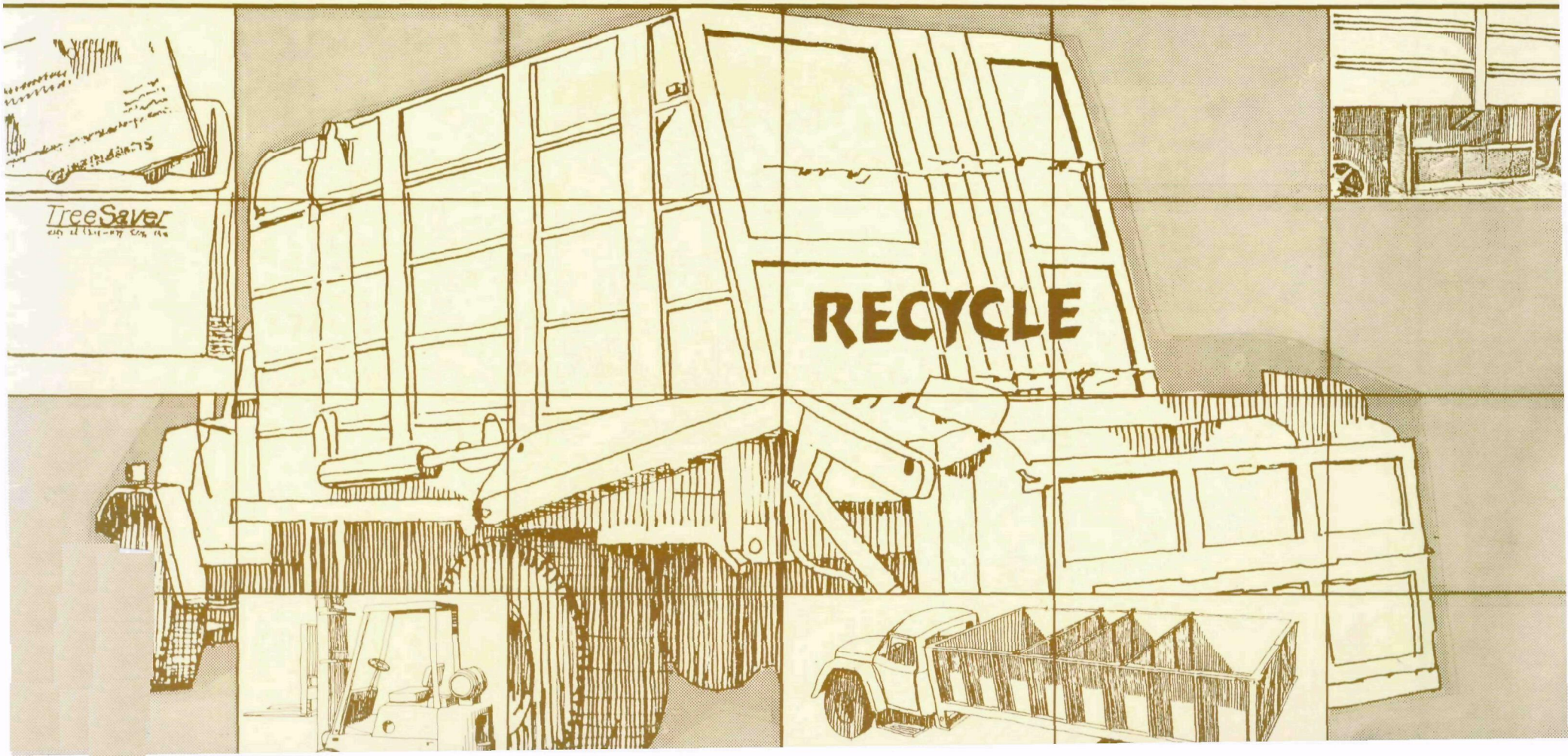
Office of Water &
Waste Management
Washington, D.C. 20460

SW-842
1980

EPA

Source Separation Collection and Processing Equipment

A User's Guide



Source Separation Collection and Processing Equipment

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This report (SW-842) was prepared
under Contract No. WA78-C292
for the Office of Solid Waste.

U.S. Environmental Protection Agency
1980

This report was prepared by Resource Planning Associates, Inc., Washington, D.C., and has been reviewed by the U.S. Environmental Protection Agency and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of commercial products constitute endorsement or recommendation for use by the U.S. Government.

ACKNOWLEDGEMENTS

We wish to express our appreciation to the many individuals and groups who provided assistance and information to us in the preparation of this document. Although it would be extremely difficult to acknowledge each one individually, we would like to single out the following people for their contributions: Chaz Miller and Penelope Hansen, U.S. Environmental Protection Agency; members of the Manual Review Committee; municipal and company officials whom we interviewed; Jerry Powell of Resource Conservation Consultants, Portland, Oregon; and David Cohen, Washington, D.C.

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We wish to thank those community and company officials who contributed information to this manual.

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Solid waste disposal is a growing problem for communities. The traditional method of disposing of solid waste —– by landfill —– is becoming more expensive and less acceptable politically. The costs of collecting and dumping solid waste are rising and available land is becoming scarce and more expensive. Furthermore, many citizens are beginning to oppose using available land to bury solid waste.

As their landfills near full capacity, many communities have begun to look for ways to reduce the amount of solid waste for disposal. One option that has proven viable is source separation. By separating paper, glass, and cans from other residential waste, communities could eliminate as much as 25 percent of their refuse now being placed in landfills (Figure 1). Furthermore, the waste that is separated can be reused by manufacturers, thus saving natural resources and energy. The number of programs in the United States in which separated materials are collected from households has increased from 2 in 1970 to 220 in 1978. In addition, over 2,000 recycling centers are currently in operation.

What is Source Separation?

Source separation is the setting aside of one or more materials such as paper, glass, and cans from refuse. Source separation program crews collect recyclable materials in two ways: by providing centers to which residents can bring materials and by collecting materials house-to-house. The materials that are collected are transported to a site for processing. Then they are delivered to a manufacturer, who uses them as raw materials to manufacture new products.

Many source separation programs began by collecting only one recyclable material —– often along with other refuse. To divert as many materials as possible from disposal, however, source separation programs are beginning to collect two or more recyclable materials. The number of multimaterial programs has increased from 2 in 1974 to 40 in 1978.

Figure 1

Recyclable Materials as Percent of Total Residential Waste

Material	Percentage of Total Waste
Paper	**30–40**
Newsprint	9–15
Magazine	1–3
Corrugated	1–2
Other	19–20
Glass, Beverage	**7–16**
Clear	4–9
Green	2–4
Brown	1–3
Glass, Other	**6.5–10**
Clear	5–6
Green	1–3
Brown	0.5–1
Ferrous, Beverage	**0.5–2**
Ferrous, Other	**3–5**
Aluminum, Beverage	**0.1–1**
Aluminum, Other	**0.1–1**
Nonrecyclable Refuse	**52.8–25**

SOURCE: A detailed waste composition study of an urban community and a suburban community in Massachusetts: **Source Separation in Marblehead and Somerville, Massachusetts - Composition of Source Separated Materials and Refuse.** U.S. Environmental Protection Agency. 1980.

Newspaper and mixed wastepaper are the materials collected most often by source separation programs because they are the most abundant recyclable materials and are easily separated from other refuse. Paper makes up approximately 50 percent of recyclable materials and 30-40 percent of all residential waste.

It is easy to collect and process; it may be collected separately or along with refuse, and may be baled to increase density and facilitate handling.

Cans and glass are often collected along with paper, even though they are collected in smaller volumes, because they bring in additional revenues and also save landfill space. Ferrous and aluminum cans must be separated and glass usually separated by color to give them a market value. Then the volume of the material must be made denser by flattening or shredding cans and crushing glass (Figure 2).

Figure 2

Densities of Processed Materials

Material	Density (lb/y^3)
Ferrous cans flattened	800 - 900
Aluminum cans flattened	250
Clear and colored glass, minus 5/8" cullet	2,300
Clear and colored glass, minus 2" cullet	1,000
Baled shredded paper bundles	750

Designing a Source Separation Program

Source separation is a relatively new concept. As a result, many municipal officials need information about how to plan and organize a program. How can they be certain that citizens will participate? How can they predict whether a program will be economically viable? How do they go about designing a collection system?

There are several steps that municipal officials can take to initiate a program that is likely to be a success:

(1) Estimate Citizen Support

As a first step, municipal officials need to find out whether citizens would support a source separation program. To probe the community's interest, they might:

- Survey citizens to determine their attitudes toward solid waste disposal and the conservation of resources
- Ask whether residents have been involved in previous recovery projects, such as paper drives
- Discuss the program with community leaders who could predict citizen participation and later help publicize the program.

(2) Survey Markets

Before deciding which materials to recycle, municipal officials should identify dealers or manufacturers who purchase recyclable materials. Then they should determine the ability of their program to prepare those materials to the degree of purity required by the markets.

Source separation programs have two kinds of markets for their materials. They may sell their recyclables to an intermediary who will process them before selling them to a manufacturer, or they may sell them directly to the manufacturer. In assessing markets, officials should weigh the following concerns:

- Price: The market that officials choose should pay prices that are high enough to enable the program to function economically.
- Location: The market should be nearby to minimize storage and transportation costs. Officials may sell their materials to a distant market, however, if the prices are high enough to offset the additional costs.

- Materials: The market should accept materials that citizens are willing to separate.

- Specifications: The market should have specifications (material preparation requirements) that the program realistically can meet. Citizens may have to bundle papers or sort glass bottles by color. A market with strict specifications must offer a price that is high enough to offset the additional cost to the program of upgrading the materials. In calculating revenues, officials should bear in mind that processed materials are more economical to transport than other materials because they can be packed more densely (Figure 2).

(3) Negotiate with a Market

When ready to negotiate with a market, officials should examine past and current prices to better understand markets and develop realistic expectations. Then, they should obtain a "letter of intent" from the market they have chosen, stating that it will purchase materials at an agreed price when the program begins operation. Later, officials will sign a formal contract (see Appendix B) with the market stating that the market will buy the materials at the agreed price for a specific period of time. Beside guaranteeing a "floor" or minimum price for the materials, the contract should grant the program a percentage of the current price when it is above the floor price for the materials.

