

## CHAPTER TWENTY

# Solid Waste

**W**aste management in the United States is historically a local responsibility. In the 1970s, however, a crisis over the environmental and health implications of landfills prompted calls for a national system of guidelines that would both reduce health risks and curtail the growth of waste generation. This crisis was precipitated in part by the fact that state and local governments exercised very little control over solid waste disposal sites. Of an estimated 16,000 or more municipal land disposal sites in 1976, only about 5,800 were recognized as complying with state regulations in 1976. Another factor contributing to the crisis was local authorities' inability to respond to increasing public opposition to new waste disposal sites.

In response, Congress in 1976 enacted the Resource Conservation and Recovery Act (RCRA), which established a cradle-to-grave management system for hazardous wastes and developed disposal criteria for nonhazardous solid wastes.

RCRA prohibited new open dumping sites, called for Environmental Protection Agency (EPA) criteria for sanitary landfills, and required that all open dumps be closed or upgraded to sanitary landfills. The act mandated nationwide minimum requirements for various disposal options, including incineration and landfilling.

RCRA also was intended to reduce waste at the source, promote resource recovery and recycling, and help identify markets for recycled waste.

RCRA sets federal standards to improve human health and the environment, but encourages state responsibility for program implementation.

In most cases, states have adopted landfill rules similar to the federal rules. Once a state has created a program to oversee and enforce RCRA landfill rules, the federal government can delegate authority to take over the RCRA program. So far, 49 states have assumed control of the program. By 1995, 40 states also had comprehensive recycling/waste reduction laws, and 44 states had legislated or announced goals for recycling/waste reduction ranging from 20 to 70 percent. Many states have enacted waste disposal bans on selected materials such as vehicle batteries and tires; many have passed mandatory source separation laws to promote collection of waste components such as glass, metals, paper, and plastics.

The goal of cradle-to-grave management is largely being met. The proportion of municipal solid waste recovered more than tripled from 1970 to 1994. Municipal waste is now either disposed of in lined landfills, incinerated, or composted. Between 1994 and 2010, incineration is



Communities have found creative solutions to waste management through recycling programs and new partnerships between the public and private sectors.

Photo Credit:  
Aluminum Company of America

expected to continue to account for about 15 percent of total municipal waste disposal, according to EPA estimates; landfilling is expected to fall from 60.9 percent of the total to 50.5 percent. EPA estimates that the remaining proportion—about 35 percent—will be accounted for by recovery.

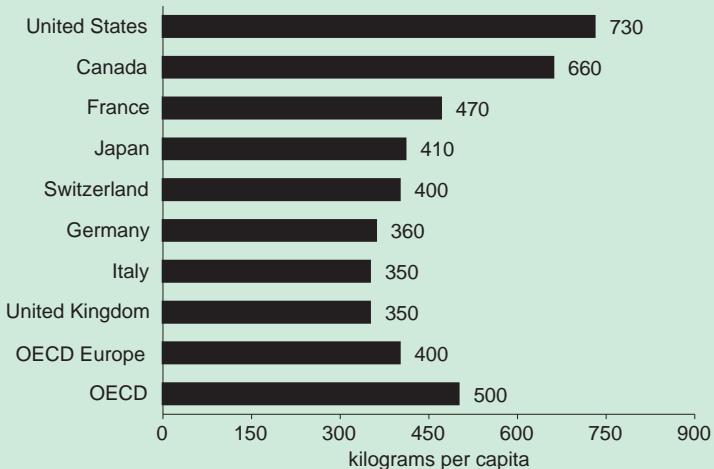
## BACKGROUND

Both in absolute and per capita terms, the United States is the largest generator of municipal solid waste among the industrialized countries of the Organisation for Economic Co-operation and Development (Figure 20.1). In fact, aver-

age per capita waste generation in Europe is only about half that of the United States.

In absolute terms, municipal waste generation in the United States has grown steadily and is expected to continue to grow (Figure 20.2). From 1960 to 1994, waste generation increased from 88 million tons to 209 million tons; projections indicate that it will rise to 262 million tons by the year 2010. Per capita generation, which rose from 2.7 pounds per day in 1960 to 4.4 pounds per day in 1994, is projected to hold steady at 4.4 pounds through the year 2000, but increase to 4.7 pounds by the year 2010 (Figure 20.3).

