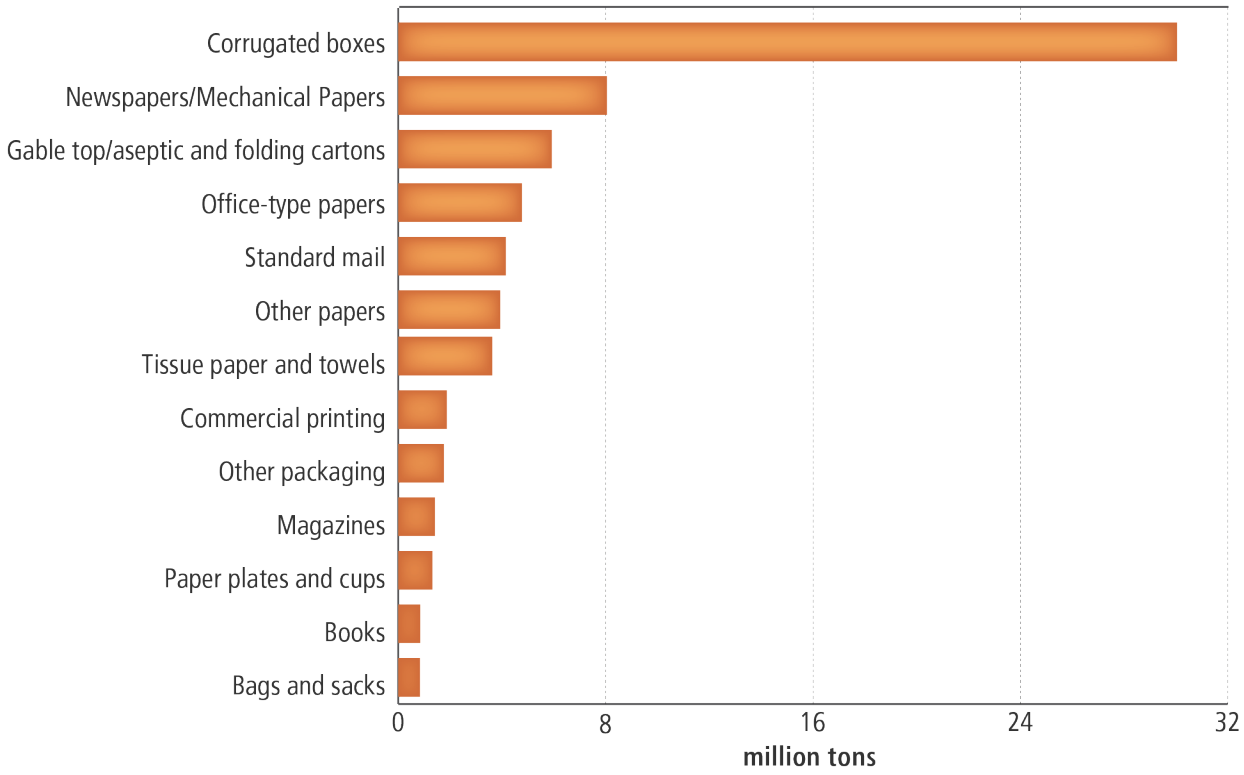
** Includes electrolytes in batteries and fluff pulp, feces, and urine in disposable diapers.

Details may not add to totals due to rounding.

Paper and Paperboard

Collectively, the many products made of paper and paperboard[1] materials comprise the largest component of MSW. The paper and paperboard materials category includes products such as office papers, newspapers, corrugated boxes, milk cartons, tissue paper, and paper plates and cups (Figure 2 and Table 4).

Figure 2. Paper and Paperboard Products Generated in MSW, 2013



Total generation of paper and paperboard in MSW has grown from 30 million tons in 1960 to 68.6 million tons in 2013 (Table 1). Generation peaked in 2000 at approximately 88 million tons. As a percentage of total MSW generation, paper represented 34 percent in 1960 (Table 1). The percentage has varied over time, but is estimated to be 27.0 percent of total MSW generation in 2013.

[1] The term "cardboard" is often used for products made of paperboard (boxboard and containerboard), but this inexact term is not used in the paper industry.

Table 4. Paper And Paperboard Products In MSW, 2013

(In thousands of tons and percent of generation)

Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent of generation)	Discards (Thousand tons)
Nondurable Goods				
Newspapers/Mechanical Papers†	8,050	5,390	67.0%	2,660
Books	850			
Magazines	1,410			
Office-type Papers*	4,770			
Standard Mail**	4,150			
Other Commercial Printing	1,870			
Tissue Paper and Towels	3,620			
Paper Plates and Cups	1,320			
Other Nonpackaging Paper***	3,940			
Subtotal Nondurable Goods excluding Newspaper/Mechanical Papers§	21,930	9,060	41.3%	12,870
Total Paper and Paperboard Nondurable Goods	29,980	14,450	48.2%	15,530
Containers and Packaging				
Corrugated Boxes	30,050	26,590	88.5%	3,460
Gable Top/Aseptic Cartons‡	550			
Folding Cartons	5,370			
Other Paperboard Packaging	70			
Bags and Sacks	830			
Other Paper Packaging	1,690			
Subtotal Containers and Packaging excluding Corrugated Boxes§	8,510	2,360	27.7%	6,150
Total Paper and Paperboard Containers and Packaging	38,560	28,950	75.1%	9,610
Total Paper and Paperboard^	**68,540**	**43,400**	**63.3%**	**25,140**

† Starting in 2010, newsprint and groundwood inserts expanded to include directories and other mechanical papers previously counted as Other Commercial Printing.

* High-grade papers such as copy paper and printer paper; both residential and commercial.

** Formerly called Third Class Mail by the U.S. Postal Service.

*** Includes paper in games and novelties, cards, etc.

§ Valid default values for separating out paper and paperboard sub-categories for recovery and discards were not available.

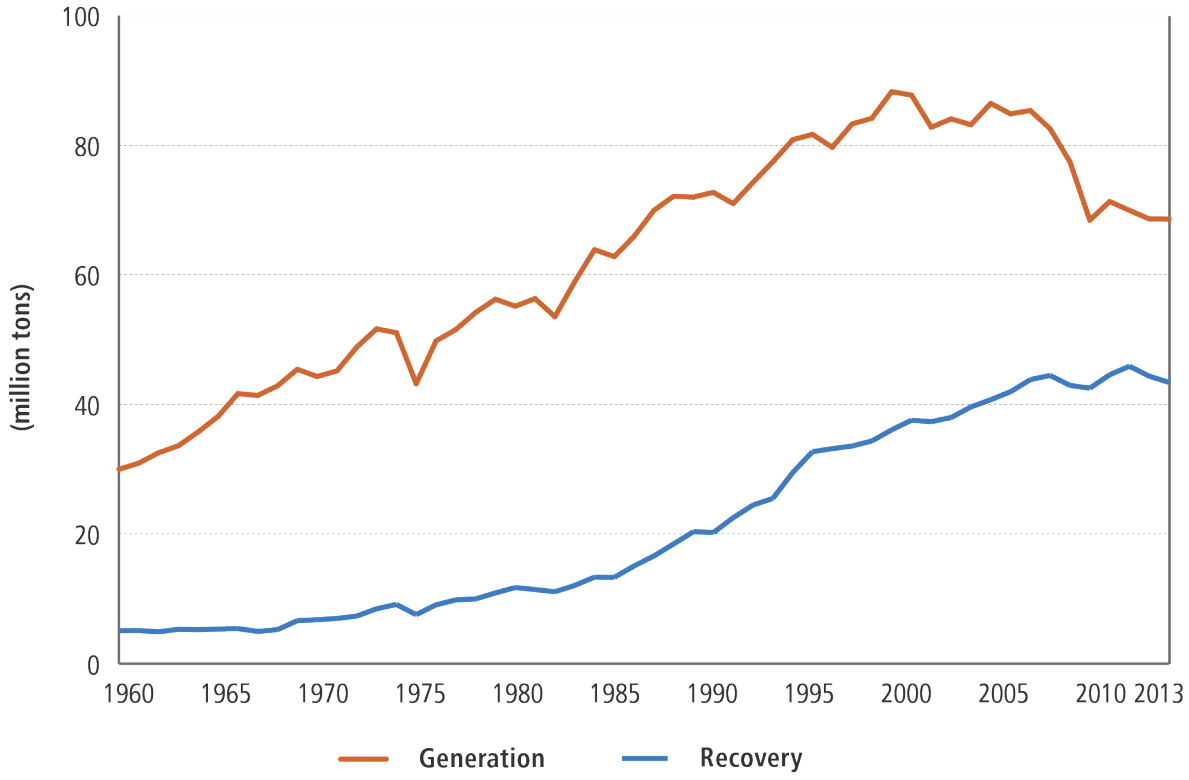
‡ Includes milk, juice, and other products packaged in gable top cartons and liquid food aseptic cartons.

^ Table 4 does not include 10,000 tons of paper used in durable goods and 50,000 tons tissue in disposable diapers (Table 1).

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

As Figure 3 illustrates, paper generation has generally increased since 1960, peaked at about 88 million tons in 2000, and declined after 2000 to less than 69.0 million tons in 2013.

Figure 3. Paper and Paperboard Generation and Recovery, 1960 to 2013



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. Similar but less pronounced declines in paper generation can be seen in other recession years. This sensitivity is most obvious after 2005.

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

Generation. Estimates of paper and paperboard generation are based on statistics published by the American Forest & Paper Association (AF&PA). These statistics include data on new supply (production plus net imports) of the various paper and paperboard grades that go into the products found in MSW. The AF&PA new supply statistics are adjusted to deduct converting scrap, which is generated when sheets or rolls 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, with a few more revisions as new data became available. Various deductions also are made to account for products diverted out of municipal solid waste, such as gypsum wallboard facings (classified as construction and demolition debris) or toilet tissue (which goes to wastewater treatment plants).

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 relatively small amount estimated to have been used in other products such as insulation and 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 (preconsumer industrial process waste) 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 more recent updates, various converting scrap recovery rates ranging from 70 percent to 98 percent were applied to the estimates for 1990 through 2013. The converting scrap recovery rates were developed for a 1992 report for the Recycling Advisory Council. Because recovered 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 among the highest rates overall compared to other materials in MSW (Table 2). As Table 4 shows, over 88 percent of all corrugated boxes were recovered for recycling in 2013; this is up from 67.3 percent in 2000 (Table 21). Newspapers/ mechanical papers were recovered at a rate of 67.0 percent. Recovery of other paper and paperboard products is estimated as mixed paper; 41.3 percent of mixed nondurable paper products and 27.7 percent of mixed paper containers and packaging were recovered. Approximately 43.4 million tons of postconsumer paper and paperboard were recovered in 2013–63.3 percent of total paper and paperboard generation. This is up from 42.8 percent in 2000 (Table 2). Starting in 2010, newspapers (including newsprint and groundwood inserts) were expanded to include directories and other mechanical papers previously counted as Other Commercial Printing.

Discards After Recovery. After recovery of paper and paperboard for recycling, discards were 25.1 million tons in 2013, or 15.1 percent of total MSW discards (Table 3).

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.

Table 5. Glass Products in MSW, 2013

Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent of generation)	Discards (Thousand tons)
Durable Goods*	2,280	Neg.	Neg.	2,280
Containers and Packaging				
Beer and Soft Drink Bottles**	5,420	2,240	41.3%	3,180
Wine and Liquor Bottles	1,740	600	34.5%	1,140
Other Bottles and Jars	2,100	310	14.8%	1,790
Total Glass Containers	9,260	3,150	34.0%	6,110
Total Glass	11,540	3,150	27.3%	8,390

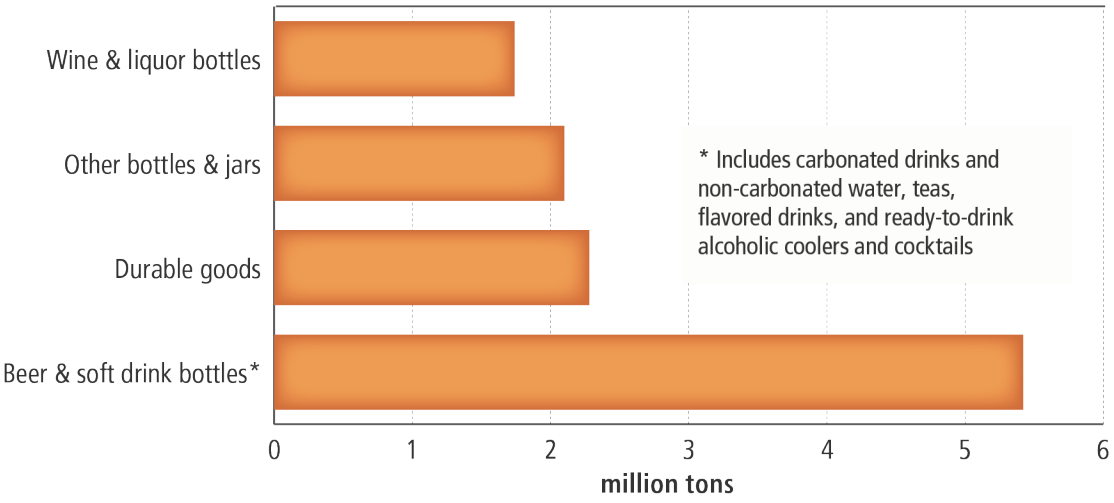
* Glass as a component of appliances, furniture, consumer electronics, etc.

** Includes carbonated drinks and non-carbonated water, teas, flavored drinks, and ready-to-drink alcoholic coolers and cocktails.

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

Details may not add to totals due to rounding.

Figure 4. Glass Products Generated in MSW, 2013



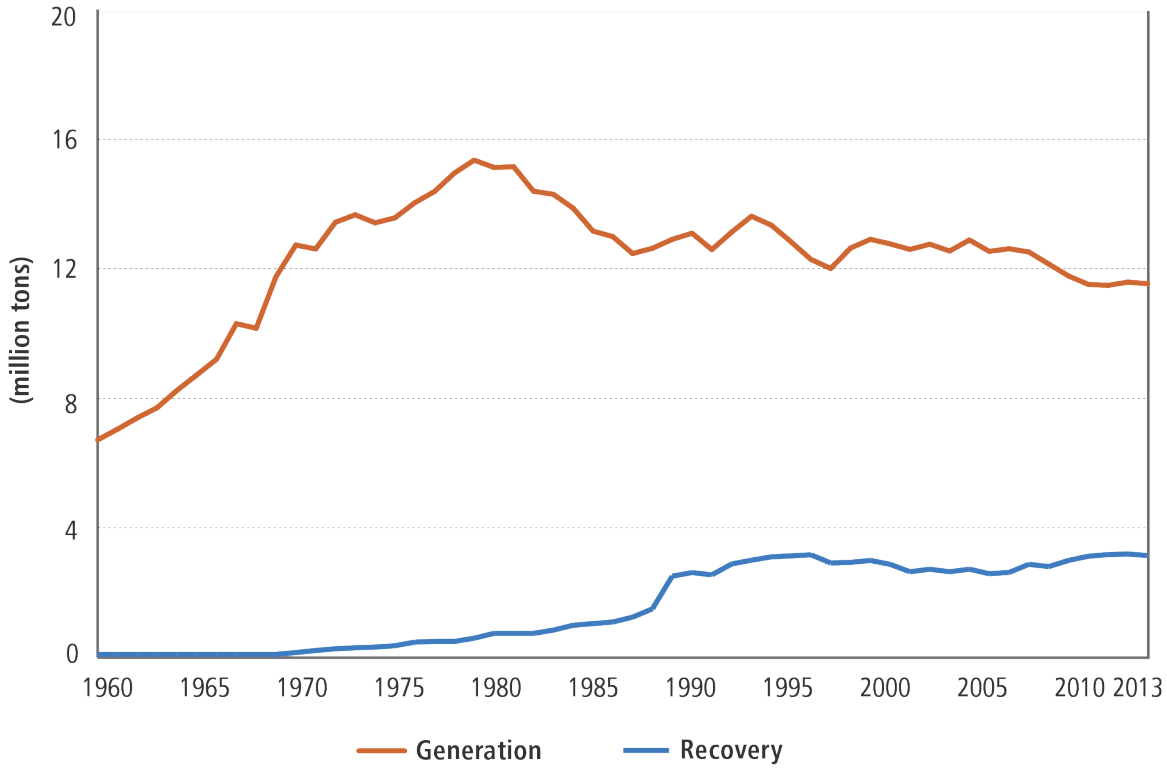
Generation. Estimated glass container generation is based on Glass Packaging Institute statistics on glass container shipments. Glass accounted for 6.7 million tons of MSW in 1960, or 7.6 percent of total generation. Generation of glass continued to grow over the next two decades, but then glass containers were widely displaced by other materials, principally aluminum and plastics. Thus the tonnage of glass in MSW declined in the 1980s, from approximately 15.1 million tons in 1980 to 13.1 million tons in 1990. Beginning about 1987, however, the decline in generation of glass containers slowed (Figure 5). During the 1990s glass generation varied from 12.0 to 13.6 million tons per year.

After 2000, glass generation trended downward from 12.8 to 11.5 million tons in 2013. Glass was 10 percent of MSW generation in 1980, declining to 4.5 percent in 2013.

Recovery. Recovered glass containers (bottles) are used to make new glass containers and other uses such as fiberglass insulation, aggregate, and glasphalt for road construction. Recovery of glass containers is based on a combination of data from the Glass Packaging Institute and state environmental agencies. Recovery of glass containers was estimated at 3.2 million tons in 2013, up from an estimated 2.6 million tons in 2005.

Discards After Recovery. Recovery for recycling lowered discards of glass to 8.4 million tons in 2013 or 5.0 percent of total MSW discards (Table 3).

Figure 5. Glass Generation and Recovery, 1960 to 2013

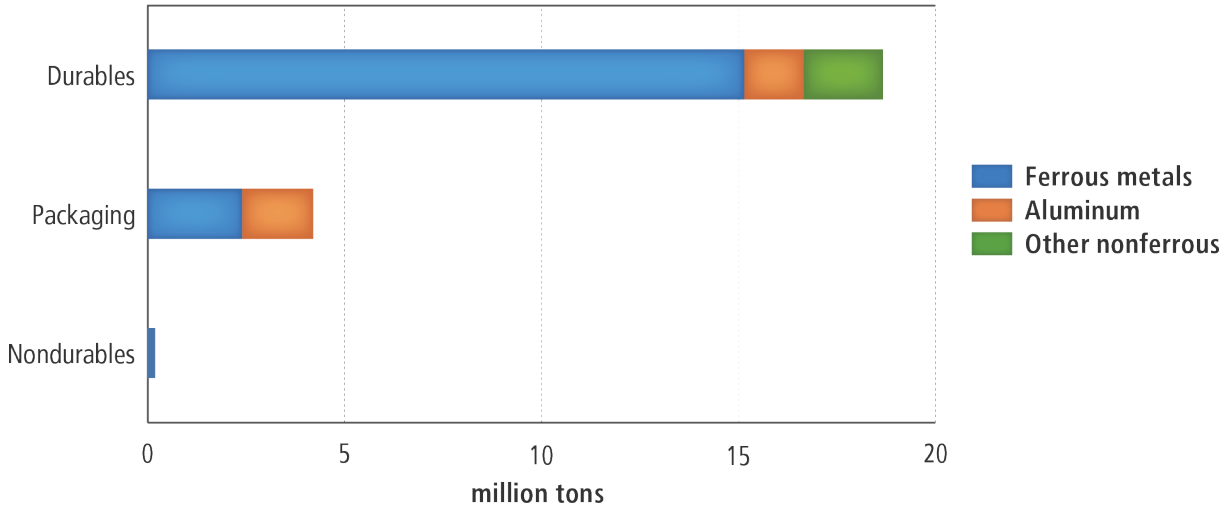


Ferrous Metals

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

Total generation and recovery of metals in MSW from 1960 to 2013 are shown in Figure 7.

Figure 6. Metal Products Generated in MSW, 2013



Generation. Based on industry data, including statistics from the Steel Recycling Institute, approximately 10.3 million tons of ferrous metals were generated in 1960. Like glass, the tonnages grew during the 1960s, but began to slow as lighter materials like aluminum and plastics replaced steel in many applications. Since 1970, generation of ferrous metals has grown from about 12.4 million tons in 1970 to 17.6 million tons in 2013 (Table 1). The percentage of ferrous metals generation in total MSW has declined from 11.7 percent in 1960 to 6.9 percent in 2013.

Recovery. The renewed emphasis on recovery and recycling in recent years has included ferrous metals. Based on data from the Steel Recycling Institute, recovery of ferrous metals from appliances ("white goods") was estimated at a rate of 82 percent in 2013. Recovery of all materials in appliances (including ferrous metals) was estimated at 58.6 percent (Table 13). Overall recovery of ferrous metals from durable goods (large and small appliances, furniture, and tires) was estimated to be 26.8 percent (4.1 million tons) in 2013 (Table 6).

Steel cans were estimated to be recovered at a rate of 70.6 percent (1.3 million tons) in 2013. Approximately 420,000 tons of other steel packaging, including strapping, crowns, and drums, were estimated to have been recovered for recycling in 2013. Recovery of ferrous metals includes material collected through recycling programs as well as metal recovered at combustion facilities.

Discards After Recovery. In 2013, discards of ferrous metals after recovery were 11.8 million tons, or 7.0 percent of total discards (Table 3).

Table 6. Metal Productions in MSW, 2013

(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*	15,150	4,060	26.8%	11,090
Aluminum**	1,510	NA	NA	1,510
Lead†	1,380	1,370	99%	10
Other Nonferrous Metals‡	630	Neg.	Neg.	630
Total Metals in Durable Goods	**18,670**	**5,430**	**29.1%**	**13,240**
Nondurable Goods				
Aluminum	190	NA	NA	190
Containers and Packaging				
Steel				
Cans	1,870	1,320	70.6%	550
Other Steel Packaging	530	420	79.2%	110
Total Steel Packaging	**2,400**	**1,740**	**72.5%**	**660**
Aluminum				
Beer and Soft Drink Cans§	1,270	700	55.1%	570
Other Cans	120	NA	NA	120
Foil and Closures	410	NA	NA	410
Total Aluminum Packaging	**1,800**	**700**	**38.9%**	**1,100**
Total Metals in Containers and Packaging	**4,200**	**2,440**	**58.1%**	**1,760**
Total Metals	23,060	7,870	34.1%	15,190
Ferrous	17,550	5,800	33.0%	11,750
Aluminum	3,500	700	20.0%	2,800
Other nonferrous	2,010	1,370	68.2%	640

* Ferrous metals (iron and steel) in appliances, furniture, tires, and miscellaneous durables.

** Aluminum in appliances, furniture, and miscellaneous durables.

† Lead in lead-acid batteries.

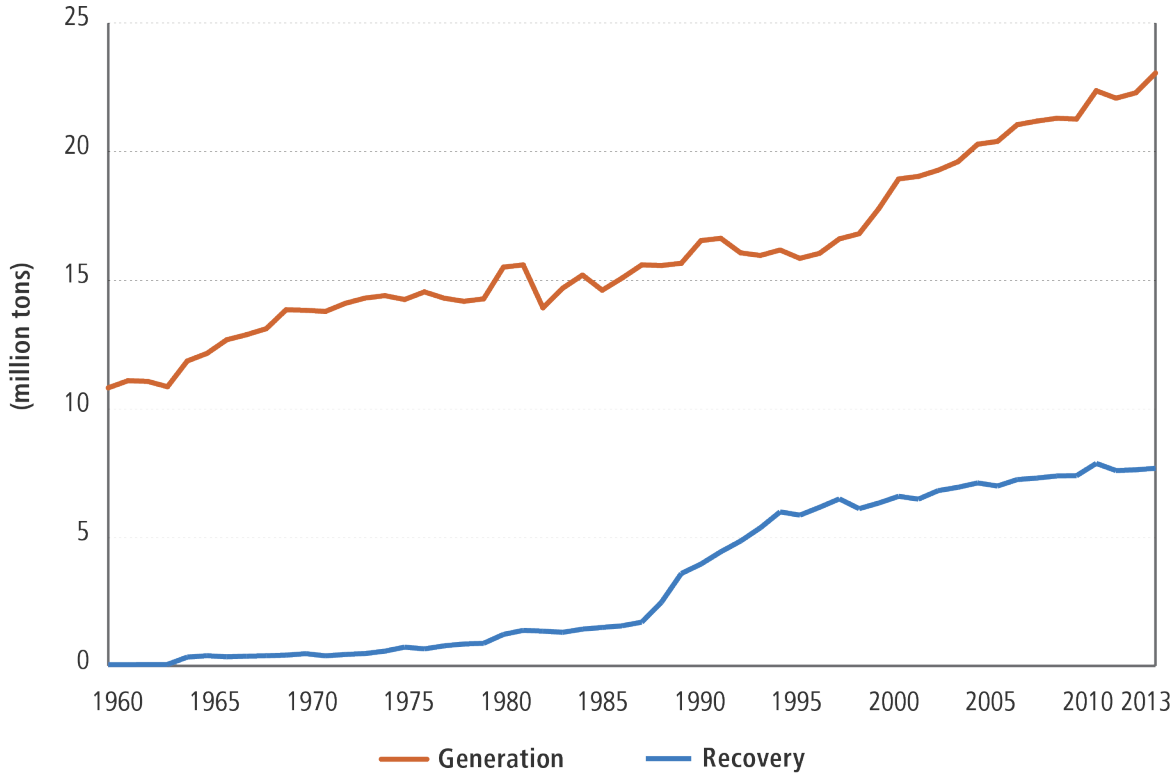
‡ Other nonferrous metals in appliances and miscellaneous durables.

§ Aluminum can recovery does not include used beverage cans imported to produce new beverage cans.

NA = Not Available

Details may not add to totals due to rounding.

Figure 7. Metals Generation and Recovery, 1960 to 2013



Aluminum

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

Generation. Estimated aluminum generation is based on Aluminum Association industry statistics. In 2013, 1.8 million tons of aluminum were generated as containers and packaging, while approximately 1.7 million tons were found in durable and nondurable goods. The total–3.5 million tons–was 1.4 percent of total MSW generation in 2013 (Table 1). Aluminum generation was only 340,000 tons (0.4 percent of MSW generation) in 1960.

Recovery. Similar to generation, recovery of aluminum beverage containers is based on industry data from the Aluminum Association. Aluminum beverage containers were recovered at a rate of 55.1 percent of generation (0.7 million tons) in 2013, and 38.9 percent of all aluminum in containers and packaging (beverage containers, food containers, foil, and other aluminum packaging) was recovered for recycling in 2013.

Discards After Recovery. In 2013, about 2.8 million tons of aluminum were discarded in MSW after recovery, which was 1.7 percent of total MSW discards (Table 3).

Other Nonferrous Metals

Other nonferrous metals (e.g., lead, copper, zinc) are found in durable products such as appliances, consumer electronics, etc. Lead in lead-acid batteries is the most prevalent nonferrous metal (other

than aluminum) in MSW. Note that only lead-acid batteries from passenger cars, trucks, and motorcycles are included. Lead-acid batteries used in large equipment or industrial applications are not included.

Generation. Generation of other nonferrous metals in MSW totaled 2.0 million tons in 2013. Lead in batteries accounted for almost 1.4 million tons of this amount. Generation of these metals has increased slowly, up from 180,000 tons in 1960, 1.1 million tons in 1990, and 1.6 million tons in 2000. As a percentage of total generation, nonferrous metals have never exceeded one percent.

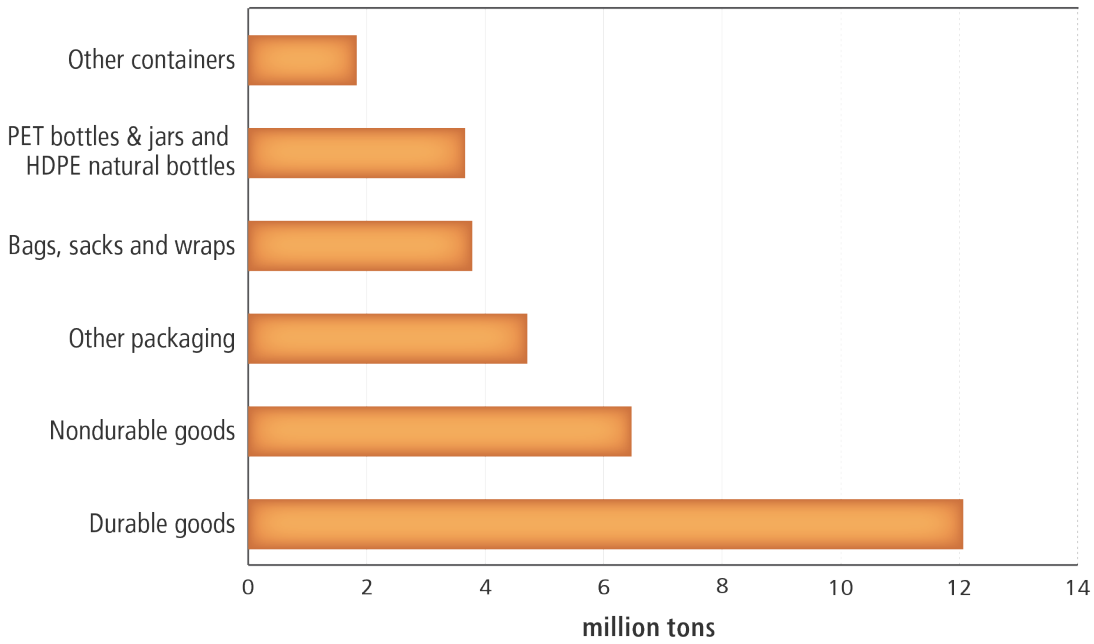
Recovery. Recovery of the other nonferrous metals was almost 1.4 million tons in 2013, with recovery being lead recovered from batteries. It was estimated about 99 percent of battery lead was recovered in 2013.

Discards After Recovery. In 2013, 640,000 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. While plastics are found in all major MSW categories, the containers and packaging category (bags, sacks, and wraps, other packaging, PET bottles, jars and HDPE natural bottles, and other containers) has the most plastic tonnage at almost 14 million tons in 2013 (Figure 8 and Table 7).

Figure 8. Plastics Products Generated in MSW, 2013



In durable goods, plastics are found in appliances, furniture, casings of lead-acid batteries, and other products. (Note that plastics in transportation products other than lead-acid batteries 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.

Table 7. Plastics in Products In MSW, 2013

(In thousands of tons, and percent of generation by resin)

Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent of generation)	Discards (Thousand tons)
Durable Goods				
PET	360			
HDPE	1,290			
PVC	240			
LDPE/LLDPE	2,080			
PP	4,110			
PS	750			
Other resins	3,240			
Total Plastics in Durable Goods	**12,070**	**830**	**6.9%**	**11,240**
Nondurable Goods‡				
Plastic Plates and Cups§				
LDPE/LLDPE	20			20
PLA	20			20
PP	180			180
PS	790			790
Subtotal Plastic Plates and Cups	1,010	Neg.	Neg.	1,010
Trash Bags				
HDPE	200			200
LDPE/LLDPE	780			780
Subtotal Trash Bags	980			980
All other nondurables*				
PET	570			
HDPE	520			
PVC	230			
LDPE/LLDPE	1,170			
PLA	20			
PP	1,210			
PS	200			
Other resins	560			
Subtotal All Other Nondurables	4,480	130	2.9%	4,350
Total Plastics in Nondurable Goods, by resin				
PET	570			
HDPE	720			
PVC	230			
LDPE/LLDPE	1,970			
PLA	40			

Table 7. Plastics in Products In MSW, 2013

(In thousands of tons, and percent of generation by resin)

Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent of generation)	Discards (Thousand tons)
PP	1,390			
PS	990			
Other resins	560			
Total Plastics in Nondurable Goods	**6,470**	**130**	**2.0%**	**6,340**
Plastic Containers & Packaging				
Bottles and Jars**				
PET	2,880	900	31.3%	1,980
Natural Bottles†				
HDPE	780	220	28.2%	560
Other plastic containers				
HDPE	1,390	300	21.6%	1,090
PVC	40	Neg.		40
LDPE/LLDPE	40	Neg.		40
PP	280	30	10.7%	250
PS	80	Neg.		80
Subtotal Other Containers	**1,830**	**330**	**18.0%**	**1,500**
Bags, sacks, & wraps				
HDPE	700	40	5.7%	660
PVC	50			50
LDPE/LLDPE	2,260	470	20.8%	1,790
PP	630			630
PS	140			140
Subtotal Bags, Sacks, & Wraps	**3,780**	**510**	**13.5%**	**3,270**
Other Plastics Packaging‡				
PET	870	30	3.4%	840
HDPE	700	10	1.4%	690
PVC	340	Neg.		340
LDPE/LLDPE	1,110	Neg.		1,110
PLA	10	Neg.		10
PP	990	10	1.0%	980
PS	310	30	9.7%	280
Other resins	380	Neg.		380
Subtotal Other Packaging	**4,710**	**80**	**1.7%**	**4,630**
Total Plastics in Containers & Packaging, by resin				
PET	3,750	930	24.8%	2,820
HDPE	3,570	570	16.0%	3,000
PVC	430	Neg.		430

Table 7. Plastics in Products In MSW, 2013

(In thousands of tons, and percent of generation by resin)

Product Category	Generation	Recovery		Discards
	(Thousand tons)	(Thousand tons)	(Percent of generation)	(Thousand tons)
LDPE/LLDPE	3,410	470	13.8%	2,940
PLA	10	Neg.		10
PP	1,900	40	2.1%	1,860
PS	530	30	5.7%	500
Other resins	380	Neg.		380
Total Plastics in Containers & Packaging	**13,980**	**2,040**	**14.6%**	**11,940**
Total Plastics in MSW, by resin				
PET	4,680	930	19.9%	3,750
HDPE	5,580	570	10.2%	5,010
PVC	900	Neg.		900
LDPE/LLDPE	7,460	470	6.3%	6,990
PLA	50	Neg.		50
PP	7,400	40	0.5%	7,360
PS	2,270	30	1.3%	2,240
Other resins	4,180	960	23.0%	3,220
Total Plastics in MSW	**32,520**	**3,000**	**9.2%**	**29,520**

‡ Nondurable goods other than containers and packaging.

§ Due to source data aggregation, PET cups are included in "Other Plastic Packaging".

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

** Injection stretch blow molded PET containers as identified in *Report on Postconsumer PET Container Recycling Activity in 2012*. National Association for PET Container Resources. Recovery includes caps, lids, and other material collected with PET bottles and jars.

† White translucent homopolymer bottles as defined in the *2007 United States National Postconsumer Plastics Bottles Recycling Report*. American Chemistry Council and the Association of Postconsumer Plastic Recyclers.

Neg. = negligible, less than 5,000 tons

HDPE = High density polyethylene

LDPE = Low density polyethylene

LLDPE = Linear low density polyethylene

‡ Other plastic packaging includes coatings, closures, lids, PET cups, caps, clamshells, egg cartons, produce baskets, trays, shapes, loose fill, etc.

PP caps and lids recovered with PET bottles and jars are included in the recovery estimate for PET bottles and jars.

Other resins include commingled/undefined plastic packaging recovery.