(4) Inform the Public

A public relations and education program can inform citizens of the benefits of recycling, instruct them how to separate materials, and familiarize them with the collection schedule. Program officials should meet with community leaders to enlist their help in educating the public.

At least one month before collection begins, television, radio, and newspaper announcements should be run to spark the interest of residents. Flyers, posters, and doorhangers are also effective tools for promoting a program. Efforts to teach the public how to use the system should begin at least three weeks before collection begins and should be resumed periodically to maintain citizen awareness and interest.

(5) Select Equipment

Municipal officials should examine equipment that is available to their program before they consider new equipment purchases. Available equipment also can be modified to meet the needs of a program. For example, a pickup truck can be used to collect newspaper if its sides are extended upward. A municipality may modify its own equipment or employ a local ironworks company to make alterations. This guide gives examples of refuse equipment modified for recyclables collection and of specially-designed equipment.

New equipment offers the advantage of being uniquely suited to a recycling program. Before purchasing equipment, however, officials should consider how many years the equipment will be in use; the high cost of equipment should be distributed over many years of program operation.

(6) Assess Labor Needs

To determine the amount of labor a source separation program will need, officials should consider the kind of equipment they will need to process the volume of materials they expect. They also should assess the degree of skill needed to operate each piece of equipment. Before hiring new employees, officials should look for existing labor. A collection crew may be available to perform processing functions for part of the day, or labor may be available from other municipal departments. Handicapped or CETA (Comprehensive Employment and Training Act) workers also might be employed.

(7) Procure Equipment

Municipal source separation program officials who decide to procure their equipment commercially should first survey literature about the equipment. (Appendix D of this guide lists manufacturers and suppliers of various collection and processing equipment.) Then they should develop specifications and issue an Invitation for Bids (IFB). (Appendix C.)

Specifications set out the essential characteristics of the items being solicited; they tell bidders exactly what the municipality wants to buy and enable them to accurately compute their bids. Design specifications for any features of an item that are essential to its proper functioning should be carefully written.

An IFB solicits bids from competing manufacturers. The IFB should contain the terms and conditions the bidder must meet and the specifications for the design of the equipment. These elements will also be incorporated into the contract that the municipality will sign with the most suitable bidder.

(8) Consider Source Separation Ordinances

Municipal officials should consider whether mandatory source separation ordinances are necessary for their community. These ordinances require citizens to separate their recyclable materials, under penalty of a fine. Most communities with mandatory ordinances experience higher participation.

Communities may find scavenging to be a severe problem, especially when material prices are high. Municipal officials may wish to enact antiscavenging ordinances containing penalties, usually fines, to help control this problem.

Source Separation Collection and Processing Equipment: A User's Guide

Equipment represents the greatest initial expenditure for most source separation programs. As a result, municipal officials and private sanitation company officials need detailed information to help them select equipment used to collect and process recyclables most suitable to their needs. Since the first program began over 10 years ago, many types of equipment have been tested and used. Little information has been published, however, describing equipment systems and discussing their availability, performance, and cost.

This guide is intended to help municipal officials and private collection companies plan to operate source separation programs by providing them with detailed information on systems and equipment. The guide covers the most successful systems used to date and lists the advantages, disadvantages, and general specifications of each piece of equipment described. Chapter one covers collection systems and equipment; chapter two covers processing systems and equipment.

A collection system must be selected carefully to meet the unique needs of the community. Program officials should begin by estimating the kind and volume of materials they will collect —— along with any specifications required by their markets —— then select the most effective equipment and labor available. Officials can increase citizen participation by making the equipment visually attractive, by providing reliable and frequent collections, and by distributing special containers to make household storage easier.

Newspapers or mixed wastepaper are the easiest materials for residents to separate from refuse and for programs to collect. Paper is easily stacked and stored in the home; on collection day, residents need only bundle it, tie it with string, or place it in containers at the curb. Crews can easily load paper either manually or mechanically onto collection, storage, and transportation vehicles. Collection systems for newspaper are more common than for mixed wastepaper because markets usually pay a higher price for separated grades of paper, such as newspaper.

Glass and cans are slightly more difficult for residents to prepare and crews to collect than paper because their markets have more stringent quality requirements. In some programs, residents may be asked to separate clear, green, and brown glass and to remove the labels and metal rings from bottles. In other programs, residents may be asked to separate aluminum from ferrous metal cans or to flatten cans. Unlike paper, glass and cans usually must be separated and stored by residents in bags or containers.

Although glass and can collection is generally more complex than paper collection, some communities have successfully simplified the process. They have sold to markets which require a minimal amount of material preparation by residents; provided special household storage containers; and collected glass and cans frequently to reduce storage requirements in the home. In addition, some communities are using specially marked containers that aid the collection crew in identifying glass and cans and special collection vehicles to keep these materials separate.

COLLECTION SYSTEMS

Recyclable materials may be collected either house-to-house by refuse trucks that collect materials which residents have placed at the curb, or from recycling centers, to which residents bring materials. Although residents are more likely to participate if recyclables are collected from their homes, recycling centers offer certain advantages. They can be less expensive to operate than separate-collection systems. Because they can hold many different kinds of storage containers, recycling centers also can collect a greater variety of recyclable materials than can separate-collection systems.

House-To-House Collection

House-to-house collection systems require residents to prepare materials as the program requests (e.g., bundle and tie newspapers) and place the materials at the curb. A crew collects the materials and places them in a vehicle. At the end of the collection day, the vehicle takes the materials either to a storage site for future transportation or processing or directly to a market.

There are three common varieties of house-to-house collection systems: separate collection of one material; collection of newspaper or mixed wastepaper and refuse; and collection of two or more recyclables. A community's choice of a system will depend on the materials it plans to collect and the resources available to it.

SEPARATE COLLECTION OF ONE MATERIAL

Separate collection of one material is the most common type of collection system. Residents place a single material at the curb and a crew and truck collect it separate from refuse. This system is most often used to collect newspaper or mixed wastepaper.

Glass has also been collected this way by some programs; however, the collection vehicle often requires compartments, bins, or drums to separate glass by color.

Existing refuse collection vehicles, such as compactor trucks, are often used by this type of system. Most municipalities have spare trucks which they use when regular refuse collection vehicles are being serviced or repaired. Many programs use spare compactor and pickup trucks to collect paper because these vehicles have adequate collection capacity. Separate collection of one material requires a separate-collection crew. Most programs have been able to make use of spare labor, however, by collecting the single material on a day other than the regular refuse collection days.

Larchmont-Mamaroneck, New York, reduced its number of refuse collection days per week from six to four and used the fifth day to collect mixed wastepaper separately. Using compactor trucks, three-man crews collect paper from a population of 20,000 in the sanitation district. They collect approximately 80 tons of paper each month. When the truck reaches its capacity, it returns to the community's former incinerator and dumps the materials through a hopper into a transfer trailer. The trailer transports five truckloads of paper to market per month.

COLLECTION OF NEWSPAPER OR MIXED WASTEPAPER AND REFUSE

A second type of system collects newspaper or mixed wastepaper at the same time as refuse. Residents place paper next to their refuse at the curb on regular collection days. A rack (a steel rectangular container that is attached to the underside or rear of a refuse collection vehicle) or trailer holds the paper. Racks can be made inexpensively and easily by a source separation program staff or by a local ironworks company and require a minimal amount of maintenance. Trailers, which are attached to the rear of a collection vehicle, can collect greater quantities of paper than racks. However, trailers are more expensive to purchase or modify than racks.

Racks and trailers may have to be unloaded on route because they may fill up more quickly than refuse collection vehicles. A rack usually will have to be unloaded at least once into another vehicle that is centrally parked or that travels to and from the route to collect the paper. Trailers have larger storage capacities than racks and are less likely to fill up before the refuse collection vehicle.

This collection system minimizes labor costs by using the same crew to collect paper and refuse simultaneously. In addition, the system does not alter collection frequency and schedules; thus, it is the easiest system for householders to remember and to participate in on a regular basis.

Enfield, Connecticut, uses a 6-cubic-yard (1.5-tons capacity) self-dumping trailer attached to its rear-loading refuse vehicle to collect newspaper. The trailer usually fills only once a day, while the refuse vehicle must be unloaded twice a day. About midway through the route, the crew unhitches the trailer and leaves it parked on route while the refuse vehicle travels to the landfill. At the end of the route, the trailer and refuse vehicle travel to the landfill; there, the trailer is backed onto a ramp above a 6-ton roll-off container, into which it hydraulically dumps the materials. The roll-off, which is provided by the market, is collected every 1.5 days, and taken to market using a roll-off truck. The town collects 85 tons per month from 40,000 residents.

Madison, Wisconsin, installed 1-cubic-yard side racks on their rear-loading compacting refuse vehicles. The racks hold approximately 600 pounds of newspaper and must be unloaded 2 to 3 times a day. A 6-ton dump truck or a flatbed truck with load lugger boxes that hold 4 tons of paper is parked centrally on the route; refuse vehicles with full racks travel to these trucks to unload. At the end of the day, the dump or flatbed truck unloads into a 75-cubic-yard transfer trailer, which is taken to market 2 to 3 times each week. The town collects 200 tons of paper per month from 170,000 residents.

COLLECTION OF TWO OR MORE RECYCLABLES

The third system collects two or more recyclables. Householders place separated recyclables in containers at the curb. The separated materials are collected either by a vehicle with compartments or bins or by a vehicle that pulls a trailer. Compartmentalized collection vehicles unload mechanically, either with a hydraulic ram or with a body that tips. Vehicles with separate bins may be self-dumping, or the bins may be lifted off the vehicle manually or by forklift.

The success of multimaterial separate-collection systems depends in part on the capacity of individual compartments or bins of the collection vehicle. If one compartment or bin reaches its capacity before another compartment or bin, collection efficiency is reduced; the collection crew has to either unload the full bin on route or combine two materials in one bin. Therefore, the capacity of each vehicle compartment or bin should be carefully tailored to carry the expected volume of recyclables collected. Vehicle bins and compartments should also be designed to assure that recyclables remain separate during collection.