Figure 20.1 Municipal Waste Generated in the United States and Other Selected OECD Countries



Source: *OECD Environmental Data, Compendium 1995* (OECD, Paris, 1995).

Note: The definition of municipal waste and the survey methods used may vary from country to country.

Data are for 1992 or latest available year.

Solid waste management is undergoing a significant change in the United States. According to EPA, by 1995, the number of municipal solid waste landfills had declined to about 3,581. This is a substantial drop from the 5,345 landfills reported in 1992, and almost half as many as were operating in 1986—7,683 (Figure 20.4). The largest declines in landfills occurred in the Southern, Midwestern, and Rocky Mountain states.

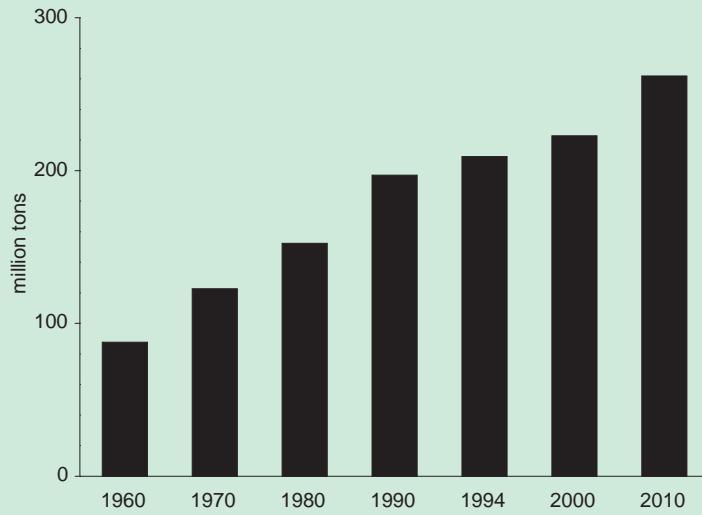
(Estimates of the number of existing landfills compiled by other organizations show a generally similar trend but somewhat different totals. According to data collected by the National Solid Wastes Management Association, there were 5,726 landfills in 1991 and 2,893 in 1995. The journal *BioCycle* reported

7,924 landfills in 1988, 5,383 in 1992, and 3,197 in 1995.)

While the number of landfills has declined, landfill disposal capacity has increased. In 1991, the majority of states had fewer than 10 years of disposal capacity, according to surveys conducted by Environmental Industry Associations. Between 1991 and 1995, 21 states increased their landfill disposal capacity, two states (Louisiana and Massachusetts) decreased theirs, and 27 states did not experience a change in capacity. In 1995, only two states (Massachusetts and New Jersey) had fewer than five years of remaining disposal capacity. This apparent lack of capacity is part of a deliberate state policy: Massachusetts has a policy of limiting development of “excess disposal capacity” until goals of source reduction,

## Solid Waste

Figure 20.2 U.S. Solid Waste Generation, 1960-1994, With Projections to 2010



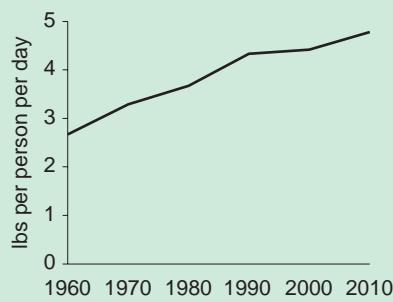
Source: See Part III, Table 67.

waste diversion, and incineration are met; and New Jersey permits facilities only in five-year increments.

The national average tipping (disposal) fee has increased nearly fourfold in the past 10 years, rising (in nominal

terms) from \$8.20 per ton in 1985 to \$32.19 per ton in 1995, according to Environmental Industry Associations (Figure 20.5). Fees vary in different regions of the country, ranging from a low of \$20.30 per ton in the South Cen-

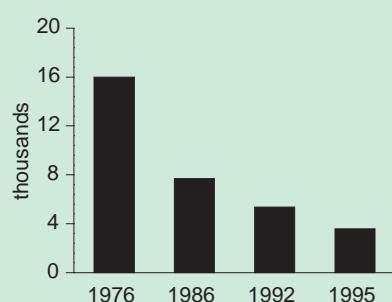
Figure 20.3 U.S. Solid Waste per Capita, 1960-2010



Source: See Part III, Table 67.