Some detail of recovery by resin omitted due to lack of data.

Plastics are found in such nondurable products as disposable diapers, trash bags, cups, eating utensils, medical devices, and household items such as shower curtains. The plastic food service items are generally made of clear or foamed polystyrene, while trash bags are made of high-density polyethylene (HDPE) or low-density polyethylene (LDPE). 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) beverage 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, and lids.

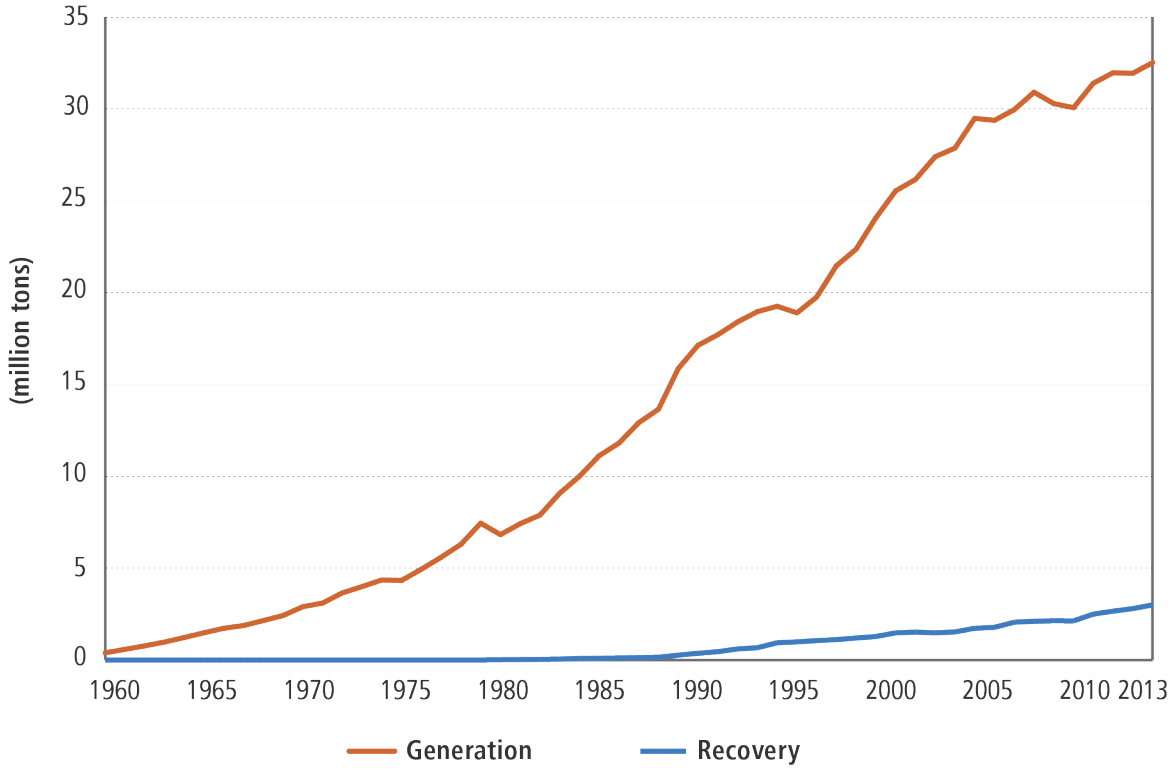
Generation. Production data on plastics resin use in products are taken from the American Chemistry Council's annual resin reports. The basic data are adjusted for product service life, fabrication losses, and net imports of plastic products to derive generation of plastics in the various products in MSW.

Plastics made up an estimated 390,000 tons of MSW generation in 1960. The quantity has increased relatively steadily to 32.5 million tons in 2013 (Figure 9). As a percentage of MSW generation, plastics were less than one percent in 1960, increasing to 12.8 percent in 2013.

Recovery for Recycling. While overall recovery of plastics for recycling is relatively small – 3.0 million tons, or 9.2 percent of plastics generation in 2013 (Table 7) – recovery of some plastic containers is more significant. PET bottles and jars were recovered at a rate of 31.3 percent in 2013. Recovery of high-density polyethylene natural bottles was estimated at 28.2 percent in 2013. Significant recovery of plastics from polypropylene lead-acid battery casings and from some other containers was also reported. The primary sources of data on plastics recovery are annual product recovery surveys conducted for the American Chemistry Council and the National Association for PET Container Resources (NAPCOR).

Discards After Recovery. Discards of plastics in MSW after recovery were 29.5 million tons, or 17.7 percent of total MSW discards in 2013 (Table 3).

Figure 9. Plastics Generation and Recovery, 1960 to 2013



Other Materials

Rubber and Leather

The predominant source of rubber in MSW is rubber tires from automobiles, trucks, and motorcycles (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. Note that only tires from passenger cars, trucks, and motorcycles are included. Tires used in large equipment, aviation, or industrial applications are not included.

Generation. Generation of rubber and leather in MSW has shown slow growth over the years, increasing from 1.8 million tons in 1960 to 7.7 million tons in 2013. One reason for the relatively slow rate of growth is that tires deliver more miles and years of service than in earlier years.

As a percentage of total MSW generation, rubber and leather has been about 3 percent for many years (Table 1).

Recovery for Recycling. The only recovery for recycling identified in this category is rubber from tires, and that was estimated to be 1.2 million tons in 2013,which is approximately 40.5 percent of the total rubber in tires generated in 2013 (Table 8). (This recovery estimate does not include tires retreaded or energy recovery from tires.) Overall, 16.1 percent of total rubber and leather generated in MSW was recovered in 2013.

Table 8. Rubber And Leather Products In MSW, 2013

(In thousands of tons and percent of generation)

Product Category	Generation (Thousand tons)	Recovery (Thousand tons)	Recovery (Percent of generation)	Discards (Thousand tons)
Durable Goods				
Rubber in Tires*	3,060	1,240	40.5%	1,820
Other Durables**	3,600	Neg.	Neg.	3,600
Total Rubber & Leather				
Durable Goods	6,660	1,240	18.6%	5,420
Nondurable Goods				
Clothing and Footwear	810	Neg.	Neg.	810
Other Nondurables	250	Neg.	Neg.	250
Total Rubber & Leather				
Nondurable Goods	1,060	Neg.	Neg.	1,060
Total Rubber & Leather	7,720	1,240	16.1%	6,480

* Automobile and truck tires. Does not include other materials in tires.

** Includes carpets and rugs and other miscellaneous durables.

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

Details may not add to totals due to rounding.

Discards After Recovery. Discards of rubber and leather after recovery were 6.5 million tons in 2013 (3.9 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 15.1 million tons of textiles were generated in 2013 or 6.0 percent of total MSW generation (Table 1). Significant amounts of textiles enter the reuse market. Since reuse occurs prior to generation, the amount of reused textiles is not included in the generation estimates (or estimated separately). However, the reused garments and wiper rags enter the waste stream eventually becoming part of MSW generation.

Recovery for Recycling and Discards. It was estimated that 14.4 percent of textiles in clothing and footwear and 18.0 percent of items such as sheets and pillowcases was recovered for export or reprocessing in 2013 (1.8 million tons) (Table 16). The recovery rate for all textiles is 15.2 percent in 2013 (2.3 million tons) (Table 2).

Wood

The sources of wood in MSW include furniture, other durable goods (e.g., cabinets for electronic equipment), wood packaging (crates, pallets), and some other miscellaneous products. Generation and recovery methodologies for wood pallets are based on market research report data combined with data from the Center for Forest Products Marketing and Management (Virginia Polytechnic Institute).

Generation. Generation of wood in MSW was 15.8 million tons in 2013 (6.2 percent of total MSW generation).

Recovery for Recycling and Discards. Wood pallet recovery for recycling (usually by chipping for uses such as mulch or bedding material, but excluding wood combusted as fuel) was estimated at 2.5 million tons in 2013 (15.7 percent recovery rate).

Accounting for recovery for recycling, wood discards were 13.3 million tons in 2013, or 8.0 percent of total MSW discards (Table 3).

Other Materials

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

Food

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

Generation. No production data are available for food. Food from residential and commercial sources were estimated using data from sampling studies in various parts of the country in combination with demographic data on population, grocery store sales, restaurant sales, numbers of employees, and

numbers of prisoners, students, and patients in institutions. Seventeen residential food measurement studies provided the basis for the average per capita generation factor (0.357 pounds per person per day) applied to population. Numerous food retail and institutional measurement studies provided the factors applied to appropriate economic data for the commercial portion of the food generation estimate. Generation of residential and commercial food was estimated to be 37.1 million tons in 2013 (14.6 percent of total generation) (Table 1). Food generation has increased, from earlier versions of this report, due to increased population and revised residential sampling study data.

Significant amounts of food products are donated by residents and commercial establishments (such as grocery stores and restaurants) to local food banks and charities. A good portion of these food donations (in particular, the commercial establishment donations of wholesome but not-for-retail food products) represents waste diversion by removing food that would otherwise need to be managed either through composting or disposal. Data on these types of programs are limited. This diversion takes place prior to generation and therefore is not included in the generation estimates presented in this report.

Recovery for Composting and Discards. Beginning in 1994 for this series of reports, a significant amount of food composting from commercial sources was identified. As the data source (a survey published by *BioCycle* magazine) improved, it became apparent that some other composted materials (e.g., industrial food processing wastes) had been included with food classified as MSW in the past. Beginning in 2004, *BioCycle* staff conducted more targeted data gathering of MSW food composting from primary sources including state solid waste officials, large-scale municipal and commercial composting facilities, and large generators (e.g., supermarkets and restaurants). Since 2010, food composting data published by state environmental agencies have been used to estimate the tonnage of food composted.

The targeted state data gathering of MSW food composting operations resulted in an estimate of 1.47 million tons of food waste composted in 2013. A separate *BioCycle* publication estimated 370,000 tons of MSW composted in 2013. MSW composting includes the composting of food as well as other organic materials found in MSW. The total – 1.8 million tons of food and other organic materials composted in 2013 – is shown in the recovery tables. Food recovered in 2013 is higher compared to earlier years due to a combination of better data measurement and growth in composting programs.

Yard Trimmings

Yard trimmings[2] include grass, leaves, and tree and brush trimmings from residential, institutional, and commercial sources.

Generation. In the earliest versions of this report, generation of yard trimmings was estimated using sampling studies and population data. While generation of yard trimmings had been increasing steadily as population and residential housing grew (i.e., constant generation on a per capita basis), in the 1990s local and state governments started enacting legislation that discouraged yard trimmings disposal in landfills.

[2] Although limited data are 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.

Legislation affecting yard trimmings disposal in landfills was tabulated, using published sources. In 1992, 11 states and the District of Columbia—accounting for more than 28 percent of the nation's population—had legislation in effect that bans or discourages yard trimmings disposal in landfills. The tabulation of current legislation shows 21 states—representing about 39 percent of the nation's population—have legislation affecting disposal of yard trimmings. In addition, some local and regional jurisdictions regulate disposal of yard trimmings. This has led to an increase in backyard composting and the use of mulching mowers to allow grass trimmings to remain in place since the early 1990's. However, we are unable to estimate the influence of backyard composting and use of mulching mowers on a yearly basis.

Using these facts, it was estimated that yard trimmings generation has declined since 1990. In the absence of significant new legislation, yard trimmings generation has been increasing slightly since 2000 (i.e., increasing as natural population and residential dwelling units increase) (Table 1). An estimated 34.2 million tons of yard trimmings were generated in MSW in 2013.

Recovery for Composting and Discards. Recovery for composting of yard trimmings was estimated using information from state composting programs that estimated tonnages composted or mulched in 2013. State reported composting tonnages may vary on a yearly basis with the amount of storm debris composted. Analysis of this information resulted in an estimate of 20.6 million tons of yard trimmings removed for composting or wood waste mulching in 2013 – a significant increase over the 2000 estimate of 15.8 million tons.

It should be noted that the estimated 20.6 million tons recovered for composting in 2013 does not include yard trimmings recovered for direct landspreading disposal. It also should be noted that these recovery estimates do not account for backyard composting by individuals and practices such as less bagging of grass clippings. These are source reduction activities taking place onsite, while the yard trimmings recovery estimates are based on material sent off-site.

Miscellaneous Inorganic Wastes

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

Generation, Recovery, and Discards. This category contributed an estimated 3.9 million tons of MSW in 2013. No recovery of these products was identified; discards are the same as generation.

Summary of Materials in Municipal Solid Waste

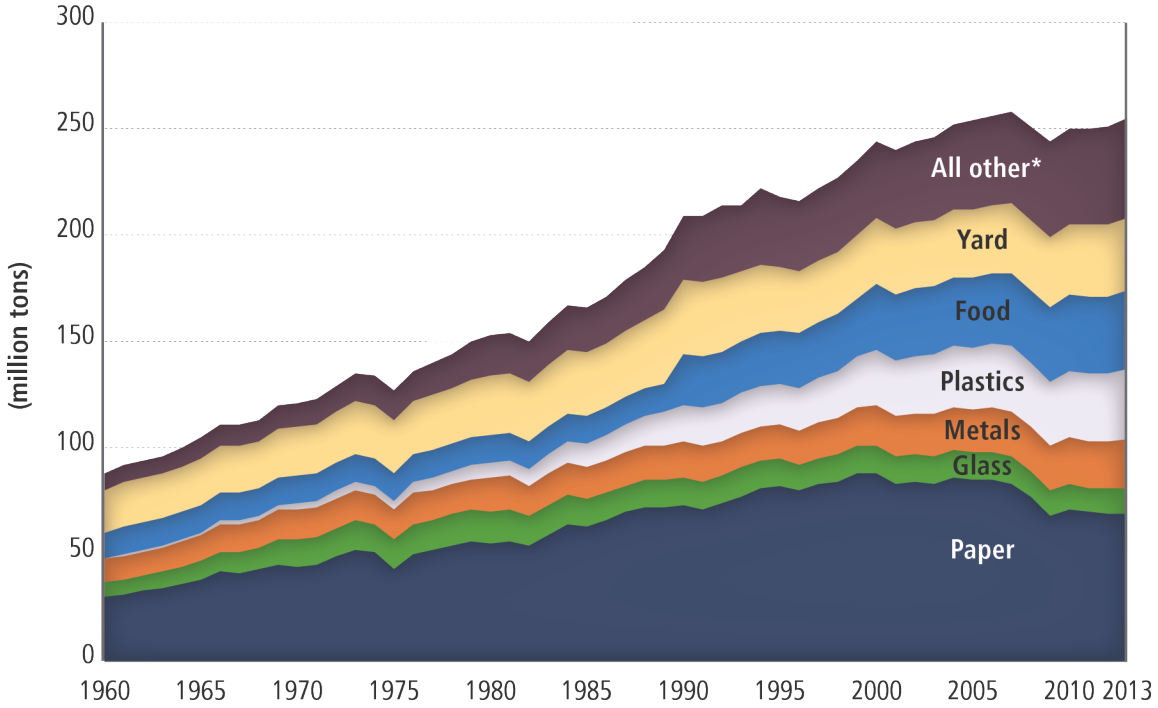
Generation. Changing quantities and composition of municipal solid waste generation are illustrated in Figure 10. Generation of MSW has grown relatively steadily, from 88.1 million tons in 1960 to 254.1 million tons in 2013.

Over the years paper and paperboard has been the dominant material category generated in MSW, accounting for 68.6 million tons (27.0 percent of generation) in 2013. Food, the second largest material component of MSW at 37.1 million tons (14.6 percent of MSW generation) has increased in terms of MSW tonnage and percentage of total MSW. Yard trimmings, the third largest material component of MSW at 34.2 million tons (13.5 percent of generation) has declined as a percentage of MSW since

1990, due to state and local legislated landfill disposal restrictions and increased emphasis on backyard composting and other source reduction measures such as the use of mulching mowers.

Metals account for 23.1 million tons (9.1 percent of MSW generation) and have remained fairly constant as a source of MSW since 2000. Glass increased until the 1980s; decreasing in tonnage and as a percent of MSW generation since the 1990s. Glass generation was 11.5 million tons in 2013, 4.5 percent of generation. Plastics have increasingly been used in a variety of products and thus have been a rapidly growing component of MSW. In terms of tonnage contributed, they ranked fourth in 2013 (behind paper, food, and yard trimmings) at 32.5 million tons, and account for 12.8 percent of MSW generation.

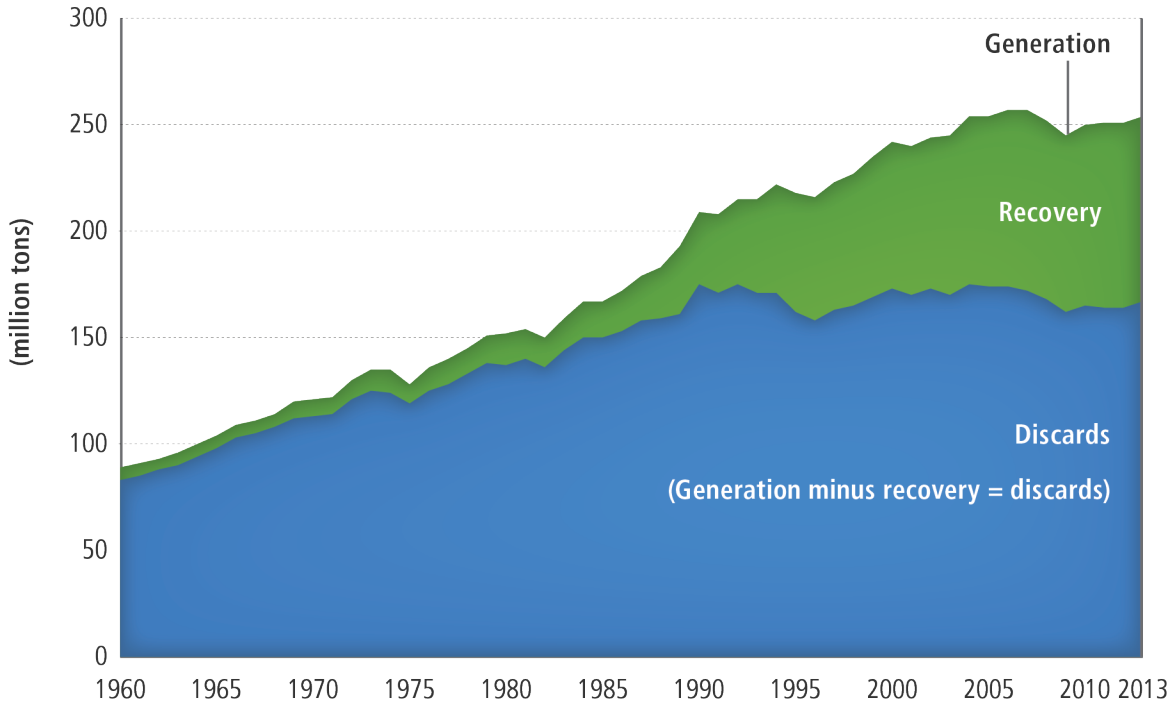
Figure 10. Generation of Materials in MSW, 1960 to 2013



* "All other" includes primarily wood, rubber and leather, and textiles.

Recovery and Discards. The effect of recovery on MSW discards is illustrated in Figure 11. Recovery of materials for recycling and composting grew at a rather slow pace from 1960 to the 1980s, increasing only from 5.6 million tons (6.4 percent of generation) in 1960 to 14.5 million tons (9.6 percent) in 1980. Renewed interest in recycling (including composting) as waste management alternatives came about in the late 1980s, and the recovery rate in 1990 was estimated to be 33.2 million tons (16.0 percent of generation), increasing to 69.5 million tons (28.5 percent) in 2000, and 87.2 million tons (34.3 percent of generation) in 2013.

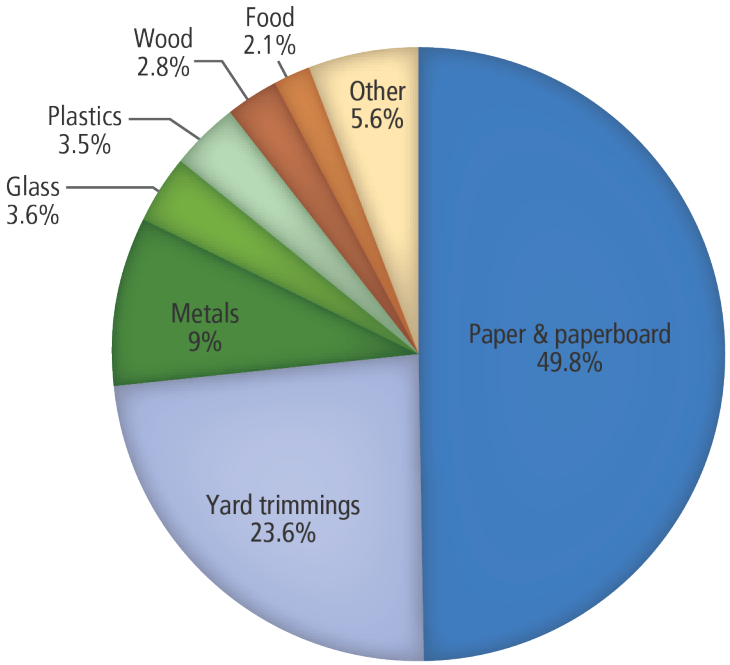
Figure 11. Recovery and Discards of Materials in MSW, 1960 to 2013



Estimated recovery of materials (including composting) is shown in Figure 12. In 2013, recovery of paper and paperboard dominated materials recovery at 49.8 percent of total tonnage recovered, while yard trimmings contributed 23.6 percent of total recovery. 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 12. Materials Recovery in MSW,* 2013

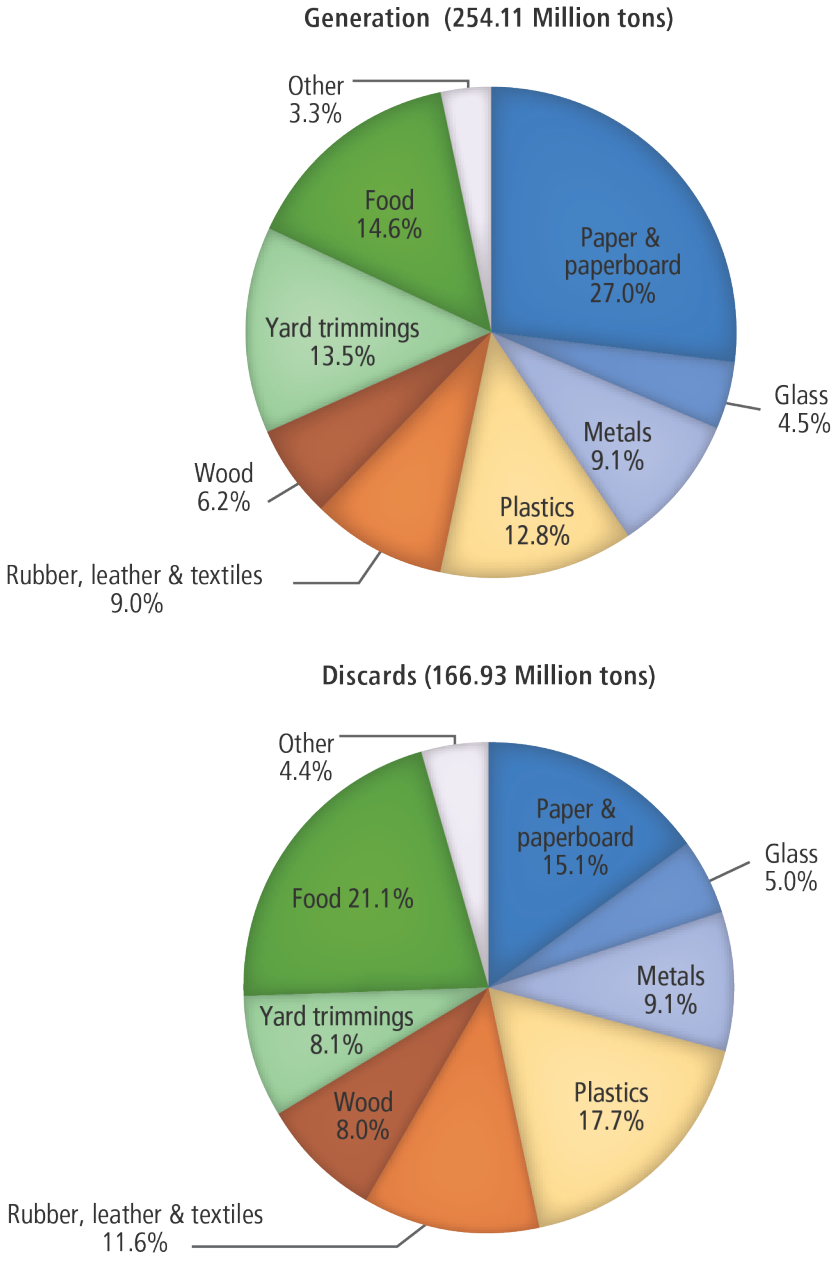
87.2 Million tons



* In percent by weight of total recovery

Figure 13 illustrates the effect of recovery of materials for recycling, including composting, on the composition of MSW discards. For example, paper and paperboard products were 27.0 percent of MSW generated in 2013, but after recovery, paper and paperboard products were 15.1 percent of discards. Materials that have less recovery exhibit a larger percentage of MSW discards compared to generation. For example, plastic products were 12.8 percent of MSW generated in 2013 and, after recovery, were 17.7 percent of discards.

Figure 13. Materials Generated and Discarded* in MSW, 2013
(In percent of total generation and discards)



* Discards in this figure include combustion with energy recovery

The Chapter 2 section above gave a breakdown of municipal solid waste by material. It described how the 254.1 million tons of MSW were generated, recycled (including composted) and disposed of. The following section breaks out the same 254.1 million tons of MSW by product.

Products in Municipal Solid Waste

The purpose of this section is to show how the products that make up municipal solid waste are generated, recycled (including composted) and discarded. For the analysis, products are divided into

three basic categories: durable goods, nondurable goods, and containers and packaging. These three categories generally follow the definitions of the U.S. Department of Commerce, one of EPA's data sources. By these definitions, durable goods, (e.g., appliances) are those that last 3 years or more, while nondurable goods (e.g., newspapers and trash bags) last less than 3 years. For this report, containers and packaging are assumed to be discarded the same year the products they contain are purchased.

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

At the bottom of each of these 15 tables (Tables 9 through 23) there is a section titled "Other Wastes." This contains information on food, yard trimmings, and miscellaneous inorganic wastes. These wastes are not products that can be estimated through the materials flow methodology, but they are estimated by other means, as described earlier.

Within Tables 9 through 23, the first three tables – Tables 9 through 11 – serve as an index to the other tables. Table 9 shows what tables to consult for detailed information on generation; Table 10 shows what tables to consult for detailed information on recovery; and Table 11 does the same for detailed information on discards. The tables on generation all have the same "bottom line" – 254.1 million tons in 2013 – with detail provided in different categories – durable goods, nondurable goods, or containers and packaging. For Table 10 and related tables, the "bottom line" is MSW is recovered – 87.2 million tons; and for Table 11 and related tables, the "bottom line" is MSW discarded – 166.9 million tons. The "bottom line" for each of the quantity tables is calculated by adding the major category subtotal lines.

Durable Goods

Durable goods generally are defined as products having a lifetime of three years or more, although there are some exceptions. In this report, durable goods include large and small appliances, furniture and furnishings, carpets and rugs, rubber tires, lead-acid automotive batteries, consumer electronics, and other miscellaneous durable goods (e.g., luggage, sporting goods, miscellaneous household goods) (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 2013, 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 51.6 million tons in 2013 (20.3 percent of total MSW generation). After recovery for recycling, 42.3 million tons of durable goods remained as discards in 2013.

Table 9. Categories of Products Generated* in the Municipal Waste Stream, 1960 to 2013

(In thousands of tons and percent of total generation)

Products	Thousands of Tons									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods	9,920	14,660	21,800	29,810	38,870	45,060	47,510	49,720	50,090	51,550
(Detail in Table 12)										
Nondurable Goods	17,330	25,060	34,420	52,170	64,010	63,650	53,480	51,590	51,430	51,600
(Detail in Table 15)										
Containers and Packaging	27,370	43,560	52,670	64,530	75,840	76,330	71,320	75,340	75,230	75,770
Detail in Table 18)										
***Total Product** Wastes*	54,620	83,280	108,890	146,510	178,720	185,040	172,310	176,650	176,750	178,920
Other Wastes										
Food	12,200	12,800	13,000	23,860	30,700	32,930	35,270	36,310	36,430	37,060
Yard Trimmings	20,000	23,200	27,500	35,000	30,530	32,070	33,200	33,710	33,960	34,200
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,500	3,690	3,820	3,870	3,900	3,930
Total Other Wastes	33,500	37,780	42,750	61,760	64,730	68,690	72,290	73,890	74,290	75,190
Total MSW Generated - Weight	88,120	121,060	151,640	208,270	243,450	253,730	244,600	250,540	251,040	254,110

Products	Percent of Total Generation									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods	11.3%	12.1%	14.4%	14.3%	16.0%	17.8%	19.4%	19.8%	20.0%	20.3%
(Detail in Table 12)										
Nondurable Goods	19.7%	20.7%	22.7%	25.0%	26.3%	25.1%	21.9%	20.6%	20.5%	20.3%
(Detail in Table 15)										
Containers and Packaging	31.1%	36.0%	34.7%	31.0%	31.2%	30.1%	29.2%	30.1%	30.0%	29.8%
(Detail in Table 19)										
***Total Product** Wastes*	62.0%	68.8%	71.8%	70.3%	73.4%	72.9%	70.4%	70.5%	70.4%	70.4%
Other Wastes										
Food	13.8%	10.6%	8.6%	11.5%	12.6%	13.0%	14.4%	14.5%	14.5%	14.6%
Yard Trimmings	22.7%	19.2%	18.1%	16.8%	12.5%	12.6%	13.6%	13.5%	13.5%	13.5%
Miscellaneous Inorganic Wastes	1.5%	1.5%	1.5%	1.4%	1.4%	1.5%	1.6%	1.5%	1.6%	1.5%
Total Other Wastes	38.0%	31.2%	28.2%	29.7%	26.6%	27.1%	29.6%	29.5%	29.6%	29.6%
Total MSW Generated - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

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

** Other than food products.

Details may not add to totals due to rounding.

Table 10. Recovery* of Municipal Solid Waste, 1960 to 2013

(In thousands of tons and percent of generation of each category)

Products	Thousands of Tons									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods	350	940	1,360	3,460	6,580	7,970	8,790	9,290	9,210	9,280
(Detail in Table 13)										
Nondurable Goods	2,390	3,730	4,670	8,800	17,560	19,770	18,890	18,830	17,270	16,410
(Detail in Table 16)										
Containers and Packaging	2,870	3,350	8,490	16,780	28,870	31,500	34,210	38,280	38,760	39,050
(Detail in Table 20)										
Total Product** Wastes	5,610	8,020	14,520	29,040	53,010	59,240	61,890	66,400	65,240	64,740
Other Wastes										
Food, Other^	Neg.	Neg.	Neg.	Neg.	680	690	850	1,270	1,740	1,840
Yard Trimmings	Neg.	Neg.	Neg.	4,200	15,770	19,860	19,900	19,300	19,590	20,600
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	4,200	16,450	20,550	20,750	20,570	21,330	22,440
Total MSW Recovered - Weight	5,610	8,020	14,520	33,240	69,460	79,790	82,640	86,970	86,570	87,180
Products	**Percent of Generation of Each Category**									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods	3.5%	6.4%	6.2%	11.6%	16.9%	17.7%	18.5%	18.7%	18.4%	18.0%
(Detail in Table 13)										
Nondurable Goods	13.8%	14.9%	13.6%	16.9%	27.4%	31.1%	35.3%	36.5%	33.6%	31.8%
(Detail in Table 16)										
Containers and Packaging	10.5%	7.7%	16.1%	26.0%	38.1%	41.3%	48.0%	50.8%	51.5%	51.5%
(Detail in Table 21)										
Total Product** Wastes	10.3%	9.6%	13.3%	19.8%	29.7%	32.0%	35.9%	37.6%	36.9%	36.2%
Other Wastes										
Food, Other^	Neg.	Neg.	Neg.	Neg.	2.2%	2.1%	2.4%	3.5%	4.8%	5.0%
Yard Trimmings	Neg.	Neg.	Neg.	12.0%	51.7%	61.9%	59.9%	57.3%	57.7%	60.2%
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	6.8%	25.4%	29.9%	28.7%	27.8%	28.7%	29.8%
Total MSW Recovered - %	6.4%	6.6%	9.6%	16.0%	28.5%	31.4%	33.8%	34.7%	34.5%	34.3%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.

** Other than food products.

^ Includes recovery of soiled paper and mixed MSW for composting.

Details may not add to totals due to rounding. Neg. = Less than 5,000 tons or 0.05 percent.

Table 11. Categories of Products Discarded* in the Municipal Waste Stream, 1960 to 2013

(In thousands of tons and percent of total discards)

Products	Thousands of Tons									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods	9,570	13,720	20,440	26,350	32,290	37,090	38,720	40,430	40,880	42,270
(Detail in Table 14)										
Nondurable Goods	14,940	21,330	29,750	43,370	46,450	43,880	34,590	32,760	34,160	35,190
(Detail in Table 17)										
Containers and Packaging	24,500	40,210	44,180	47,750	46,970	44,830	37,110	37,060	36,470	36,720
(Detail in Table 22)										
***Total Product** Wastes*	49,010	75,260	94,370	117,470	125,710	125,800	110,420	110,250	111,510	114,180
Other Wastes										
Food	12,200	12,800	13,000	23,860	30,020	32,240	34,420	35,040	34,690	35,220
Yard Trimmings	20,000	23,200	27,500	30,800	14,760	12,210	13,300	14,410	14,370	13,600
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,500	3,690	3,820	3,870	3,900	3,930
Total Other Wastes	33,500	37,780	42,750	57,560	48,280	48,140	51,540	53,320	52,960	52,750
Total MSW Discarded - Weight	82,510	113,040	137,120	175,030	173,990	173,940	161,960	163,570	164,470	166,930

Products	Percent of Total Discards									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods	11.6%	12.1%	14.9%	15.1%	18.6%	21.3%	23.9%	24.7%	24.9%	25.3%
(Detail in Table 14)										
Nondurable Goods	18.1%	18.9%	21.7%	24.8%	26.7%	25.2%	21.4%	20.0%	20.8%	21.1%
(Detail in Table 17)										
Containers and Packaging	29.7%	35.6%	32.2%	27.3%	27.0%	25.8%	22.9%	22.7%	22.2%	22.0%
(Detail in Table 23)										
***Total Product** Wastes*	59.4%	66.6%	68.8%	67.1%	72.3%	72.3%	68.2%	67.4%	67.8%	68.4%
Other Wastes										
Food	14.8%	11.3%	9.5%	13.6%	17.3%	18.5%	21.3%	21.4%	21.1%	21.1%
Yard Trimmings	24.2%	20.5%	20.1%	17.6%	8.5%	7.0%	8.2%	8.8%	8.7%	8.1%
Miscellaneous Inorganic Wastes	1.6%	1.6%	1.6%	1.7%	2.0%	2.1%	2.4%	2.4%	2.4%	2.4%
Total Other Wastes	40.6%	33.4%	31.2%	32.9%	27.7%	27.7%	31.8%	32.6%	32.2%	31.6%
Total MSW Discarded - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Discards after materials and compost recovery. In this table, discards include combustion with energy 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.