Many multimaterial separate-collection programs collect recyclables once per week. Less frequent collections tend to discourage residents from participating because they must store materials longer. Most multimaterial programs collect all recyclables on the same day because residents are more likely to remember a single collection date. Some programs collect materials on a revolving basis (e.g., glass on the 2nd Monday of the month; paper on the 1st and 3rd Monday of the month) because they lack vehicles, compartments or bins that are sufficiently large or numerous to keep several materials separate. These multimaterial systems, however, reduce resident participation because they increase storage requirements and increase the number of collection dates.

Modesto, California, was one of the first multimaterial separate-collection programs in the country. The program is operated by a private company that collects newspaper, mixed glass, and mixed metals weekly using a pickup truck attached to a trailer with bins. The truck carries drums to contain metals; the trailer holds paper and glass in separate bins. The total capacity of the truck and trailer system is 14.6 cubic yards. Metals are unloaded manually from the truck; paper and glass are unloaded with a forklift. Metals are separated, flattened, shredded at the program facility, then stored and transported in 30- and 40-cubic-yard roll-off containers. Glass is dumped into 20-cubic-yard roll-off containers at the facility, placed in containers, and transported to market. The program collects about 65 tons of glass, 100 tons of newspaper, and 21 tons of metals each month from an area of 80,000 residents.

Recycling Centers

Recycling centers are stationary sites to which residents bring materials. The volume of materials brought to recycling centers is generally significantly less than that collected by separate-collection programs, because the centers require residents not only to prepare and store recyclables but also to transport them. Recycling centers, however, are an option for municipalities that lack the personnel, equipment, or money to begin a separate-collection program. Recycling centers have also been established by municipalities that are collecting some recyclables but want to divert additional recyclables from their waste stream. Other municipalities, which do not provide refuse collection service and require residents to bring their refuse to an incinerator or dump, have set up recycling centers at their refuse disposal sites. These centers experience high participation levels. The municipalities require residents merely to keep recyclables separated and to place them in the appropriate storage containers. Some recycling centers pay the public for materials to increase the amounts recycled.

A small recycling center may service several neighborhoods, while a large center at a municipal public works yard may service an entire community. Whatever the size of the recycling center, the

site should be convenient to a community's most densely populated areas. The center should be located on a well-traveled road to reduce vandalism and scavenging and to enable residents to combine trips to the center with other errands. In addition, the site should be large enough to allow storage bins to be situated, filled, and removed safely, and residents to drive their cars close to the bins when unloading recyclables. Finally, large and attractive signs should be posted at the entrance of the recycling center. Signs should also be placed above or near storage containers to explain sorting requirements for recyclables. Storage containers at small neighborhood centers should be movable (e.g., 55-gallon drums for glass) because recyclables will have to be taken to market at regular intervals. Recyclables can be placed into larger mobile containers or stationary containers because the increased volumes justify a second handling of materials for transportation to the market or processing site.

Recycling centers use less labor and equipment than separate-collection systems. However, they need staff to monitor the site and to transport materials to a market or processing site. Since recycling centers can operate independently of refuse collection programs, citizen groups often staff the centers voluntarily and are compensated from profits resulting from selling materials.

The recycling center in Wellesley, Massachusetts, is located at the disposal site to which all residents bring their refuse. Because it requires little additional effort, more than 50 percent of the 8,000 households participate in the recycling programs. Citizens separate glass into clear, brown, and green and cans into aluminum and ferrous and place them in separate 50-cubic-yard roll-off containers. Newspapers are placed directly into a baler at the disposal site. The center received 30 tons of glass, 55 tons of newspaper, and 25 tons of metals each month. In addition, citizens may bring magazines, books, clothes, large metal items, tires, motor oil, batteries, and cardboard to the center for recycling.

SELECTING COLLECTION EQUIPMENT

Officials who are starting a source separation program need to select equipment to collect and store recyclables. In selecting equipment, they should consider efficiency, cost, safety, labor requirements, and the frequency with which materials are collected.

To operate efficiently, collection equipment (i.e., collection vehicles, storage containers, and hauling vehicles) should have a capacity appropriate to the expected volume of materials.

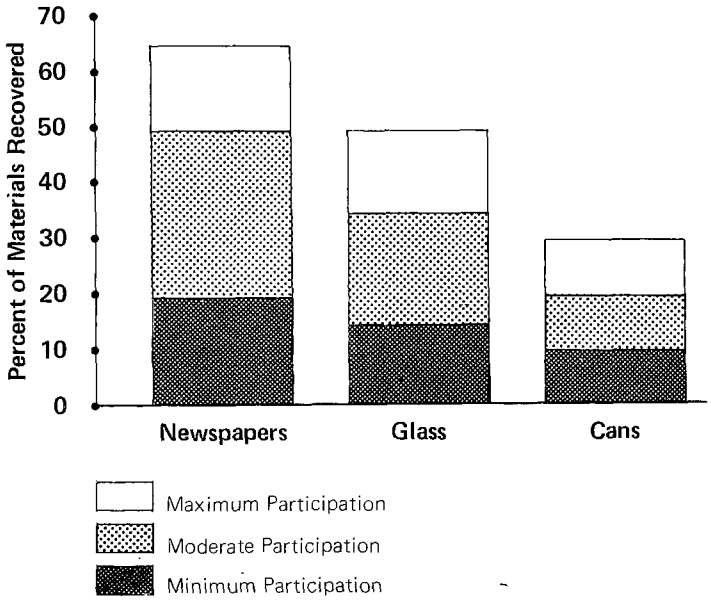
Program officials can estimate the volume of materials to be collected by estimating the average composition of their waste stream, then computing the total weight of recyclables being discarded. Figure 3 shows the average composition of waste materials in various cities.

Officials should adjust their estimates of the amount of recyclables that will be collected to reflect the expected rates of participation in their communities. The EPA has surveyed many communities that have implemented source separation programs. The most successful separate-collection programs have recovered about 50 to 65 percent of the communities' newspapers, 35 to 50 percent of their glass and 20 to 30 percent of their cans (Figure 3). Programs that are well publicized and that have some recycling experience (e.g., paper drives, recycling centers) can expect moderate participation. Programs with little publicity and minimum citizen interest can expect only minimum participation. Once estimates of the weight of recyclables that will be collected have been obtained, volumes can be estimated from the following densities:

Material	Density
Newspapers	500-600 lbs/cu yd
Whole bottles	600 lbs/cu yd
Whole ferrous cans	150-200 lbs/cu yd
Whole aluminum cans	74 lbs/cu yd

Figure 3

Recovery of Source-Separated Materials From Separate Collection



SOURCE: Resource Planning Associates, Inc.

Officials should consider the cost of the equipment they select. In assessing equipment costs, they should include the cost of the labor required to operate the equipment. Figure 4 lists the general characteristics, including equipment cost, of the collection systems examined in preparing this guide.

All equipment should be examined and tested by a safety consultant or professional engineer to assure its safety. Safety problems can occur, for instance from improper specifications for brakes on trailers or on vehicles that pull trailers. Incorrect placement of taillights and unusually high loading heights for the collection crew are also safety hazards. Therefore, collection equipment designs, especially those that are modified or purchased by a program sponsor, should be carefully checked for safety in order to avoid operational hazards.

Figure 4

Collection Systems and Their Characteristics

Location/ Operator	Households in Collection Area	Materials Collected	Tons Per Month Collected	Collection Vehicle Crew Size	Frequency of Collection	Equipment	Capital Cost ($)*1	Modification Cost ($)*2
El Cerrito, California/ Municipality	9,400	Newspaper Magazines Mixed Glass Ferrous Metals Aluminum	68.0 8.0 32.0 7.0 1.0	2	1/week	Household separation units Flat bed truck with bins Forklift	3.25 (each) 1,900.00 8,000.00	2,100.00
Modesto, California/ Ecology Action Institute	20,000	Newspaper Mixed Glass Ferrous Metals Aluminum Metals	100.0 65.0 20.0 1.5	1-2	2/month	Flat bed truck (2) Trailer with bins (2) Forklift	5,400.00 (each) 3,100.00 (each) 4,000.00	1,000.00 95.00
Downey, California/ CAL-SAN, Inc.	16,000	Mixed Wastepaper Mixed Glass Mixed Metals	88.4	1	1/week	Metal-sided dumping truck Side-loading refuse compactor truck (box only)	20,000.00 8,000.00	
Davis, California/ Davis Waste Removal	8,000	Newspaper Mixed Glass Ferrous Metals Aluminum Metals	100.0 40.0 5.0 1.0	2	1/week	Pickup truck Trailer with bins Trailer Scooters	5,500.00 6,500.00 900.00 3,000.00 (each)	1,500.00
Santa Rosa, California/ Redwood Empire Disposal	23,000	Newspaper Mixed Glass Mixed Metals	112.0 68.0 21.0	2	1/week	Household separation units (1,600) Flat bed truck with bins Forklift	15.00 (each) 5,850.00 9,000.00	500.00
Wellesley, Massachusetts/ Municipality (recycling center)	8,000	Newspaper Colored Glass Clear Glass Ferrous Metals Aluminum Metals	55.0 13.0 15.0 25.0 .5			Roll-off boxes	3,000.00 (each) 5,000.00 (each)	
Lexington, Massachusetts/ Miller Disposal Company	9,000	Newspaper Mixed Glass Ferrous Metals Aluminum Metals	81.7 25.0 3.6 36.5	1	1/week	Compartmentalized dump truck	NA	NA
Newton, Massachusetts/ Municipality	26,000	Newspaper Mixed Glass Mixed Metals	159.0 67.0	2	1/week	Compartmentalized truck (body only) (2) Refuse compactor truck	12,000.00 (each) NA	NA
Larchmont-Mamaroneck, New York/ Municipality	4,500	Mixed Wastepaper Mixed Glass Aluminum Metals	80.0 42.0 NA	4 (recycling center)	1/week	Refuse compactor truck Transfer trailer *3 Tractor *3 Transfer station *3 Lugger box (rental fee)	NA 30,000.00 45,000.00 60.00 (month)	 20,000.00

SOURCE: Resource Planning Associates, Inc.