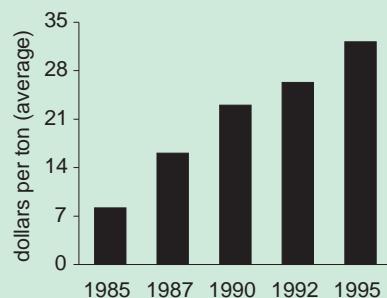
Note: Data are based on estimates and projections.

Figure 20.4 U.S. Solid Waste Landfills in Use, 1986-1995



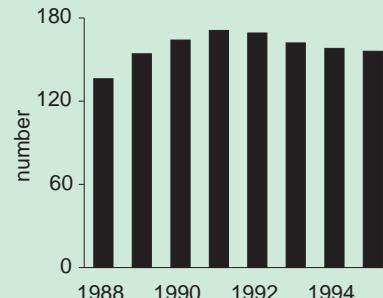
Source: EPA, 1995 *List of Municipal Solid Waste Landfills* (1996), and unpublished data.

**Figure 20-5 U.S. Solid Waste Landfill Tipping Fees, 1985-1995**



Sources: National Solid Wastes Management Association (data for 1985, 1987, 1990, and 1992); *Solid Waste Digest* (data for 1995).

**Figure 20.6 U.S. Solid Waste Incinerators in Use, 1988-1995**



Source: R. Steuteville, "The State of Garbage in America, Part I," *BioCycle* (April 1996).

central states (Arizona, Arkansas, Louisiana, New Mexico, Oklahoma, and Texas) to as much as \$73.17 per ton in the Northeast (Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont).

Refuse transfer stations, which facilitate the consolidation of wastes, are in many cases replacing closed landfills; *BioCycle* reports 2,625 such stations in the 44 states that provided data. Transfer

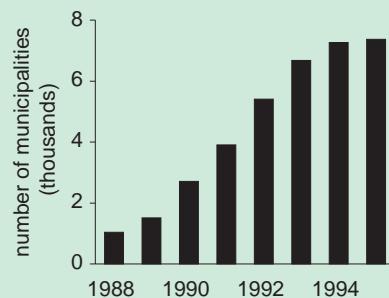
stations generally offer more opportunities to separate and recover materials, so this changeover should further progress in recovery and recycling.

Combustion, which handled as much as 30 percent of generated waste in 1960, has shrunk considerably in importance as a solid waste management option. Combustion tonnage was estimated at about 32 million tons, or 15 percent of total waste generation, in 1994 and is expected to maintain that share through the rest of the decade. *BioCycle* reports that there were 156 incinerators in operation nationally at the end of 1995, down slightly since 1991 (Figure 20.6). About 80 percent of these facilities have waste-to-energy components. Tipping fees at incinerators averaged about \$51 per ton nationwide.

An estimated 7,375 curbside recycling programs were in operation by 1995—a roughly sevenfold increase since 1988 (Figure 20.7). Growth in new curbside programs appears to be leveling off; however, there were 110 new programs in 1995, compared to 587 in 1994 and 1,274 in 1993. The population served by these programs is still rising; 121 million people were served in 1995, compared to 108 million people the year before. Pennsylvania leads the nation in the number of curbside programs with 772, followed by Minnesota (679) and Wisconsin (600). In addition, 35 states reported a combined total of 8,773 recycling dropoff sites. Three states—Florida, Minnesota, and New Jersey—report recycling rates of 40 percent or more; nine other states indicate that they are recycling 30 percent or more of their waste. (Rates are not

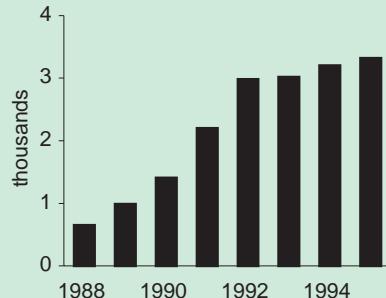
## Solid Waste

Figure 20.7 U.S. Participation in Curbside Recycling, 1988-1995



Source: R. Steuteville, "The State of Garbage in America, Part I," *BioCycle* (April 1996).