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 Market Profile, Appliance Manufacturer Shipments Forecasts,* and *Appliance Statistical Review.* 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 up to 30 years.

Generation of major appliances has increased very slowly over the years. In 2013, generation was 4.5 million tons, or 1.8 percent of total MSW generation. In general, the number of units of appliances has increased but average weight per unit has decreased over the years. Ferrous metals (steel and iron) are the predominant materials in major appliances, but other metals, plastics, glass, and other materials are also present.

Data on recovery of ferrous metals from major appliances are taken from a survey conducted by the Steel Recycling Institute. Recovery of ferrous metals from shredded appliances was estimated to be 2.6 million tons in 2013, leaving 1.9 million tons of appliances to be discarded.

Small Appliances. This category includes items such as toasters, hair dryers, electric coffee pots, and the like. Information on shipments of small appliances was obtained from Department of Commerce data, *Annual Appliance Industry Forecasts*, and *Appliance Statistical Review*. Information on weights and materials composition of discarded small appliances was obtained through manufacturer specifications and interviews. It was estimated that 2 million tons of small appliances were generated in 2013. A small amount of ferrous metals in small appliances is recovered through magnetic separation.

Furniture and Furnishings. Data on sales of furniture and furnishings are provided by the Department of Commerce in dollars. These data are converted to tons using factors developed for this study over the years. For example, factors are developed by applying sales growth statistics (expressed as constant dollars) in household and office furniture, curtains, and mattresses to textile consumption (in tons) in household and office furniture, curtains, and mattresses manufacturing for those years where consumption data are available. These factors are then applied to those years where sales statistics are available but consumption data are not available. Adjustments are made for imports and exports and adjustments are made for the lifetimes of the furniture.

Generation of furniture and furnishings represents products at the end-of-life (after primary use and reuse by secondary owners). Generation of furniture and furnishings in MSW has increased from 2.2 million tons in 1960 to 11.6 million tons in 2013 (4.6 percent of total MSW). The only recovery of materials from furniture identified was mattress recovery. According to an industry representative, mattress recovery is estimated at 10,000 tons. Wood is the largest material category in furniture, with ferrous metals second. Plastics, glass, and other materials are also found in furniture. Although recovery of wood, textiles, and metals may be occurring, no measurable data source could be identified for this analysis.

Table 12. Products Generated* in the Municipal Waste Stream, 1960 to 2013 (With Detail On Durable Goods)

(In thousands of tons and percent of total generation)

Products	Thousands of Tons									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods										
Major Appliances	1,630	2,170	2,950	3,310	3,640	3,610	3,760	4,080	4,190	4,470
Small Appliances**				460	1,040	1,180	1,630	1,900	1,950	1,950
Furniture and Furnishings	2,150	2,830	4,760	6,790	8,120	9,340	10,500	11,130	11,500	11,620
Carpets and Rugs**				1,660	2,460	2,960	3,550	3,830	3,860	3,820
Rubber Tires	1,120	1,890	2,720	3,610	4,930	4,910	4,780	4,740	4,710	4,770
Batteries, Lead-Acid	Neg.	820	1,490	1,510	2,280	2,750	2,890	3,000	2,920	2,880
Miscellaneous Durables										
Selected Consumer Electronics***					1,900	2,630	3,190	3,300	3,270	3,140
Other Miscellaneous Durables					14,500	17,680	17,210	17,740	17,690	18,900
Total Miscellaneous Durables	5,020	6,950	9,880	12,470	16,400	20,310	20,400	21,040	20,960	22,040
Total Durable Goods	9,920	14,660	21,800	29,810	38,870	45,060	47,510	49,720	50,090	51,550
Nondurable Goods	17,330	25,060	34,420	52,170	64,010	63,650	53,480	51,590	51,430	51,600
(Detail in Table 15)										
Containers and Packaging	27,370	43,560	52,670	64,530	75,840	76,330	71,320	75,340	75,230	75,770
(Detail in Table 18)										
Total Product Wastes†	54,620	83,280	108,890	146,510	178,720	185,040	172,310	176,650	176,750	178,920
Other Wastes										
Food	12,200	12,800	13,000	23,860	30,700	32,930	35,270	36,310	36,430	37,060
Yard Trimmings	20,000	23,200	27,500	35,000	30,530	32,070	33,200	33,710	33,960	34,200
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,500	3,690	3,820	3,870	3,900	3,930
Total Other Wastes	33,500	37,780	42,750	61,760	64,730	68,690	72,290	73,890	74,290	75,190
Total MSW Generated - Weight	88,120	121,060	151,640	208,270	243,450	253,730	244,600	250,540	251,040	254,110

Products	Percent of Total Generation									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods										
Major Appliances	1.8%	1.8%	1.9%	1.6%	1.5%	1.4%	1.5%	1.6%	1.7%	1.8%
Small Appliances**				0.2%	0.4%	0.5%	0.7%	0.8%	0.8%	0.8%
Furniture and Furnishings	2.4%	2.3%	3.1%	3.3%	3.3%	3.7%	4.3%	4.4%	4.6%	4.6%
Carpets and Rugs**				0.8%	1.0%	1.2%	1.5%	1.5%	1.5%	1.5%
Rubber Tires	1.3%	1.6%	1.8%	1.7%	2.0%	1.9%	2.0%	1.9%	1.9%	1.9%
Batteries, Lead-Acid	Neg.	0.7%	1.0%	0.7%	0.9%	1.1%	1.2%	1.2%	1.2%	1.1%
Miscellaneous Durables										
Selected Consumer Electronics***					0.8%	1.0%	1.3%	1.3%	1.3%	1.2%
Other Miscellaneous Durables					6.0%	7.0%	7.0%	7.1%	7.0%	7.4%
Total Miscellaneous Durables	5.7%	5.7%	6.5%	6.0%	6.7%	8.0%	8.3%	8.4%	8.3%	8.7%
Total Durable Goods	11.3%	12.1%	14.4%	14.3%	16.0%	17.8%	19.4%	19.8%	20.0%	20.3%
Nondurable Goods	19.7%	20.7%	22.7%	25.0%	26.3%	25.1%	21.9%	20.6%	20.5%	20.3%
(Detail in Table 15)										
Containers and Packaging	31.1%	36.0%	34.7%	31.0%	31.2%	30.1%	29.2%	30.1%	30.0%	29.8%
(Detail in Table 19)										
Total Product Wastes†	62.0%	68.8%	71.8%	70.3%	73.4%	72.9%	70.4%	70.5%	70.4%	70.4%
Other Wastes										
Food	13.8%	10.6%	8.6%	11.5%	12.6%	13.0%	14.4%	14.5%	14.5%	14.6%
Yard Trimmings	22.7%	19.2%	18.1%	16.8%	12.5%	12.6%	13.6%	13.5%	13.5%	13.5%
Miscellaneous Inorganic Wastes	1.5%	1.5%	1.5%	1.4%	1.4%	1.5%	1.6%	1.5%	1.6%	1.5%
Total Other Wastes	38.0%	31.2%	28.2%	29.7%	26.6%	27.1%	29.6%	29.5%	29.6%	29.6%
Total MSW Generated - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

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

** Not estimated separately prior to 1990. † Other than food products. Neg. = Less than 5,000 tons or 0.05 percent.

*** Not estimated separately prior to 1999. For more information on consumer electronics see Electronics Management in the U.S. Through 2009. This 2009 electronics report examines a smaller selection of types of electronics. www.epa.gov/waste/conserve/materials/ecycling/manage.htm

Table 13. Recovery* of Products in Municipal Solid Waste, 1960 to 2013 (With Detail on Durable Goods)

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

Products	Thousands of Tons									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods										
Major Appliances	10	50	130	1,070	2,000	2,420	2,510	2,620	2,680	2,620
Small Appliances**				10	20	20	110	120	120	120
Furniture and Furnishings	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	10	10	10	10
Carpets and Rugs**				Neg.	190	250	260	270	290	240
Rubber Tires	330	250	150	440	1,290	1,640	2,130	2,080	1,980	1,930
Batteries, Lead-Acid	Neg.	620	1,040	1,470	2,130	2,640	2,860	2,970	2,890	2,850
Miscellaneous Durables										
Selected Consumer Electronics***					190	360	600	850	1,000	1,270
Other Miscellaneous Durables					760	640	310	370	240	240
Total Miscellaneous Durables	10	20	40	470	950	1,000	910	1,220	1,240	1,510
Total Durable Goods	350	940	1,360	3,460	6,580	7,970	8,790	9,290	9,210	9,280
Nondurable Goods	2,390	3,730	4,670	8,800	17,560	19,770	18,890	18,830	17,270	16,410
(Detail in Table 16)										
Containers and Packaging	2,870	3,350	8,490	16,780	28,870	31,500	34,210	38,280	38,760	39,050
(Detail in Table 20)										
Total Product Wastes†	5,610	8,020	14,520	29,040	53,010	59,240	61,890	66,400	65,240	64,740
Other Wastes										
Food	Neg.	Neg.	Neg.	Neg.	680	690	850	1,270	1,740	1,840
Yard Trimmings	Neg.	Neg.	Neg.	4,200	15,770	19,860	19,900	19,300	19,590	20,600
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	4,200	16,450	20,550	20,750	20,570	21,330	22,440
Total MSW Recovered - Weight	5,610	8,020	14,520	33,240	69,460	79,790	82,640	86,970	86,570	87,180

Products	Percent of Generation of Each Product									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods										
Major Appliances	0.6%	2.3%	4.4%	32.3%	54.9%	67.0%	66.8%	64.2%	64.0%	58.6%
Small Appliances**				2.2%	1.9%	1.7%	6.7%	6.3%	6.2%	6.2%
Furniture and Furnishings	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	0.1%	0.1%	0.1%	0.1%
Carpets and Rugs**				Neg.	7.7%	8.4%	7.3%	7.0%	7.5%	6.3%
Rubber Tires	29.5%	13.2%	5.5%	12.2%	26.2%	33.4%	44.6%	43.9%	42.0%	40.5%
Batteries, Lead-Acid	Neg.	75.6%	69.8%	97.4%	93.4%	96.0%	99.0%	99.0%	99.0%	99.0%
Miscellaneous Durables										
Selected Consumer Electronics***					10.0%	13.7%	18.8%	25.8%	30.6%	40.4%
Other Miscellaneous Durables					5.2%	3.6%	1.8%	2.1%	1.4%	1.3%
Total Miscellaneous Durables	0.2%	0.3%	0.4%	3.8%	5.8%	4.9%	4.5%	5.8%	5.9%	6.9%
Total Durable Goods	3.5%	6.4%	6.2%	11.6%	16.9%	17.7%	18.5%	18.7%	18.4%	18.0%
Nondurable Goods	13.8%	14.9%	13.6%	16.9%	27.4%	31.1%	35.3%	36.5%	33.6%	31.8%
(Detail in Table 16)										
Containers and Packaging	10.5%	7.7%	16.1%	26.0%	38.1%	41.3%	48.0%	50.8%	51.5%	51.5%
(Detail in Table 21)										
Total Product Wastes†	10.3%	9.6%	13.3%	19.8%	29.7%	32.0%	35.9%	37.6%	36.9%	36.2%
Other Wastes										
Food	Neg.	Neg.	Neg.	Neg.	2.2%	2.1%	2.4%	3.5%	4.8%	5.0%
Yard Trimmings	Neg.	Neg.	Neg.	12.0%	51.7%	61.9%	59.9%	57.3%	57.7%	60.2%
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	6.8%	25.4%	29.9%	28.7%	27.8%	28.7%	29.8%
Total MSW Recovered - %	6.4%	6.6%	9.6%	16.0%	28.5%	31.4%	33.8%	34.7%	34.5%	34.3%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap.

** Not estimated separately prior to 1990. † Other than food products. Neg. = Less than 5,000 tons or 0.05 percent.

*** Not estimated separately prior to 1999. For more information on consumer electronics see Electronics Management in the U.S. Through 2009. This 2009 electronics report examines a smaller selection of types of electronics. www.epa.gov/waste/conserve/materials/ecycling/manage.htm

Table 14. Products Discarded* in the Municipal Waste Stream, 1960 to 2014 (With Detail on Durable Goods)

(In thousands of tons and percent of total discards)

Products	Thousands of Tons									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods										
Major Appliances	1,620	2,120	2,820	2,240	1,640	1,190	1,250	1,460	1,510	1,850
Small Appliances**				450	1,020	1,160	1,520	1,780	1,830	1,830
Furniture and Furnishings	2,150	2,830	4,760	6,790	8,120	9,340	10,490	11,120	11,490	11,610
Carpets and Rugs**				1,660	2,270	2,710	3,290	3,560	3,570	3,580
Rubber Tires	790	1,640	2,570	3,170	3,640	3,270	2,650	2,660	2,730	2,840
Batteries, Lead-Acid	Neg.	200	450	40	150	110	30	30	30	30
Miscellaneous Durables										
Selected Consumer Electronics***					1,710	2,270	2,590	2,450	2,270	1,870
Other Miscellaneous Durables					13,740	17,040	16,900	17,370	17,450	18,660
Total Miscellaneous Durables	5,010	6,930	9,840	12,000	15,450	19,310	19,490	19,820	19,720	20,530
Total Durable Goods	9,570	13,720	20,440	26,350	32,290	37,090	38,720	40,430	40,880	42,270
Nondurable Goods	14,940	21,330	29,750	43,370	46,450	43,880	34,590	32,760	34,160	35,190
(Detail in Table 17)										
Containers and Packaging	24,500	40,210	44,180	47,750	46,970	44,830	37,110	37,060	36,470	36,720
(Detail in Table 22)										
Total Product Wastes†	49,010	75,260	94,370	117,470	125,710	125,800	110,420	110,250	111,510	114,180
Other Wastes										
Food	12,200	12,800	13,000	23,860	30,020	32,240	34,420	35,040	34,690	35,220
Yard Trimmings	20,000	23,200	27,500	30,800	14,760	12,210	13,300	14,410	14,370	13,600
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,500	3,690	3,820	3,870	3,900	3,930
Total Other Wastes	33,500	37,780	42,750	57,560	48,280	48,140	51,540	53,320	52,960	52,750
Total MSW Discarded - Weight	82,510	113,040	137,120	175,030	173,990	173,940	161,960	163,570	164,470	166,930

Products	Percent of Total Discards									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods										
Major Appliances	2.0%	1.9%	2.1%	1.3%	0.9%	0.7%	0.8%	0.9%	0.9%	1.1%
Small Appliances**				0.3%	0.6%	0.7%	0.9%	1.1%	1.1%	1.1%
Furniture and Furnishings	2.6%	2.5%	3.5%	3.9%	4.7%	5.4%	6.5%	6.8%	7.0%	7.0%
Carpets and Rugs**				0.9%	1.3%	1.6%	2.0%	2.2%	2.2%	2.1%
Rubber Tires	1.0%	1.5%	1.9%	1.8%	2.1%	1.9%	1.6%	1.6%	1.7%	1.7%
Batteries, Lead-Acid	Neg.	0.2%	0.3%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%
Miscellaneous Durables										
Selected Consumer Electronics***					1.0%	1.3%	1.6%	1.5%	1.4%	1.1%
Other Miscellaneous Durables					7.9%	9.8%	10.4%	10.6%	10.6%	11.2%
Total Miscellaneous Durables	6.1%	6.1%	7.2%	6.9%	8.9%	11.1%	12.0%	12.1%	12.0%	12.3%
Total Durable Goods	11.6%	12.1%	14.9%	15.1%	18.6%	21.3%	23.9%	24.7%	24.9%	25.3%
Nondurable Goods	18.1%	18.9%	21.7%	24.8%	26.7%	25.2%	21.4%	20.0%	20.8%	21.1%
(Detail in Table 17)										
Containers and Packaging	29.7%	35.6%	32.2%	27.3%	27.0%	25.8%	22.9%	22.7%	22.2%	22.0%
(Detail in Table 23)										
Total Product Wastes†	59.4%	66.6%	68.8%	67.1%	72.3%	72.3%	68.2%	67.4%	67.8%	68.4%
Other Wastes										
Food	14.8%	11.3%	9.5%	13.6%	17.3%	18.5%	21.3%	21.4%	21.1%	21.1%
Yard Trimmings	24.2%	20.5%	20.1%	17.6%	8.5%	7.0%	8.2%	8.8%	8.7%	8.1%
Miscellaneous Inorganic Wastes	1.6%	1.6%	1.6%	1.7%	2.0%	2.1%	2.4%	2.4%	2.4%	2.4%
Total Other Wastes	40.6%	33.4%	31.2%	32.9%	27.7%	27.7%	31.8%	32.6%	32.2%	31.6%
Total MSW Discarded - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Discards after materials and compost recovery. In this table, discards include combustion with energy recovery.

** Not estimated separately prior to 1990. † Other than food products. Neg. = Less than 5,000 tons or 0.05 percent.

*** Not estimated separately prior to 1999. For more information on consumer electronics see Electronics Management in the U.S. Through 2009. This 2009 electronics report examines a smaller selection of types of electronics. www.epa.gov/waste/conserve/materials/ecycling/manage.htm

Carpets and Rugs. Prior to 2000, an industry publication, *Carpet and Rug Industrial Review*, published data on carpet sales in square yards. These data were converted to tons using pounds per square yard factors developed for this report. In recent years, carpet sales from the Department of Commerce Current Industrial Report Carpet and Rug series have been used. An estimated 3.8 million tons of carpets and rugs were generated in MSW in 2013, which was 1.5 percent of total generation.

Recovery of carpet fiber, backing, and padding – estimated from industry data – was 240,000 tons in 2013 (6.3 percent of carpet generation).

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

The quantities of tires in units are converted to weight and materials composition using factors developed for this series of reports. In addition to rubber, tires include relatively small amounts of textiles and ferrous metals. Generation of rubber tires increased from 1.1 million tons in 1960 to 4.8 million tons in 2013 (1.9 percent of total MSW). Since 2000, the generation of rubber tires has remained fairly constant; decreasing slightly since 2011. Note that only tires from passenger cars, trucks, and motorcycles are included. Tires used in large equipment, aviation, or industrial applications are not included.

Data on recovery of tires are based on data from the Rubber Manufacturing Association. The tire recovery rate increased from 26.2 percent in 2000 to 40.5 percent in 2013. Since 2009, the quantity of tires generated remained relatively steady. Starting in 2009, the percentage of tires recovered through recycling decreased slightly. Tires recovered for fuel are not included in recovery through recycling. Tires going to combustion facilities as fuel are included in the combustion estimates in Chapter 3.

After recovery, 2.8 million tons of tires were discarded in 2013. Tire 2011 and 2012 recovery estimates were revised from previous versions of this report due to revisions in the data sources used in developing these estimates.

Lead-Acid Batteries. The methodology for estimating generation of lead-acid batteries is similar to the methodology for rubber tires as described above. An estimated 2.9 million tons of lead-acid batteries from automobiles, trucks, and motorcycles were generated in MSW in 2013 (1.1 percent of total generation).

The Battery Council International provided the most recent data on recovery of batteries. Since 2000, recovery of batteries for recycling has fluctuated between 93 percent and 99 percent; recovery has increased since 1980 as a growing number of communities have restricted batteries from disposal at landfills or combustion facilities. In 2013, 99 percent of the lead in these batteries was estimated to be recovered for recycling as well as the polypropylene battery casings. (Some electrolytes and other materials in batteries are removed from the municipal solid waste stream along with recovered lead and polypropylene; these materials are counted as “recovered” along with the recyclable materials.)

Battery 2011 and 2012 generation and 2009 through 2012 recovery estimates were revised from previous versions of this report due to revisions in the numbers of deregistered vehicles and the recovery estimates available from data sources used in developing these estimates.

Miscellaneous Durable Goods. Miscellaneous durable goods include consumer electronics such as television sets, videocassette recorders, and personal computers; luggage; sporting equipment; and the like. An estimated 22.0 million tons of these goods were generated in 2013, amounting to 8.7 percent of MSW generated.

As in recent previous updates of this report, generation of selected consumer electronic products was estimated as a subset of miscellaneous durable goods. In 2013, an estimated 3.1 million tons of these goods were generated. Of this, 1.3 million tons of selected consumer electronics were collected for recycling (40.4 percent recovery rate). This is up from the 2012 recovery rate for selected consumer electronics, which was 30.6 percent. It is unclear whether the large increase in the electronics recycling rate from 2012 to 2013 is due to an actual increase in recycling or the result of improved and expanded data. Selected consumer electronics include products such as TVs, VCRs, DVD players, video cameras, stereo systems, telephones, and computer equipment. EPA has analyzed television, computer products, and cell phone management separately in the 2010 report *Electronics Waste Management in the United States Through 2009*. The 2010 EPA report examines a smaller selection of electronic products which results in lower quantity estimates and different recycling rates than are shown in Tables 12 through 14.

The miscellaneous durable goods category, as a whole, includes ferrous metals as well as plastics, glass, rubber, wood, and other metals. An estimated 170,000 tons of ferrous metals were estimated to have been recovered from this category through pre-combustion and post-combustion magnetic separation at MSW combustion facilities in 2013, bringing total recovery from this category to 1.5 million tons. Discards of miscellaneous durable goods were 20.5 million tons in 2013.

Nondurable Goods

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

Generation of nondurable goods in MSW was 51.6 million tons in 2013 (20.3 percent of total generation). Recovery of paper products in this category is quite significant, resulting in 16.4 million tons of nondurable goods recovered in 2013 (31.8 percent of nondurables generation). This means that 35.2 million tons of nondurable goods were discarded in 2013 (21.1 percent of total 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 2013 was shown earlier in Table 4. Generation of paper and paperboard nondurable products declined from 47.8 million tons in 2000 to 30.6 million tons in 2012 to 30 million tons in 2013. Each of the paper and paperboard product categories in nondurable goods is discussed briefly below.

- Newspapers/mechanical papers are the largest single component of the paper products in the nondurable goods category, at 8.1 million tons generated in 2013 (3.2 percent of total MSW). In 2013, an estimated 5.4 million tons of newspapers/mechanical papers generated were recovered for recycling. Starting in 2010, newspapers (including newsprint and groundwood[3] inserts) were expanded to include directories and other mechanical papers previously counted as Other Commercial Printing.
- Books amounted to approximately 850,000 tons, or 0.3 percent of total MSW generation, in 2013. Books are made of both groundwood and chemical pulp.
- Magazines accounted for an estimated 1.4 million tons, or 0.6 percent of total MSW generation, in 2013. Magazines are predominantly made of coated groundwood, but some uncoated groundwood and chemical pulps are also used.
- Many different kinds of papers are generated in offices. For this report, office-type paper estimates include the high grade papers such as copier paper, computer printout, stationery, etc. Generation of these office papers was 4.8 million tons, or 1.9 percent of total MSW generation in 2013. 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.
- Standard mail includes catalogs and other direct bulk mailings; these amounted to an estimated 4.2 million tons, or 1.6 percent of MSW generation, in 2013. Both groundwood and chemical pulps are used in these mailings. The U.S. Postal Service has implemented a program to increase recovery of bulk mail, and many curbside collection programs also include mail.
- Other commercial printing includes a wide range of paper items, including brochures, reports, menus, and invitations. Both groundwood and chemical pulps are used in these varied items. Generation was estimated at 1.9 million tons, or 0.7 percent of MSW generation, in 2013.
- With the exception of newspapers/mechanical papers recovery, other nondurable paper product recovery, by individual products, is not well documented. Industry provided nondurable goods recovered paper estimates are presented as a total for books, magazines, office-type papers, standard mail, and other commercial printing. Total recovery (excluding newspapers/mechanical papers) was estimated at 9.1 million tons, or 41.3 percent of nondurable goods paper generation (Table 4).
- Tissue paper and towels generation includes facial and sanitary tissues and table napkins, but not bathroom tissue, which is nearly all diverted from MSW into the wastewater treatment system. Other examples include decorative and laminated tissue papers and crepe papers. Tissue products are used in homes, restaurants, other commercial establishments, and institutions such as hospitals. Tissue paper and towels (not including bathroom tissue) amounted to 3.6 million tons (1.4 percent of total MSW generation) in

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

2013. No significant recovery of tissue products for recycling was identified, although there is some composting of these items.

- Paper plates and cups include paper plates, cups, bowls, and other food service products used in homes, in commercial establishments like restaurants, and in institutional settings such as schools. Generation of these products was estimated at 1.3 million tons (0.5 percent of total MSW generation) in 2013. No significant recovery for recycling of these products was identified, although there is some composting of these items.
- Other nonpackaging papers–including posters, photographic papers, cards, and games – accounted for 3.9 million tons (1.6 percent of total MSW generation) in 2013. No significant recovery for recycling of these papers was identified.

Overall, generation of paper and paperboard products in nondurable goods was 30 million tons in 2013 (Table 4). While newspapers were recovered at the highest rate, other paper products, such as books, magazines, office papers, directories, standard mail, and other commercial printing also were recovered for recycling, and the overall recovery rate for paper in nondurables was 48.2 percent in 2013. Thus 15.5 million tons of paper in nondurables were discarded in 2013 (Table 4).

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 primarily of polystyrene resin. An estimated 1.0 million tons of these products were generated in 2013, or 0.4 percent of total MSW (Table 15). No significant recovery for recycling was identified in 2013.

Trash Bags. This category includes plastic trash bags made of high-density polyethylene and low-density polyethylene for both indoor and outdoor use. Generation of plastic trash bags amounted to about 1.0 million tons in 2013 (0.4 percent of MSW generation). No significant recovery for recycling was identified.

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 3.6 million tons of disposable diapers were generated in 2013, or 1.4 percent of total MSW generation. (This tonnage includes an adjustment for the urine and feces contained within the discarded diapers.) The materials portion of the diapers includes wood pulp, plastics (including the super-absorbent materials now present in most diapers), and tissue paper. No significant recycling or composting of disposable diapers was identified in 2013.

Clothing and Footwear. Generation of clothing and footwear was estimated to be 11.1 million tons in 2013 (4.4 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 American Apparel & Footwear Association along with data on average weights for each type of products included. Adjustments are made for net imports (domestic production minus exports plus imports) of these products based on International Trade Commission data.

The Secondary Material & Recycled Textiles Association has reported on recovery of textiles for exports, reprocessing, and reuse. Using their information, it was estimated that 1.6 million tons of textiles in clothing were recovered for recycling in 2013 (14.4 percent). (Reuse occurs before generation and is not included in the generation or recycling estimates.)

Towels, Sheets, and Pillowcases. An estimated 1.3 million tons of towels, sheets, and pillowcases were generated in 2013. Generation was estimated using a methodology similar to that for clothing. An estimated 230,000 tons of these textiles were recovered for export or recycling in 2013 (18.0 percent).

Other Miscellaneous Nondurables. Generation of other miscellaneous nondurables was estimated to be 3.6 million tons in 2013 (1.4 percent of MSW). The primary material component of miscellaneous nondurables is plastics, although some aluminum, rubber, and textiles also are present. Typical products in miscellaneous nondurables include shower curtains and other household items, disposable medical supplies, novelty items, and the like.

Generation of plastic products in miscellaneous nondurables is taken from resin sales data published annually by the American Chemistry Council. Generation of other materials in these nondurable products is estimated based on information in past reports in this series.

Table 15. Products Generated* in the Municipal Waste Stream, 1960 to 2013 (With Detail on Nondurable Goods)

(In thousands of tons and percent of total generation)

Products	Thousands of Tons									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods	9,920	14,660	21,800	29,810	38,870	45,060	47,510	49,720	50,090	51,550
(Detail in Table 12)										
Nondurable Goods										
Newspapers/Mechanical Papers†	7,110	9,510	11,050	13,430	14,790	12,790	7,760	9,150	8,380	8,050
Directories†**				610	680	660	650	-	-	-
Other Paper Nondurable Goods										
Books and Magazines	1,920	2,470	3,390							
Books**				970	1,240	1,100	960	930	860	850
Magazines**				2,830	2,230	2,580	1,450	1,510	1,470	1,410
Office-Type Papers***	1,520	2,650	4,000	6,410	7,420	6,620	5,380	5,100	4,750	4,770
Standard Mail§				3,820	5,570	5,830	4,650	4,380	4,150	4,150
Other Commercial Printing†	1,260	2,130	3,120	4,460	7,380	6,440	3,490	2,010	2,130	1,870
Tissue Paper and Towels	1,090	2,080	2,300	2,960	3,220	3,460	3,490	3,510	3,510	3,620
Paper Plates and Cups	270	420	630	650	960	1,160	1,170	1,340	1,290	1,320
Other Nonpackaging Paper	2,700	3,630	4,230	3,840	4,250	4,490	4,420	3,940	4,010	3,940
Total Other Paper Nondurable Goods								22,720	22,170	21,930
Disposable Diapers	Neg.	350	1,930	2,700	3,230	3,410	3,810	3,630	3,590	3,600
Plastic Plates and Cups§			190	650	870	930	900	1,030	1,060	1,010
Trash Bags**				780	850	1,060	1,000	1,010	1,020	980
Clothing and Footwear	1,360	1,620	2,170	4,010	6,470	7,890	9,120	9,070	10,310	11,120
Towels, Sheets and Pillowcases**				710	820	980	1,230	1,310	1,290	1,280
Other Miscellaneous Nondurables	100	200	1,410	3,340	4,030	4,250	4,000	3,670	3,610	3,630
Total Nondurable Goods	17,330	25,060	34,420	52,170	64,010	63,650	53,480	51,590	51,430	51,600
Containers and Packaging	27,370	43,560	52,670	64,530	75,840	76,330	71,320	75,340	75,230	75,770
(Detail in Table 18)										
Total Product Wastes‡	54,620	83,280	108,890	146,510	178,720	185,040	172,310	176,650	176,750	178,920
Other Wastes	33,500	37,780	42,750	61,760	64,730	68,690	72,290	73,890	74,290	75,190
Total MSW Generated - Weight	88,120	121,060	151,640	208,270	243,450	253,730	244,600	250,540	251,040	254,110

Table 15. Products Generated* in the Municipal Waste Stream, 1960 to 2013 (With Detail on Nondurable Goods)

(In thousands of tons and percent of total generation)

Products	Percent of Total Generation									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods	11.3%	12.1%	14.4%	14.3%	16.0%	17.8%	19.4%	19.8%	20.0%	20.3%
(Detail in Table 12)										
Nondurable Goods										
Newspapers/Mechanical Papers†	8.1%	7.9%	7.3%	6.4%	6.1%	5.0%	3.2%	3.7%	3.3%	3.2%
Directories†**				0.3%	0.3%	0.3%	0.3%	-	-	-
Other Paper Nondurable Goods										
Books and Magazines	2.2%	2.0%	2.2%							
Books**				0.5%	0.5%	0.4%	0.4%	0.4%	0.3%	0.3%
Magazines**				1.4%	0.9%	1.0%	0.6%	0.6%	0.6%	0.6%
Office-Type Papers***	1.7%	2.2%	2.6%	3.1%	3.0%	2.6%	2.2%	2.0%	1.9%	1.9%
Standard Mail§				1.8%	2.3%	2.3%	1.9%	1.7%	1.7%	1.6%
Other Commercial Printing†	1.4%	1.8%	2.1%	2.1%	3.0%	2.5%	1.4%	0.8%	0.8%	0.7%
Tissue Paper and Towels	1.2%	1.7%	1.5%	1.4%	1.3%	1.4%	1.4%	1.4%	1.4%	1.4%
Paper Plates and Cups	0.3%	0.3%	0.4%	0.3%	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%
Other Nonpackaging Paper	3.1%	3.0%	2.8%	1.8%	1.7%	1.8%	1.8%	1.6%	1.6%	1.6%
Total Other Paper Nondurable Goods								9.1%	8.8%	8.6%
Disposable Diapers	Neg.	0.3%	1.3%	1.3%	1.3%	1.3%	1.6%	1.4%	1.4%	1.4%
Plastic Plates and Cups§			0.1%	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
Trash Bags**				0.4%	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%
Clothing and Footwear	1.5%	1.3%	1.4%	1.9%	2.7%	3.1%	3.7%	3.6%	4.1%	4.4%
Towels, Sheets and Pillowcases**				0.3%	0.3%	0.4%	0.5%	0.5%	0.5%	0.5%
Other Miscellaneous Nondurables	0.1%	0.2%	0.9%	1.6%	1.7%	1.7%	1.6%	1.5%	1.4%	1.4%
Total Nondurables	19.7%	20.7%	22.7%	25.0%	26.3%	25.1%	21.9%	20.6%	20.5%	20.3%
Containers and Packaging	31.1%	36.0%	34.7%	31.0%	31.2%	30.1%	29.2%	30.1%	30.0%	29.8%
(Detail in Table 19)										
Total Product Wastes‡	62.0%	68.8%	71.8%	70.3%	73.4%	72.9%	70.4%	70.5%	70.4%	70.4%
Other Wastes	38.0%	31.2%	28.2%	29.7%	26.6%	27.1%	29.6%	29.5%	29.6%	29.6%
Total MSW Generated - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

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

† Starting in 2010, newsprint and groundwood inserts expanded to include directories and other mechanical papers previously counted as Other Commercial Printing.

** Not estimated separately prior to 1990.

*** High-grade paper such as printer paper; generated in both commercial and residential sources.

§ Standard Mail: Not estimated separately prior to 1990. Formerly called Third Class Mail and Standard (A) Mail by the U.S. Postal Service.

§ Plastic Plates and Cups: Not estimated separately prior to 1980.

‡ Other than food products.

\- Detailed data not available.