Figure 4 (continued)

Collection Systems and Their Characteristics

Location/ Operator	Households in Collection Area	Materials Collected	Tons Per Month Collected	Collection Vehicle Crew Size	Frequency of Collection	Equipment	Capital Cost ($)	Modification Cost ($)
Mamaroneck, New York/ Municipality	3,750	Mixed Paper	60.0	3	1/week	Refuse compactor truck Transfer trailer *3 Tractor *3	NA 40,000.00 NA	
Garden City, New York/ Municipality	6,000	Newspaper	67.0	1	1/week	Side-loading refuse compactor truck	31,000.00	
Carmel, New York/ Municipality	8,000	Mixed Wastepaper Mixed Glass Ferrous Metals Aluminum Metals	64.3 14.0 9.8 0.2	3	1/week	Stake-body truck Pickup truck Front-end loader	3,500.00 (used) 4,610.00 1,500.00	
West Orange, New Jersey/ Hackensack Paper Company	11,000	Newspaper Mixed Glass	87.5 62.5	2	1/week	Box-bed truck (2)	10,000.00 (each)	
East Hartford, Connecticut/ Municipality	12,500	Newspaper	37.3	3	1/week	Trailer (7) Stationary bins Demolition trailer	3,220.00 (each) 10,000.00 5,000.00	NA
East Lyme, Connecticut/ Municipality	5,000	Newspaper Mixed Glass and Cans	32.2 45.0	2	1/week	Side-loading refuse compactor truck Trailer (3) *4	22,000.00 233.00 (each)	100.00 (each)
Newington, Connecticut/ Trash-Away Company	7,500	Newspaper Mixed Glass	50.0 11.0	3	1/week	Rack (3) Box-bed truck	250.00 (each) 8,000.00	290.00
Enfield, Connecticut/ Municipality	11,000	Newspaper	85.0	3	1/week	Trailer (6)	3,000.00 (each)	
Deerfield Beach, Florida/ Municipality	6,700	Newspaper Corrugated Paper	40.0 4.0	3	1/week	Stake-body truck	10,500.00	
Temple Terrace, Florida/ Municipality	2,000	Newspaper Corrugated Paper Mixed Glass Aluminum Cans	22.0 18.0 24.0 1.0	3	1/3 weeks	Trailer Pickup truck Side-loading rack (2) Rear-loading rack	600.00 NA 175.00 (each) 175.00	450.00

SOURCE: Resource Planning Associates, Inc.

Figure 4 (continued)

Collection Systems and Their Characteristics

Location/ Operator	Households in Collection Area	Materials Collected	Tons Per Month Collected	Collection Vehicle Crew Size	Frequency of Collection	Equipment	Capital Cost ($)	Modification Cost ($)
Boca Raton, Florida/ Municipality	12,000	Newspaper	248.0	3	1/week	Stake-body trucks (rental fee) (2) Refuse compactor trucks (2)	450.00 (month, each) NA	
Grand Rapids, Michigan/ Recycling Unlimited, Inc. (recycling center)	10,000	Corrugated Paper Mixed Glass Ferrous Metals Aluminum Metals	12.5 65.0 7.5 2.0			Beverage trucks (5) Gravel dump truck	300.00 - 1,200.00 (each, used) NA	
Madison, Wisconsin/ Municipality	42,000	Newspaper	200.0	2	1/week	Rack (44) *4 Dump trucks	175.00 (each) NA	
Racine, Wisconsin/ Municipality	32,000	Newspaper	34.0	2	1/week	Rack (21) *4 Box-bed truck	170.00 (each) NA	
Univeristy City, Missouri/ Municipality	2,000	Newspaper	50.0	3	2/month	Household separation units (11,000) Refuse compactor truck	6.95 (each) NA	
Seattle, Washington/ Seattle Recycling, Inc.	10,000	Newspaper Mixed Glass Mixed Metals	26.0 20.0 5.0	2	1/month	Household separation units (13,000) Flat bed truck Trailer Collection bins (21) Forklift	0.30 (each) 10,800.00 2,900.00 240.00 (each) 5,200.00	1,200.00

*1 Capital Cost: Initial cost of purchasing or building equipment.
*2 Modification Cost: Cost of modifications to equipment.
*3 Purchased originally for refuse program.
*4 Built by municipality.

SOURCE. Resource Planning Associates, Inc.

COLLECTION EQUIPMENT CATALOGUE

The following catalogue is designed to inform officials of municipalities and private sanitation companies about a wide range of equipment currently being used to collect recyclable materials.

It illustrates each piece of equipment and discusses its application, design specifications, advantages, and disadvantages. It also addresses design and selection issues and provides a list of communities using each piece of equipment. A list of manufacturers of collection equipment may be found in Appendix D. The catalogue should help officials to decide which pieces of equipment best suit their programs and to design effective collection systems.

The catalogue is organized by the steps involved in the collection process: household separation, collection, and storage.

HOUSEHOLD SEPARATION EQUIPMENT

Residents of communities that have source separation programs are responsible for sorting recyclables from other waste at home. They may use household separation units (specially designed bags, boxes, or cans) to keep recyclables separate from refuse until collection day or they may make do with common household containers.

Several communities have provided residents with special containers to make household separation and storage easier. On collection days, these containers may be set out at the curb. Special containers have the advantages of publicizing the program and helping collectors identify recyclables at the curb. The cost to the community of special containers is often offset by increased participation in the recycling program.

Most communities, however, expect residents to use household containers to store their recyclables. A few communities have given residents stickers to mark recyclables placed in garbage cans at the curb.

Common Household Containers

Use of common household containers, such as grocery bags, cardboard boxes, or string to tie bundled paper, involves little or no cost to either the source separation program or the resident. But household containers have disadvantages. When the proper items are not available, the householder may be discouraged from separating recyclable waste. Furthermore, household containers, such as paper bags, may get wet and tear or allow materials to blow away.

Advantage

- Involve little or no cost

Disadvantages

- Require more effort of residents
- Do not publicize program
- Do not distinguish recyclables from regular refuse

Special Markers

Some communities distribute markers for residents to place on garbage cans holding recyclables at the curb. These markers are often inexpensive decals or tags that display the name and logo of the recycling program. Markers help collectors to distinguish recyclables from refuse and remind citizens to recycle.

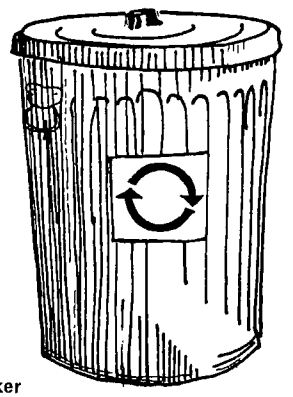
East Lyme, Connecticut, distributed decals to all its residents for placement on their recyclables containers. The decals, which were made by the community's senior citizens, distinguished recyclables from refuse containers.

Advantages

- Low cost
- Help publicize the program
- Can be sent to residents through the mail (e.g., with utility bills)

Disadvantage

- Not as effective as special containers



Special Marker

Special Containers

Special containers may be used to store one or more materials. A community can either purchase such containers directly from a refuse container manufacturer or design and manufacture its own. The community may sell the containers or distribute them free of charge to residents.

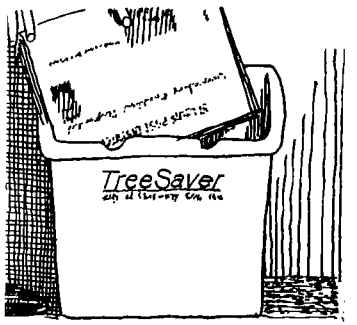
Special containers encourage participation in source separation programs. They not only help to publicize a program, but also demonstrate the commitment of local officials. Special containers provide a convenient way for residents to separate and store materials and make it easy for collection crews to distinguish recyclables from other waste. In addition, they reduce the likelihood of materials blowing away or getting wet.

SINGLE-MATERIAL UNITS

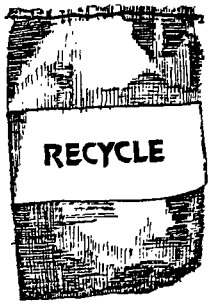
Single-material units are used in homes to separate and store one recyclable, usually paper. If more than one recyclable is being collected, a resident may store one material in the unit and handle or bag the other material(s) separately.

The "TreeSaver" was designed and patented by University City, Missouri, and manufactured by Rubbermaid and GET Plastics. The city provides the TreeSaver, which holds 2 weeks' accumulation of newspapers, free of charge to residents. Residents position the unit at the curb with the longer side on top to protect the paper from rain and snow. Distribution of the TreeSaver unit in University City doubled the rate of citizen participation in the separate-collection program.

In a Seattle, Washington, program, onion sacks and plastic bags are distributed free of charge to residents. Crews collect one bag of cans and one bag of glass each collection day. The onion sacks are 18"x32" and hold 15-20 lbs of glass or 8-10 lbs of mixed metals. The 25"x38" plastic bags contain up to 35 pounds of newspaper.



Plastic Container



Onion Sack

Advantages

- Provide convenient storage
- Are visible to residents and easily identified by collectors
- Are easily unloaded
- Provide convenient substitute for handling and tying of newspaper

Disadvantages

- Incur initial and replacement costs
- Must be distributed to residents

Design Issues

Strength
Durability
Capacity keyed to collection frequency
Color or special markings
Ease of handling by residents and collectors
Cost
Weather protection

Communities Using the Equipment

University City, Missouri
Seattle, Washington

General Specifications for "TreeSaver"

Height:	14" - 19"
Length:	18" - 20"
Width:	6"
Capacity:	20-lb. newspaper
Weight:	3 lbs.
Cost:	$5.00 - $10.00
Material:	high-density U.V. stabilized polyethylene

MULTIMATERIAL UNITS

Multimaterial separation units are used to store more than one recyclable at a time. These units may take the form of compartmentalized waste cans or separate stacking units. The units pictured are not readily available commercially but could be made by a container manufacturer.