Figure 20.8 U.S. Yard Trim-  
mings Facilities, 1988-1995



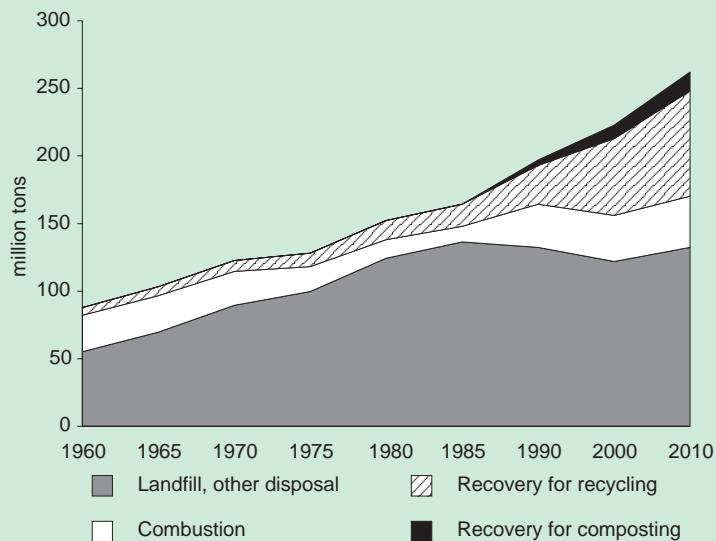
Source: R. Steuteville, "The State of Garbage in America, Part I," *BioCycle* (April 1996).

entirely consistent across states because of differences in definition and data gathering.)

The number of facilities handling "yard trimmings" (grass, leaves and brush), currently estimated at 3,316, also

is up dramatically since 1988, but the growth in new facilities seems to be leveling off (Figure 20.8). Florida, which has a disposal ban on yard trimmings, reports the highest total recovery of grass, leaves, and brush (1.8 million tons). New Jersey,

Figure 20.9 U.S. Municipal Solid Waste Management, 1960-1994, with Projections to 2010



Source: See Part III, Table 67.



Paper and Paperboard represent the largest category of the waste stream. Today the United States supplies more than half the world's recovered paper.

Photo Credit: S.C. Delaney  
U.S. Environmental Protection Agency

Massachusetts, and New York each are diverting more than 500,000 tons annually of yard trimmings. In managing yard trimmings—in addition to composting—22 states use direct land application, 38 states are using mulching, and about half the states have backyard composting programs.

Most of the future increase in waste generation will be handled through recovery for recycling or composting programs (Figure 20.9 and Box 20.1). Traditional disposal methods—landfilling or combustion—will continue to be used for the majority of solid waste, but their share of total waste will gradually diminish. For example, landfill tonnage is expected to decrease from 127 million

tons (61 percent of generation) in 1994 to 122 million tons in 2000 (55 percent of generation), largely because of a projected significant diversion of yard trimmings. Combustion, which handled as much as 30 percent of generated waste in 1960, has shrunk in importance. Recovery programs, on the other hand, are growing steadily, both in number and in terms of the proportion of total solid waste they handle. In 1994, recovery accounted for 49.3 million tons—that is, almost a quarter of all solid waste generated that year was recovered.

Under the right conditions—continued emphasis by state and local governments on recovery programs and purchase of recycled products, continued

**Box 20.1**  
**Recycling and Recovery Trends**

- **Ferrous Metal.** Steel can and appliance recycling rates have increased approximately 250 percent between 1988 and 1994.
- **Aluminum.** The overall recovery rate for aluminum was 34 percent in 1994; for aluminum cans alone, the recovery rate was 65 percent.
- **Glass.** Glass was recovered at a rate of 24 percent in 1994, with glass containers being recovered at a rate of 37 percent.
- **Paper and Paperboard.** Paper and paperboard represent the largest category of the waste stream, with 81.3 million tons generated annually. Recovery of paper and paperboard is at 35 percent of generation, and accounts for more than half (nearly 29 million tons) of total municipal solid waste recovery. The United States supplies more than half of the world's recovered paper.
- **Wood.** Wood, at 14.6 million tons, accounts for 7 percent of the waste stream. Sources of wood in municipal solid waste include furniture and wood packaging (i.e., pallets).
- **Yard Trimmings.** Yard trimmings account for 14.6 percent of the waste stream at 30.6 million tons annually. Currently, 23 states—comprising more than 50 percent of the nation's population—have legislation banning yard trimmings from landfills. Over 3,300 composting facilities for yard trimmings are now in operation.
- **Rubber.** The predominant source of rubber in municipal solid waste is tires from automobiles and trucks. Recovery of rubber from tires was estimated at 450,000 tons in 1994—roughly 15 percent of tire production.
- **Plastics.** While overall recovery of plastics for recycling is relatively small, recovery of some plastic containers is increasing. Polyethylene terephthalate (PET) bottles, which are commonly used for soft drinks, were recovered at a rate of 50 percent in 1994. Recovery of high-density polyethylene milk and water bottles was estimated at 30 percent in 1994.