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

Table 16. Recovery* of Products in Municipal Solid Waste, 1960 to 2013 (With Detail on Nondurable Goods)

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

Products	Thousands of Tons									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods	350	940	1,360	3,460	6,580	7,970	8,790	9,290	9,210	9,280
(Detail in Table 13)										
Nondurable Goods										
Newspapers/Mechanical Papers†	1,820	2,250	3,020	5,110	8,720	9,360	6,840	6,630	5,870	5,390
Directories†**				50	120	120	240	-	-	-
Other Paper Nondurable Goods										
Books and Magazines	100	260	280							
Books**				100	240	270	320	-	-	-
Magazines**				300	710	960	780	-	-	-
Office-Type Papers***	250	710	870	1,700	4,090	4,110	3,990	-	-	-
Standard Mail§				200	1,830	2,090	2,950	-	-	-
Other Commercial Printing†	130	340	350	700	810	1,440	2,310	-	-	-
Tissue Paper and Towels	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	-	-	-
Paper Plates and Cups	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	-	-	-
Other Nonpackaging Paper	40	110	Neg.	Neg.	Neg.	Neg.	Neg.	-	-	-
Total Other Paper Nondurable Goods								10,610	9,570	9,060
Disposable Diapers				Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Plastic Plates and Cups§			Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Trash Bags**				Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Clothing and Footwear	50	60	150	520	900	1,250	1,250	1,250	1,470	1,600
Towels, Sheets and Pillowcases**				120	140	170	210	230	230	230
Other Miscellaneous Nondurables	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	110	130	130
Total Nondurable Goods	2,390	3,730	4,670	8,800	17,560	19,770	18,890	18,830	17,270	16,410
Containers and Packaging	2,870	3,350	8,490	16,780	28,870	31,500	34,210	38,280	38,760	39,050
(Detail in Table 20)										
Total Product Wastes‡	5,610	8,020	14,520	29,040	53,010	59,240	61,890	66,400	65,240	64,740
Other Wastes	Neg.	Neg.	Neg.	4,200	16,450	20,550	20,750	20,570	21,330	22,440
Total MSW Recovered - Weight	5,610	8,020	14,520	33,240	69,460	79,790	82,640	86,970	86,570	87,180

Table 16. Recovery* of Products in Municipal Solid Waste, 1960 to 2013 (With Detail on Nondurable Goods)

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

Products	Percent of Generation of Each Product									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods	3.5%	6.4%	6.2%	11.6%	16.9%	17.7%	18.5%	18.7%	18.4%	18.0%
(Detail in Table 13)										
Nondurable Goods										
Newspapers/Mechanical Papers†	25.6%	23.7%	27.3%	38.0%	59.0%	73.2%	88.1%	72.5%	70.0%	67.0%
Directories†**				8.2%	17.6%	18.2%	36.9%	-	-	-
Other Paper Nondurable Goods										
Books and Magazines	5.2%	10.5%	8.3%							
Books**				10.3%	19.4%	24.5%	33.3%	-	-	-
Magazines**				10.6%	31.8%	37.2%	53.8%	-	-	-
Office-Type Papers***	16.4%	26.8%	21.8%	26.5%	55.1%	62.1%	74.2%	-	-	-
Standard Mail§				5.2%	32.9%	35.8%	63.4%	-	-	-
Other Commercial Printing†	10.3%	16.0%	11.2%	15.7%	11.0%	22.4%	66.2%	-	-	-
Tissue Paper and Towels	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	-	-	-
Paper Plates and Cups	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	-	-	-
Other Nonpackaging Paper	1.5%	3.0%	Neg.	Neg.	Neg.	Neg.	Neg.	-	-	-
Total Other Paper Nondurable Goods								46.7%	43.2%	41.3%
Disposable Diapers				Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Plastic Plates and Cups§			Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Trash Bags**				Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Clothing and Footwear	Neg.	Neg.	Neg.	13.0%	13.9%	15.8%	13.7%	13.8%	14.3%	14.4%
Towels, Sheets and Pillowcases**				16.9%	17.1%	17.3%	17.1%	17.6%	17.8%	18.0%
Other Miscellaneous Nondurables	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	3.6%
Total Nondurables	13.8%	14.9%	13.6%	16.9%	27.4%	31.1%	35.3%	36.5%	33.6%	31.8%
Containers and Packaging	10.5%	7.7%	16.1%	26.0%	38.1%	41.3%	48.0%	50.8%	51.5%	51.5%
(Detail in Table 21)										
Total Product Wastes‡	10.3%	9.6%	13.3%	19.8%	29.7%	32.0%	35.9%	37.6%	36.9%	36.2%
Other Wastes	Neg.	Neg.	Neg.	6.8%	25.4%	29.9%	28.7%	27.8%	28.7%	29.8%
Total MSW Recovered - %	6.4%	6.6%	9.6%	16.0%	28.5%	31.4%	33.8%	34.7%	34.5%	34.3%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap. Details may not add to totals due to rounding.

† Starting in 2010, newsprint and groundwood inserts expanded to include directories and other mechanical papers previously counted as Other Commercial Printing.

** Not estimated separately prior to 1990.

*** High-grade paper such as printer paper; generated in both commercial and residential sources.

§ Standard Mail: Not estimated separately prior to 1990. Formerly called Third Class Mail and Standard (A) Mail by the U.S. Postal Service.

§ Plastic Plates and Cups: Not estimated separately prior to 1980.

‡ Other than food products.

\- Detailed data not available.

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

Table 17. Products Discarded* in the Municipal Waste Stream, 1960 to 2013 (With Detail on Nondurable Goods)

(In thousands of tons and percent of total discards)

Products	Thousands of Tons									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods	9,570	13,720	20,440	26,350	32,290	37,090	38,720	40,430	40,880	42,270
(Detail in Table 14)										
Nondurable Goods										
Newspapers/Mechanical Papers†	5,290	7,260	8,030	8,320	6,070	3,430	920	2,520	2,510	2,660
Directories†**				560	560	540	410	-	-	-
Other Paper Nondurable Goods										
Books and Magazines	1,820	2,210	3,110							
Books**				870	1,000	830	640	-	-	-
Magazines**				2,530	1,520	1,620	670	-	-	-
Office-Type Papers***	1,270	1,940	3,130	4,710	3,330	2,510	1,390	-	-	-
Standard Mail§				3,620	3,740	3,740	1,700	-	-	-
Other Commercial Printing†	1,130	1,790	2,770	3,760	6,570	5,000	1,180	-	-	-
Tissue Paper and Towels	1,090	2,080	2,300	2,960	3,220	3,460	3,490	-	-	-
Paper Plates and Cups	270	420	630	650	960	1,160	1,170	-	-	-
Other Nonpackaging Paper	2,660	3,520	4,230	3,840	4,250	4,490	4,420	-	-	-
Total Other Paper Nondurable Goods								12,110	12,600	12,870
Disposable Diapers	Neg.	350	1,930	2,700	3,230	3,410	3,810	3,630	3,590	3,600
Plastic Plates and Cups§			190	650	870	930	900	1,030	1,060	1,010
Trash Bags**				780	850	1,060	1,000	1,010	1,020	980
Clothing and Footwear	1,310	1,560	2,020	3,490	5,570	6,640	7,870	7,820	8,840	9,520
Towels, Sheets and Pillowcases**				590	680	810	1,020	1,080	1,060	1,050
Other Miscellaneous Nondurables	100	200	1,410	3,340	4,030	4,250	4,000	3,560	3,480	3,500
Total Nondurable Goods	14,940	21,330	29,750	43,370	46,450	43,880	34,590	32,760	34,160	35,190
Containers and Packaging	24,500	40,210	44,180	47,750	46,970	44,830	37,110	37,060	36,470	36,720
(Detail in Table 22)										
Total Product Wastes‡	49,010	75,260	94,370	117,470	125,710	125,800	110,420	110,250	111,510	114,180
Other Wastes	33,500	37,780	42,750	57,560	48,280	48,140	51,540	53,320	52,960	52,750
Total MSW Discarded - Weight	82,510	113,040	137,120	175,030	173,990	173,940	161,960	163,570	164,470	166,930

Table 17. Products Discarded* in the Municipal Waste Stream, 1960 to 2013 (With Detail on Nondurable Goods)

(In thousands of tons and percent of total discards)

Products	Percent of Total Discards									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods	11.6%	12.1%	14.9%	15.1%	18.6%	21.3%	23.9%	24.7%	24.9%	25.3%
(Detail in Table 14)										
Nondurable Goods										
Newspapers/Mechanical Papers†	6.4%	6.4%	5.9%	4.8%	3.5%	2.0%	0.6%	1.5%	1.5%	1.6%
Directories†**				0.3%	0.3%	0.3%	0.3%	-	-	-
Other Paper Nondurable Goods										
Books and Magazines	2.2%	2.0%	2.3%							
Books**				0.5%	0.6%	0.5%	0.4%	-	-	-
Magazines**				1.4%	0.9%	0.9%	0.4%	-	-	-
Office-Type Papers***	1.5%	1.7%	2.3%	2.7%	1.9%	1.4%	0.9%	-	-	-
Standard Mail§				2.1%	2.1%	2.2%	1.0%	-	-	-
Other Commercial Printing†	1.4%	1.6%	2.0%	2.1%	3.8%	2.9%	0.7%	-	-	-
Tissue Paper and Towels	1.3%	1.8%	1.7%	1.7%	1.9%	2.0%	2.2%	-	-	-
Paper Plates and Cups	0.3%	0.4%	0.5%	0.4%	0.6%	0.7%	0.7%	-	-	-
Other Nonpackaging Paper	3.2%	3.1%	3.1%	2.2%	2.4%	2.6%	2.7%	-	-	-
Total Other Paper Nondurable Goods								7.4%	7.7%	7.7%
Disposable Diapers	Neg.	0.3%	1.4%	1.5%	1.9%	2.0%	2.4%	2.2%	2.2%	2.2%
Plastic Plates and Cups§			0.1%	0.4%	0.5%	0.5%	0.6%	0.6%	0.6%	0.6%
Trash Bags**				0.4%	0.5%	0.6%	0.6%	0.6%	0.6%	0.6%
Clothing and Footwear	1.6%	1.4%	1.5%	2.0%	3.2%	3.8%	4.9%	4.8%	5.4%	5.7%
Towels, Sheets and Pillowcases**				0.3%	0.4%	0.5%	0.6%	0.7%	0.6%	0.6%
Other Miscellaneous Nondurables	0.1%	0.2%	1.7%	1.9%	2.3%	2.4%	2.5%	2.2%	2.1%	2.1%
Total Nondurables	18.1%	18.9%	21.7%	24.8%	26.7%	25.2%	21.4%	20.0%	20.8%	21.1%
Containers and Packaging	29.7%	35.6%	32.2%	27.3%	27.0%	25.8%	22.9%	22.7%	22.2%	22.0%
(Detail in Table 23)										
Total Product Wastes‡	59.4%	66.6%	68.8%	67.1%	72.3%	72.3%	68.2%	67.4%	67.8%	68.4%
Other Wastes	40.6%	33.4%	31.2%	32.9%	27.7%	27.7%	31.8%	32.6%	32.2%	31.6%
Total MSW Discarded - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

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

† Starting in 2010, newsprint and groundwood inserts expanded to include directories and other mechanical papers previously counted as Other Commercial Printing.

** Not estimated separately prior to 1990.

*** High-grade paper such as printer paper; generated in both commercial and residential sources.

§ Standard Mail: Not estimated separately prior to 1990. Formerly called Third Class Mail and Standard (A) Mail by the U.S. Postal Service.

§ Plastic Plates and Cups: Not estimated separately prior to 1980.

‡ Other than food products.

- Detailed data not available.

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

Containers and Packaging

Containers and packaging make up a major portion of MSW, amounting to 75.8 million tons of generation in 2013 (29.8 percent of total generation). Table 18 shows generation trended downward by about 7 percent between 2005 and 2009, followed by a 6 percent increase between 2009 and 2013 (to 75.8 million tons). Generation of most types of packaging declined from 2005 to 2009 due to the economic downturn. Plastic containers and wood packaging showed a slight increase during this time. Between 2009 and 2013 generation of some types of packaging continued to decline while others increased.

Glass packaging generation declined 7.6 percent between 2005 and 2009 and another 4.1 percent between 2009 and 2013. Steel packaging decreased 5.5 percent between 2005 and 2009 and increased 7.1 percent between 2009 and 2013. Aluminum packaging generation declined 2.6 percent over the four year period 2005 to 2009 and another 4.2 percent decline between 2009 and 2013.

Paper and paperboard packaging generation declined 11.9 percent between 2005 and 2009 and increased 10.4 percent between 2009 and 2013. Plastic packaging generation increased 0.9 percent from 2005 and 2009 and increased another 11.6 percent between 2009 and 2013.

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 2013, 51.5 percent of containers and packaging generated was recovered for recycling. Because of this recovery, containers and packaging comprised 22.0 percent of total MSW discards in 2013.

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

Glass Containers. Glass containers include beer and soft drink bottles (which include carbonated drinks and non-carbonated waters, teas, flavored drinks containing not more than 10 percent fruit juice and ready-to-drink alcoholic coolers and cocktails), wine and liquor bottles, and bottles and jars for food and juices, cosmetics, and other products. Prior to 2009, generation of glass containers was estimated using Department of Commerce data. Beginning in 2009, the Glass Packaging Institute provided production data. Adjustments are made for imports and exports of both empty glass containers and containers holding products, e.g., imported beer (domestic production minus exports plus imports).

Generation of these glass containers was 9.3 million tons in 2013, or 3.6 percent of MSW generation (Tables 18 and 19). This tonnage is lower than was generated in almost all of the previous years.

An estimated 3.2 million tons of glass containers were recovered for recycling, or 34.0 percent of generation, in 2013. Glass container discards were 6.1 million tons in 2013, or 3.7 percent of total MSW discards.

Steel Containers and Packaging. Steel food and other cans, and other steel packaging (e.g., strapping, crowns, and steel barrels and drums), totaled 2.4 million tons in 2013 (0.9 percent of total MSW generation), with most of that amount being cans for food products (Tables 18 and 19). Generation

estimates are based on data supplied by the Steel Recycling Institute (SRI). Estimates include adjustments for net imports (domestic production minus exports plus imports).

The Steel Recycling Institute also provided recovery data for steel containers and packaging. An estimated 1.7 million tons of steel packaging were recovered in 2013, or 72.5 percent of generation. The estimates include recovery from residential sources; pre-combustion and post-combustion magnetic separation of steel cans and other ferrous products at MSW combustion facilities; and recycling of drums and barrels not suitable for reconditioning.

Aluminum Containers and Packaging. Aluminum containers and packaging include beer and soft drink cans (including all carbonated and non-carbonated soft drinks, tea, tonic, waters, and juice beverages), other cans, and foil and closures (including semi rigid foil containers, caps, closures, and flexible packaging). Aluminum can generation has been estimated based on the Aluminum Association data on number of cans consumed domestically and average can weight, while estimates of the net import of unfilled aluminum cans is based on Department of Commerce data. Other aluminum packaging is based on Aluminum Association data.

Prior to 2000, the Can Manufacturers Institute published data on consumption of beverages in aluminum cans. After 2000, the Aluminum Association provided consumption data. The consumption data are adjusted for imports and exports of beverages in cans, and therefore are more accurate for generation calculations than shipments alone (domestic production minus exports plus imports). Total aluminum container and packaging generation in 2013 was 1.8 million tons, or 0.7 percent of total MSW generation.

Aluminum can recovery data are provided by the Aluminum Association; the industry association recovery number includes imported used beverage cans (UBC). The imported UBC are subtracted from the tonnage of UBC reported by the Aluminum Association to have been melted by U.S. end-users and recovered for export. Thus, the aluminum can recovery rate reported here is somewhat less than that published by the Aluminum Association.

Recovery of aluminum beverage cans in 2013 was 700,000 tons, or 55.1 percent of generation. Recovery data for the other aluminum packaging categories are not available for 2013. After recovery for recycling, 1.1 million tons of aluminum packaging were discarded in 2013.

Table 18. Products Generated* in the Municipal Waste Stream, 1960 to 2013 (With Detail on Containers and Packaging)

(In thousands of tons)

Products	Thousands of Tons									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods	9,920	14,660	21,800	29,810	38,870	45,060	47,510	49,720	50,090	51,550
(Detail in Table 12)										
Nondurable Goods	17,330	25,060	34,420	52,170	64,010	63,650	53,480	51,590	51,430	51,600
(Detail in Table 15)										
Containers and Packaging										
Glass Packaging										
Beer and Soft Drink Bottles**	1,400	5,580	6,740	5,640	5,710	6,540	6,000	5,530	5,580	5,420
Wine and Liquor Bottles	1,080	1,900	2,450	2,030	1,910	1,630	1,710	1,770	1,820	1,740
Other Bottles & Jars	3,710	4,440	4,780	4,160	3,420	2,290	1,950	2,000	2,000	2,100
Total Glass Packaging	6,190	11,920	13,970	11,830	11,040	10,460	9,660	9,300	9,400	9,260
Steel Packaging										
Beer and Soft Drink Cans	640	1,570	520	150	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Cans	3,760	3,540	2,850	2,540	2,630	2,130	1,880	1,800	1,850	1,870
Other Steel Packaging	260	270	240	200	240	240	360	380	380	530
Total Steel Packaging	4,660	5,380	3,610	2,890	2,870	2,370	2,240	2,180	2,230	2,400
Aluminum Packaging										
Beer and Soft Drink Cans	Neg.	100	850	1,550	1,520	1,450	1,360	1,320	1,300	1,270
Other Cans	Neg.	60	40	20	50	80	60	120	120	120
Foil and Closures	170	410	380	330	380	400	460	450	430	410
Total Aluminum Packaging	170	570	1,270	1,900	1,950	1,930	1,880	1,890	1,850	1,800
Paper & Paperboard Pkg										
Corrugated Boxes	7,330	12,760	17,080	24,010	30,210	30,930	27,190	29,440	29,480	30,050
Other Paper & Paperboard Pkg										
Gable Top/Aseptic Cartons‡			790	510	550	500	460	540	550	550
Folding Cartons			3,820	4,300	5,820	5,530	4,980	5,540	5,490	5,370
Other Paperboard Packaging	3,840	4,830	230	290	200	160	90	80	70	70
Bags and Sacks			3,380	2,440	1,490	1,120	910	750	960	830
Wrapping Papers			200	110	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Other Paper Packaging	2,940	3,810	850	1,020	1,670	1,400	1,310	1,670	1,460	1,690
Subtotal Other Paper & Paperboard Pkg								8,580	8,530	8,510
Total Paper & Board Pkg	14,110	21,400	26,350	32,680	39,940	39,640	34,940	38,020	38,010	38,560
Plastics Packaging										
PET Bottles and Jars			260	430	1,720	2,540	2,570	2,740	2,790	2,880
HDPE Natural Bottles			230	530	690	800	760	770	780	780
Other Containers	60	910	890	1,430	1,740	1,420	1,750	1,870	1,850	1,830
Bags and Sacks			390	940	1,650	1,640	660	-	-	-
Wraps			840	1,530	2,550	2,810	3,190	-	-	-
Subtotal Bags, Sacks, and Wraps			1,230	2,470	4,200	4,450	3,850	3,880	3,810	3,780
Other Plastics Packaging	60	1,180	790	2,040	2,840	3,210	3,600	4,640	4,550	4,710
Total Plastics Packaging	120	2,090	3,400	6,900	11,190	12,420	12,530	13,900	13,780	13,980
Other Packaging										
Wood Packaging	2,000	2,070	3,940	8,180	8,610	9,230	9,790	9,700	9,610	9,410
Other Misc. Packaging	120	130	130	150	240	280	280	350	350	360
Total Containers & Pkg	27,370	43,560	52,670	64,530	75,840	76,330	71,320	75,340	75,230	75,770
Total Product Wastes†	54,620	83,280	108,890	146,510	178,720	185,040	172,310	176,650	176,750	178,920
Other Wastes										
Food	12,200	12,800	13,000	23,860	30,700	32,930	35,270	36,310	36,430	37,060
Yard Trimmings	20,000	23,200	27,500	35,000	30,530	32,070	33,200	33,710	33,960	34,200
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,500	3,690	3,820	3,870	3,900	3,930
Total Other Wastes	33,500	37,780	42,750	61,760	64,730	68,690	72,290	73,890	74,290	75,190
Total MSW Generated - Weight	88,120	121,060	151,640	208,270	243,450	253,730	244,600	250,540	251,040	254,110

* Generation before materials recovery or combustion. Details may not add to totals due to rounding.
** Includes carbonated drinks and non-carbonated water, teas, flavored drinks, and ready-to-drink alcoholic coolers and cocktails.
‡ Includes milk, juice, and other products packaged in gable top cartons and liquid food aseptic cartons.
† Other than food products. Neg. = Less than 5,000 tons or 0.05 percent. NA = Not Available - Detailed data not available.

Table 19. Products Generated* in the Municipal Waste Stream, 1960 to 2013 (With Detail on Containers and Packaging)

(In percent of total generation)

Products	Percent of Total Generation									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods	11.3%	12.1%	14.4%	14.3%	16.0%	17.8%	19.4%	19.8%	20.0%	20.3%
(Detail in Table 12)										
Nondurable Goods	19.7%	20.7%	22.7%	25.0%	26.3%	25.1%	21.9%	20.6%	20.5%	20.3%
(Detail in Table 15)										
Containers and Packaging										
Glass Packaging										
Beer and Soft Drink Bottles**	1.6%	4.6%	4.4%	2.7%	2.3%	2.6%	2.5%	2.2%	2.2%	2.1%
Wine and Liquor Bottles	1.2%	1.6%	1.6%	1.0%	0.8%	0.6%	0.7%	0.7%	0.7%	0.7%
Other Bottles & Jars	4.2%	3.7%	3.2%	2.0%	1.4%	0.9%	0.8%	0.8%	0.8%	0.8%
Total Glass Packaging	7.0%	9.8%	9.2%	5.7%	4.5%	4.1%	3.9%	3.7%	3.7%	3.6%
Steel Packaging										
Beer and Soft Drink Cans	0.7%	1.3%	0.3%	0.1%	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Cans	4.3%	2.9%	1.9%	1.2%	1.1%	0.8%	0.8%	0.7%	0.7%	0.7%
Other Steel Packaging	0.3%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%	0.2%
Total Steel Packaging	5.3%	4.4%	2.4%	1.4%	1.2%	0.9%	0.9%	0.9%	0.9%	0.9%
Aluminum Packaging										
Beer and Soft Drink Cans	Neg.	0.1%	0.6%	0.7%	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%
Other Cans	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	0.02%	0.05%	0.05%	0.05%
Foil and Closures	0.2%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Total Aluminum Packaging	0.2%	0.5%	0.8%	0.9%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%
Paper & Paperboard Pkg										
Corrugated Boxes	8.3%	10.5%	11.3%	11.5%	12.4%	12.2%	11.1%	11.8%	11.7%	11.8%
Other Paper & Paperboard Pkg										
Gable Top/Aseptic Cartons‡			0.5%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Folding Cartons			2.5%	2.1%	2.4%	2.2%	2.0%	2.2%	2.2%	2.1%
Other Paperboard Packaging	4.4%	4.0%	0.2%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%
Bags and Sacks			2.2%	1.2%	0.6%	0.4%	0.4%	0.3%	0.4%	0.3%
Wrapping Papers			0.1%	0.1%	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Other Paper Packaging	3.3%	3.1%	0.6%	0.5%	0.7%	0.6%	0.5%	0.7%	0.6%	0.7%
Subtotal Other Paper & Paperboard Pkg								3.4%	3.4%	3.3%
Total Paper & Board Pkg	16.0%	17.7%	17.4%	15.7%	16.4%	15.6%	14.3%	15.2%	15.1%	15.2%
Plastics Packaging										
PET Bottles and Jars			0.2%	0.2%	0.7%	1.0%	1.1%	1.1%	1.1%	1.1%
HDPE Natural Bottles			0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Other Containers	0.1%	0.8%	0.6%	0.7%	0.7%	0.6%	0.7%	0.7%	0.7%	0.7%
Bags and Sacks			0.3%	0.5%	0.7%	0.6%	0.3%			
Wraps			0.6%	0.7%	1.0%	1.1%	1.3%			
Subtotal Bags, Sacks, and Wraps			0.8%	1.2%	1.7%	1.8%	1.6%	1.5%	1.5%	1.5%
Other Plastics Packaging	0.1%	1.0%	0.5%	1.0%	1.2%	1.3%	1.5%	1.9%	1.8%	1.9%
Total Plastics Packaging	0.1%	1.7%	2.2%	3.3%	4.6%	4.9%	5.1%	5.5%	5.5%	5.5%
Other Packaging										
Wood Packaging	2.3%	1.7%	2.6%	3.9%	3.5%	3.6%	4.0%	3.9%	3.8%	3.7%
Other Misc. Packaging	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Total Containers & Pkg	31.1%	36.0%	34.7%	31.0%	31.2%	30.1%	29.2%	30.1%	30.0%	29.8%
Total Product Wastes†	62.0%	68.8%	71.8%	70.3%	73.4%	72.9%	70.4%	70.5%	70.4%	70.4%
Other Wastes										
Food	13.8%	10.6%	8.6%	11.5%	12.6%	13.0%	14.4%	14.5%	14.5%	14.6%
Yard Trimmings	22.7%	19.2%	18.1%	16.8%	12.5%	12.6%	13.6%	13.5%	13.5%	13.5%
Miscellaneous Inorganic Wastes	1.5%	1.5%	1.5%	1.4%	1.4%	1.5%	1.6%	1.5%	1.6%	1.5%
Total Other Wastes	38.0%	31.2%	28.2%	29.7%	26.6%	27.1%	29.6%	29.5%	29.6%	29.6%
Total MSW Generated - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Generation before materials recovery or combustion. Details may not add to totals due to rounding.

** Includes carbonated drinks and non-carbonated water, teas, flavored drinks, and ready-to-drink alcoholic coolers and cocktails.

‡ Includes milk, juice, and other products packaged in gable top cartons and liquid food aseptic cartons.

† Other than food products.

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

Table 20. Recovery* of Products in Municipal Solid Waste, 1960 to 2013 (With Detail on Containers and Packaging)

(In thousands of tons)

Products	Thousands of Tons									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods	350	940	1,360	3,460	6,580	7,970	8,790	9,290	9,210	9,280
(Detail in Table 13)										
Nondurable Goods	2,390	3,730	4,670	8,800	17,560	19,770	18,890	18,830	17,270	16,410
(Detail in Table 16)										
Containers and Packaging										
Glass Packaging										
Beer and Soft Drink Bottles**	90	140	730	1,890	1,530	2,000	2,340	2,270	2,290	2,240
Wine and Liquor Bottles	10	10	20	210	430	250	430	610	620	600
Other Bottles & Jars	Neg.	Neg.	Neg.	520	920	340	230	300	300	310
Total Glass Packaging	100	150	750	2,620	2,880	2,590	3,000	3,180	3,210	3,150
Steel Packaging										
Beer and Soft Drink Cans	10	20	50	40	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Cans	20	60	150	590	1,530	1,340	1,240	1,270	1,310	1,320
Other Steel Packaging	Neg.	Neg.	Neg.	60	160	160	290	300	300	420
Total Steel Packaging	30	80	200	690	1,690	1,500	1,530	1,570	1,610	1,740
Aluminum Packaging										
Beer and Soft Drink Cans	Neg.	10	320	990	830	650	690	720	710	700
Other Cans	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	NA	NA	NA	NA
Foil and Closures	Neg.	Neg.	Neg.	20	30	40	NA	NA	NA	NA
Total Aluminum Pkg	Neg.	10	320	1,010	860	690	690	720	710	700
Paper & Paperboard Pkg										
Corrugated Boxes	2,520	2,760	6,390	11,530	20,330	22,100	22,100	26,800	26,810	26,590
Other Paper & Paperboard Pkg										
Gable Top/Aseptic Cartons‡			Neg.	Neg.	Neg.	Neg.	30	-	-	-
Folding Cartons			520	340	410	1,190	2,490	-	-	-
Other Paperboard Packaging			Neg.	Neg.	Neg.	Neg.	Neg.	-	-	-
Bags and Sacks			Neg.	200	300	320	450	-	-	-
Wrapping Papers			Neg.	Neg.	Neg.	Neg.	Neg.	-	-	-
Other Paper Packaging	220	350	300	Neg.	Neg.	Neg.	Neg.	-	-	-
Subtotal Other Paper & Paperboard Pkg								1,860	2,110	2,360
Total Paper & Board Pkg	2,740	3,110	7,210	12,070	21,040	23,610	25,070	28,660	28,920	28,950
Plastics Packaging										
PET Bottles and Jars			10	140	380	590	720	800	860	900
HDPE Natural Bottles			Neg.	20	210	230	220	220	220	220
Other Containers	Neg.	Neg.	Neg.	20	170	140	290	290	310	330
Bags and Sacks										
Wraps										
Subtotal Bags, Sacks, and Wraps			Neg.	60	180	230	360	430	440	510
Other Plastics Packaging	Neg.	Neg.	Neg.	20	90	90	130	60	70	80
Total Plastics Packaging	Neg.	Neg.	10	260	1,030	1,280	1,720	1,800	1,900	2,040
Other Packaging										
Wood Packaging	Neg.	Neg.	Neg.	130	1,370	1,830	2,200	2,350	2,410	2,470
Other Misc. Packaging	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Containers & Pkg	2,870	3,350	8,490	16,780	28,870	31,500	34,210	38,280	38,760	39,050
Total Product Wastes†	5,610	8,020	14,520	29,040	53,010	59,240	61,890	66,400	65,240	64,740
Other Wastes										
Food	Neg.	Neg.	Neg.	Neg.	680	690	850	1,270	1,740	1,840
Yard Trimmings	Neg.	Neg.	Neg.	4,200	15,770	19,860	19,900	19,300	19,590	20,600
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	4,200	16,450	20,550	20,750	20,570	21,330	22,440
Total MSW Recovered - Weight	5,610	8,020	14,520	33,240	69,460	79,790	82,640	86,970	86,570	87,180

* Recovery of postconsumer wastes; does not include converting/fabrication scrap. Details may not add to totals due to rounding.

** Includes carbonated drinks and non-carbonated water, teas, flavored drinks, and ready-to-drink alcoholic coolers and cocktails.

† Other than food products.

‡ Includes milk, juice, and other products packaged in gable top cartons and liquid food aseptic cartons.

Neg. = Less than 5,000 tons or 0.05 percent. NA = Not Available - Detailed data not available.

Table 21. Recovery* of Products in Municipal Solid Waste, 1960 to 2013 (With Detail on Containers and Packaging)

(In percent of generation of each product)

Products	Percent of Generation of Each Product									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods	3.5%	6.4%	6.2%	11.6%	16.9%	17.7%	18.5%	18.7%	18.4%	18.0%
(Detail in Table 13)										
Nondurable Goods	13.8%	14.9%	13.6%	16.9%	27.4%	31.1%	35.3%	36.5%	33.6%	31.8%
(Detail in Table 16)										
Containers and Packaging										
Glass Packaging										
Beer and Soft Drink Bottles**	6.4%	2.5%	10.8%	33.5%	26.8%	30.6%	39.0%	41.0%	41.0%	41.3%
Wine and Liquor Bottles	Neg.	Neg.	Neg.	10.3%	22.5%	15.3%	25.1%	34.5%	34.1%	34.5%
Other Bottles & Jars	Neg.	Neg.	Neg.	12.5%	26.9%	14.8%	11.8%	15.0%	15.0%	14.8%
Total Glass Packaging	1.6%	1.3%	5.4%	22.1%	26.1%	24.8%	31.1%	34.2%	34.1%	34.0%
Steel Packaging										
Beer and Soft Drink Cans	1.6%	1.3%	9.6%	26.7%	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Cans	Neg.	1.7%	5.3%	23.2%	58.2%	62.9%	66.0%	70.6%	70.8%	70.6%
Other Steel Packaging	Neg.	Neg.	Neg.	30.0%	66.7%	66.7%	80.6%	78.9%	78.9%	79.2%
Total Steel Packaging	Neg.	1.5%	5.5%	23.9%	58.9%	63.3%	68.3%	72.0%	72.2%	72.5%
Aluminum Packaging										
Beer and Soft Drink Cans	Neg.	10.0%	37.6%	63.9%	54.6%	44.8%	50.7%	54.5%	54.6%	55.1%
Other Cans	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	NA	NA	NA	NA
Foil and Closures	Neg.	Neg.	Neg.	6.1%	7.9%	10.0%	NA	NA	NA	NA
Total Aluminum Pkg	Neg.	1.8%	25.2%	53.2%	44.1%	35.8%	36.7%	38.1%	38.4%	38.9%
Paper & Paperboard Pkg										
Corrugated Boxes	34.4%	21.6%	37.4%	48.0%	67.3%	71.5%	81.3%	91.0%	90.9%	88.5%
Other Paper & Paperboard Pkg										
Gable Top/Aseptic Cartons‡			Neg.	Neg.	Neg.	Neg.	6.5%	-	-	-
Folding Cartons			Neg.	Neg.	7.0%	21.5%	50.0%	-	-	-
Other Paperboard Packaging			Neg.	Neg.	Neg.	Neg.	Neg.	-	-	-
Bags and Sacks			Neg.	Neg.	20.1%	28.6%	49.5%	-	-	-
Wrapping Papers			Neg.	Neg.	Neg.	Neg.	Neg.	-	-	-
Other Paper Packaging	7.5%	9.2%	35.3%	Neg.	Neg.	Neg.	Neg.	-	-	-
Subtotal Other Paper & Paperboard Pkg								21.7%	24.7%	27.7%
Total Paper & Board Pkg	19.4%	14.5%	27.4%	36.9%	52.7%	59.6%	71.8%	75.4%	76.1%	75.1%
Plastics Packaging										
PET Bottles and Jars			3.8%	32.6%	22.1%	23.2%	28.0%	29.2%	30.8%	31.3%
HDPE Natural Bottles			Neg.	3.8%	30.4%	28.8%	28.9%	28.6%	28.2%	28.2%
Other Containers	Neg.	Neg.	Neg.	1.4%	9.8%	9.9%	16.6%	15.5%	16.8%	18.0%
Bags and Sacks										
Wraps										
Subtotal Bags, Sacks, and Wraps			Neg.	2.4%	4.3%	5.2%	9.4%	11.1%	11.5%	13.5%
Other Plastics Packaging	Neg.	Neg.	Neg.	1.0%	3.2%	2.8%	3.6%	1.3%	1.5%	1.7%
Total Plastics Packaging	Neg.	Neg.	Neg.	3.8%	9.2%	10.3%	13.7%	12.9%	13.8%	14.6%
Other Packaging										
Wood Packaging	Neg.	Neg.	Neg.	1.6%	15.9%	19.8%	22.5%	24.2%	25.1%	26.2%
Other Misc. Packaging	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Containers & Pkg	10.5%	7.7%	16.1%	26.0%	38.1%	41.3%	48.0%	50.8%	51.5%	51.5%
Total Product Wastes†	10.3%	9.6%	13.3%	19.8%	29.7%	32.0%	35.9%	37.6%	36.9%	36.2%
Other Wastes										
Food	Neg.	Neg.	Neg.	Neg.	2.2%	2.1%	2.4%	3.5%	4.8%	5.0%
Yard Trimmings	Neg.	Neg.	Neg.	12.0%	51.7%	61.9%	59.9%	57.3%	57.7%	60.2%
Miscellaneous Inorganic Wastes	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Total Other Wastes	Neg.	Neg.	Neg.	6.8%	25.4%	29.9%	28.7%	27.8%	28.7%	29.8%
Total MSW Recovered - %	6.4%	6.6%	9.6%	16.0%	28.5%	31.4%	33.8%	34.7%	34.5%	34.3%

* Recovery of postconsumer wastes; does not include converting/fabrication scrap. Details may not add to totals due to rounding.
** Includes carbonated drinks and non-carbonated water, teas, flavored drinks, and ready-to-drink alcoholic coolers and cocktails.
† Other than food products.
‡ Includes milk, juice, and other products packaged in gable top cartons and liquid food aseptic cartons.
Neg. = Less than 5,000 tons or 0.05 percent. NA = Not Available - Detailed data not available.