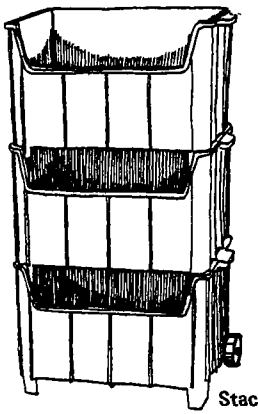
Santa Rosa, California, uses stacking units to store newspaper, cans, and glass. The householder is given three interlocking units, each of which may be unloaded separately. The bottom units have wheels so that they may be rolled out to the curb for collection.

Advantages

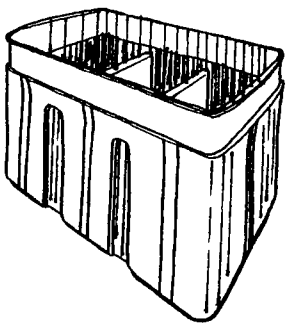
- Are visible to residents and easily identified by collectors
- Separate and store materials easily
- Facilitate collection

Disadvantages

- Must be distributed to residents
- Must be custom-designed and manufactured
- Incur initial and replacement costs



Stacking Unit



Compartmentalized Unit

Design Issues

Logo
Strength
Durability
Ease of handling by residents and collectors
Segregation of materials
Cost
Capacity (should be keyed to collection frequency and volume of materials)

Communities Using the Equipment

Santa Rosa, California
Nottingham, New Hampshire

General Specifications for Stacking Units

Height:	12"
Width:	12"
Length:	18"

Two wheels on bottom unit

Capacity:	1.5 cu ft
Materials:	wood, polyethylene
Cost:	$15

COLLECTION EQUIPMENT

Most municipalities use compactor vehicles or other public works department vehicles, such as pickup or stake body trucks, to collect recyclables. These "adapted" vehicles, which can be used for a variety of municipal operations, minimize capital costs and are generally rellable and easily maintained. A growing number of municipalities, however, are using "special" collection equipment such as racks, trailers, and compartmentalized vehicles. Many of these municipalities have particular collection needs. Some must collect two or more recyclables simultaneously; others need to combine their recycling and refuse collection programs.

The following sections describe a variety of "adapted" and "special" types of collection equipment, explain how the equipment is being used, and outline the advantages and disadvantages of each type.

Adapted Equipment

Some side-loading vehicles, however, are significantly less fuel-efficient than rear-loading compactors. They require an additional engine to operate a compacting blade that pushes the materials out of the vehicle when dumping. Most rear-loading compactors require only one engine to operate the truck and the compacting blade. Both refuse compactors must be cleaned before recyclables are loaded to prevent contamination from refuse.

The town of Mamaroneck, New York, currently collects newspapers from single-family residences on a weekly basis. It uses three 20-cubic-yard rear-loading compactor trucks manned by three-member crews. Each truck collects 6 tons of newspaper per collection day and dumps paper through a hopper into a storage and transport trailer.

Garden City, New York, uses a 29-cubic-yard Shupack side-loading compactor truck to collect newspaper on a weekly basis. The single crew member collects approximately 4 tons of newspaper from 1,200 homes each day, five days a week. East Lyme, Connecticut, uses an 18-cubic-yard Truxmore side-loading compactor truck to collect a mixture of cans and glass. A two-man crew loads the mixture into the loading hopper from either side of the truck.

COMPACTOR TRUCKS

Many communities use compactor trucks to collect recyclables, most commonly newspaper, because they are available as spare refuse collection equipment.

Compactor trucks have larger capacities than special collection equipment such as racks and trailers. When racks or trailers are attached, they can be used to collect both refuse and recyclables. A community may find that it collects enough recyclables with a compactor truck to modify the regular refuse collection schedule and reduce the number of routes.

Most municipalities use rear-loading compactor vehicles manned by two- or three-member crews to collect refuse and recyclables. Several municipaliteis, however, are using side-loading vehicles.

Although commercially available side- and rear-loading compactor trucks have similar capacities, the side-loading vehicle may be more efficient. One crew member can collect and load recyclables into the side-loading vehicle's hopper. The loading hopper is close to the cab and may be accessible from both sides of the street.

Advantages

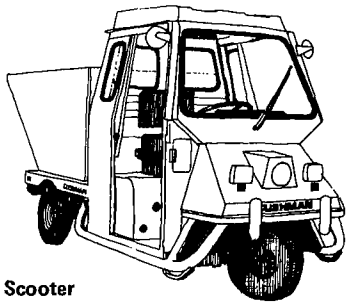
- Use existing equipment and labor
- Usually have capacity of at least 16 cubic yards
- Load and unload easily
- May be used in other municipal operations
- Are commercially available
- Are easily maintained
- Can attach trailers or rack vehicles to collect another recyclable

Disadvantages

- Some side-loading compactor trucks have high loading height
- Contamination may occur if refuse compactor is not cleaned before storing recyclables in body
- Separate truck requires extra maintenance

Communities Using the Equipment

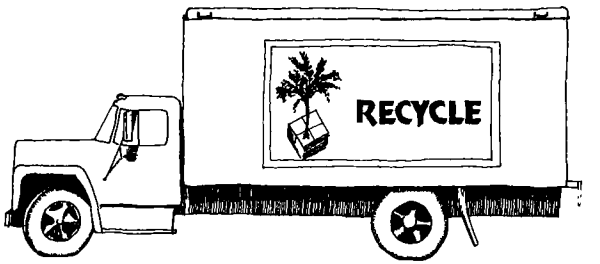
Mamaroneck, New York
Larchmont-Mamaroneck, New York
Boca Raton, Florida
Lexington, Massachusetts
Newton, Massachusetts
East Lyme, Connecticut
Garden City, New York



Refuse Scooter

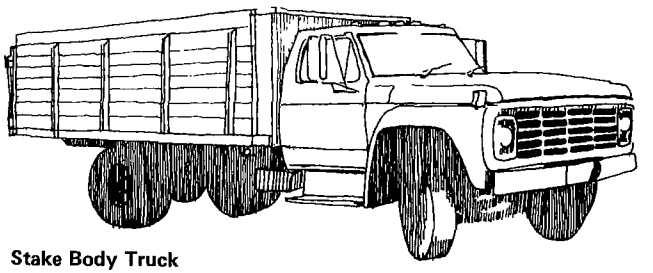
OTHER VEHICLES

Recyclables can be collected without being compacted, by other spare equipment, such as refuse scooters, or box-bed, pickup, dump-body, and stake-body trucks. These smaller vehicles may be operated and maintained at lower costs than compacting vehicles and can be tailored to meet the needs of a program. In particular, they may be equipped with bins or drums to collect and store more than one material. Racks and trailers may also be attached to noncompacting vehicles, many of which can be designed to handle heavy materials.



Box-Bed Truck

The major disadvantage of using noncompacting vehicles is that many do not have dumping mechanisms; materials must be unloaded manually. Furthermore, although the capacity of dump trucks, pickup trucks, and refuse scooters is greater than that of racks or trailers, these vehicles have less capacity than compactor vehicles.



Stake Body Truck

Temple Terrace, Florida, uses pickup trucks to store newspaper and cardboard while hauling a trailer with bins to collect glass and cans. Boca Raton, Florida, collects approximately 60 tons of

newspaper each week with two self-dumping stake body trucks. The city rented the 15-cubic-yard vehicles from a local firm and modified the side walls and back openings of the vehicles to increase their capacity.

A private hauling company in West Orange, New Jersey, uses two box-bed trucks to collect newspaper and glass. The glass collection truck houses thirty 55-gallon drums that hold color-sorted glass. The one-man crew of the newspaper collection truck loads newspaper through a rear or side opening on the passenger side.

Davis, California, contracts with a private hauler who uses a refuse scooter with 2.5-cubic-yard self-dumping bins to collect newspaper. Because of the small capacity of the bins, the vehicles must be unloaded on-route into a larger vehicle, either a stationary "mother" vehicle or a mobile "satellite" vehicle. In Montclair, New Jersey, a 12-foot step van collects 3-4 tons of newspaper at a time.

Advantages

- Are available commercially
- Offer variety of sizes
- Are available for rental
- Have lower purchase and operating costs than compacting trucks
- Are generally available to municipalities as spare multipurpose vehicles
- May be easily modified
- Are readily serviced
- Have good maneuverability

Disadvantages

- Most vehicles require manual unloading
- Some vehicles have small storage capacities
- Some vehicles have high loading height

Design Issues

Capacity
Availability of vehicles and replacement parts
Durability

Communities Using the Equipment

Deerfield Beach, Florida (stake-body truck)
Temple Terrace, Florida (pickup truck with trailer)
Boca Raton, Florida (self-dumping stake-body truck)
Carmel, New York (stake-body truck with bins and pickup truck)
West Orange, New Jersey
Montclair, New Jersey
Davis, California

Special Equipment

RACKS

Racks may be mounted into the side or rear of refuse collection vehicles to store newspaper or mixed wastepaper. Mounted racks enable a crew to collect refuse and separated paper simultaneously. When collection of the two materials is combined, routes need not be altered and residents need not learn a new schedule.

The most common type of rack is the side-loading rack; it is the easiest to fabricate, install, and load. Some municipalities, however, install overhead racks above the rear-loading hoppers of refuse compactors because these racks generally have larger storage capacities and are easier to unload.

When the amount of newspaper collected exceeds the storage capacity of a rack, a mother or satellite vehicle may receive the additional paper. Mother vehicles are trucks or mobile containers stationed at prearranged points on collection routes; satellite trucks travel around collection routes to collect paper that has been dropped at pre-designated points. The latter generally are the more convenient. Unloading racks into a passing truck takes only

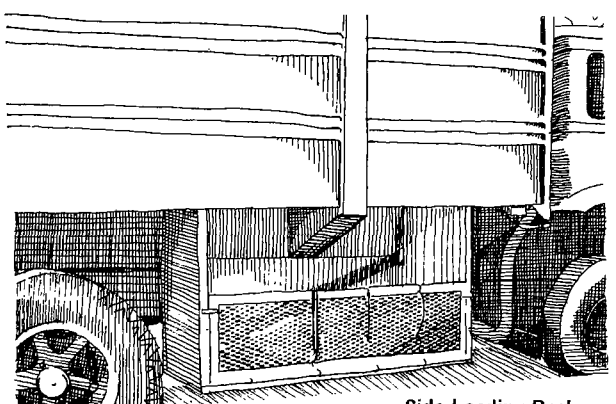
a few minutes; traveling to a stationary truck or container can add up to 20 minutes to a collection trip.