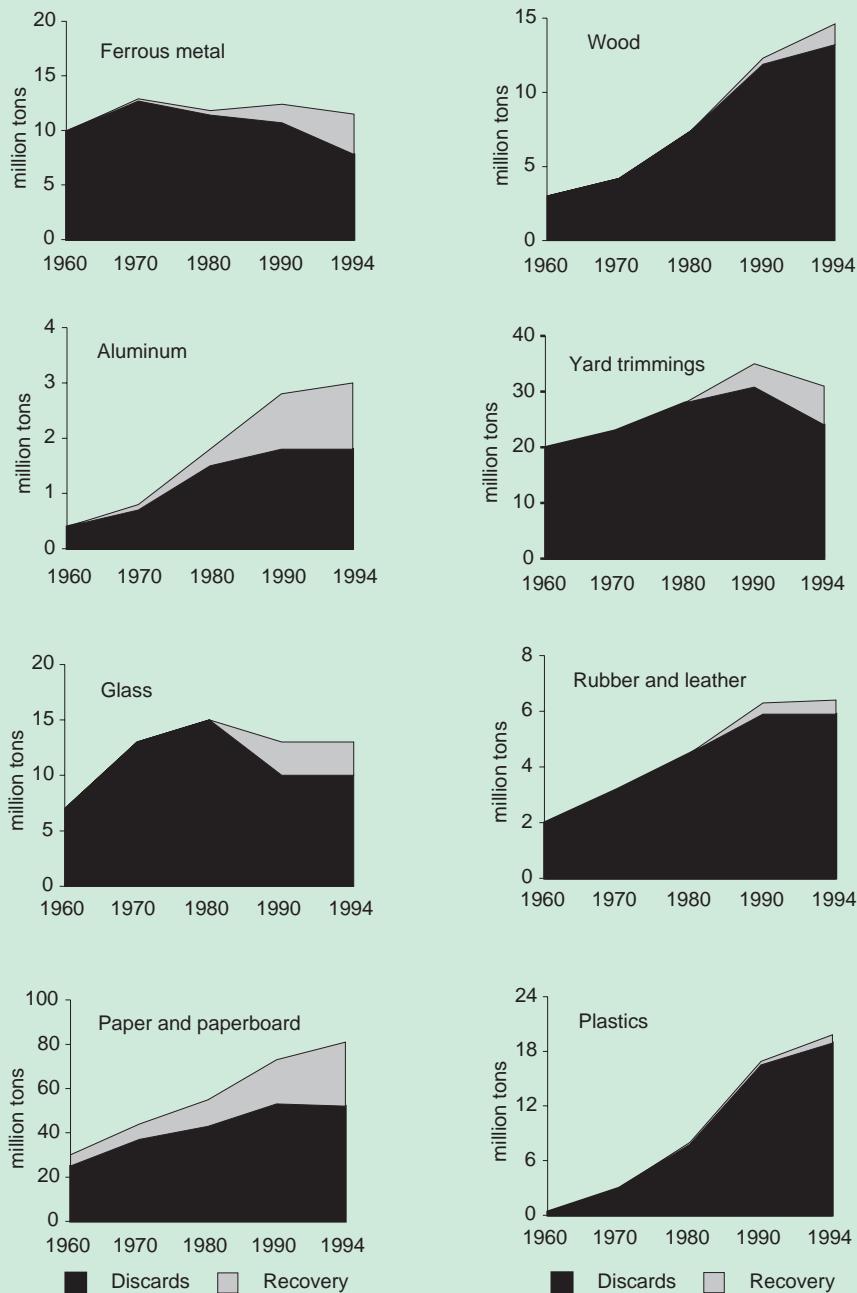
investment by industries, continued efforts to expand programs to keep yard trimmings out of landfills, and continued access to recovery programs for most U.S. citizens—30 percent of total solid waste generation could be recovered by the year 2000 and 35 percent by 2010. According to EPA estimates, to reach a recovery rate of 30 percent nationwide in 2000, 43 percent of all paper and paperboard, 27 percent of all glass, 44 percent of metals, 40 percent of yard trimmings,

and over 7 percent of plastics would have to be recovered.