Table 22. Products Discarded* in the Municipal Waste Stream, 1960 to 2013 (With Detail on Containers and Packaging)

(In thousands of tons)

Products	Thousands of Tons									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods	9,570	13,720	20,440	26,350	32,290	37,090	38,720	40,430	40,880	42,270
(Detail in Table 14)										
Nondurable Goods	14,940	21,330	29,750	43,370	46,450	43,880	34,590	32,760	34,160	35,190
(Detail in Table 17)										
Containers and Packaging										
Glass Packaging										
Beer and Soft Drink Bottles**	1,310	5,440	6,010	3,750	4,180	4,540	3,660	3,260	3,290	3,180
Wine and Liquor Bottles	1,070	1,890	2,430	1,820	1,480	1,380	1,280	1,160	1,200	1,140
Other Bottles & Jars	3,710	4,440	4,780	3,640	2,500	1,950	1,720	1,700	1,700	1,790
Total Glass Packaging	6,090	11,770	13,220	9,210	8,160	7,870	6,660	6,120	6,190	6,110
Steel Packaging										
Beer and Soft Drink Cans	630	1,550	470	110	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Cans	3,740	3,480	2,700	1,950	1,100	790	640	530	540	550
Other Steel Packaging	260	270	240	140	80	80	70	80	80	110
Total Steel Packaging	4,630	5,300	3,410	2,200	1,180	870	710	610	620	660
Aluminum Packaging										
Beer and Soft Drink Cans	Neg.	90	530	560	690	800	670	600	590	570
Other Cans	Neg.	60	40	20	50	80	60	120	120	120
Foil and Closures	170	410	380	310	350	360	460	450	430	410
Total Aluminum Pkg	170	560	950	890	1,090	1,240	1,190	1,170	1,140	1,100
Paper & Paperboard Pkg										
Corrugated Boxes	4,810	10,000	10,690	12,480	9,880	8,830	5,090	2,640	2,670	3,460
Other Paper & Paperboard Pkg										
Gable Top/Aseptic Cartons‡			790	510	550	500	430	-	-	-
Folding Cartons			3,300	3,960	5,410	4,340	2,490	-	-	-
Other Paperboard Packaging	3,840	4,830	230	290	200	160	90	-	-	-
Bags and Sacks			3,380	2,240	1,190	800	460	-	-	-
Wrapping Papers			200	110	Neg.	Neg.	Neg.	-	-	-
Other Paper Packaging	2,720	3,460	550	1,020	1,670	1,400	1,310	-	-	-
Subtotal Other Paper & Paperboard Pkg								6,720	6,420	6,150
Total Paper & Board Pkg	11,370	18,290	19,140	20,610	18,900	16,030	9,870	9,360	9,090	9,610
Plastics Packaging										
PET Bottles and Jars			250	290	1,340	1,950	1,850	1,940	1,930	1,980
HDPE Natural Bottles			230	510	480	570	540	550	560	560
Other Containers	60	910	890	1,410	1,570	1,280	1,460	1,580	1,540	1,500
Bags and Sacks										
Wraps										
Subtotal Bags, Sacks, and Wraps			1,230	2,410	4,020	4,220	3,490	3,450	3,370	3,270
Other Plastics Packaging	60	1,180	790	2,020	2,750	3,120	3,470	4,580	4,480	4,630
Total Plastics Packaging	120	2,090	3,390	6,640	10,160	11,140	10,810	12,100	11,880	11,940
Other Packaging										
Wood Packaging	2,000	2,070	3,940	8,050	7,240	7,400	7,590	7,350	7,200	6,940
Other Misc. Packaging	120	130	130	150	240	280	280	350	350	360
Total Containers & Pkg	24,500	40,210	44,180	47,750	46,970	44,830	37,110	37,060	36,470	36,720
Total Product Wastes†	49,010	75,260	94,370	117,470	125,710	125,800	110,420	110,250	111,510	114,180
Other Wastes										
Food	12,200	12,800	13,000	23,860	30,020	32,240	34,420	35,040	34,690	35,220
Yard Trimmings	20,000	23,200	27,500	30,800	14,760	12,210	13,300	14,410	14,370	13,600
Miscellaneous Inorganic Wastes	1,300	1,780	2,250	2,900	3,500	3,690	3,820	3,870	3,900	3,930
Total Other Wastes	33,500	37,780	42,750	57,560	48,280	48,140	51,540	53,320	52,960	52,750
Total MSW Discarded - Weight	82,510	113,040	137,120	175,030	173,990	173,940	161,960	163,570	164,470	166,930

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

** Includes carbonated drinks and non-carbonated water, teas, flavored drinks, and ready-to-drink alcoholic coolers and cocktails.

† Other than food products. ‡ Includes milk, juice, and other products packaged in gable top cartons and liquid food aseptic cartons.

Neg. = Less than 5,000 tons or 0.05 percent. - Detailed data not available.

Table 23. Products Discarded* in the Municipal Waste Stream, 1960 to 2013 (With Detail on Containers and Packaging)

(In percent of total discards)

Products	Percent of Total Discards									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Durable Goods	11.6%	12.1%	14.9%	15.1%	18.6%	21.3%	23.9%	24.7%	24.9%	25.3%
(Detail in Table 14)										
Nondurable Goods	18.1%	18.9%	21.7%	24.8%	26.7%	25.2%	21.4%	20.0%	20.8%	21.1%
(Detail in Table 17)										
Containers and Packaging										
Glass Packaging										
Beer and Soft Drink Bottles**	1.6%	4.8%	4.4%	2.1%	2.4%	2.6%	2.3%	2.0%	2.0%	1.9%
Wine and Liquor Bottles	1.3%	1.7%	1.8%	1.0%	0.9%	0.8%	0.8%	0.7%	0.7%	0.7%
Other Bottles & Jars	4.5%	3.9%	3.5%	2.1%	1.4%	1.1%	1.1%	1.0%	1.0%	1.1%
Total Glass Packaging	7.4%	10.4%	9.6%	5.3%	4.7%	4.5%	4.1%	3.7%	3.8%	3.7%
Steel Packaging										
Beer and Soft Drink Cans	0.8%	1.4%	0.3%	0.1%	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Cans	4.5%	3.1%	2.0%	1.1%	0.6%	0.5%	0.4%	0.3%	0.3%	0.3%
Other Steel Packaging	0.3%	0.2%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Total Steel Packaging	5.6%	4.7%	2.5%	1.3%	0.7%	0.5%	0.4%	0.4%	0.4%	0.4%
Aluminum Packaging										
Beer and Soft Drink Cans	Neg.	0.1%	0.4%	0.3%	0.4%	0.5%	0.4%	0.4%	0.4%	0.3%
Other Cans	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	0.1%	0.1%	0.1%
Foil and Closures	0.2%	0.4%	0.3%	0.2%	0.2%	0.2%	0.3%	0.3%	0.3%	0.2%
Total Aluminum Pkg	0.2%	0.5%	0.7%	0.5%	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%
Paper & Paperboard Pkg										
Corrugated Boxes	5.8%	8.8%	7.8%	7.1%	5.7%	5.1%	3.1%	1.6%	1.6%	2.1%
Other Paper & Paperboard Pkg										
Gable Top/Aseptic Cartons‡			0.6%	0.3%	0.3%	0.3%	0.3%	-	-	-
Folding Cartons			2.4%	2.3%	3.1%	2.5%	1.5%	-	-	-
Other Paperboard Packaging	4.7%	4.3%	0.2%	0.2%	0.1%	0.1%	0.1%	-	-	-
Bags and Sacks			2.5%	1.3%	0.7%	0.5%	0.3%	-	-	-
Wrapping Papers			0.1%	0.1%	Neg.	Neg.	Neg.	-	-	-
Other Paper Packaging	3.3%	3.1%	0.4%	0.6%	1.0%	0.8%	0.8%	-	-	-
Subtotal Other Paper & Paperboard Pkg								4.1%	3.9%	3.7%
Total Paper & Board Pkg	13.8%	16.2%	14.0%	11.8%	10.9%	9.2%	6.1%	5.7%	5.5%	5.8%
Plastics Packaging										
PET Bottles and Jars			0.2%	0.2%	0.8%	1.1%	1.1%	1.2%	1.2%	1.2%
HDPE Natural Bottles			0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Other Containers	0.1%	0.8%	0.6%	0.8%	0.9%	0.7%	0.9%	1.0%	0.9%	0.9%
Bags and Sacks										
Wraps										
Subtotal Bags, Sacks, and Wraps			0.9%	1.4%	2.3%	2.4%	2.2%	2.1%	2.0%	2.0%
Other Plastics Packaging	0.1%	1.0%	0.6%	1.2%	1.6%	1.8%	2.1%	2.8%	2.7%	2.8%
Total Plastics Packaging	0.1%	1.8%	2.5%	3.8%	5.8%	6.4%	6.7%	7.4%	7.2%	7.2%
Other Packaging										
Wood Packaging	2.4%	1.8%	2.9%	4.6%	4.2%	4.3%	4.7%	4.5%	4.4%	4.2%
Other Misc. Packaging	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%
Total Containers & Pkg	29.7%	35.6%	32.2%	27.3%	27.0%	25.8%	22.9%	22.7%	22.2%	22.0%
Total Product Wastes†	59.4%	66.6%	68.8%	67.1%	72.3%	72.3%	68.2%	67.4%	67.8%	68.4%
Other Wastes										
Food	14.8%	11.3%	9.5%	13.6%	17.3%	18.5%	21.3%	21.4%	21.1%	21.1%
Yard Trimmings	24.2%	20.5%	20.1%	17.6%	8.5%	7.0%	8.2%	8.8%	8.7%	8.1%
Miscellaneous Inorganic Wastes	1.6%	1.6%	1.6%	1.7%	2.0%	2.1%	2.4%	2.4%	2.4%	2.4%
Total Other Wastes	40.6%	33.4%	31.2%	32.9%	27.7%	27.7%	31.8%	32.6%	32.2%	31.6%
Total MSW Discarded - %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

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

** Includes carbonated drinks and non-carbonated water, teas, flavored drinks, and ready-to-drink alcoholic coolers and cocktails.

† Other than food products. ‡ Includes milk, juice, and other products packaged in gable top cartons and liquid food aseptic cartons.

Neg. = Less than 5,000 tons or 0.05 percent. - Detailed data not available

Paper and Paperboard Containers and Packaging. Corrugated boxes are the largest single product category of MSW at 30.1 million tons generated, or 11.8 percent of total generation, in 2013. Corrugated boxes also represent the largest single category of product recovery. At 26.6 million tons of recovery in 2013, 88.5 percent of boxes generated were recovered. After recovery, 3.5 million tons of corrugated boxes were discarded, or 2.1 percent of MSW discards in 2013.

Other paper and paperboard packaging in MSW includes gable top and aseptic cartons (includes milk, juice, and other products packaged in gable top cartons and liquid food aseptic cartons), folding cartons (e.g., cereal boxes, frozen food boxes, some department store boxes), bags and sacks, wrapping papers, and other paper and paperboard packaging (primarily set-up boxes such as shoe, cosmetic, and candy boxes). Overall, paper and paperboard containers and packaging totaled 38.6 million tons of MSW generation in 2013, or 15.2 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 about 2.4 million tons in 2013). The overall recovery rate for paper and paperboard packaging in 2013 was 75.1 percent. Other paper packaging such as cartons and sacks is mostly recovered as 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 and water bottles, high-density polyethylene (HDPE) milk and water jugs, film products (including bags and sacks) made of low-density polyethylene (LDPE), and other containers and other packaging (including clamshells, trays, caps, lids, egg cartons, loose fill, produce baskets, coatings, closures, etc.) made of polyvinyl chloride (PVC), polystyrene (PS), polypropylene (PP), and other resins. Estimates of generation of plastic containers and packaging are based on resin sales data by end use, published annually by the American Chemistry Council's annual plastics resin survey.

Plastic containers and packaging have exhibited rapid growth in MSW, with generation increasing from 120,000 tons in 1960 (0.1 percent of generation) to about 14 million tons in 2013 (5.5 percent of MSW generation). (Note: plastic packaging as a category in this report does not include single-service plates and cups and trash bags, which are classified as nondurable goods.)

Estimates of recovery of plastic products are based on data published annually by the American Chemistry Council supplemented with additional industry data. PET bottles and jars were estimated to have been recovered at a 31.3 percent rate in 2013 (900,000 tons). Recovery of HDPE natural bottles (e.g., milk and water bottles) was estimated to have been 220,000 tons, or 28.2 percent of generation. Overall, recovery of plastic containers and packaging was estimated to be 2.0 million tons, or 14.6 percent in 2013. Discards of plastic packaging thus were 11.9 million tons in 2013, or 7.2 percent of total MSW generation.

The plastic container and packaging recycling estimates, similar to other product estimates in this report, may include other recyclable and nonrecyclable materials. For example, the quantity of PET bottles recovered includes caps, lids, labels and adhesives collected along with the bottles. Although NAPCOR, the industry association supplying the PET data for this report, has sufficient detail to separate the non-PET materials from the PET, statistics from other industry sources do not have the same level of detail. To maintain consistency across material categories, the "gross" recycling rate is used instead of the "net" recycling rate throughout this report.

Wood Packaging. Wood packaging includes wood crates and pallets (mostly pallets). Data on production of wood packaging are from market research reports, and the USDA Forest Service Southern Research Station and Virginia Polytechnic Institute. In 2013, 9.4 million tons of wood pallets and other wood packaging were estimated to have been generated, or 3.7 percent of total MSW generation.

Wood pallet recovery for recycling (usually by chipping for uses such as mulch or bedding material, but excluding wood combusted as fuel) was estimated at 2.5 million tons in 2013.

Accounting for pallet reuse and recovery for recycling, wood packaging discards were 6.9 million tons in 2013, or 4.2 percent of total MSW discards.

Other Packaging. Estimates are included for some other miscellaneous packaging such as bags made of textiles, small amounts of leather, and the like. These latter quantities are not well documented; it was estimated that 360,000 tons were generated in 2013.

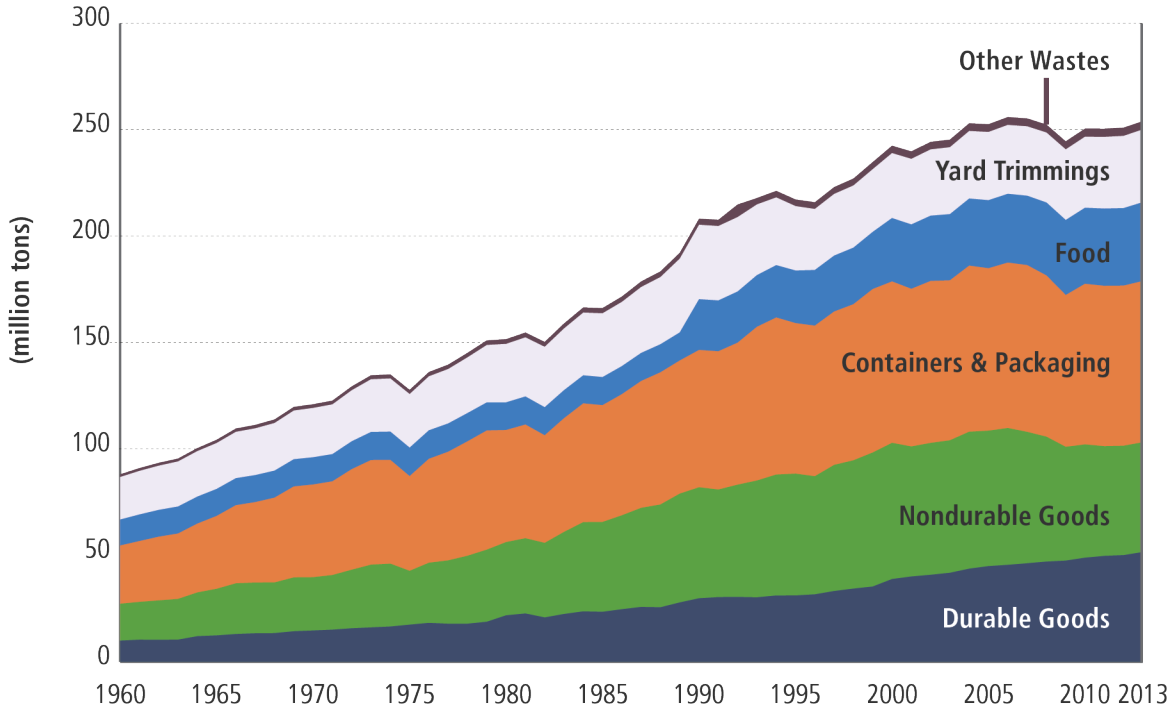
Summary of Products in Municipal Solid Waste

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

The materials composition of nondurable goods in 2013 is shown in Figure 15. Paper and paperboard made up 58.2 percent of nondurables in MSW generation, with plastics contributing 12.5 percent, and textiles 21.2 percent. Other materials contributed lesser percentages. After recovery for recycling, paper and paperboard were 44.3 percent of nondurable discards, with plastics being 18.0 percent, and textiles 25.9 percent.

The materials composition of containers and packaging in MSW in 2013 is shown in Figure 16. By weight, paper and paperboard products made up 50.9 percent of containers and packaging generation; plastics accounted for 18.5 percent. Glass was 12.2 percent, wood was 12.9 percent, and metals were 5.5 percent.

Figure 14. Generation of Products in MSW, 1960 to 2013

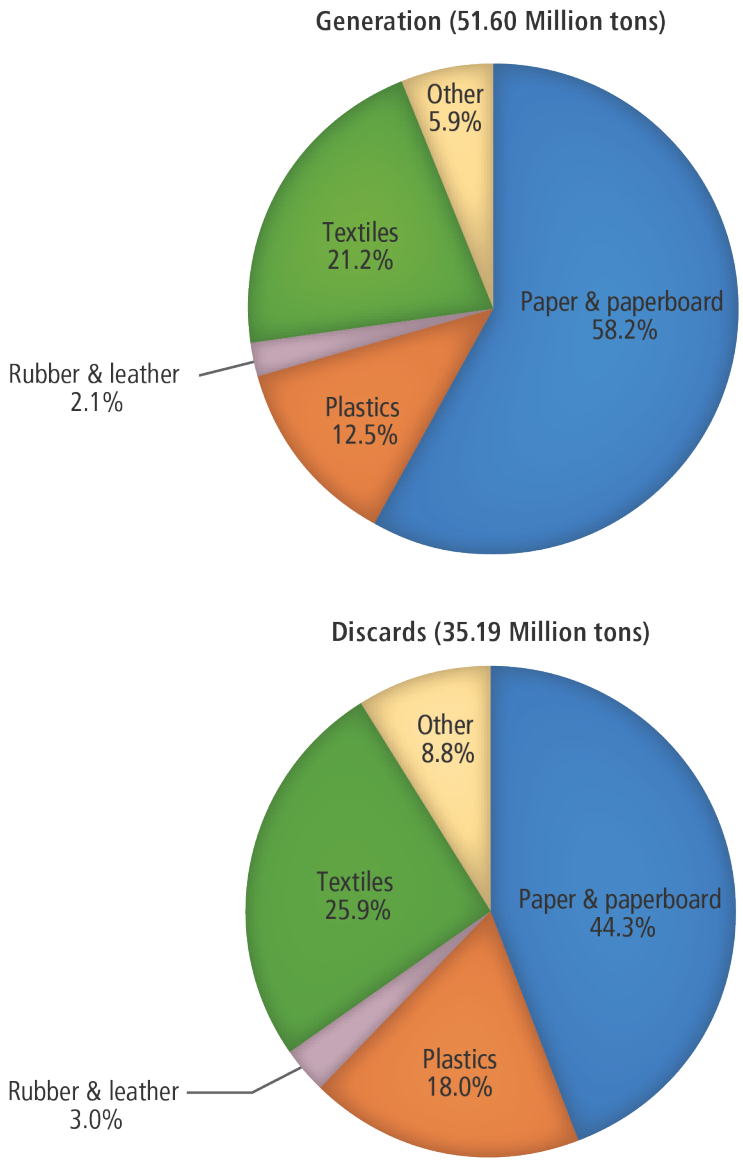


The percentage of materials discards from containers and packaging is affected by recovery for recycling. After recovery for recycling, paper and paperboard dropped to 26.2 percent of discards. Glass containers accounted for 16.6 percent of discards of containers and packaging, plastics were 32.5 percent, wood was 19.9 percent, and metals were 4.8 percent.

Additional containers and packaging detail is shown in Figure 17. Corrugated boxes account for 40 percent of total containers and packaging generation but, due to a high recovery rate, only account for nine percent of discards. Wood packaging makes up 12 percent of containers and packaging generation and 19 percent of discards. Plastic bags, sacks, and wraps are five percent of generation and nine percent of discards. Although steel and aluminum containers and packaging have high recovery rates (see Table 17), each account for two to three percent of generation and discards. This is due to the relatively small amounts of these products generated.

Figure 15. Nondurable Goods Generated and Discarded* in MSW, 2013

(In percent of total generation and discards)



* Discards in this figure include combustion with energy recovery

Figure 16. Containers and Packaging Materials Generated, Recovered, and Discarded* in Municipal Solid Waste, 2013

(In percent of total generation, recovery, and discards)

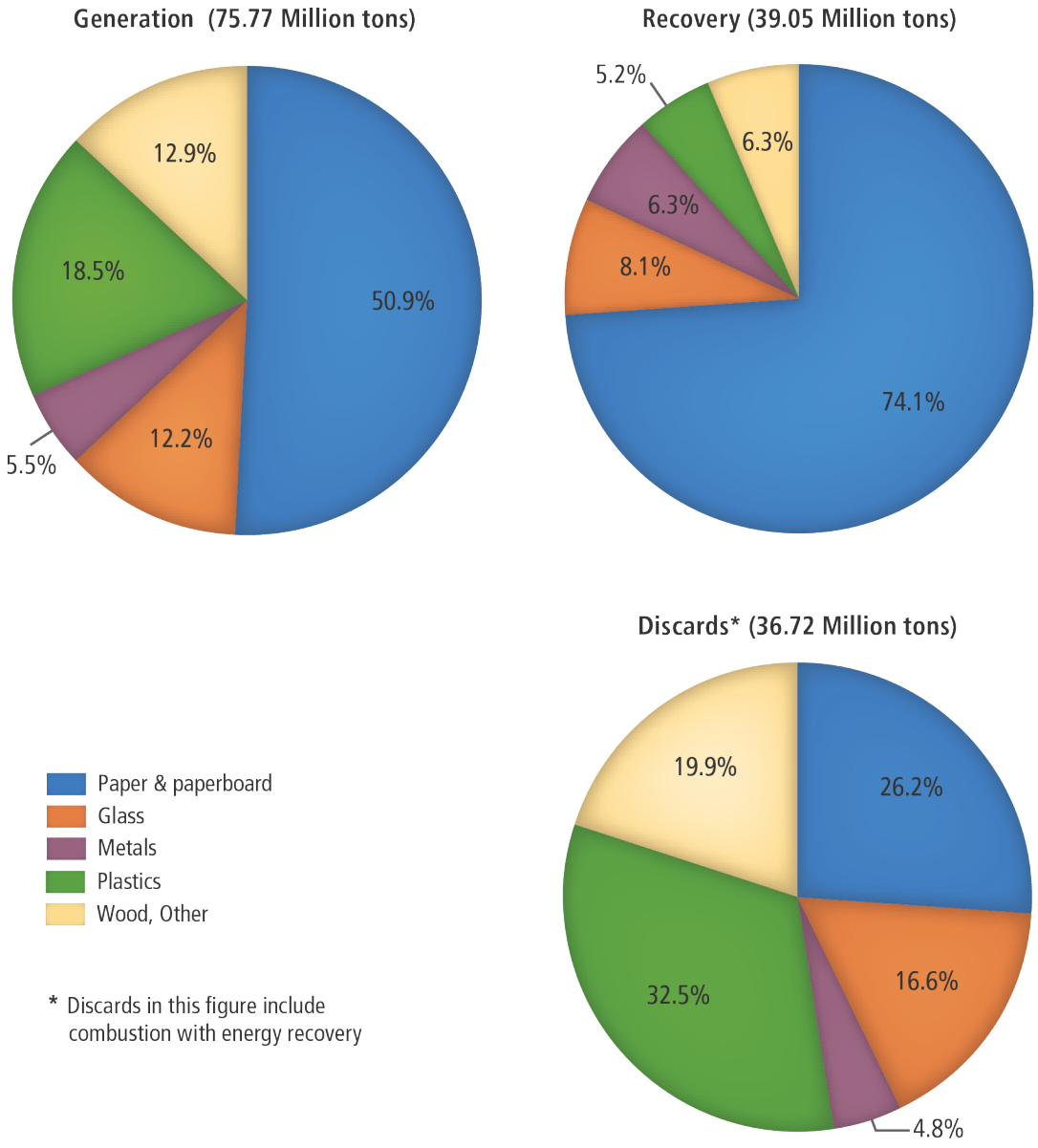
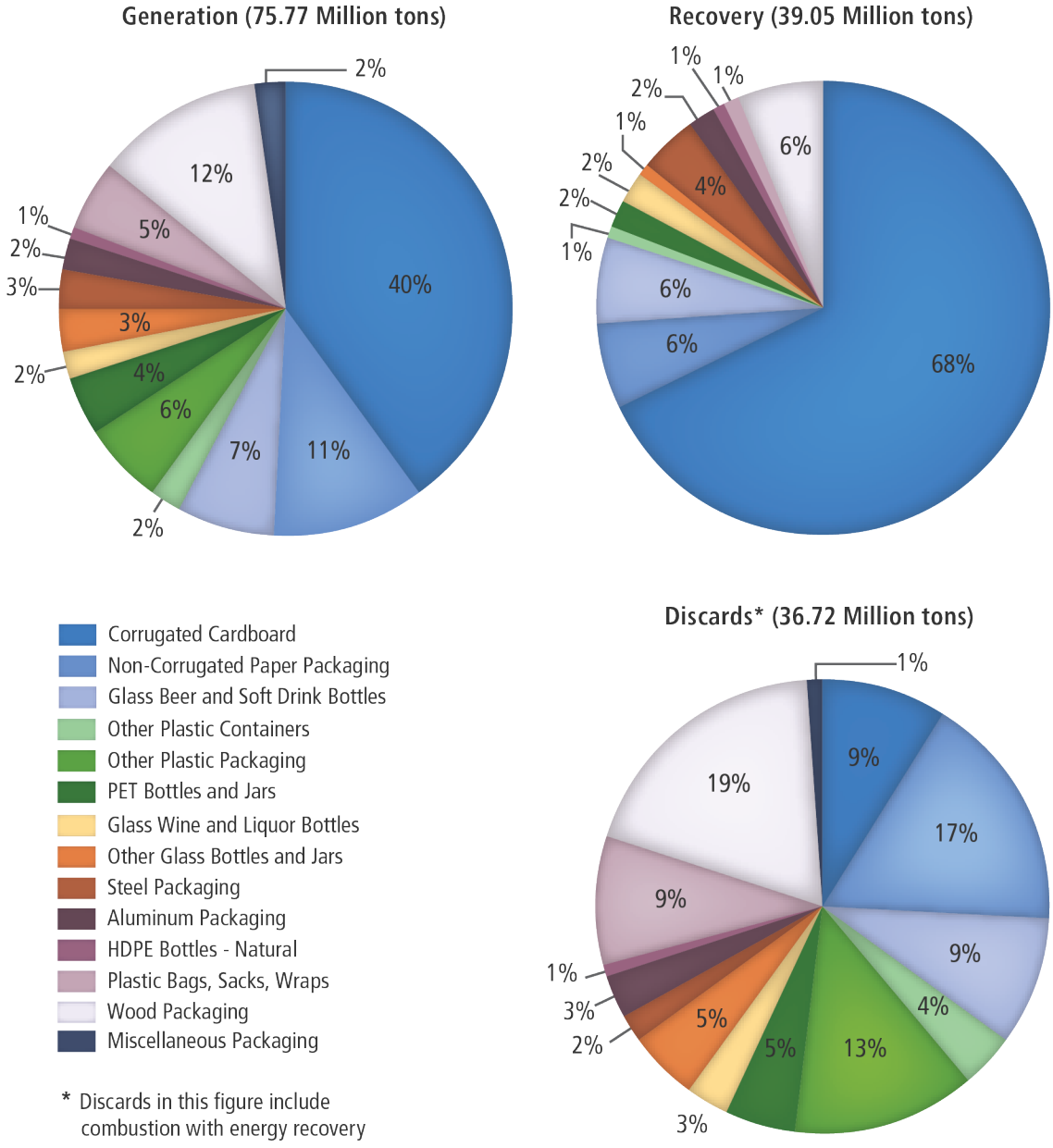


Figure 17. Containers and Packaging Generated, Recovered, and Discarded* in Municipal Solid Waste, 2013

(In percent of total generation, recovery, and discards)



* Discards in this figure include combustion with energy recovery

Summary

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

MSW Generation

- Total generation of municipal solid waste in 2013 was 254.1 million tons, which was slightly more than the 251.0 million tons generated in 2012. This compares to 1990, when total generation of MSW was 208.3 million tons.
- Per capita MSW generation increased from 4.38 pounds per person per day in 2012 to 4.40 pounds per person per day in 2013. MSW generation per person per day peaked in 2000. The 4.40 pounds per person per day is one of the lowest since 1980.
- Paper and paperboard products made up the largest percentage of all the materials in MSW, at 27.0 percent of total generation. Generation of paper and paperboard products declined from 84.8 million tons in 2005 to 68.6 million tons in 2013. Generation of newspapers has been declining since 2000, and this trend is expected to continue, partly due to decreased page size, but mainly due to increased use of electronic communication of news. Generation of office-type (high grade) papers also has been in decline, due at least partially to increased use of electronic transmission of reports, etc. Paper and paperboard products have ranged between 33 and 27 percent of generation since 2005.
- Yard trimmings comprised the third largest material category, estimated at 34.2 million tons, or 13.5 percent of total generation, in 2013. This compares to 35.0 million tons (16.8 percent of total generation) in 1990. The decline in yard trimmings generation since 1990 is largely due to state legislation discouraging yard trimmings disposal in landfills, including source reduction measures such as backyard composting and leaving grass trimmings on the yard.
- Plastic products generation in 2013 was 32.5 million tons, or 12.8 percent of generation. This was an increase of 2.5 million tons from 2009 to 2013. This increase in plastics generation came from durable goods and the containers and packaging categories. Although plastics generation has grown from 8.2 percent of generation in 1990 to 12.8 percent in 2013, plastics generation as a percent of total generation has remained fairly steady over the past three years.
- In 2013, an estimated 3.1 million tons of selected consumer electronics were generated. This represents less than 2 percent of MSW generation. Selected consumer electronics include products such as TVs, VCRs, DVD players, video cameras, stereo systems, telephones, and computer equipment.

MSW Recovery

- Recovery of materials in MSW increased from 5.6 million tons in 1960 (6.4 percent of total generation) to 69.5 million tons in 2000 (28.5 percent of generation) to 79.8 million tons in 2005 (31.4 percent of generation) to 87.2 million tons in 2013 (34.3 percent of generation).

- Recovery of paper and paperboard products, the largest component of recovery, increased from 16.9 percent in 1960 to 42.8 percent in 2000 to 49.5 percent in 2005 to 63.3 percent in 2013.
- The increase in recovery of paper and paperboard products over the longer term has been due to increases in recovery, over time, from all categories: newspapers, books, magazines, office papers, directories, Standard mail (advertisements, circulars, etc.), and other commercial printing.
- Newspapers/mechanical papers recovery rate decreased from 72.5 percent to 67.0 percent between 2011 and 2013. Prior to 2011, newspaper recovery was reported separately from mechanical papers (and therefore not comparable to earlier years). Newspapers/ mechanical papers generation decreased from 9.2 million tons to 8.1 million tons from 2011 to 2013.
- Containers and packaging recovery increased from 34.2 million tons in 2009 to 39.1 million tons in 2013; percentage recovery increased from 48.0 percent to 51.5 percent.
- Nondurable goods recovery decreased from 18.9 million tons in 2009 to 16.4 million tons in 2013. The percentage recovery of nondurable goods decreased from 35.3 percent to 31.8 percent over this same time period.
- Selected consumer electronics recovery increased to 1.3 million tons (40.4 percent recovery rate). This is up from the 2012 recovery rate for selected consumer electronics, which was 30.6 percent. It is unclear whether the large increase in the electronics recycling rate from 2012 to 2013 is due to an actual increase in recycling or the result of improved and expanded data.
- Measured by tonnage, the most recovered products and materials in 2013 were corrugated boxes (26.6 million tons), yard trimmings (20.6 million tons), mixed nondurable paper products (9.1 million tons), newspapers/mechanical papers (5.4 million tons), glass containers (3.2 million tons), lead-acid batteries (2.9 million tons), major appliances (2.6 million tons), wood packaging (2.5 million tons), mixed paper containers and packaging (2.4 million tons), tires (1.9 million tons), food (1.8 million tons), and selected consumer electronics (1.3 million tons). Collectively, these products accounted for 90 percent of total MSW recovery in 2013.
- Measured by percentage of generation, products with the highest recovery rates in 2013 were lead-acid batteries (99.0 percent), corrugated boxes (88.5 percent), newspapers/mechanical papers (67.0 percent), steel packaging (72.5 percent), major appliances (58.6 percent), yard trimmings (60.2 percent), aluminum cans (55.1 percent), mixed nondurable paper products (41.3 percent), tires (40.5 percent), selected consumer electronics (40.4 percent), glass packaging (34.0 percent), PET bottles and jars (31.3 percent), and HDPE natural bottles (28.2 percent).

Long Term Trends

- Generation of MSW has increased (except in recession years), from 88.1 million tons in 1960 to 254.1 million tons in 2013. After 2005, generation decreased due to the depressed economy. Generation decreased 3.6 percent between 2005 and 2009 followed by a rise in generation of 3.9 percent from 2009 to 2013.

- Generation of paper and paperboard, the largest material component of MSW, fluctuates from year to year, but has decreased from 87.7 million tons in 2000 to 68.6 million tons in 2013. Generation of yard trimmings has increased since 2000. Generation of other material categories also fluctuates from year to year, but overall MSW generation increased from 1960 to 2005, with the trend reversing 2005 to 2009, and rising again from 2009 through 2013.
- In percentage of total MSW generation, recovery for recycling (including composting) did not exceed 15 percent until 1990. Growth in the recovery rate was significant over the next 15 years. The recovery rate has grown more slowly over the last few years. The 2013 recovery rate was 34.3 percent.
- Recovery (as a percentage of generation) of most materials in MSW has increased dramatically over the last 43 years. Some examples:

	1970	1980	1990	2000	2013
Paper and paperboard	15%	21%	28%	43%	63%
Glass	1%	5%	20%	23%	27%
Metals	4%	8%	24%	35%	34%
Plastics	Neg.	<1%	2%	6%	9%
Yard trimmings	Neg.	Neg.	12%	52%	60%
Selected Consumer Electronics				10%	40%
Lead-acid batteries	76%	70%	97%	93%	99%

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

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3. MANAGEMENT OF MUNICIPAL SOLID WASTE

Introduction

EPA developed a hierarchy ranking the most environmentally sound strategies for municipal solid waste. The hierarchy places emphasis on reducing, reusing, and recycling the majority of wastes and demonstrates the key components of EPA's Sustainable Materials Management Program (SMM).