Side-Loading Racks

Side-loading racks are rectangular containers usually welded onto the bottom right side of compacting trucks. They are used to receive and hold paper loaded from the curb. Racks placed on both sides of a truck are used to collect paper simultaneously from both sides of the street.

Side-loading racks are usually made of steel. They may have doors to help contain blowing paper. Madison, Wisconsin, uses a side door made of wire mesh hinged to the bottom of the rack frame. This door hooks onto the top of the rack with an elastic rope that allows the rack to fill to capacity without losing paper.

All side racks are loaded and unloaded manually. Temple Terrace, Florida, uses a side rack designed to "tilt dump"; the rack sits on metal runners so that it can be pulled out from underneath the truck. The rack is tilted manually until the paper is dumped, then brought back to its original horizontal position and pushed back underneath the truck.



Side-Loading Rack

Most side racks are designed, built, and installed by a public works department or by a local ironworks company. Although no compactor manufacturers advertise racks, several large manufacturers will construct them if requested by a municipality. If a rack is to be added to a truck, the chassis manufacturer should be informed so he can make sure that the fuel tanks and other hydraulic lines do not interfere with the rack placement. He may not be albe to accommodate racks on both sides of the truck.

Advantages

- Combined refuse and recyclables collection
- Have low loading height
- Are manufactured easily
- Are installed and maintained at low cost

Disadvantages

- Have limited capacity; may require other collection vehicles to handle full load
- Must be manually unloaded
- Some trucks cannot be fitted with racks

Design Issues

Capacity
Durability
Door to contain paper

Communities Using the Equipment

Madison, Wisconsin
Racine, Wisconsin
San Francisco, California
Temple Terrace, Flordia
Newington, Connecticut

General Specifications

Height: 2' - 2'6"
Width: 2'4" 2'6"
Length: 5' - 6'6"
Capacity: 1 cu yd to 1-1/2 cu yds - 500-900 lbs of paper
Distance from rack to cab: 1'
Distance from rack to rear-loading hopper: 8'
Height from street to rack bottom: 1-1/2' minimum
Construction materials: frame of 1/8"x2'x2'; angle iron: 1/8"; flat stock side and bottom: 3/4"; flat wire mesh welded to 1'x5' door frame and hinged to rack frame with piano hinge; 3/8" rod to hold rope

Rear-Loading Racks

Rear-loading or overhead racks are built onto the back of refuse vehicles above the rear-loading hopper. These racks are generally larger than side-loading racks; the rear of a compactor vehicle has fewer space restraints than the sides. Newspaper is tossed into the racks from the side.

Collectors often develop shoulder and neck problems loading rear-loading racks, especially when they are loading heavy bundles, because the racks are high. As a result, several communities, including Temple Terrace, Florida, have attempted to design overhead racks with front panels or doors that can be lowered. These rear-loading racks are unloaded by unhitching the front door or the bottom panel of the rack and allowing the paper to fall.

Rear-loading racks are more difficult to design, build, and install than side racks and are usually more costly. Because newspaper bundles are tossed into the racks, the racks must be made from construction materials that can continually withstand the weight of falling newspaper. Doors or panels in front must be designed so that paper will not fall out while the rack is being loaded or while the vehicle is moving.

Advantage

- Have greater capacity than side racks

Disadvantages

- Have high loading height
- Unloading poses safety problems

Design Issues

Safety for collectors
Capacity
Durability
Loading and unloading procedures

Communities Using the Equipment

Temple Terrace, Florida

General Specifications

Height: 3'9"
Width: 7"
Capacity: 2 cu yds
Construction materials: angle iron frame, expanded metal

TRAILERS

A variety of trailers can be used for collecting recyclables: standard trailers, self-dumping trailers, and trailers with bins. Trailers are being used by an increasing number of municipalities to collect one or more recyclables simultaneously or to collect one or more recyclables and refuse at the same time. Trailers attached to collection vehicles gather recyclables more efficiently than separate trucks and crews. Collection time is increased only minimally when newspapers or other recyclables are loaded into a trailer.

While some municipalities have modified standard trailers for recyclables collection, others have provided local equipment

manufacturers and ironworks companies with design specifications and asked them to construct the trailers.

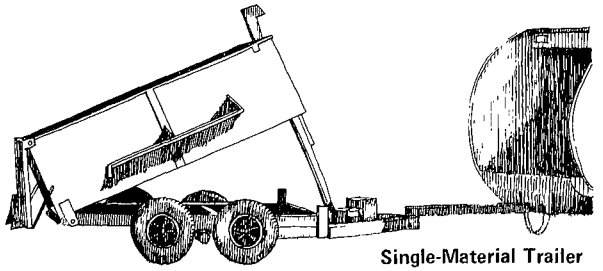
Trailers cannot be used in municipalities that have steep hills, numerous alleys, or cul-de-sacs because of maneuvering problems. In addition, state laws may prohibit hauling a trailer or more than one trailer behind a refuse vehicle. Trailers that force collectors to step over a tow bar can be dangerous. Taillights should be installed on all trailers.

Single-Material Trailers

Single-material trailers usually collect newspaper and are attached to a refuse truck. Because trailers have larger storage capacities than racks, they usually do not need to unload on route.

Single-material trailers are available commercially in a variety of sizes and designs. The storage capacities of single-axle trailers generally range from 4-6 cubic yards, while tandem-axle trailers average 10 cubic yards. Many single-material trailers are also able to dump. Trailers should be able to dump to reduce unloading time and to minimize potential safety problems.

Because many single-material trailers haul 1-2 ton loads of newspaper, a strong towbar and trailer brakes are needed as well as a vehicle that is heavy enough to pull the weight of the trailer and materials. Low towbars and gooseneck towbars are safer than ones placed directly above the compactor bumper.



Single-Material Trailer

Advantages

- Have greater storage capacity than racks
- Require minimal time for loading
- Are commercially available
- Require little maintenance
- Cost less than separate collection

Disadvantages

- Are difficult to maneuver
- Incur higher capital costs than racks
- Have potential safety hazards

Design Issues

Sufficient braking
Low or gooseneck towbar
Suitable capacity
Durability
Dumping mechanism
Single or tandem axle
Strong pulling vehicle

Communities Using the Equipment

East Hartford, Connecticut
Enfield, Connecticut
East Lyme, Connecticut

General Specifications for Dumping Trailer

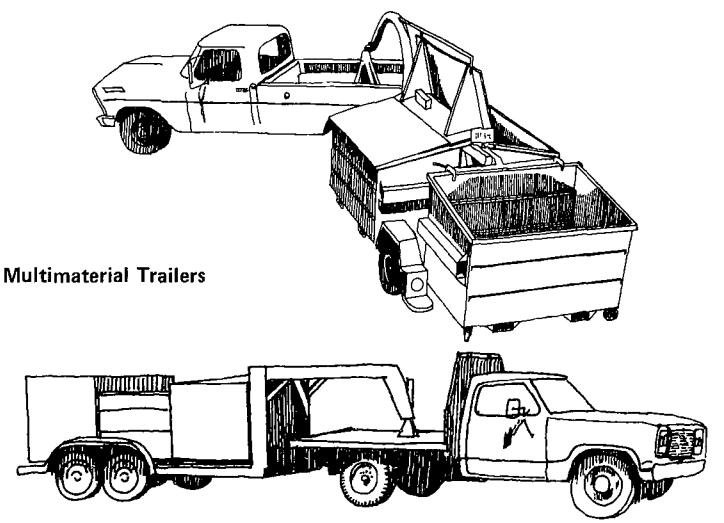
Side height:	3'	Construction materials:	10 - 12 ga. steel
Bed length:	8' 10'		
Width:	4' - 6'	Dumping mechanism:	hydraulic pump
Height of bed from street:	2' - 3'		
Cost:	$3,000 - $6,000		
Capacity:	4 - 6 cu yds		

Multimaterial Trailers

Multimaterial trailers are often attached to pulling vehicles and used to collect two or more recyclables simultaneously. A trailer can collect multiple materials more economically than can a special vehicle or separate truck and crew.

Most multimaterial trailers carry separate bins for each material. A forklift can lift the bins off the trailer bed or they can dump hydraulically to the side. Partitions may be fitted into single-material trailers to form separate material compartments. These compartments can dump if doors are placed between them. The doors should be locked during collection and unlocked to dump one material at a time.

Midway Fishing Tool Company of California manufactures gooseneck trailers that can carry any model of standard waste collection bin. Each trailer carries three separate containers which are loaded and unloaded with a hydraulic fork-lift system. Two trailers may be joined and pulled by a single vehicle.



Multimaterial Trailers

Advantages

- May collect and segregate more than one recyclable
- Require minimal time for loading
- Cost less than specialized vehicle or separate collections

Disadvantages

- Have lower capacity for any one material than single-material trailers
- Are difficult to maneuver
- Require strong pulling vehicle

Design Issues

Sufficient braking
Strong towbar
Low towbar
Suitable capacity of bins or compartments
Swamper steps on trailer to facilitate loading of bins
Durability
Unloading procedure
Single or tandem axle

Communities Using the Equipment

Modesto, California
Davis, California
San Luis Obispo, California
Fresno, California
Bakersfield, California
Temple Terrace, Florida

General Specifications for Midway Fishing Tool Trailer

Loading height:	5.5' (low pull towbar) 6.5' (5th wheel towbar)
Length of vehicle:	16' - 19' (including towbar)
Width of vehicle:	8'
Bin capacity:	up to 1,000 lbs

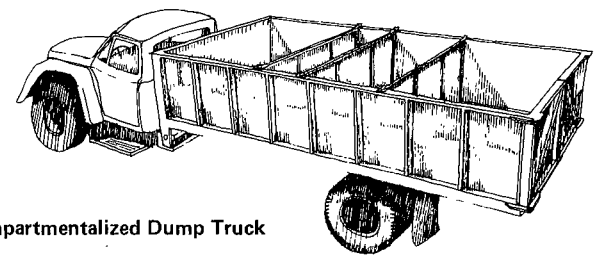
COMPARTMENTALIZED VEHICLES

Several municipalities are using a truck which has distinct loading and storage compartments to collect two or more recyclables at once. Compartmentalized vehicles are designed to collect two or more recyclables efficiently; have a greater capacity than multimaterial trailers or adapted trucks with bins. In addition, compartmentalized vehicles encourage participation because they collect all recyclables on the same day and are most visible to residents. Although most compartmentalized vehicles are more costly than other types of equipment, they collect larger volumes of recyclables. Revenues from selling the recyclables, as well as savings to refuse collectors, may offset the higher costs of purchasing compartmentalized vehicles.