**TRENDS IN SOLID WASTE MANAGEMENT**

Compared to the practice, commonplace until just a few decades ago, of dumping trash in an open landfill, solid waste disposal practices have undergone a major transformation that provides both economic and environmental benefits

**Box Figure 20.1 U.S. Recovery and Recycling Trends, 1960-1994**



Source: See Part III, Table 68.

**Box 20.2**  
**Recycling Creates Jobs**

Studies suggest that recycling has a strong positive impact on jobs. In North Carolina, it is estimated that for every 100 jobs created by recycling, 13 jobs are lost in solid waste and virgin material extraction within the state. Recycling is a significant employer in North Carolina, providing about 9,000 jobs, mostly in the private sector. And a study of three cities—Baltimore, Richmond, and Washington—found more than 5,100 individuals employed in recycling, compared to about 1,100 employed in solid waste disposal, despite four times as much material going to disposal than to recycling.

largely a product of the landfill crisis era, but most that were enacted seem likely to endure because they help keep problem materials out of landfills and reduce overall disposal tonnage. According to a 1996 *BioCycle* survey, 42 states now ban disposal of vehicle batteries, 32 ban tires, 23 ban yard materials, and 20 ban motor oil. Banning disposal of products such as lead-acid batteries can increase the incentive to return them to retailers for recycling. Bans on materials such as yard waste can be coupled with educational campaigns to encourage people to leave grass clippings and compost waste in their backyards.

Governments are major generators of solid waste and can use source reduction strategies to reduce this waste. In 1993, President Clinton issued a series of executive orders to promote recycling and use of recycled products.

Connecticut has legislation requiring state agencies to take steps to eliminate purchase of products that are not reusable. The state has begun a successful—and profitable—program in which agency employees place all paper, cans, and bottles in canisters to be picked up by a recycling contractor. The state also is using remanufactured laser toner cartridges, which are functioning just as well as the disposable cartridges used previously.

Minnesota also has a creative source reduction program. Highlights of its efforts include refurbishing highway signs instead of disposing of old signs, seeking extended warranties for purchases of some durable goods, and contracting with a company to retread radial and off-

(Box 20.2). Components of this transformation include source reduction and recycling, community composting, and new types of public-private partnerships.

### **Source Reduction and Recycling**

The goal of source reduction is to prevent the creation of waste, either by reducing the quantity of materials, reusing materials already manufactured, lengthening the life of products to postpone disposal, or managing nonproduct organic wastes through onsite composting or other alternatives to disposal.

Many creative new approaches are under way to promote source reduction and recycling. For example, regulatory measures can be used to mandate or encourage reduced waste. Many states have adopted bans on the disposal of specific materials. These disposal bans were

road truck tires; this last measure alone is saving about 23 tons of waste per year.

Governments also are using grants and education programs to encourage source reduction and recycling. It is currently estimated that 39 states are spending about \$245 million annually in state grants to support waste diversion programs. Most of the money is used to support local solid waste recovery programs, while some is spent for disposal of problem materials such as tires or for the private sector to develop new uses for recycled materials.

Overall, the strongest programs are in a half-dozen states with dedicated sources of funding. Florida, with a 0.2 percent surcharge on its sales tax, spent \$35 million on recycling grants in 1995, mostly for local programs and tire disposal. California, Minnesota, New Jersey, Pennsylvania, and Wisconsin also have dedicated funding sources; altogether, these six states account for about 70 percent of all recycling grants.

More than 2,700 communities in North America now have adopted pricing systems that require customers to pay more for throwing away more garbage. This variable rate pricing is catching on fast; a 1992-93 study had identified only 1,000 communities with such programs. A few states mandate variable rates, and many states actively promote such programs either through legislation or state policy. Programs are now in place in 37 states and cover about 11 percent of the U.S. population. Surveys have shown average recycling increases of more than 50 percent after variable rate programs are implemented.