SMM is an effort to protect the environment and conserve resources for future generations through a systems approach that seeks to reduce materials use and their associated environmental impacts over their entire life cycles, starting with extraction of natural resources and product design and ending with decisions on recycling or final disposal.

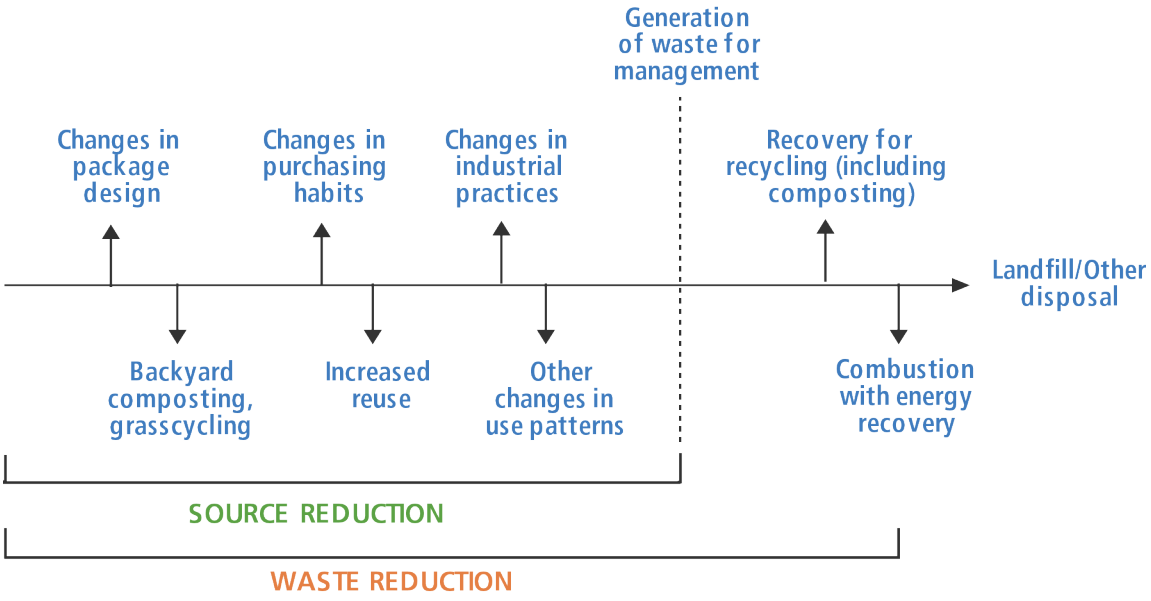
EPA's integrated waste management hierarchy, depicted below, includes the following four components:

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

Although we encourage the use of strategies that emphasize the top of the hierarchy whenever possible, all four components remain important within an integrated waste management system. The four components are put into context in Figure 18.

This chapter addresses the major activities within an integrated waste management system: source reduction, recycling (including composting), combustion with energy recovery, and disposal. Source reduction activities have the effect of reducing MSW generation, while other management alternatives deal with MSW once it is generated.

Figure 18. Diagram of Solid Waste Management



Estimates of the historical recovery of materials for recycling, including composting, are presented in Chapter 2. Chapter 3 discusses the current MSW management infrastructure. Current solid waste collection, processing, combustion with energy recovery, and disposal programs and facilities are highlighted with tables and figures. It also presents estimates for quantities of waste landfilled, which are obtained by subtracting the amounts recovered for recycling and composting and the amounts combusted with energy recovery from total MSW generation.

Source Reduction

Since 1960, the amount of waste each person creates has increased from 2.68 to 4.40 pounds per day. An effective way to stop this trend is by preventing waste from being generated in the first place.

Because of the lifecycle environmental benefits, source reduction is the most preferred materials management approach. Source reduction can:

- Save natural resources.
- Conserve energy.
- Reduce pollution. Reduce the toxicity of our waste.
- Save money for consumers and manufacturers.

Source reduction is gaining more attention as an important solid waste management option. Source reduction, often called “waste prevention,” is defined by EPA as “any change in the design, manufacturing, purchase, or use of materials or products (including packaging) to reduce their amount

or toxicity before they become municipal solid waste. Prevention also refers to the reuse of products or materials."[4] 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 recycling (including composting) or disposal.

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

- Redesigning products or packages so as to reduce the quantity of materials or the toxicity of the materials used, by substituting lighter materials for heavier ones and lengthening the life of products to postpone disposal.
- Removing unnecessary layers of packaging and using right-sized packaging.
- Using packaging that reduces the amount of damage or spoilage to the product.
- Reducing amounts of products or packages used through modification of current practices by processors and consumers.
- Reusing products or packages already manufactured.
- Managing non-product organic wastes (food, yard trimmings) through backyard composting or other on-site alternatives to disposal.

Table 24. Selected Examples of Source Reduction Practices

Source Reduction Practice	MSW Product Categories			
	Durable Goods	Nondurable Goods	Containers & Packaging	Organics (Wood, Yard Waste, Food, etc.)
Product or Packaging Redesign				
Materials reduction	▪ Downgauge metals in appliances	▪ Paperless purchase orders ▪ Concentrated products	▪ Container lightweighting ▪ Right size packaging ▪ Eliminate unnecessary layers of packaging ▪ Refillable/reusable containers, including use of flexible pouches for refills for rigid containers	▪ Xeriscaping ▪ Just in time ordering / inventory control ▪ Adjust menus to reduce frequently uneaten or wasted items
Materials substitution	▪ Use of composites in appliances and electronic circuitry		▪ Replace rigid or heavy packaging with lighter or more compact options, e.g., cereal in bags. coffee in brick packs ▪ Use life cycle data to choose material with lower lifecycle impact	
Lengthen Life	▪ High mileage tires ▪ Electronic components reduce moving parts	▪ Regular servicing ▪ Consider purchasing warranties to make repair more affordable ▪ Extend warranties	▪ Design for secondary use ▪ Design for upgrades (e.g., add computer memory or processing capacity, battery upgrades) ▪ Reusable packaging	▪ Clearer label information on food expiration date ▪ Avoid spoilage by changing: – Packaging

[4] U.S. Environmental Protection Agency. Source reduction definition from Glossary of Terms at web page Wastes – Educational Materials, accessed January 2015 at http://www.epa.gov/osw/education/quest/gloss1a.htm#sr.

Table 24. Selected Examples of Source Reduction Practices

Source Reduction Practice	MSW Product Categories			
	Durable Goods	Nondurable Goods	Containers & Packaging	Organics (Wood, Yard Waste, Food, etc.)
				– Storage and transportation – Supply chain management
Consumer Practices				
	▪ Purchase long lived products ▪ Regular servicing ▪ Repair ▪ Buying less stuff	▪ Repair ▪ Duplex printing ▪ Sharing ▪ Reduce unwanted mail ▪ Purchasing concentrated products ▪ Buying less stuff	▪ Purchasing products in bulk (less packaging) ▪ Reusable bags and containers ▪ Buying less stuff	▪ Food donation ▪ Avoid spoilage by monitoring and tracking food and purchases and use ▪ Reduce over-purchasing ▪ Proper food storage and preparation ▪ Repurposing (e.g., older bread can be made into croutons) ▪ Backyard composting ▪ Vermi-composting ▪ Grasscycling
Reuse				
By Design	▪ Document materials and methods for disassembly/ repair/reuse ▪ Use materials and systems that exhibit modularity, and standardization to facilitate reuse and repair – Minimize connections between parts and/or make connections more accessible for ease of repair and replacement of parts – Mechanical connections with bolts and screws instead of glues, to facilitate repair – Minimize connections to increase ease of repair or part replacement – Provide adequate tolerances to allow for removal and replacement or repair of parts without affecting adjacent components	▪ Reusable shipping or mailing envelopes	▪ Reusable pallets ▪ Returnable secondary packaging ▪ Reusable/refillable dispensers for cleaning products ▪ Reusable service ware in food service ▪ Use durable reusable water bottles instead of disposable bottles	

Table 24. Selected Examples of Source Reduction Practices

Source Reduction Practice	MSW Product Categories			
	Durable Goods	Nondurable Goods	Containers & Packaging	Organics (Wood, Yard Waste, Food, etc.)
Secondary	▪ Borrow or rent for temporary use ▪ Give to charity ▪ Buy or sell at garage sales	▪ Donate clothing, books ▪ Waste paper scratch pads	▪ Loosefill ▪ Grocery sacks ▪ Dairy containers ▪ Glass and plastic bottles and jars	
Reduce/Eliminate Toxins				
	▪ Eliminate PCBs	▪ Soy or waterbased inks ▪ Waterbased solvents ▪ Reduce mercury	▪ Replace lead foil on wine bottles ▪ Replace BPA-containing plastic products, liners, and coatings with alternative materials	

Source Reduction through Redesign

Since source reduction of products and packages can save money by reducing materials and energy costs, manufacturers and packaging designers have been pursuing these activities for many years. Combined with other source reduction measures, redesign can have a significant effect on material use and eventual discards, as long as the reduction in packaging maintains its protective performance and does not result in increased damage, leaks, or spoilage of the product inside the package. Design for source reduction can take several approaches.

Products can be redesigned to reduce weight or volume so that less packaging is required to deliver the product. Removing water from pre-diluted products is an effective way to reduce not only the size of a package but also its shipping weight, reducing both material use and transport fuel use. Single-strength liquid laundry detergent, for example, has now essentially been replaced by triple-strength concentrates that deliver the same amount of active ingredients in a much smaller bottle. Flavored beverage concentrates in the form of powders and drops that consumers mix with water at home are gaining popularity and can reduce the number of disposable beverage bottles entering the waste stream.

Reductions in packaging can also be achieved by making container walls thinner, changing the shape or design of the package, or changing the package manufacturing process. Significant reductions in material use (and disposal) have been made in beverage packaging in recent years. Examples of packaging source reduction achievements for different material types include the following:

- Plastics: The weights of plastic bottles and containers, particularly beverage bottles, have been reduced considerably over the years. Since 1980, the weight of two-liter PET soft drink bottles has dropped by about 34 percent, from 68 grams per bottle to 42-45 grams today. The weight of a 32 ounce sports drink bottle was reduced from 45 grams to 39 grams, a 13 percent reduction that saved 595,000 pounds of plastic in the U.S. and almost 9 million pounds in Europe. The weight of a 500 ml water bottle has been reduced by half since 2002. Other types of plastic packaging have seen significant weight reductions as well. The weight of one brand's plastic yogurt cups are now about half the weight they were in the 1970s. The amount of plastic (and overall weight) of other plastic food trays and containers has

been reduced by replacing some of the plastic content with mineral fillers, or by replacing solid plastic with plastic material that has a microcellular structure that reduces material weight and improves insulating performance without affecting recyclability.

- Aluminum: In 2013, a 12 ounce aluminum beverage can weighed 0.0286 pounds (2.86 pounds per 100 cans, or 13 grams per can); down from 3.51 pounds per 100 cans (15.9 grams per can) in 1992 and 4.5 pounds per 100 cans (20.4 grams per can) in 1972. This is a reduction of almost 19 percent since 1992 and 36 percent since 1972.
- Steel cans: Over the years, steel food cans have been lightweighted by shifts from three piece to two-piece can designs, using thinner gauges of steel for can walls, and improvements in easy-open end (EOE) cans. Today's steel food cans are about 1/3 lighter than they were 25 years ago.
- Glass: Significant lightweighting has been achieved in soft drink, beer, and wine bottles, as well as food jars, through use of manufacturing techniques such as the NNPB (narrow neck press and blow) process, which can achieve weight reductions of 10 to 30 percent compared to conventional glass bottles.
- Corrugated boxes: The amount of corrugated used for packaging can be reduced by ensuring that boxes are not overspecified (do not use boxboard that is thicker and heavier than the application requires). In some cases, the amount of corrugated can be reduced by using a different box configuration, e.g., a box with smaller flaps, or by replacing corrugated boxes with corrugated trays and pads used with a film overwrap. One innovative company installs equipment that feeds corrugated sheet into forming machines at customers' plants to produce made-to-order boxes tailor-fit to each order.

Material substitution is another way to make a product or package lighter, use less material and/or reduce environmentally hazardous characteristics of the product. For example, there has been a continuous trend of substitution of lighter materials such as plastics and aluminum for materials such as glass and steel. Substitution also may involve replacing a rigid package with a lighter or more compact flexible package. Improvements in strength and barrier properties of new film resins and technologies can allow significant reductions in packaging film thickness (and weight) without diminishing protective performance. A related source reduction approach is using lightweight, flexible packages to sell refills for heavier rigid containers. This solution can be used for products like laundry detergent and liquid hand soap, where the refill material from the pouch is poured into the original rigid container, rather than purchasing another filled rigid container. A foodservice refill pouch of salad dressing that can be poured into refillable individual bottles reduced plastic use by 60 percent compared to the rigid bulk refill container used previously.

Redesign of a product to make it smaller and/or lighter can also result in savings in the amount of transport packaging used to ship products to stores. For example, when a large consumer product company reduced the thickness of their disposable diapers in 2013, the amount of plastic film wrap and corrugated shipping boxes used to package and ship the diapers was reduced by 10 percent.

Elimination of unnecessary packaging is an important form of source reduction. Some companies have removed cardboard cores inside rolls of paper towels or bathroom tissue, with one company reporting elimination of 8.5 pounds of waste per case of tissue. Some farmers use reusable field-to-store containers for shipping produce. After the produce is picked it is put into a container that will be used

not only to ship the product but also to display the product in the retail store. These display-ready containers result in savings in many areas. With no repacking, less labor is required, fewer containers are used, and spoilage and produce damage that can occur during repacking processes is reduced. Reusable display-ready containers are often sturdier and provide more protection during shipment compared to single-use containers. Other companies have eliminated exterior boxes for health and beauty products such as bottles of cough syrup. Using "right-sized" shipping boxes is another very effective approach that can reduce not only the amount of material used for the box but also the amount of fill material used to surround the product inside the box. Cube optimization (designing product and packaging so that it more efficiently uses space in transport packaging) can lead to both waste reduction and ancillary benefits of more efficient transport (less truckloads required to ship same amount of product, with associated fuel and GHG reductions). One very large retailer was able to increase deliveries by 830 million cases while simultaneously reducing 300 million miles driven, compared to their 2005 baseline. Manufacturers should consider the entire packaging system to ensure that a change made in one area does not result in tradeoffs in another area. For example, removal of exterior packaging at the product level could result in additional packaging needed for palletizing and shipping the product.

Lengthening product life delays the time when the product enters the municipal waste stream. The responsibility for lengthening product life lies partly with manufacturers and partly with consumers. Manufacturers can design products to last longer and be easier to repair. Since some of these design modifications may make products more expensive, at least initially, manufacturers must be willing to invest in new product development, and consumers must demand the products and be willing to pay for them to make the goal work. Unfortunately there currently is no standardized way for manufacturers to communicate – and consumers to understand – the relative durability or lifespan of competing products. Consumers and manufacturers also must be willing to care for and repair products.

Modifying Practices to Reduce Materials Use

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

Individuals and businesses can request removal from mailing lists to reduce the amount of mail received and discarded. When practical, products can be purchased in large sizes or in bulk to minimize the amount of packaging per unit of product. Concentrated products also can reduce packaging requirements. The use of reusable shopping bags reduces the quantity of plastic and paper bags produced.

Dining services across the country are finding significant reductions in food waste simply by going trayless. Trayless dining has on average, reduced post-consumer plate waste by 30 percent.

Reuse of Products and Packages

Similar to lengthening product life, reuse of products and packaging delays the time when the items must finally be discarded as waste. When a product is reused, presumably manufacture, purchase and use of a new product is delayed, although this may not always be true. 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. Many of the products characterized for this report are reused in sizable quantities (e.g., furniture, wood pallets, and clothing). The recovery of products and materials for recycling (including composting) as characterized in Chapter 2 does *not* include reuse of products, but reuse is discussed in this section.

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

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

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

Containers and Packaging. Glass bottles are a prime example of reuse of a container for its original purpose. Refillable glass bottles can be collected, washed, and refilled for use again. Some years ago large numbers of refillable glass soft drink bottles were used; however, single-use glass bottles, plastic bottles, and aluminum cans have largely replaced these. While refillable glass soft drink bottles have largely disappeared from use in the U.S., refillable bottles are seeing an increase in popularity for beer and dairy products. According to a 2011 USA Today article, hundreds of brewpubs, breweries and even grocery stores are cashing in on the growing popularity of 64-ounce refillable glass beer bottles called growlers. A California dairy reports a return rate of over 80 percent of their glass milk bottles. The bottles are washed, sanitized and reused an average of 4-6 times before being recycled.

Consumers are also increasingly choosing to purchase reusable vessels to use for on-the-go consumption of drinking water and other beverages, rather than buying beverages in disposable bottles. Water bottle refill stations are now available at locations including schools, national parks, and airports.

Another example in the reuse category is the use of refurbished wood pallets for shipping palletized goods. It is estimated that over 8 million tons of wood pallets were refurbished and returned to service in 2013. It is also common practice to recondition steel drums and barrels for reuse.

Use of returnable containers for closed-loop shipping cycles between product manufacturers and their customers continues to expand, as companies realize the environmental and cost benefits of using a much smaller supply of durable boxes to make shipment cycles that would require much greater numbers of single-use boxes that are typically disposed or recycled after one use. Many companies sell or lease rigid and collapsible plastic containers made of solid molded panels or corrugated plastic that can be reused dozens or hundreds of times. Fiber corrugated boxes can often be reused for several shipping cycles before they become worn out and are sent to a recycler. Use of returnable containers can save huge quantities of material if container losses due to theft and damage can be minimized. One major snack food company reports operating a corrugated box reuse system with a 96.8 percent box reuse rate. The boxes are used an average of 5 times before they are recycled, saving 5 million trees a year. Some corrugated box brokers are successfully selling used corrugated boxes, which bring a higher price than selling baled used boxes to a recycler.

In addition to use for shipments of finished products, reusable packaging has important benefits for shipments between parts suppliers and manufacturers. Use of reusable boxes and racks designed for specific parts can drastically reduce not only the amount of one-way packaging to be recycled or disposed but can also lead to reductions in part damage, greatly improved efficiencies in space utilization in transport and in plants, increased material handling efficiencies at manufacturing plants, and associated cost savings.

Many types of containers and packaging can be either recycled or reused. Although recycling is an effective means of reducing solid waste disposal, energy is required for recycling and remanufacturing processes. Direct reuse of a product or package is a very effective source reduction technique that is less energy-intensive than recycling. Many grocery stores offer reusable bags for sale and encourage reuse of any shopping bags, often allowing a refund for each bag brought back for reuse. Also, many parcel shippers will take back plastic packaging “peanuts” for reuse.

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

Just as consumer participation is key to increasing recycling, responsible consumer behavior is key to the success of many source reduction measures. For example, source-reduced packaging designed to be light in weight and minimize material usage can become litter or marine debris if improperly managed by consumers. Products that have been designed to have long lives will not result in source reduction if consumers dispose of the product when a replaceable or repairable component fails or do not maintain the product properly.

Management of Organic Materials

Food and yard trimmings combined made up over 28 percent of MSW generation in 2013, so source reduction measures aimed at these products can have an important effect on waste generation. Composting is the usual methodology for recovering these organic materials. As defined in this report,

composting of organic materials after they are taken to a central composting facility is a recycling activity. Estimates for these off-site composting activities are included in this chapter.

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

Part of the impetus for source reduction and recycling of yard trimmings is the large number of state regulations discouraging landfilling or other disposal of yard trimmings. The Composting Council and other sources reported that in 1992, 11 states and the District of Columbia (amounting to over 28 percent of the nation's population) had in effect legislation affecting management of yard trimmings. By 2013, 21 states (amounting to about 39 percent of the nation's population) had legislation discouraging the disposal of yard trimmings. In addition, some local and regional jurisdictions regulate disposal of yard trimmings.

Measuring Source Reduction

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

The November 1999 *National Source Reduction Characterization Report for Municipal Solid Waste in the United States* (EPA 530-R-99-034) provides additional information including an explanation of a methodology that has been used to generate source reduction estimates.

Recovery for Recycling and Composting

Recyclables Collection

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

Curbside Recyclables and Food Collection. In 2011, more than 9,800 curbside recyclables collection programs were reported in the United States. Curbside collection programs commonly require residents to do at least some sorting of the recyclable materials put at the curb. In recent years,

however, there has been a trend toward single-stream curbside collections programs, in which no sorting is required of the residents. The American Forest & Paper Association (AF&PA) estimated that 65 percent of curbside recyclables collection programs were single-stream in 2010.[5] These programs require that the materials be taken to a materials recovery facility (MRF) for processing.

EPA estimates over 70 percent of the U.S. population had access to curbside recyclables[6] collection programs in 2011 (based on data from states representing 71.2 percent of the U.S. population). In comparison, a 2009 American Beverage Association study estimated that 74 percent of the U.S. population had access to curbside recycling programs.[7]

Communities offering residential curbside food collection programs were identified for 209 communities across 16 states in 2013. Table 25 shows that these residential curbside collection programs were available to 2.7 million households, which is 2.3 percent of all U.S. households in 2013.

Table 25. Residential Food Collection and Composting Programs in the U.S., 2013

State	Households Served	State	Households Served
California	1,301,966	New York	31,800
Colorado	37,824	Ohio	73,813
Iowa	39,400	Oregon	213,728
Kansas	73	Pennsylvania	3,400
Maryland	4,540	Texas	15,600
Massachusetts	9,599	Vermont	2,700
Michigan	47,500	Washington	770,458
Minnesota	157,596	Wisconsin	700
New Jersey	8,138		
Total U.S. Households Served			**2,718,835**
Total U.S. Households			**116,291,033**
			2.3%

BioCycle March 2013. Residential Food Waste Collection In The U.S. — BioCycle Nationwide Survey. Supplemental tables.
Additional web search to supplement *BioCycle* survey.
New York City's pilot program served over 30,000 households in 2013. The program was expanded in 2014 to 100,000 households served. Several other pilot programs around the country were started or expanded in 2014, including Cambridge, MA and Austin, TX.

Several alternative composting collection programs exist to serve communities where curbside collection is not an option. First, many cities and towns encourage residents to compost food in their backyards, if space is available. Second, a number of communities—such as Cambridge and Manchester-by-the-Sea in Massachusetts; Minneapolis, Ramsey, and Hennepin Counties in Minnesota;

5 AF&PA. "2010AF&PA Community Survey Executive Summary." This report also estimated that 63 percent of the U.S. population is served by curbside recyclables collection.
6 U.S. Environmental Protection Agency. Municipal Solid Waste in the United States 2011 Facts and Figures. May 2013.
7 American Beverage Association. "2008 ABA Community Survey. Final Report." September 2009.

Boulder County in Colorado; Napa Valley in California; and Washington, D.C.—have drop-off sites that accept food for composting in place of or in addition to curbside programs. Third, new private companies have formed to fill the demand for home pick-up services for food composting where municipal curbside programs do not exist.

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

It is difficult to quantify drop-off centers in the United States. It is estimated that there were 12,694 programs in 1997, according to a *BioCycle* survey. In 2010, the "2010 AF&PA Community Survey Executive Summary" estimated over 21,000 communities have drop-off centers. The 2009 American Beverage Association study estimated 83 percent of the U.S. population has access to drop-off collection programs. Both of these later studies stated that many communities have access to both curbside and drop-off recyclables collection. In some areas, particularly those with sparse population, drop-off centers may be the only option for collection of recyclable materials. In other areas, they supplement other collection programs.

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

Deposit Systems. Ten states have container deposit systems: California, Connecticut, Hawaii, Iowa, Maine, Massachusetts, Michigan, New York, Oregon, and Vermont (Figure 19). In these programs, the consumer pays a deposit on beverage containers at the point of purchase, which is redeemed on return of the empty containers. In California, beverage distributors also pay a per container fee. In addition to these fees, handling fees are also assessed in most of the states listed.

Deposit systems generally target beverage containers, which account for about 5 percent of total MSW generation (dairy products are typically excluded). The 2007 version of this report series estimated that about 35 percent of all recovery of beverage containers comes from ten of the eleven states with deposit legislation,[8] and an additional 20 percent of recovered beverage containers come from California. (Note: These recovery estimates reflect not only containers redeemed by consumers for deposit, but also containers recovered through existing curbside and drop-off recycling programs. Containers recovered through these programs eventually are credited to the distributor and counted towards the redemption rate.)

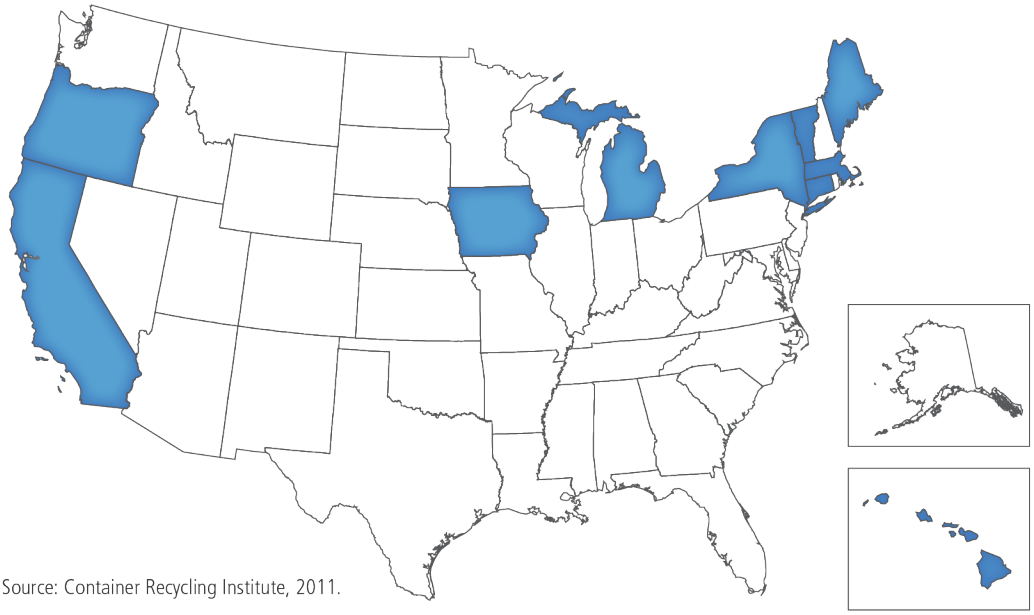
Commercial Recyclables Collection. The largest quantity of recovered materials comes from the commercial sector. Old corrugated containers (OCC) and office papers are widely collected from commercial establishments. Grocery stores and other retail outlets that require corrugated packaging are part of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

[8] Delaware deposit legislation was repealed by Senate Bill 234. Deposit collection ceased on December 1, 2010. http://www.bottlebill.org/legislation/usa/delaware.htm

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

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

Figure 19. States with Bottle Deposit Rules



Source: Container Recycling Institute, 2011.

Recyclables Processing

Processing recyclable materials is performed at materials recovery facilities (MRFs), mixed waste processing facilities, and mixed waste composting facilities. Some materials are sorted at the curb and require less attention. Other materials are sorted into categories at the curb, such as a paper category and a container category, with additional sorting at a facility (MRF). There is a more recent trend towards MRFs that can sort recyclable materials that are picked up unsorted (single-stream recycling). Mixed waste can also be processed to pull out recyclable and compostable materials.

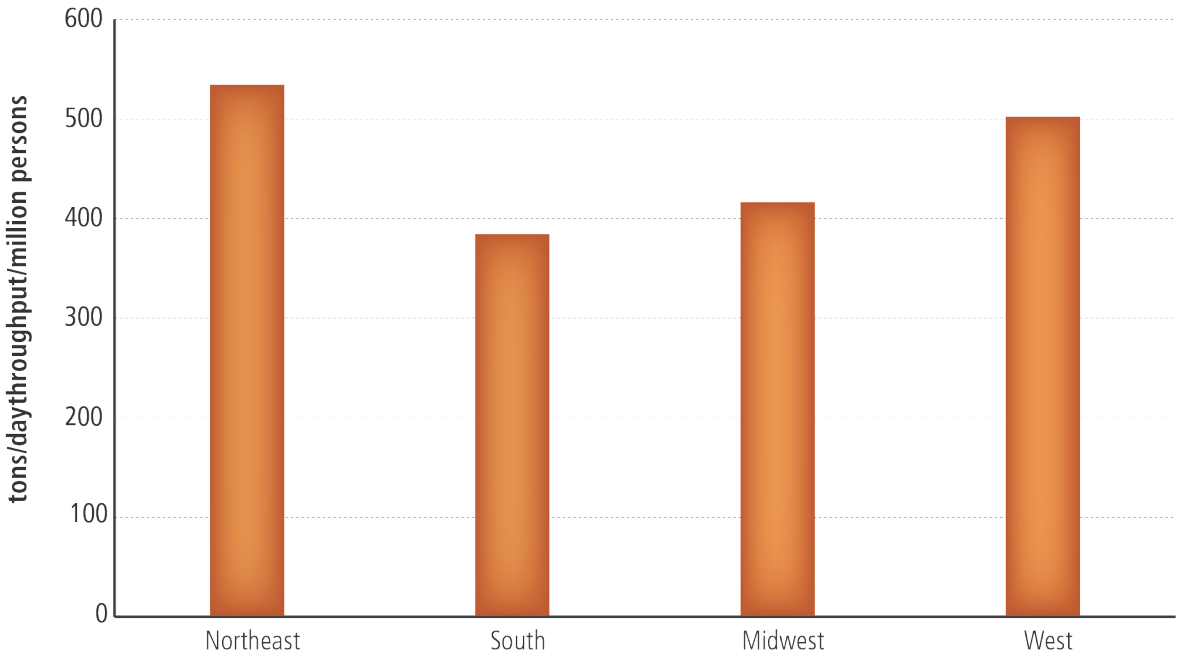
Materials Recovery Facilities. Materials recovery facilities vary widely across the United States, depending on the incoming materials and the technology and labor used to sort the materials. In 2013, 797 MRFs were operating in the United States, with an estimated total daily throughput of over 140,000 tons per day (Table 26). The most extensive recyclables processing throughput occurs in the Northeast and West (Figure 20).

Table 26. Material Recovery Facilities (MRF), 2013

Region	Number	Estimated Throughput (tpd)
NORTHEAST	175	29,792
SOUTH	238	45,375
MIDWEST	231	28,003
WEST	153	37,176
U.S. Total	**797**	**140,346**

Source: Governmental Advisory Associates, Inc. Data provided December 2014.

Figure 20. Estimated MRF Throughput, 2013
(Tons per day per million persons)



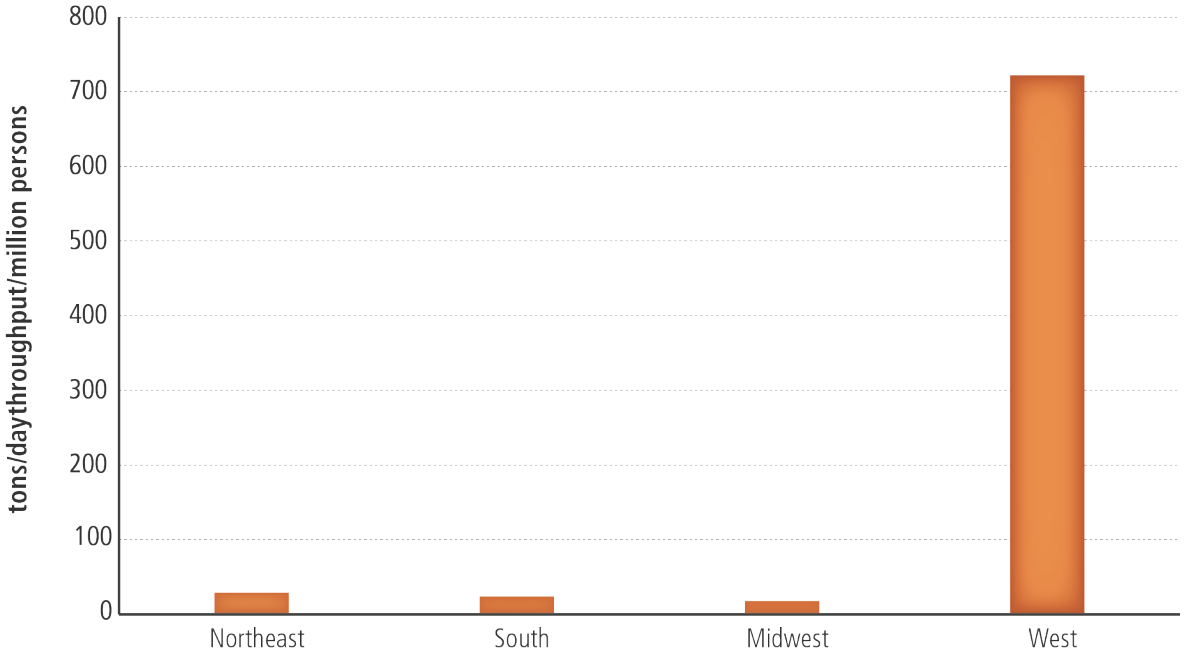
Source: U.S. Census Bureau, Governmental Advisory Associates, Inc. Data provided December 2014.

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

Mixed Waste Processing. Mixed waste processing facilities are less common than conventional MRFs, but there are several facilities in operation in the United States, as illustrated in Figure 21. Mixed waste processing facilities receive mixed solid waste (including recyclable and non-recyclable materials), which is then loaded on conveyors. Using both mechanical and manual (high and low technology) sorting, recyclable materials are removed for further processing. In 2013, there were reported 52

mixed waste processing facilities in the U.S., handling about 58,700 tons of waste per day. The Western region has the largest concentration of these processing facilities (representing over 90 percent of the daily throughput).

Figure 21. Mixed Waste Processing Estimated Throughput, 2013
(Tons Per Day Per Million Persons)

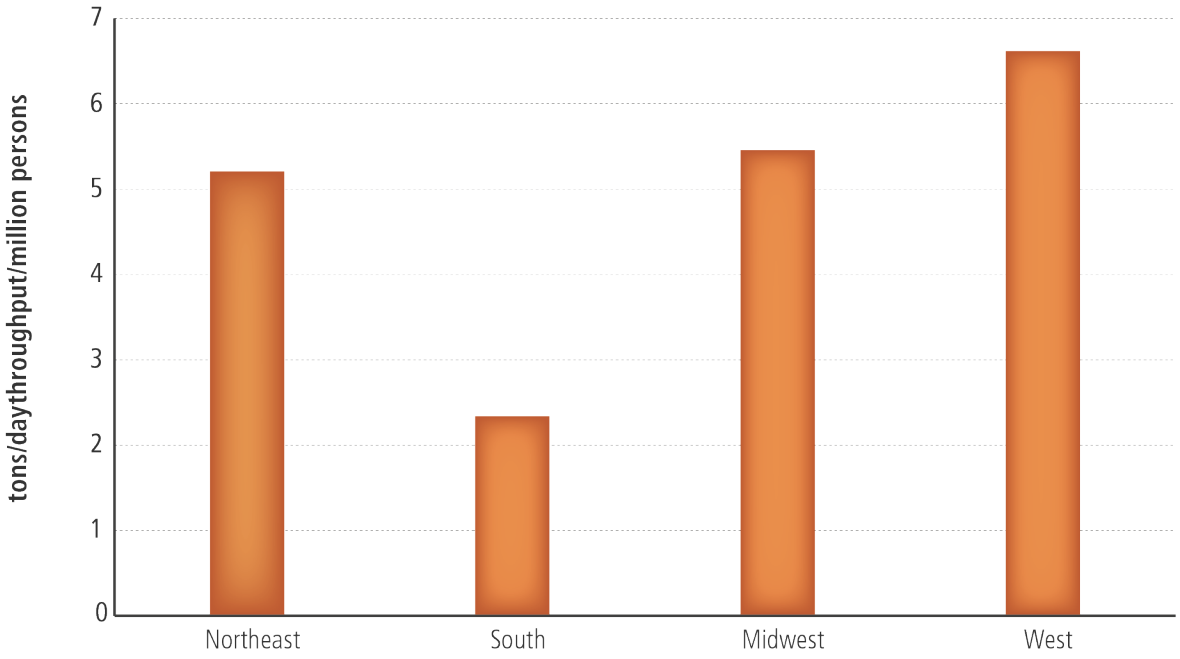


Source: U.S. Census Bureau, Governmental Advisory Associates, Inc. Data provided December 2014.