The U.S. Environmental Protection Agency (EPA) provided funds and technical assistance to Marblehead and Somerville, Massachusetts, to operate a compartmentalized vehicle with rear-loading buckets.* Another vehicle, which collects three recyclables along with refuse, is presently being tested by a private firm. A private hauling company in Lexington, Massachusetts, has used a compartmentalized dump truck to collect three colors of glass and cans. A private hauling company in Santa Rosa, California, which has been using modified trucks with storage bins, has plans to purchase a vehicle with bins designed specifically for multimaterial collection.

Compartmentalized Dump Trucks

A standard dump truck modified to include compartments was used by one-man crews of a private hauling company in Lexington, Massachusetts, to collect color-sorted glass and cans. Of the truck's four compartments with a total storage capacity of 12-15 cubic yards, the clear glass compartment was the largest and the can compartment next in size. Swing doors that could be opened for unloading divided the compartments. The truck also provided a space for paper bags.



Compartmentalized Dump Truck

Advantages

- Collect two materials simultaneously
- Need one-man crews
- Unload easily
- Do not mix materials
- Capital cost is low compared to that of other compartmentalized vehicles

Disadvantages

- Loading height is high
- One compartment could fill up faster than other compartments

Design Issues

Capacity of compartments
Loading height
Unloading procedure

Community Using the Equipment

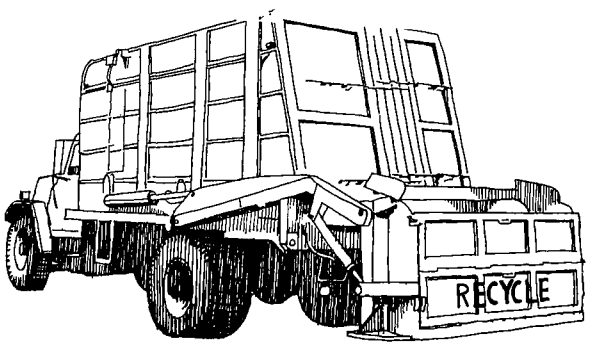
Lexington, Massachusetts

* For further information on the Marblehead compartmentalized vehicle, see **Multimaterial Source Separation in Marblehead and Somerville, Massachusetts: Collection and Marketing (SW-822),** which evaluated the vehicle performance for EPA.

Rear Loading Vehicles

Rear-loading compartmentalized vehicles have capacites of 16-20 cubic yards, significantly greater than those of multimaterial trailers. The vehicles were demonstrated in Marblehead and Somerville, Massachusetts; the design was further refined for multimaterial collection in Newton, Massachusetts.

The Rendispos Company designed the Newton vehicle with a compartmentalized hydraulically operated bucket into which one or two collectors can place recyclables. The bucket is tipped to unload materials into the compartmentalized truck body. The Marblehead vehicle's bucket can collect newspaper, a mixture of clear glass and cans, and a mixture of colored glass and cans simultaneously.



Rear-Loading Compartmentalized Vehicle

Rear-loading compartmentalized vehicles have standard chassis and cabs but specially fabricated bodies. The bodies of non-packing vehicles are approximately rectangular. The material compartments in the truck body and loading bucket of rear-loading vehicles are adjustable. These adjustable compartments compensate for wide weekly fluctuations in the composition of the load of recyclables. The Marblehead vehicle minimizes bucket-cycle time, i.e., the amount of time required for the bucket to dump into the truck body. This feature is particularly important because collection times and efficiency depend heavily on low bucket-cycle times.

Advantages

- Are commercially available
- Collect two or more recyclables simultaneously
- Load and unload easily
- Have greater capacity than trailers
- Can use two-man crews

Disadvantages

- May mix materials or litter while dumping
- Have high capital costs
- Have higher maintenance costs than multimaterial trailers

Design Issues

Capacity of compartments
Flexibility of compartments
Clearance and time required for loading buckets
Loading and unloading procedures

Communities Using the Equipment

Marblehead, Massachusetts
Newton, Massachusetts

General Specifications for Rendispos Vehicle

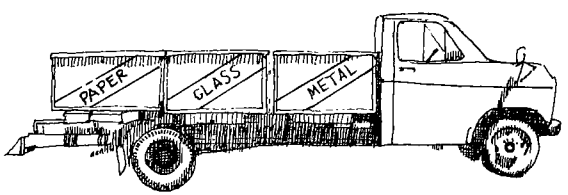
Total capacity:	16-20 cu yds
Body height:	6'2"
Width:	8'
Body and chassis length:	21'4"
Total length:	26'8" (with buckets)

Special Trucks With Bins

Several communities are using trucks that contain separate bins to collect two or more recyclables simultaneously.

A private hauling company in Santa Rosa, California, collects paper, glass, and cans in a modified flat-bed truck with six metal bins, two bins for each material. The newspaper bins have capacities of 2 cubic yards, while the glass and metal ones hold 1.5 cubic yards of materials. The bins slide onto three cross frames and are secured with pins to prevent them from sliding off the truck. The major advantage of this collection method is that the bins can be unloaded easily and quickly with a forklift.

The capital cost of a truck with bins is less than that of most compartmentalized vehicles. However, the bins can only collect 800 pounds of glass, 500 pounds of metals, and 1,200 pounds of paper at a time, and one storage bin often fills up faster than the others.



Flat-Bed Truck With Bins

LoDal, Inc., has designed a front-loading vehicle with three self-dumping bins, two with 4-cubic-yard capacity, and one with an 8-cubic-yard capacity. One-man crews employed by the Santa Rosa company will use these vehicles to collect three materials simultaneously. The two 4-cubic-yard bins dump hydraulically to the sides of the truck, while the 8-cubic-yard bin dumps to the rear. LoDal also offers other combinations of bin sizes for the collection of two or three recyclables.

Advantages

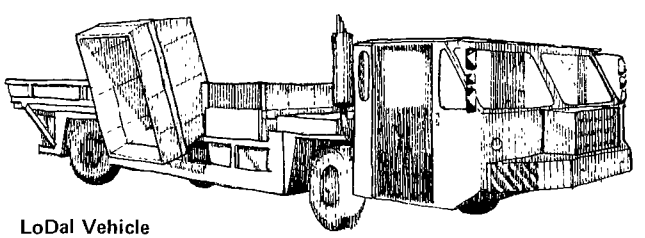
- Have large capacity
- May be operated by one-man crew
- Have dual-drive cab
- Bins are apportioned to volume
- Can collect several materials simultaneously
- Segregate materials
- Are self-dumping
- Have low loading height

Communities Using the Equipment

Santa Rosa, California

General Specifications (LoDal Vehicle)

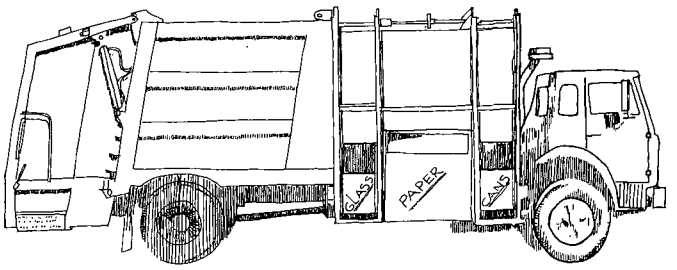
Overall length:	33'
Width:	95-3/4"
Loading height:	5'
Dumping height:	12'4"



LoDal Vehicle

Combined Refuse And Recyclables Carriers

A vehicle has been designed and developed by Recycling and Conservation, Inc. and Drew-It Corporation to combine the collection of three recyclables and refuse. This vehicle, called



Separated Discards Carrier

the Separated Discards Carrier, is still being tested and is not yet commercially available.

The Separated Discards Carrier stores recyclable materials in its center section in compartmentalized containers. Glass and cans are placed into side-loading buckets which, when full, are mechanically lifted and dumped into 4-cubic-yard bins. Newspapers are loaded into enclosed shelves on the side of the truck. The shelves have a combined capacity of 42 cubic feet; they lift off to unload. Regular refuse is placed into a rear-loading hopper and fed with an auger into a 15-cubic-yard compactor body.

Advantage

- Collect 3 recyclable materials and refuse simultaneously

Disadvantages

- Large number of mechanisms increases maintenance
- One bin may fill up faster than another

General Specifications

Glass bin capacity: 5 cu yds
Can bin capacity: 5 cu yds
Paper rack capacity: 2 cu yds
Compactor capacity: 15 cu yds of refuse
Truck: International Harvester Cargostar Model CO-1950 diesel engine, V-6, automatic drive, power take-off for auxiliary functions, continuous operating while idling or driving, two axles, GVW minimum 32,000 lbs
Wheelbase: 202''
Overall length: 29'

STORAGE EQUIPMENT

Most communities must store recyclable materials until they collect a sufficient quantity to transport to market.

There are two basic types of storage containers: mobile and stationary. Mobile containers can haul materials directly to market; they are either pulled by or placed on a vehicle. Stationary containers cannot be moved; materials must be loaded from them and placed in another container or vehicle for transportation to market. Both containers may be used at community recycling centers; citizens may bring their materials and place them directly in the containers.

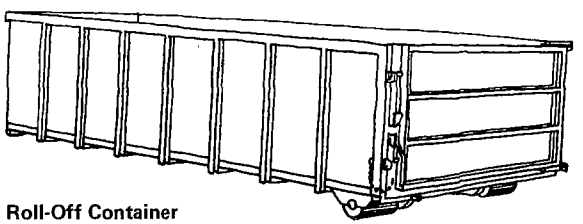
Mobile Containers

Mobile containers include roll-off containers, refuse transfer trailers, lugger boxes, 55-gallon drums, and other open-top containers. Of these, the most efficient are roll-off containers and transfer trailers, which have greater capacity than a single-collection vehicle. Mobile containers may be loaded manually or with a front-end loader.