In response to President Clinton's executive orders and agency-specific initiatives, many federal agencies are actively involved in source reduction and recycling efforts. For example, the immense supply depot operated by the Department of Defense in New Cumberland, Pennsylvania, processes over 20,000 customer orders per day and spends over \$6 million annually on pallets, dimension lumber, and packing materials. The center saves all incoming packing material either for reuse or recycling. In 1995, almost 100,000 cardboard cartons were reused along with about 250,000 cubic feet of packaging, saving more than \$400,000 in procurement costs. The recycling of corrugated cardboard generated another \$144,000 in revenue. However, there may be additional costs associated with collecting and reusing these materials.

The U.S. Postal Service reported in June 1995 that it was generating 1.2 million tons annually of undeliverable mail and discards. Weyerhaeuser agreed to purchase 550 tons per week from 375 post offices in an 11-state region in the West. Additionally, the Post Office plans to implement recycling in all 35,000 U.S. post offices by the end of the decade.

### Community Composting

Community composting can be an economically attractive alternative to landfilling. In 1994, for example, officials in Montgomery County, Maryland, had to choose between spending \$2 million to expand and upgrade the county's existing composting site in Dickerson or aggressively promote "grasscycling" and

backyard composting. County officials took the latter option, spending \$600,000 over two years for a high-visibility marketing and advertising program to promote backyard composting. Among other activities, the county sold 16,000 subsidized compost bins for \$5 each, held over 300 workshops, and offered rebates for the purchase of mulching mowers. Instead of the 36,000 tons of grass clippings that were expected to go to the Dickerson plant in 1994, only around 9,000 tons actually made it to the composting site.

Many other communities are reaping significant benefits through backyard composting programs. In Alameda County, California, a survey of bin-using families indicated that trash disposal dropped by about one-half can per family per week. In Gainesville, Florida, it was estimated that each backyard composter was keeping about 200 pounds of waste per year out of the city's landfill.

The economic benefits of composting can be significant for communities. According to a recent study by a California consulting firm, local governments reduce solid waste disposal and collection by an average of at least \$43 for every ton of yard trimmings and kitchen scraps that are composted at home by residents. Home composting programs that responded to the survey were diverting an average of 14 percent of the yard trimmings generated in their communities.

### New Partnerships

Many communities are devising successful new partnerships with the private sector in the collection and disposal of

solid waste. Such partnerships can free municipal resources for other investments and provide improved environmental services at the lowest possible cost to the public.

There are several keys to a successful partnership, according to an EPA study. These include a strong local incentive to seek private assistance, a legal and institutional environment that fosters such endeavors, a pricing system that can ensure the private sector partner a reasonable return, the willingness of the community to work with other communities in providing environmental services, strong community support, and agreement on the allocation of risks.

There are numerous examples of such partnerships:

- In Lee County, Alabama, a private company sited, constructed, operates, and owns a landfill. The company has separate agreements to accept waste from public and private customers in a multicounty area. Because of the large volume of waste disposed at the landfill, the company can provide disposal services at low per-unit costs.
- In Bristol, Connecticut, communities worked together to reach an arrangement with a private firm to design, construct, operate, and own a resource recovery facility. The facility was financed by tax-exempt state revenue bonds. Bristol receives tax revenues from the facility and fees from 10 other communities using the facility. Tipping fees are reduced by revenues from the sale of electricity generated by the facility.

- In Hillsborough County, Florida, officials entered into an arrangement with a private partner for the design, construction, and operation of a resource recovery facility owned by the county. Tax-exempt bonds sold to finance the facility are backed by revenues from the countywide solid waste disposal system. The sale of electricity generated by the facility to Tampa Electric Company provides revenues to the county.

## RECENT DEVELOPMENTS

Two important policy debates—both spawned by Supreme Court decisions—continue to cloud the future course of solid waste practices: the authority of state and local governments to adopt “flow control” laws, which give local governments the right to dictate the disposal of waste generated within their borders; and the “interstate waste” issue, which concerns the authority of states to ban imports of waste from other states.

In May 1994, the U.S. Supreme Court ruled, in *C.A. Carbone Inc. vs. Town of Clarkstown*, that flow control was an unconstitutional interference with interstate commerce. The court held that, in the absence of authorization by Congress, state and local governments may not use their regulatory powers to favor local enterprises by prohibiting out-of-state competitors or their facilities. The decision has significant implications for the future of state and local solid waste management plans.