Mixed Waste Composting. Mixed waste composting starts with unsorted MSW. Large items are removed, as well as ferrous and other metals, depending on the type of operation. Mixed waste composting takes advantage of the high percentage of organic components of MSW, such as paper, food and yard trimmings, wood, and other materials. In 2013, there were 12 mixed waste composting facilities, the same number of facilities reported in 2009.

Nationally, mixed waste composting facilities handled about 1,400 tons per day in 2013, up from 1,100 tons per day in 2009. In 2013, the highest processing capacity per million persons was found in the West and Midwest, as shown in Figure 22.

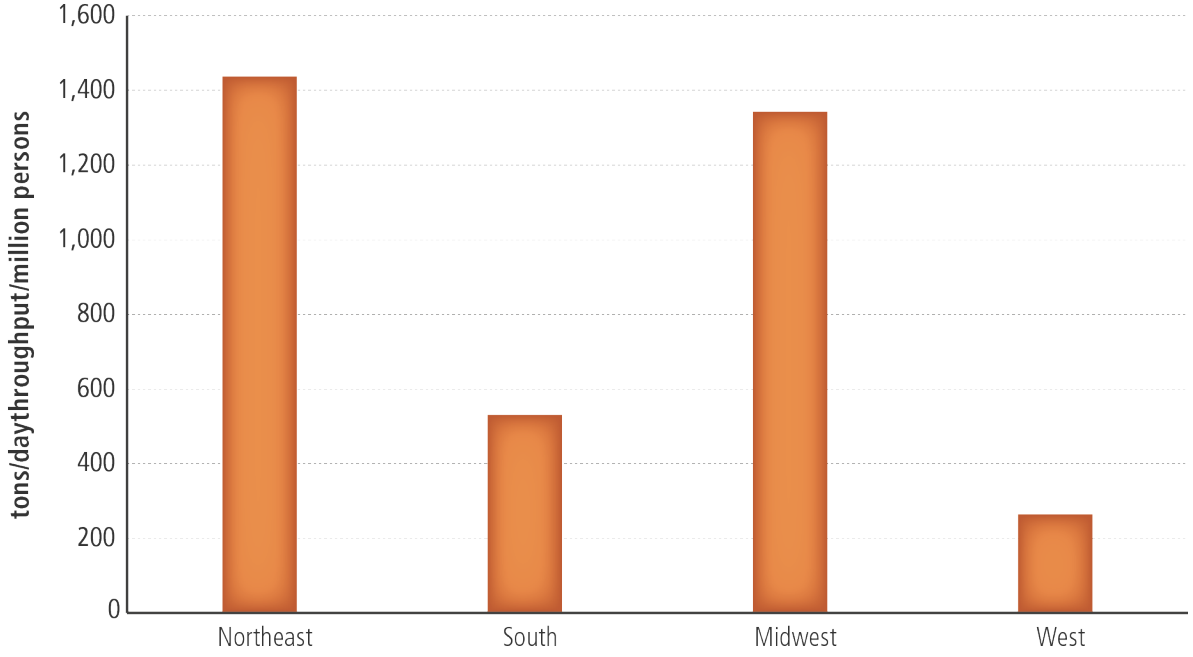
Figure 22. MSW Composting Capacity, 2013
(Capacity in Tons Per Day Per Million Persons)



Source: U.S. Census Bureau; BioCycle, November 2011, Medina County, Ohio and West Wendover, Nevada websites.

Yard Trimmings Composting. Yard trimmings composting is much more prevalent than mixed waste composting. On-site management of yard trimmings (backyard composting) is discussed earlier in this chapter, and is classified as source reduction, not recycling. In 2013, about 3,560 yard trimmings composting programs were identified. In 2013, about 50 percent of these programs were in the Midwest region, as shown in Figure 23. Based on 20.6 million tons of yard trimmings recovered for composting in the United States (Table 2, Chapter 2), yard trimmings composting facilities handled approximately 56,400 tons per day in 2013.

Figure 23. Yard Trimmings Composting Facilities, 2013
(In Number of Facilities)



Source: Institute for Local Self-Reliance. July 2014 "State of Composting in the U.S."Facilities composting yard trimmings. Includes data for 44 states. An Internet search provided remaining information for Alaska, Hawaii, Louisiana, Nevada, Oklahoma, West Virginia, and the District of Columbia

Combustion with Energy Recovery

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

Total U.S. MSW combustion with energy recovery, referred to as waste-to-energy (WTE) combustion, had a 2013 design capacity of about 95,300 tons per day. There were 80 WTE facilities in 2013 (Table 27), down from 102 in 2000. In tons of capacity per million persons, the Northeast region had the most MSW combustion capacity in 2013 (Figure 24).

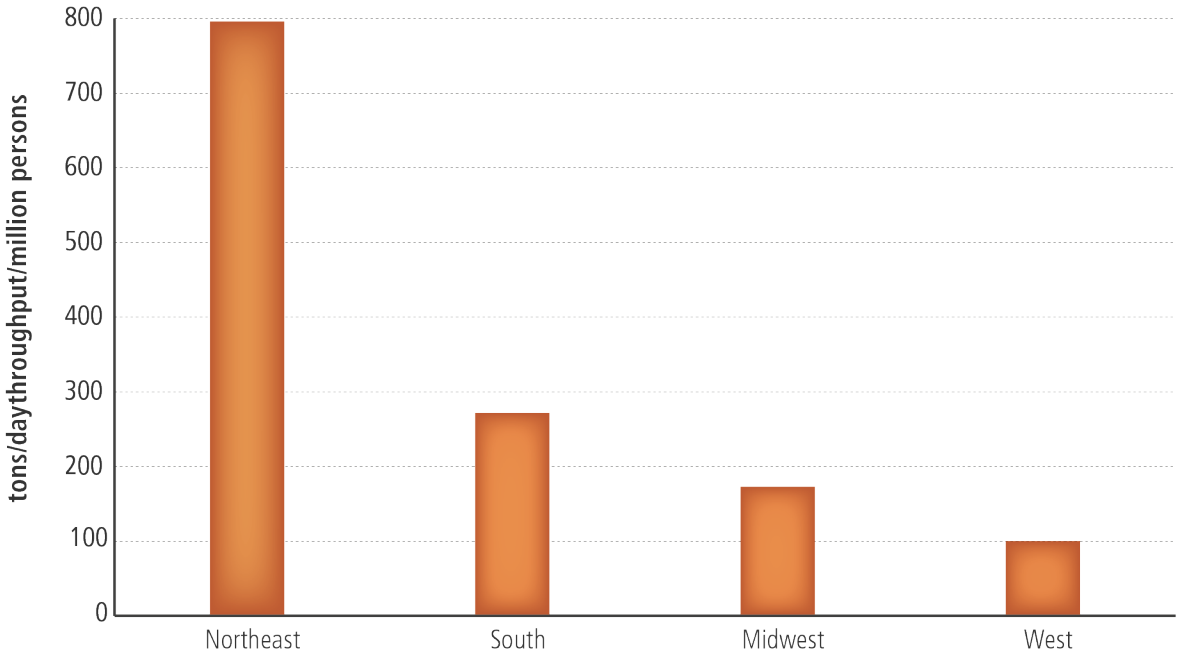
In addition to facilities combusting mixed MSW (processed or unprocessed), there is a small but growing amount of combustion of source-separated MSW. In particular, rubber tires have been used as fuel in cement kilns, utility boilers, pulp and paper mills, industrial boilers, and dedicated scrap tire-to-energy facilities. In addition, there is combustion of wood wastes and some paper and plastic wastes, usually in boilers that already burn some other type of solid fuel. For this report, it was estimated that about 3.2 million tons of MSW were combusted in this manner in 2013, with tires contributing a majority of the total.

Table 27. Municipal Waste-To-Energy Projects, 2013

Region	Number Operational	Design Capacity (tpd)
NORTHEAST	38	44,415
SOUTH	21	32,004
MIDWEST	14	11,524
WEST	7	7,310
U.S. Total*	80	95,253

* Excludes 4 inactive facilities (representing another 996 tpd capacity).
WTE includes mass burn, modular, and refuse-derived fuel combustion facilities.
Source: "The 2014 ERC Directory of Waste-to-Energy Facilities." Energy Recovery Council (ERC). May 2014.

Figure 24. Municipal Waste-To-Energy Capacity, 2013
(Capacity in Tons Per Million Persons)



Source: U.S. Census Bureau, Energy Recovery Council (ERC). May 2014.

Residues from Waste Management Facilities

Whenever municipal wastes are processed, residues will remain. For the purposes of this report, it is assumed that most of these residues are landfilled. 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, 5 to 10 percent is probably typical for a MRF. Residues from a MRF or compost facility are generally landfilled. Since the recovery estimates in this report are based on

recovered materials purchased by end users rather than materials entering a processing facility, the residues are counted with other disposed materials.

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 is managed separately[9]. (There are a number of efforts underway to reuse ash.) As a general "rule of thumb," MSW combustor ash amounts to about 25 percent (by weight) of unprocessed MSW input. This percentage will vary from facility to facility depending upon the types of waste input and the efficiency and configuration of the facility.

Landfills

In 2013, there were 1,908 municipal solid waste landfills reported in the United States. Table 28 and Figure 25 show the number of landfills in each region. The South and West had the largest number of landfills. Thirty-eight percent of the landfills are located in the West, 35 percent in the South, and 21 percent in the Midwest. Less than 7 percent are located in the Northeast.

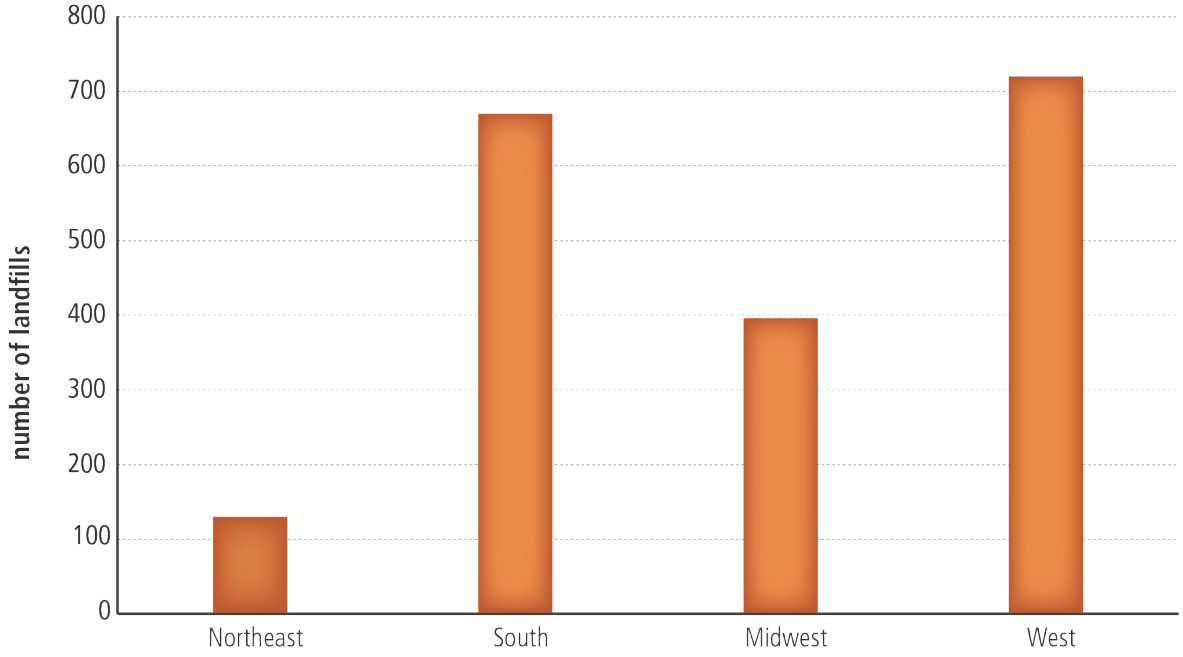
Table 28. Landfill Facilities, 2013

Region	Number of Landfills
NORTHEAST	128
SOUTH	668
MIDWEST	394
WEST	718
U.S. Total	1,908

Source: *BioCycle* October 2010. Latest report available.

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

Figure 25. Number of landfills in the U.S., 2013



Source: BioCycle October 2010. Latest report available.

Recycling and Job Creation

A recent Institute of Scrap Recycling Industries (ISRI) report noted that the scrap recycling industry in 2011, indirectly and directly created 459,140 jobs with $26 billion in wages and $90.1 billion in economic activity. That amounts to 137,640 direct jobs by the manufacturing and brokerage operations of the scrap recycling industry in the United States that includes purchasing, processing and brokering of scrap materials made of ferrous and nonferrous metals, paper, electronics, rubber, plastics, glass and textiles. These jobs paid an average wage and benefits of $66,704.

The Tellus Institute prepared the 2011 More Jobs, Less Pollution: Growing the Recycling Economy in the U.S. that noted a possible 1.5 million more jobs could be created with the doubling of the recycling rate over the next two decades. In the late 1990's and early 2000's, EPA carried out the U.S. Recycling Economic Information Project to establish the Jobs through Recycling and recycling economic analysis efforts across the country. From early EPA community case study efforts, the Institute for Local Self Reliance developed these initial job creation estimates as shown in Table 29.

Table 29. Jobs Created through Reuse, Recycling, and Disposal
(jobs per 10,000 tons per year managed)

Type of Operation	Jobs per 10,000 TPY
Product Reuse	
Computer Reuse	296
Textile Reclamation	85
Misc. Durables Reuse	62
Wooden Pallet Repair	28
Recycling-based Manufacturers	**25**
Paper Mills	18
Glass Product Manufacturers	26
Plastic Product Manufacturers	93
Conventional Materials Recovery Facilities	**10**
Composting	**4**
Landfill and Incineration	**1**

Source: Institute for Local Self-Reliance. Washington, DC. 1997.

The estimation of economic impacts of recycling and source reductions has been carried on by various states and regional entities completing their own studies since EPA's seminal work.

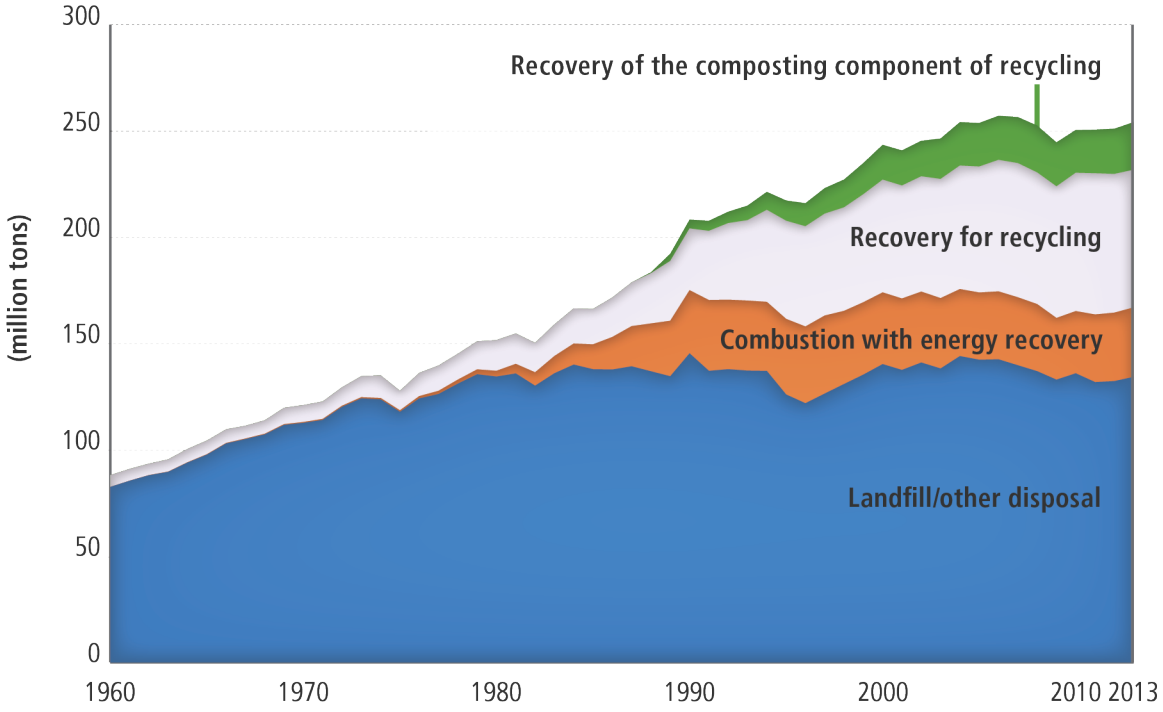
Summary of Historical and Current MSW Management

This summary provides some perspective on historical and current municipal solid waste management practices in the United States. The results are summarized in Table 30 and Figure 26.

Historically, municipal solid waste generation has grown steadily (from 88.1 million tons in 1960 to 254.1 million tons at present). In the 1960s and early 1970s a large percentage of MSW was burned, with little recovery for recycling. Landfill disposal typically consisted of open dumping, often accompanied with open burning of the waste for volume reduction.

Through the mid-1980s, incineration declined considerably and landfills became difficult to site, and waste generation continued to increase. Materials recovery rates increased very slowly in this time period, and the burden on the nation's landfills grew dramatically. As Figure 26 shows, discards of MSW to landfill or other disposal apparently peaked in 1990 and then began to decline as materials recovery and combustion with energy recovery increased.

Figure 26. Municipal Solid Waste management, 1960 to 2013



Recovery has increased steadily. Combustion with energy recovery, as a percentage of generation, has been declining. MSW discards to landfills rose to about 142.3 million tons in 2005, and then declined to 134.3 million tons in 2013. As a percentage of total MSW generation, discards to landfills or other disposal has consistently decreased–from 88.6 percent of generation in 1980 to 52.8 percent in 2013.

Table 30. Generation, Materials Recovery, Composting, Combustion, and Discards of Municipal Solid Waste, 1960 to 2013

(In thousands of tons and percent of total generation)

	Thousands of Tons									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Generation	88,120	121,060	151,640	208,270	243,450	253,730	244,600	250,540	251,040	254,110
Recovery for recycling	5,610	8,020	14,520	29,040	53,010	59,240	61,890	66,400	65,240	64,740
Recovery for composting*	Neg.	Neg.	Neg.	4,200	16,450	20,550	20,750	20,570	21,330	22,440
Total Materials Recovery	5,610	8,020	14,520	33,240	69,460	79,790	82,640	86,970	86,570	87,180
Discards after recovery	82,510	113,040	137,120	175,030	173,990	173,940	161,960	163,570	164,470	166,930
Combustion with energy recovery**	0	400	2,700	29,700	33,730	31,620	29,010	31,800	32,200	32,660
Discards to landfill, other disposal†	82,510	112,640	134,420	145,330	140,260	142,320	132,950	131,770	132,270	134,270
	Pounds per Person per Day									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Generation	2.68	3.25	3.66	4.57	4.74	4.69	4.37	4.41	4.38	4.40
Recovery for recycling	0.17	0.22	0.35	0.64	1.03	1.10	1.10	1.17	1.14	1.12
Recovery for composting*	Neg.	Neg.	Neg.	0.09	0.32	0.38	0.37	0.36	0.37	0.39
Total Materials Recovery	0.17	0.22	0.35	0.73	1.35	1.48	1.47	1.53	1.51	1.51
Discards after recovery	2.51	3.03	3.31	3.84	3.39	3.21	2.90	2.88	2.87	2.89
Combustion with energy recovery**	0.00	0.01	0.07	0.65	0.66	0.58	0.52	0.56	0.56	0.57
Discards to landfill, other disposal†	2.51	3.02	3.24	3.19	2.73	2.63	2.38	2.32	2.31	2.32
Population (thousands)	179,979	203,984	227,255	249,907	281,422	296,410	307,007	311,592	313,914	316,129

	Percent of Total Generation									
	1960	1970	1980	1990	2000	2005	2009	2011	2012	2013
Generation	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Recovery for recycling	6.4%	6.6%	9.6%	14.0%	21.8%	23.3%	25.3%	26.5%	26.0%	25.5%
Recovery for composting*	Neg.	Neg.	Neg.	2.0%	6.7%	8.1%	8.5%	8.2%	8.5%	8.8%
Total Materials Recovery	6.4%	6.6%	9.6%	16.0%	28.5%	31.4%	33.8%	34.7%	34.5%	34.3%
Discards after recovery	93.6%	93.4%	90.4%	84.0%	71.5%	68.6%	66.2%	65.3%	65.5%	65.7%
Combustion with energy recovery**	0.0%	0.3%	1.8%	14.2%	13.9%	12.5%	11.9%	12.7%	12.8%	12.9%
Discards to landfill, other disposal†	93.6%	93.1%	88.6%	69.8%	57.6%	56.1%	54.4%	52.6%	52.7%	52.8%

* Composting of yard trimmings, food and other MSW organic material. Does not include backyard composting.

** Includes combustion of MSW in mass burn or refuse-derived fuel form, and combustion with energy recovery of source separated materials in MSW (e.g., wood pallets and tire-derived fuel). 2013 includes 29,500 MSW, 510 wood, and 2,650 tires (1,000 tons)

† Discards after recovery minus combustion with energy recovery. Discards include combustion without energy recovery.

Details may not add to totals due to rounding.

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APPENDIX A: MATERIALS FLOW METHODOLOGY

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

Domestic Production

Data on domestic production of materials and products were compiled using published data series. U.S. Department of Commerce sources were used where available, but in several instances more detailed information on production of goods by end use is available from industry 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, recovered 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.

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.

Recovery

Data on recovery of materials and products for recycling are compiled using industry data adjusted, when appropriate, with U.S. Department of Commerce import/export data. Recovery estimates of yard trimmings or food waste for composting are developed from data provided by state officials and processors of these materials.

Discards

Mathematically, discards equal that portion of generation remaining after recovery for recycling and composting. Discards can be disposed through combustion with or without energy recovery or landfilling. The amount of MSW consumed at combustion facilities with energy recovery is estimated, and the difference between total discards and the amount sent to combustion for energy recovery is assumed to be landfilled or combusted without energy recovery. (This assumption is not quite accurate, as some MSW is littered or disposed on-site, e.g., by backyard burning. These amounts are believed to be a small fraction of total discards.)

Municipal Solid Waste Generation, Recovery, 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.

Figure A-1. Materials Flow Methodology for Estimating Generation of Products and Materials in Municipal Solid Waste

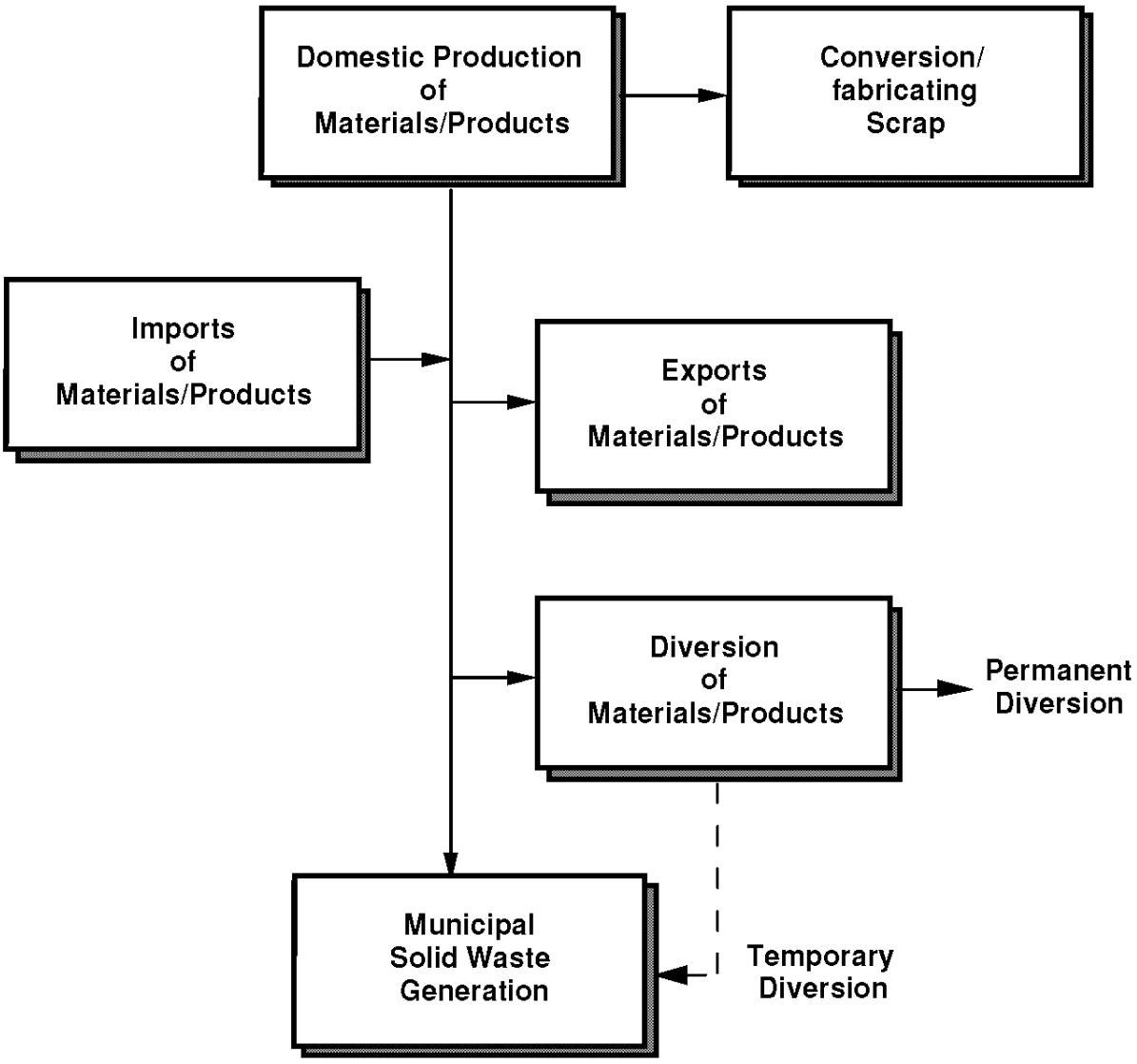
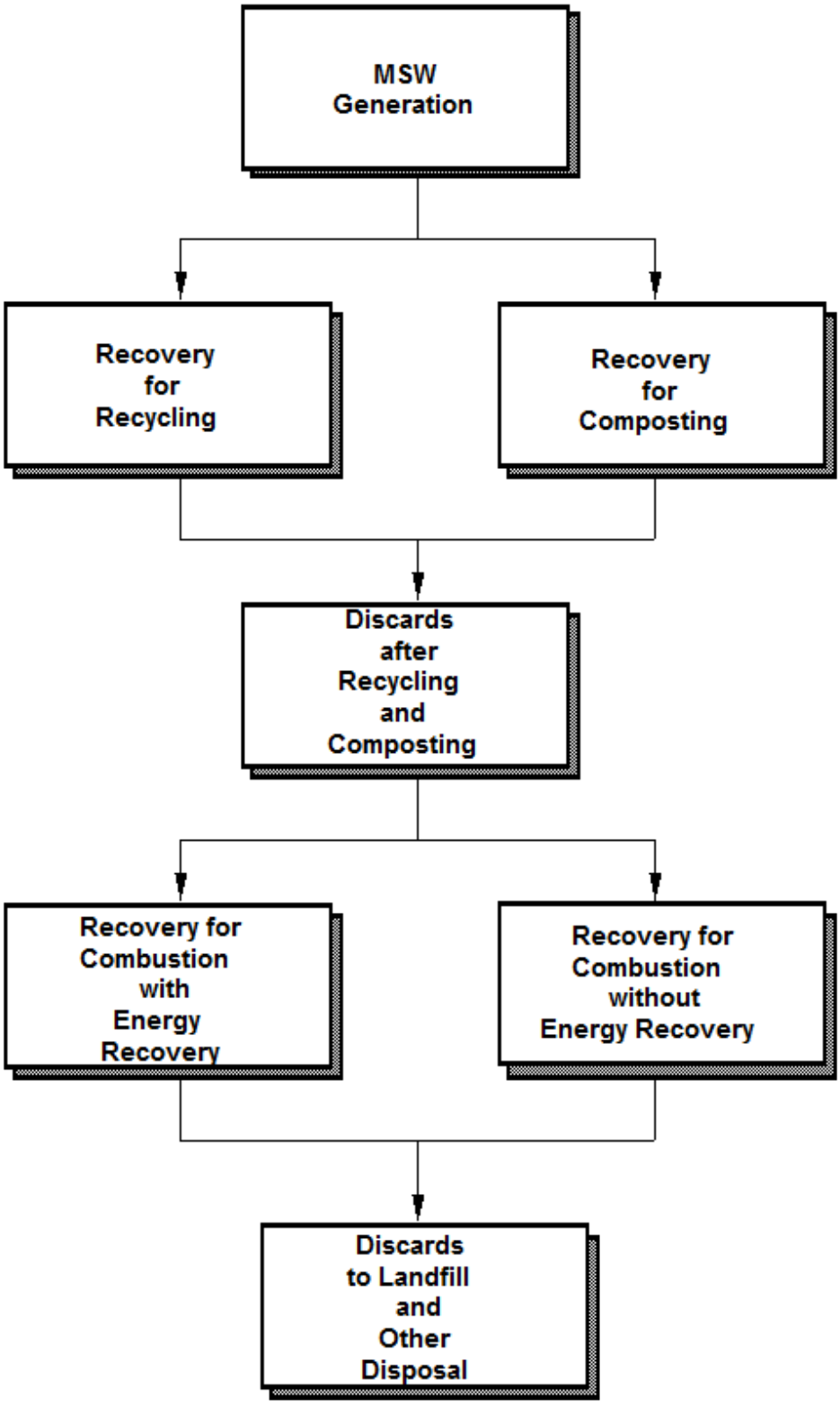


Figure A-2. Materials Flow Methodology for Estimating Discards of Products and Materials in Municipal Solid Waste



Appendix B: Construction and Demolition Debris Generation

Introduction

Construction and demolition (C&D) debris includes a variety of materials that may be generated from different sources (e.g., construction, renovation, demolition, land-clearing, and natural disasters). The C&D estimates presented in this appendix are generated from construction, renovation and demolition of buildings, roads, and bridges.

EPA estimated how much C&D debris is generated in the United States using a materials flow analysis. Materials estimated through the materials flow analysis are Portland cement concrete, steel, wood products, gypsum wallboard and plaster, brick, clay tile, and asphalt shingles. The method used to estimate asphalt concrete differed from the materials flow analysis. The asphalt concrete generation was estimated using industry gathered consumption data and an estimated asphalt concrete recovery rate.

Construction and Demolition Debris Generation

This section includes a detailed description of the methodology used by EPA to estimate C&D debris generation and results from the analysis. In order to capture the greatest portion of C&D debris generation possible, EPA chose to use a top-down estimation method developed from a materials flow analysis by Cochran and Townsend (2010). This method is similar to that used for calculation of waste generation from durable goods in municipal solid waste. Historical construction-material usage (consumption) is tabulated and typical lifespans of material types are assumed. The materials flow analysis estimates when each material has reached end-of-life (EOL) and is ready for management.

Two alternative approaches for estimating generation have been proposed. The first requires annual construction, demolition, and renovation data such as annual square footage of construction or construction and demolition permits as well as information on the amount and type of materials per unit of construction or demolition in order to estimate and characterize the waste at the national level. Since these data are not readily available for non-building related C&D generation, this approach would lead to underestimation of C&D debris generation. The second approach is a bottom-up approach that uses state-level diversion and disposal data to build up to a national estimate. This approach relies on data gathered by individual state agencies. The data are gathered over different time periods, presented at differing levels of data aggregation, supported by different material and management definitions, all of which would make comparison across all of the states difficult.

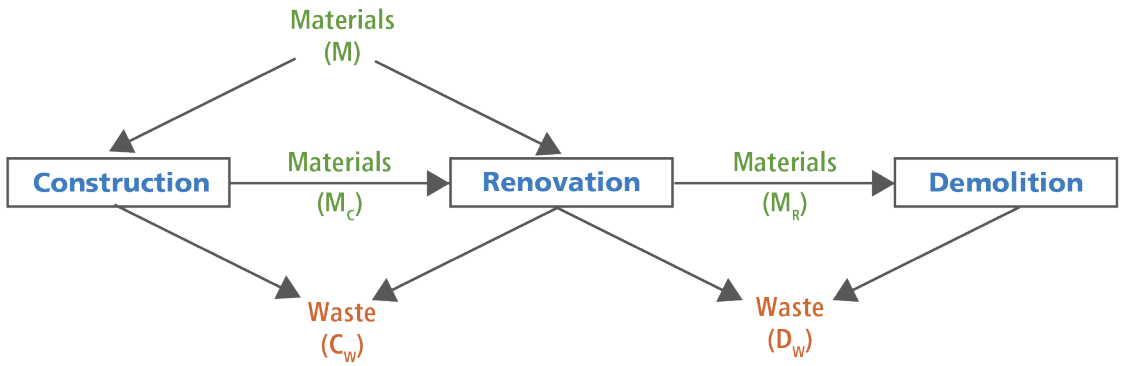
The materials flow method outlined by Cochran and Townsend, and used as a starting point here, draws on publicly available historical materials consumption data from several government and industry organizations to estimate C&D debris generation for Portland cement concrete, steel, wood

products, gypsum wallboard and plaster, brick, clay tile, and asphalt shingles. The method EPA used to estimate asphalt concrete differed from the materials flow analysis. Industry gathered data on recycled asphalt pavement (RAP) consumption and an estimated asphalt concrete recovery rate were used to estimate generation. These products represent the major components of construction. C&D debris generation from land clearing or natural disasters is not included.

C&D Debris Generation Methodology

Based on the Cochran and Townsend methodology, EPA derived total C&D debris generation from the sum of waste generated during construction and demolition activities. Figure B-1 depicts the flow of materials resulting from construction, renovation, and demolition over the lifetime of a building, road, or other structure. Cochran and Townsend define C&D debris generated during construction (C_w) as the portion of purchased construction materials that are not incorporated into the actual structure, such as scraps and surplus materials. New construction and the installation phase of renovation projects both contribute to waste generated during construction. Demolition waste (D_w) is the sum of materials removed from a structure during renovation and the materials generated from a structure's final demolition.