According to a March 1995 Environmental Protection Agency report, 35 states authorize flow control directly, 4 states authorize it through mechanisms such as solid waste management plans and home rule authority, and 11 states have no flow control authority.

Flow control authority has been used by state and local governments to foster development of in-state capacity to manage municipal solid waste by making it easier to adequately size and finance waste management facilities. Controlling the disposition of locally generated solid waste allows planners to accurately determine how much waste must be managed. It also ensures that waste management facilities will be fully utilized.

Supporters say flow controls have assisted state and local governments in financing new solid waste capacity—particularly new waste-to-energy and high-tech materials recovery facilities—by ensuring long-term receipt of enough waste to generate sufficient revenues to service the public bonds and other costs associated with the facility.

Opponents of flow control argue that such arrangements substantially increase the cost of local solid waste disposal. A study by National Economic Research Associates found that flow control adds approximately \$14 per ton, or 40 percent, to the average disposal charge. EPA found that flow control was an “administratively efficient tool for local governments to plan and fund solid waste management systems,” but was “not essential for developing MSW management capacity, or for achieving recycling goals.”

Some environmental groups also argue that flow control has tended to favor the use of high-tech incineration and materials recovery approaches to waste disposal over low-tech recycling. The EPA study, for example, found that flow control supported about 58 percent of municipal waste-to-energy plants, but only about 3 percent of materials that were recycled.

Reflecting their larger capital costs, flow control has been significant in high-tech materials recovery facilities. EPA found that flow controls direct 32 percent of the throughput at high technology facilities, but only 7 percent of throughput in low-tech recovery facilities.

The second major and unresolved policy debate confronting Congress and the states is that of interstate waste. A 1978 case, *New Jersey v. Philadelphia*, held that states were without authority to ban waste imports from other states unless Congress provides express authorization. This decision has resulted in persistent efforts by "importing" states to secure Congressional authorization for interstate waste bans, and countervailing efforts by "exporting" states and affected industries to oppose Congressional authorization of interstate waste measures that will increase disposal costs.

State and local governments have continued to press Congress for authorization to impose interstate waste import bans and flow control measures. In March 1995, the Senate Environment and Public Works Committee approved a bill (S. 534) that would allow states and localities limited rights to restrict both imports and exports of solid waste to or

from their jurisdiction. The bill also stipulated that flow control arrangements started before May 15, 1994, could continue for no more than 30 years.

### Policy Reforms

Within the Clinton Administration, the emphasis is on removing barriers to recycling and easing the regulatory burden on low-risk wastes.

To encourage recycling of household hazardous wastes, such as discarded batteries, thermostats, and pesticides, EPA revised its rules to help stores and businesses collect these items for recycling. In April 1995, EPA issued a new regulation that eases the burden by as much as a half-million work hours on participating retail stores and businesses.

To advance EPA's commitment to target the highest risks to public health and the environment, in November 1995 EPA proposed a new hazardous waste identification rule that will refocus the regulatory program on high risk wastes. The purpose of the rule is to exempt wastes that do not pose a significant public health threat from the hazardous waste management regulatory system—resulting in substantial savings to businesses handling these low-risk wastes. The proposed rule is currently undergoing public comment.

To increase local flexibility in handling waste, EPA in January 1996 proposed a rule that provides flexibility to states and tribes to implement performance standards for municipal solid waste landfill permits. Most states and

many tribes have already opted to use this new flexibility in setting their standards.

### FUTURE CHALLENGES

While there have been significant advances in solid waste disposal practices, major uncertainties remain. The flow control and interstate waste issues remain unresolved, and may remain at an impasse. In addition, under severe pressure to curtail spending, some state legislatures are cutting back on programs to support source reduction and recycling. Whether localities have developed sufficient infrastructure to be self-sufficient remains to be seen.

New waste management alternatives such as recycling are providing significant new economic opportunities that should

carry on into the future. In October 1995, the Chicago Board of Trade opened a recyclables commodities exchange. Prices for recyclable materials have fluctuated, but the long-term outlook remains good.

Overall, both the economy and the environment should continue to benefit from solid waste disposal practices, which have undergone a quiet revolution in the United States over the past two decades. Traditional waste disposal methods are now much more protective of the environment; and new approaches emphasizing source reduction, recycling, and reuse may provide both environmental and economic benefits. Such innovations should provide states and localities more cost-effective ways to deal with the rising volume of solid waste generation.

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