Figure B-1. Materials Flow Diagram for Construction, Renovation, and Demolition



Source: Cochran and Townsend (2010)

Construction guides, used by builders to estimate the amount of materials to purchase for a construction project, provide the average amount of waste expected during construction for a range of materials. Cochran and Townsend used these guides to estimate the average percentage of materials discarded during construction, shown in Table B-1. Equation 1 below shows the calculation of waste during construction for a given year based on annual material consumption and average percentage of material waste during construction.

$$(1)\quad C_{w,y} = M_y \times W_c$$

where:

$C_{w,y}$ = amount of material waste discarded during construction in year y;

M_y = the amount of a given material consumed in the U.S. in year y; and,

W_c = the percentage of material discarded during new construction or the installation phase of renovation.

Table B-1. Percent of Material Discarded during Construction

Material	Percent Discarded
Concrete	3%
Wood products	5%
Drywall and Plasters	10%
Steel	0%
Brick and Clay Tile	4%
Asphalt Shingles	10%
Asphalt Concrete	0%

Source: As cited in Cochran and Townsend (2010): DelPico (2004) and Thomas (1991)

Any material incorporated into the actual structure remains until removed during renovation or demolition, at which point it becomes demolition waste.[10] Since C&D debris generated from demolition in a given year is dependent on the lifespan of each construction material, Cochran and Townsend (2010) calculated a range of C&D debris generation from demolition based on the short, typical, and long lifespan of the material and source of C&D debris shown in Table B-2, resulting in three different values for C&D demolition debris for each year by material and source.

Table B-2. Lifespan of Construction Materials by Source (Years)

Material	Source	Lifespan		
		Short	Typical	Long
Concrete	Buildings	50	75	100
	Roads & Bridges	23	25	40
	Other Structures	20	30	50
Lumber	Buildings	50	75	100
Plywood and Veneers	Buildings	50	75	100
Wood Paneling	Buildings	20	25	30
Drywall and Plasters	Buildings	25	50	75

[10] For a material such as asphalt shingles that reaches its assumed end of life before other materials associated with the same structure, EPA assumes that the material is removed from service through renovation and accounted for in the demolition amount. This approach does not capture demolition materials generated during renovation for aesthetic or other reasons that remove materials prior to their end of life.

Table B-2. Lifespan of Construction Materials by Source (Years)

Material	Source	Lifespan		
		Short	Typical	Long
Steel	Buildings/ Roads & Bridges	50	75	100
Brick	Buildings	50	75	100
Clay Floor & Wall Tile	Buildings	15	20	25
Asphalt Shingles	Buildings	20	25	30
Asphalt Concrete	Buildings	20	25	30

Source: As cited in Cochran and Townsend (2010): Zapata and Gambatese (2005), Katz (2004), Park et al. (2003), Scheuer et al. (2003), Junnila and Horvath (2003), Chapman and Izzo (2002), Cross and Parsons (2002), Thormark (2002), Keoleian et al, (2001), Horvath and Hendrickson (1998), Bolt (1997), and Packard (1994). Additional corroboration with USGS (2010).

Table B-3 shows the results for C&D debris generation of brick when using the Cochran and Townsend method for calculating demolition debris. While this method reflects the variability in demolition debris due to the uncertainty in material lifespan, each of the three demolition waste estimates are based on a single data point, i.e., historical consumption data for a single year. Furthermore, the overall C&D debris generation is presented as a range, while a single representative total waste value would be more useful. To calculate a single representative total waste value for each material and source in a given year, only one demolition debris estimate must be chosen. However, it is not clear which of the three demolition debris estimates (short, typical, or long) would be the most representative of actual demolition debris generated in a given year. For instance, Table B-3 reveals that the demolition debris estimate for bricks calculated with the Cochran and Townsend method using the typical 75 year lifespan for bricks ranges from nearly 20 million short tons in 2000 to less than 3 million short tons in 2008.

Because waste during construction estimates remains fairly steady and contributes less than 10 percent of total C&D debris between 2000 and 2008, demolition debris estimates drive the observed changes. The rapid drop in demolition debris generation between 2004 and 2007 is due to falling consumption of bricks for construction as the Great Depression began in the late 1920's. Given that a strong economy is indicative of high construction activity and thus demolition in order to make space for new buildings, it seems unlikely that in 2007, at the height of the U.S. economy before the recession, demolition waste from bricks was half of what it was in 2006 and a quarter of what it was in 2005 simply because of low construction activity during the Great Depression 75 years ago. The same issues that cause highly variable C&D debris generation using a typical material lifespan can also affect demolition debris estimates using short or long lifespans.

Table B-3. U.S. Annual C&D Brick Debris Generation using Cochran and Townsend's (2010) Method to Calculate Demolition Debris Generation (Tons)

Year	Brick Waste During Construction	Demolition Brick			Total C&D Brick Debris		
		Short Life	Typical Life	Long Life	Short Life	Typical Life	Long Life
2000	587,760	12,179,130	19,317,300	14,411,010	12,766,890	19,905,060	14,998,770
2001	568,880	12,756,340	19,163,380	16,258,090	13,325,220	19,732,260	16,826,970
2002	567,510	11,332,560	18,220,600	17,181,620	11,900,070	18,788,110	17,749,130
2003	568,570	11,294,080	16,989,220	17,123,900	11,862,650	17,557,790	17,692,470
2004	637,010	12,929,510	14,699,620	17,508,710	13,566,520	15,336,630	18,145,720
2005	661,300	15,199,870	11,755,850	19,932,990	15,861,170	12,417,150	20,594,290
2006	613,990	15,565,430	6,195,390	20,471,720	16,179,420	6,809,380	21,085,710
2007	523,990	12,814,070	2,693,650	19,971,470	13,338,060	3,217,640	20,495,470
2008	390,970	12,159,890	2,482,000	16,161,880	12,550,860	2,872,970	16,552,850
2009	276,950	14,122,410	2,693,650	20,414,000	14,399,350	2,970,590	20,690,940
2010	259,570	13,352,790	4,386,800	19,086,420	13,612,370	4,646,370	19,345,990
2011	237,390	12,852,550	7,349,810	17,701,110	13,089,940	7,587,200	17,938,500
2012	234,840	13,256,590	8,061,700	18,028,200	13,491,430	8,296,540	18,263,030
2013	234,840	14,257,090	6,791,840	17,162,380	14,491,930	7,026,680	17,397,220

Instead of calculating demolition debris generation based on one service life at a time (short, typical, long), EPA calculated an average demolition debris generation for the full range of a material's expected lifespan for each source. The demolition debris generation from brick in 2013 is used as an example. The expected lifespan of brick ranges from 50-100 years (Table B-2). EPA calculated demolition debris resulting from consumption of bricks for each year in 1913-1963, and then averaged the results. Equation 2 below shows the calculation used to estimate demolition waste for a given year.

$$(2)\quad D_{w,y} = \frac{\sum_{i=(y-l)}^{(y-s)} (M_i - C_{w,i})}{(l-s)+1}$$

where:

y = the given year for which demolition waste generation is calculated;

l = the longest expected lifetime of the material (see Table Y);

s = the shortest expected lifetime of the material;

$D_{w,y}$ = the amount of demolition waste generated from material removed during renovation or demolition in year y;

M_i = the amount of a given material consumed in the U.S. in year i, where i ranges from year y-l to year y-s;

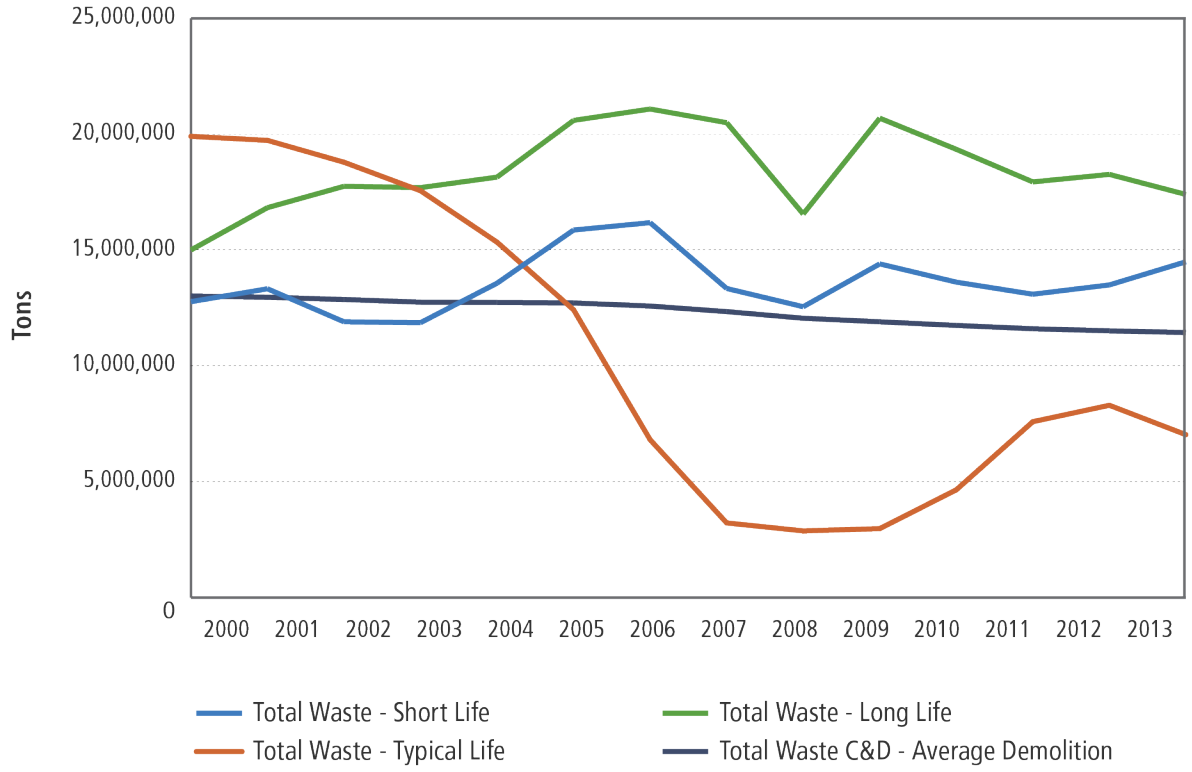
$C_{w,i}$ = the amount of material wasted during construction in year i, where i ranges from year y-l to year y-s.

Table B-4 shows waste generated during construction, demolition, and total C&D debris from bricks for 2000-2013 using this averaging method. The total C&D estimates using EPA's method are much less susceptible to the influence of construction industry spending at the point of consumption. However, the estimates are also not fully sensitive to the construction industry spending for the exact year for which the generation amount is estimated. For example, at heights of construction activity, EPA's method will capture above-average C&D debris generated by construction activities, but not the above-average C&D debris generated by demolition activities driven by the need to make space for new construction, nor the above-average C&D debris generated by renovations completed for reasons other than the end of a material's useful lifespan. Figure B-2 shows total C&D brick debris generated between 2000 and 2013 using EPA's method to estimate demolition debris compared to the Cochran and Townsend method.

Table B-4. U.S. Annual C&D Debris Generation from Bricks using Average Demolition Debris Generation over the Range of Material's Useful Life (Tons)

Year	Waste Brick During Construction	Demolition Brick	Total C&D Brick Debris
2000	587,760	12,423,600	13,011,360
2001	568,880	12,391,160	12,960,040
2002	567,510	12,294,580	12,862,090
2003	568,570	12,179,130	12,747,710
2004	637,010	12,096,890	12,733,900
2005	661,300	12,051,620	12,712,920
2006	613,990	11,965,980	12,579,970
2007	524,000	11,815,830	12,339,830
2008	390,970	11,662,660	12,053,630
2009	276,950	11,622,670	11,899,620
2010	259,570	11,484,220	11,743,790
2011	237,390	11,361,990	11,599,380
2012	234,840	11,274,840	11,509,670
2013	234,840	11,200,890	11,435,730

Figure B-2. Comparison of Total C&D Debris Generation for Bricks
EPA's average demolition method* and Cochran and Townsend's short, typical, and long material lifespan method



*Total C&D Debris – Average Demolition estimates shown in Table 4.

Historical Consumption Data

The following seven sections describe the historical consumption data used for each construction material, and any assumptions necessary to determine the share of consumption associated with the construction of buildings, roads, and other structures.

Portland Cement Concrete

EPA derived historical concrete consumption from cement consumption data published by the U.S. Geological Survey (USGS) for the years 1900 to 2013 (USGS, 2014a) (van Oss, 2015). The USGS also reports the amount of cement by end-use, including Portland cement for 1975-2012 (USGS, 2005) (van Oss, 2014). Since cement end-use statistics were not readily available for years prior to 1975, EPA assumed 96 percent of cement was consumed in Portland cement, based on the average of end-use data for 1975-2012. For 2013, EPA assumed the same percentage of cement used in Portland cement as in 2012. USGS data includes sales of cement blended with fly ash. However, this may not capture concrete production where Portland cement and fly ash are purchased separately and mixed at the concrete plant. This may result in an underestimation of annual concrete consumption.

EPA converted Portland cement consumption into estimated concrete consumption using the density of cement and concrete and amount of cement used per unit of concrete. As cited by Cochran and Townsend (2010), the 2003 American Society for Testing Materials (ASTM) International standard

reports an average density of 2,300 kg/m^3 for concrete, and the Portland Cement Association (PCA) gives an average density of 3,150 kg/m^3 for Portland cement and a typical concrete composition of 11 percent Portland cement by volume. These values translate to 6.64 tons of concrete consumed per ton of Portland cement.

EPA used the method suggested by Cochran and Townsend (2010) to allocate consumption of concrete across the three sources of concrete C&D debris: buildings, roads and bridges, and other structures. PCA estimates that in 2002, 47 percent of Portland cement was used in buildings, 33 percent in roads and bridges, and 20 percent in other structures (Townsend and Cochran, 2010). Since this study assumes concrete consumption is directly related to cement consumption, the 2002 percentages for cement were used to calculate concrete consumption by buildings, roads and bridges, and other structures in 2002. The following list describes the steps taken to estimate the division of concrete consumption between buildings, roads and bridges, and other structures using the percentages for 2002 from PCA and historical datasets from the U.S. Census Bureau on the annual value of construction put-in-place grouped by type of structure (U.S. Census Bureau, 1975a, 1975b, 2003, 2008, and 2015). EPA used differences in construction spending between 2002 and a given year in each of the three source categories to adjust the 2002 percentages from PCA to reflect changes in the distribution of concrete consumption between buildings, roads and bridges, and other structures over time.

1. Converted all construction put-in-place values into 1996 constant dollars:
    a. 1964-2002 values (U.S. Census Bureau, 2003a): No conversion necessary.
    b. 1915-1963 values (U.S. Census Bureau, 1975a): Converted values presented in 1957-1979 constant dollars by multiplying each value by a factor of 6.39, which was the relative value of a constant 1996 dollar to constant 1957-1959 dollar based on index tables. This value was computed by 1) calculating the ratio of the 1970 index value and 1957-1959 index value using data from series N1 and N30 (U.S. Census Bureau, 1975a); 2) calculating the ratio of the 1996 index value to the 1970 index value in the 1964-2002 historical value of construction put-in-place (U.S. Census Bureau, 2003a and 2003b); and 3) multiplying these two ratios together.
    c. For 2003-2013 values (U.S. Census Bureau, 2008 and 2015a): Converted values presented in current dollars using the annual price indexes of new single-family homes (U.S. Census Bureau, 2015b). The index for each year was calculated by multiplying the current dollar for a given year by the 1996 index value and dividing by the index value of the given year.
2. Calculated construction put-in-place for buildings, roads, and other structures by summation of subcategory values (in constant 1996 dollars).
    a. For 1915-2002, the buildings category includes residential and non-residential buildings from private and public construction as well as non-residential farm construction; roads includes publicly constructed highways, roads, and streets; and other structures includes all privately constructed public utilities and all other private structures as well as public construction of military facilities, sewer and water systems, conservation and development, public service enterprises, and all other public structures.

   b. For 2003-2013, the buildings category includes residential and non-residential lodging, office, commercial, health care, educational, religious, public safety, and amusement and recreation categories; roads includes the highways and streets category; and other structures includes the communication, power, transportation, sewer and waste disposal, water supply, conservation and development, and manufacturing categories.

3. Calculated the ratio of spending to tons of concrete (constant $1996/ ton) consumed for buildings, roads and bridges, and other structures in 2002.

   a. Multiplied total concrete consumption in 2002 by PCA's estimated distribution of cement among the three sources in 2002 (47 percent for buildings, 33 percent for roads and bridges, 20 percent for other).

   b. Divided 2002 construction put-in-place values for buildings, roads and bridges, and other structures (in constant 1996 dollars) by tons of concrete consumed by each of the three categories.

4. Calculated the percent of concrete use by source for each year using the spending per ton of concrete ratios developed in Step 3.

   a. Divided spending (in constant 1996 dollars) on buildings, roads and bridges, other structures, and total construction spending for each year by the corresponding 2002 spending per ton of concrete ratio for each source.

   b. Divided the tons of concrete for each source estimated in Step 4a using 2002 spending ratios by the total tons of concrete for that year derived from construction spending to calculate percent distribution of concrete consumption across buildings, roads and bridges, and other structures for the years 1915-2013.

   c. Estimated 1900-1914 concrete consumption distribution for the three sources based on the average distribution for 1915-2014.

5. Calculated the tons of concrete consumed for buildings, roads and bridges, and other structures in a given year by multiplying the total tons of concrete consumed in construction (based on USGS cement consumption data) by the percent distribution of concrete use associated with each source (Step 4) for a given year.

Wood Products

USGS provides consumption data for lumber, wood paneling, and plywood and veneer products available for 1900 to 2011 (USGS, 2014b). EPA assumed the same consumption in 2012 and 2013 as in 2011 for each of the three wood product categories. EPA assumed that all wood panels as well as plywood and veneer are used in building applications. A study published by the USDA Forest Service reports approximately 78 percent of lumber is used in construction; 60 percent is used for residential buildings, 7 percent is consumed in non-residential construction, and 11 percent is used in other unspecified construction applications such as non-residential upkeep and improvements (Howard, 2007). No data were found to allocate the 18 percent of lumber consumption for non-residential and unspecified uses between buildings and other structures. Since non-residential buildings such as barns, warehouses, and small commercial buildings are assumed to consume a greater amount of lumber

than other structures, the entire amount of lumber for construction is allocated to the buildings category. The remaining 22 percent of lumber is used in non-construction applications including transport packaging such as pallets and manufacturing wooden consumer goods such as furniture (Howard, 2007).

Gypsum Drywall and Plasters

EPA used USGS historical consumption data for crude and synthetic gypsum for 1900 through 2013 (USGS, 2014c) (Crangle, 2014a). USGS also publishes end-use statistics for crude and synthetic gypsum, available for 1975-2012, that document annual consumption in drywall (listed as prefabricated products) and plasters made from calcined gypsum (USGS, 2005b) (Crangle, 2015). EPA used these data to calculate the percent of gypsum consumed by drywall and plasters for the years 1975-2012. To calculate annual drywall and plaster consumption before 1975, EPA multiplied total apparent gypsum consumed each year in 1900-1974 by 75 percent, the average percent of gypsum used in drywall and plasters during 1975-2012. EPA assumed the same percent of gypsum used in drywall and plasters for 2013 as calculated for 2012.

Steel

The *Statistical History of the United States: From Colonial Times to the Present* from the U.S. Census Bureau (1975c) provides the amount of structural iron and steel shapes produced for 1900-1970 and USGS published steel consumption data for 1979 through 2010 by end-use, including construction (USGS, 2005c) (Fenton, 2014). Steel consumption for construction for 1971-1978 was estimated by interpolation based on data for 1970 and 1979. EPA estimated 2013 steel consumption for construction using the total apparent steel consumption reported by USGS (Fenton, 2015) and the assumption that the percent of steel consumed by construction activities in 2013 remained the same as in 2012 (Fenton, 2014). Note that consumption of steel for construction includes use in buildings, roads, and bridges; data were not available to allocate steel use between buildings and other infrastructure.

Bricks and Clay Floor and Wall Tile

The U.S. Census Bureau's *Statistical History* (1975d) reports the number of bricks consumed for building construction for the years 1900-1969. EPA used the conversion factor of 550 bricks per metric ton as cited in Cochran and Townsend (2010). For 1970-2012, USGS published clay end-use data, including bricks, for miscellaneous clay and shale (USGS, 2005d) (Virta, 1975 and 2014a) and kaolin clay (Virta, 2014b) for 1975-2012. For clay tile, EPA used USGS end-use data for miscellaneous clay and shale (USGS, 2005d) (Virta, 1975 and 2014a), ball clay (USGS, 2005e) (Virta, 1975 and 2014a) and kaolin clay (Virta, 2014b) available for 1975-2012. Since overall clay production and sales in the U.S. changed only slightly between 2012 and 2013 (Virta, 2015), consumption of bricks and clay tile were assumed the same in 2013 as reported in 2012.

Asphalt Shingles

Since historical data on asphalt shingle consumption are not readily available, EPA used production and sales of roofing granules published by USGS as an indicator of changes in asphalt shingle consumption. In 2006, the Asphalt Roofing Manufacturers Association (ARMA et al., 2011) reported sales of nearly

149,830,000 squares[11] of roof coverage. Table 1-1 in *Roofing the Right Way* (Bolt, 1997) presents a range of 210-250 pounds per square of roofing coverage. Using the midpoint of 230 pounds per square, EPA converted 2006 shingle sales in squares to tons of shingles sold in 2006. USGS end-use statistics for 1980-2012 include roofing granules made from construction sand and gravel (USGS, 2005f) (Bolen, 2014), crushed stone (Tepordei, 2006) (Willett, 2014), and silica (USGS, 2005g) (Dolley, 2014). USGS reports large portions of sand and gravel and crushed stone as "unspecified uses." To account for roofing granules included in unspecified uses, EPA calculated the percent roofing granules of all specified end uses for each year, and multiplied by total apparent consumption. For years where USGS did not calculate roofing granules consumed, EPA estimated consumption by averaging the consumption from the previous and following years. In order to estimate roofing granule consumption in 2013, the ratio of roofing granules to total apparent consumption for each type of aggregate was assumed the same as in 2012 (Bennett, 2015) (Willet, 2015) (Dolley, 2015). The final step entailed multiplying the weight of shingles sold in 2006 by the ratio of roofing granules consumed in a given year to roofing granules consumed in 2006.

Asphalt Concrete

EPA employed data on recycled asphalt pavement (RAP) published by the National Asphalt Pavement Association (NAPA) and the U.S Department of Transportation Federal Highway Administration (FHWA) to estimate asphalt concrete waste generation. NAPA's 2014 report (Hansen and Copeland, 2014) provides annual estimates of the tons of RAP from 2009 to 2013 based on their survey on recycled materials and warm-mix asphalt usage, data from state asphalt pavement associations, and each state's highway apportionment. RAP has a high value and NAPA (2006) states that 80 percent or more of asphalt concrete removed from service each year is reclaimed for reuse. Thus, to calculate total asphalt concrete waste generated, EPA divided the amount of RAP accepted by asphalt producers each year (Hansen and Copeland, 2014) by 0.80. EPA chose this method as opposed to the materials flow analysis using USGS end-use statistics on consumption of aggregates used in asphaltic and bituminous aggregates, because RAP data are directly related to total asphalt concrete waste generation and no assumptions about the lifespan of the asphalt concrete were required.

C&D Debris Generation Results

This section presents results for 2012 and 2013 C&D debris generation estimates. Table B-5 displays the amount of C&D debris generation from buildings, roads and bridges, and other structures for each material. The other structures category includes communication, power, transportation, sewer and waste disposal, water supply, conservation and development, and manufacturing infrastructure. Although results do not vary greatly between 2012 and 2013, C&D debris generation is slightly higher in 2013 than in 2012 in almost all cases. Figure B-3 illustrates waste generation for 2013 and highlights that in 2013 roads and bridges contributed significantly more to C&D debris generation than buildings and other structures, and Portland cement concrete made up the largest share of C&D debris generation for all three categories.

Table B-6 presents the amount of C&D waste generation from waste generated during construction, demolition, and total C&D debris for each material. Total C&D generation is about 520 million tons in 2012 and 530 million tons in 2013. Portland cement concrete consumption created much more waste

[11] One "square" refers to the amount of shingles required to cover 100 square feet of a roof.

during construction than any other material. However, Figure B-4 shows that waste during construction for drywall and plasters contributes a much greater percentage of the overall C&D debris for drywall and plasters than is the case for Portland cement concrete. Demolition plays the largest role in determining C&D debris generation as demolition debris comprises over 90 percent of total C&D debris generation for all materials except drywall and plasters.

Table B-5. C&D Debris Generation by Source (Tons)

	Buildings		Roads and Bridges		Other	
	2012	2013	2012	2013	2012	2013
Portland Cement Concrete	77,239,900	79,966,560	147,843,670	148,363,110	123,365,750	124,540,940
Wood Products[a]	39,968,330	40,217,410				
Drywall and Plasters	12,614,110	13,059,480				
Steel[b]	4,229,800	4,282,120				
Brick and Clay Tile	12,179,740	12,109,740				
Asphalt Shingles	12,807,440	12,603,090				
Asphalt Concrete			89,125,000	95,125,000		
Total	***159,039,320***	***162,238,400***	***236,968,670***	***243,488,110***	***123,365,750***	***124,540,940***

[a] Wood consumption in buildings also includes some lumber consumed for the construction of other structures. Data were not available to allocate the 18 percent of lumber consumption for non-residential and unspecified uses between buildings and other structures. Since non-residential buildings such as barns, warehouses, and small commercial buildings are assumed to consume a greater amount of lumber than other structures, the entire amount of lumber for construction is included in the buildings source category.

[b] Steel consumption in buildings also includes steel consumed for the construction of roads and bridges. Data were not available to allocate steel consumption across different sources, but buildings are assumed to consume the largest portion of steel for construction.

Figure B-3. C&D Debris Generated in 2013 by Material and Source

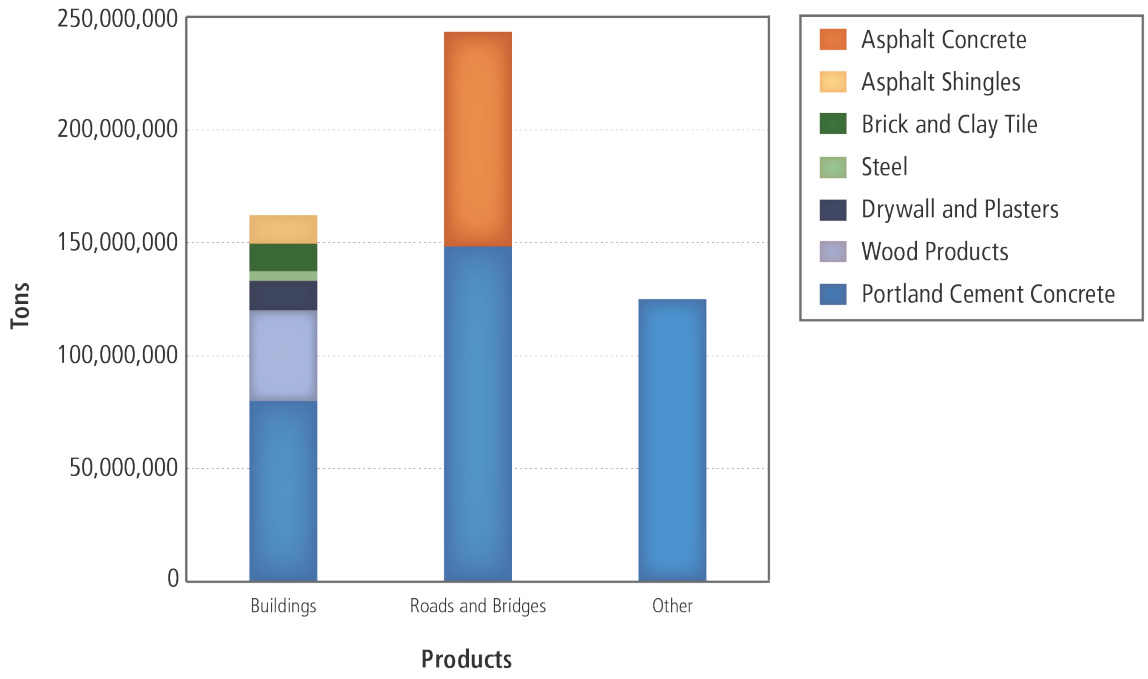
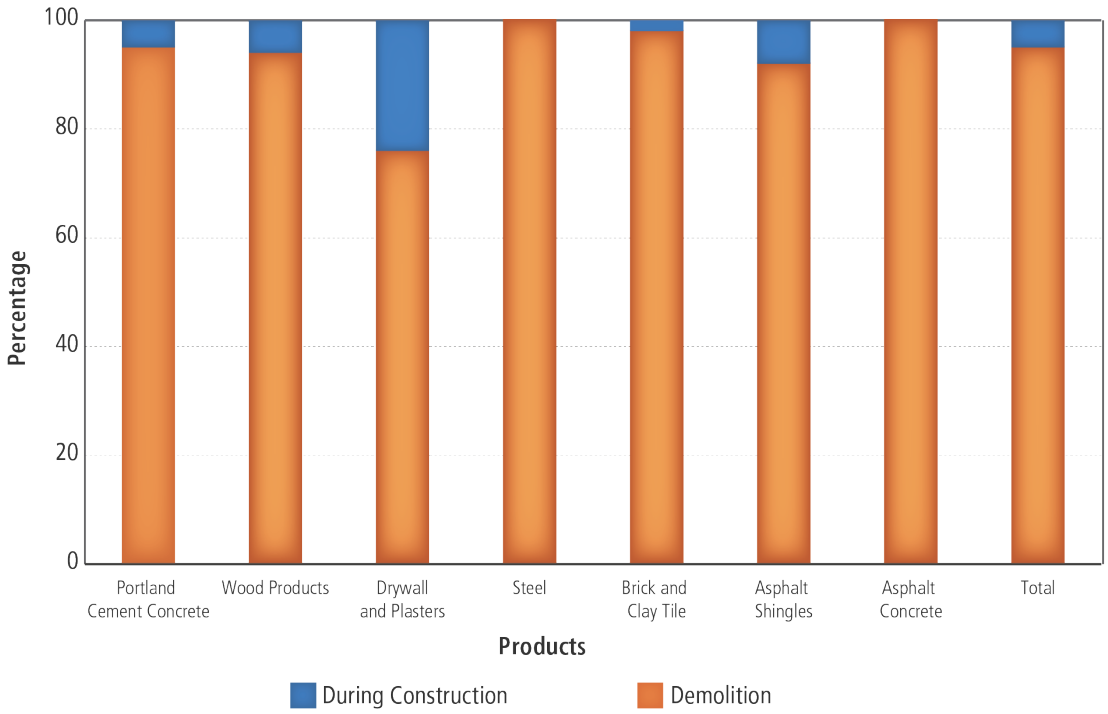


Table B-6. C&D Debris Generation by Material and Activity (Tons)

	Waste During Construction		Demolition Debris		Total C&D Debris	
	2012	2013	2012	2013	2012	2013
Portland Cement Concrete	16,681,010	17,494,720	331,768,310	335,375,880	348,449,320	352,870,610
Wood Products	2,487,140	2,487,140	37,481,190	37,730,260	39,968,330	40,217,410
Drywall and Plasters	2,978,000	3,123,510	9,636,110	9,935,970	12,614,110	13,059,480
Steel	0	0	4,229,800	4,282,120	4,229,800	4,282,120
Brick and Clay Tile	265,130	265,130	11,914,620	11,844,620	12,179,740	12,109,740
Asphalt Shingles	1,023,920	1,035,300	11,783,520	11,567,790	12,807,440	12,603,090
Asphalt Concrete	0	0	89,125,000	95,125,000	89,125,000	95,125,000
Total	***23,435,200***	***24,405,800***	***495,938,550***	***505,861,640***	***519,373,740***	***530,267,450***

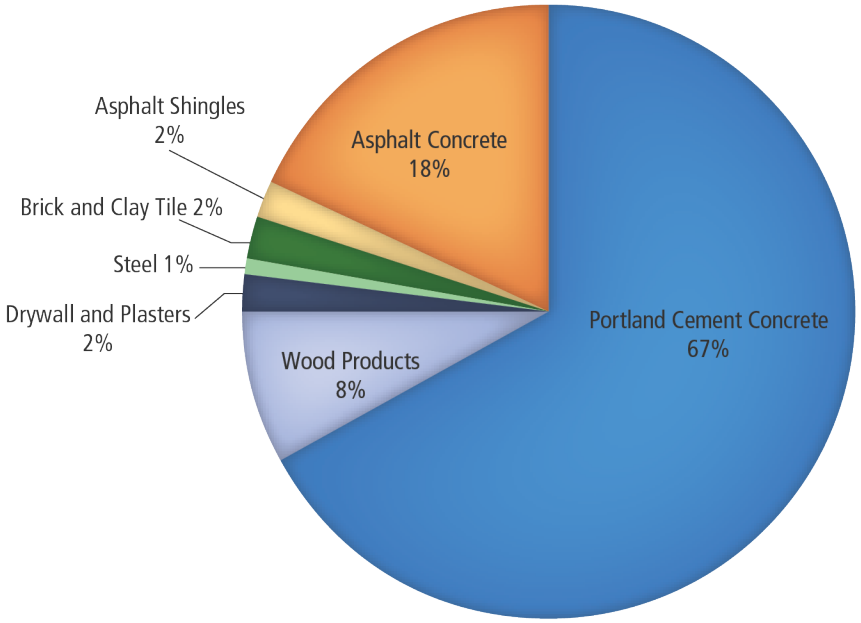
Figure B-4. Contribution of Construction and Demolition Phases to Total 2013 C&D Debris Generation



C&D Generation Composition

The 2013 C&D generation estimates presented in Table B-6 are depicted in Figure B-5. Portland cement concrete is the largest portion (67 percent), followed by asphalt concrete (18 percent). These materials are used in both building and road and bridge sectors. Wood products make up eight percent and the other products account for seven percent combined.

Figure B-5. C&D Generation Composition by Material



Conclusions

The generation methodology developed and presented in this appendix is structured to allow the continuation of the analysis in future years. All historical consumption and distribution data are in place for Portland cement concrete, steel, wood products, gypsum wallboard and plaster, brick, clay tile, and asphalt shingles. The asphalt concrete generation estimate, based on industry data, can be easily updated. It is anticipated that the asphalt industry source will continue to gather and publish the data required for this methodology. Two data points that need updating in future estimates are the Asphalt Roofing Manufacturers Association asphalt shingle sales data and the Portland Cement Association estimation of cement consumption by end use. Both of these data points are from 2002; more recent data would improve the methodology assumptions for asphalt shingles and cement end use markets. Further research is needed to determine the distribution of steel C&D debris generation across the buildings, roads and bridges, and other structures categories.

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