They are commercially available; commonly used for refuse operations, they may often be acquired from municipalities and private sanitation companies as spare containers.

ROLL-OFF CONTAINERS

Roll-off containers are available in a variety of sizes and may be used to store any material. Compartmentalized roll-off containers may be loaded manually or mechanically. Some communities have built a ramp above the roll-off box from which collection vehicles may dump materials. Once full, the containers are pulled onto the roll-off truck by a winch or hydraulic cylinder and transported to the market.



Roll-Off Container

Advantages

- Come in a variety of sizes
- Require little maintenance
- Eliminate second handling
- Are available commercially
- Can be leased

Disadvantage

- Don't protect materials from weather

Design Issues

Capacity
Loading procedure
Watertightness

Communities Using the Equipment

Modesto, California
Newton, Massachusetts
Lexington, Massachusetts
Wellesley, Massachusetts
East Hartford, Connecticut
Newington, Connecticut
Enfield, Connecticut
East Lyme, Connecticut
Davis, California
Temple Terrace, Florida

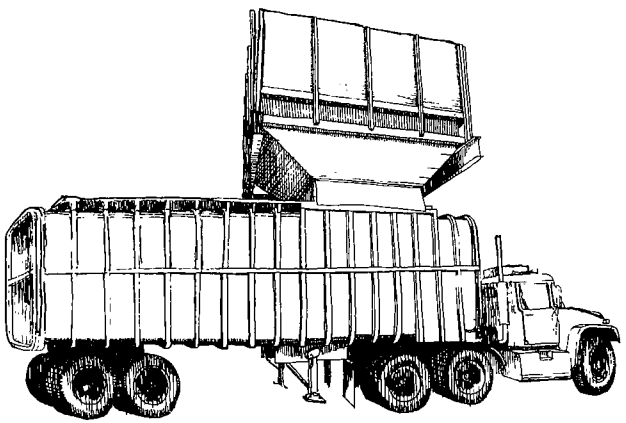
General Specifications

Capacity:	10 - 50 cu yds
Height:	3' - 8'
Width:	5' - 8'
Length:	5' - 22'
Cost:	$3,000 - 6,000
Materials:	welded steel

REFUSE TRANSFER TRAILERS

Transfer trailers are used to store and haul a single material, most commonly newspaper or mixed wastepaper, to market. The material may be loaded into the vehicle either manually or by a hopper positioned above the transfer trailer. Either the hopper or the trailer contains a hydraulic ram that compacts the materials. When the trailer is full, any trailer tractor can take it to market. There the compactor ram unloads the trailer by pushing materials out of the body.

Source-separation programs can make efficient use of trailers. Trailers serve as both containers and vehicles; they store and haul materials. Trailers may be used to transport refuse at times when they are not used for recyclables.



Transfer Station

Advantages

- Have high capacity
- Load and unload easily
- Are available commercially
- Are easily maintained
- Are durable
- Are hauled easily
- May be used for several purposes

Disadvantage

- Cost is higher than that of roll-off containers

Communities Using the Equipment

Mamaroneck, New York
Larchmont-Mamaroneck, New York

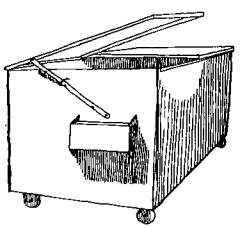
General Specifications

Capacity: 50 - 80 cu yds

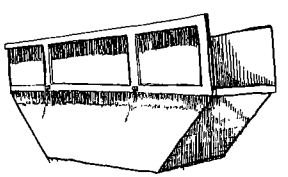
OTHER MOBILE CONTAINERS

Containers such as lugger boxes, 55-gallon drums, and other open-top containers may be used to store materials temporarily. These units may be filled either manually or mechanically.

Containers should be selected on the basis of their availability, capacity, and cost. The availability of machinery to unload the containers should also be considered. Although units are available commercially, a source separation program can make its own with existing labor and materials. Reinforced steel containers are more durable than wooden ones.



Open-Top Container



Lugger Box

Advantages

- Have adequate capacity
- Load and unload easily
- Are available commercially
- Are durable
- Cost is low
- Require little maintenance
- Can be used for refuse

Disadvantage

- Hold only one material

Design Issues

Loading and unloading procedures
Weather protection

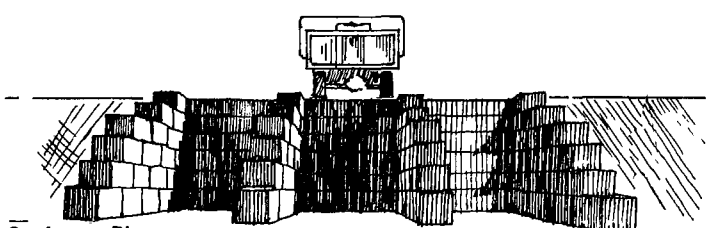
Communities Using the Equipment

Larchmont-Mamaroneck, New York
Mamaroneck, New York
Carmel, New York
Newington, Connecticut
Grand Rapids, Michigan
Wellesley, Massachusetts
Madison, Wisconsin

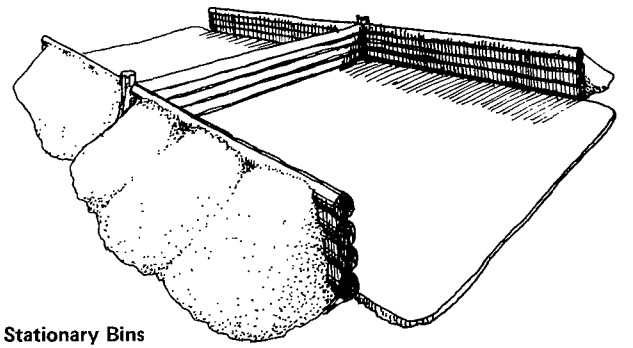
Stationary Bins

Containers such as wooden or steel boxes or cement bins may store one or more materials at a central facility. The containers may be filled either manually or mechanically and are emptied by a front-end loader that transfers the materials to a hauling vehicle.

Although manufactured containers may be used, most programs build their own stationary containers with existing labor and materials. Programs that build their own containers must be aware of existing laws that specify safety requirements for refuse containers. Stationary containers used at recycling centers may serve the dual purpose of receiving and storing materials.



Stationary Bins



Stationary Bins

Advantages

- Serve several purposes
- Have large capacity
- Have low cost
- Require little maintenance

Disadvantages

- Hauling requires additional handling of materials
- Are not watertight

Design Issues

Capacity
Strength
Durability
Loading and unloading procedures
Construction materials

Communities Using the Equipment

East Hartford, Connecticut
West Orange, New Jersey
Wellesley, Massachusetts

Many programs increase the market value of their source-separated materials by processing them to upgrade their purity and size. But by processing materials, these programs incur additional labor and equipment costs. Before deciding to process, program officials should be certain that the increase in revenues they will gain will offset the additional costs.

Paper can be upgraded at a lower cost than glass or metals because markets do not require that it be as pure as other materials and because it is shredded and baled easily. It also can be recovered in higher volumes. The market price of paper varies, but baled paper is usually worth much more than unbaled paper. Baled paper can easily be stored for long periods or shipped to distant markets to take advantage of higher prices. Newspaper markets have varying standards for quality of separated paper. Many have very high standards, requiring that newspaper be free of magazines and corrugated paper. Newspaper which is free of other materials generally receives a higher price.

Systems to separate ferrous from nonferrous cans are slightly more complex than systems to process paper. These systems separate cans magnetically and then flatten or shred them for shipment. Steel cans make up a smaller portion of the total recyclables in the waste stream than paper or glass, and their market price is lower than that of glass (see Figure 5). Even so, processing significantly improves the value of metal cans. Mixed cans have no industrial market; magnetically separated cans are worth $20 to $40 a ton. Aluminum cans bring the highest market price of any recyclable at $460 a ton, and are lower in quantity than other recyclables, but provide the highest profit margin per ton after shredding.

Glass systems are considerably more complex than paper and can systems. They separate glass by color and free it of ceramic contaminants. Residents separate colored glass at the curb or recycling center. At the processing facility, glass is further separated by color and contaminants are removed by hand. (No mechanical systems to remove ceramics or to separate glass by color are available commercially. Although mechanical optical sorting systems are being tested, they are extremely expensive.) After glass has been cleaned, it is crushed and screened to remove metal caps and rings and labels. Although the labor and equipment needed to process glass are more costly than those needed for paper or cans, they often generate greater revenues. Glass can be recovered in large quantities and brings a market price of $10 to $30 a ton.

Figure 5

Volume and Market Price of Unprocessed and Processed Recyclables*

Product	Industrial Market Price (FOB) of Unprocessed Recyclables ($ per ton)	Industrial Market Price (FOB) of Processed Recyclables ($ per ton)
Baled Newspaper	0 - 25	20 - 60 fluctuates
Glass Cullet	0 - 15	35 - 60 steady
Ferrous Metal	0 - 10	10 - 50 fluctuates
Aluminum Metal	400	500 - 700

* Marblehead, Massachusetts multimaterial source separation program, 1978.

SOURCE: Resource Planning Associates, Inc.

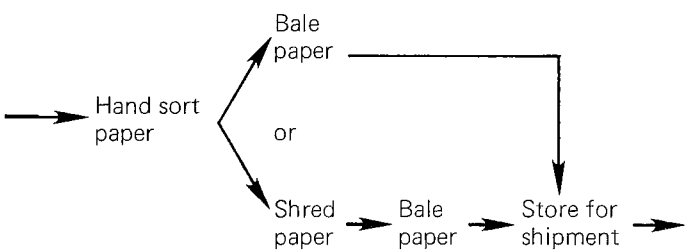
PROCESSING SYSTEMS

A processing facility can have several systems, or lines, including ones to process:

- Paper
- Mixed glass
- Mixed cans
- Mixed glass and cans.

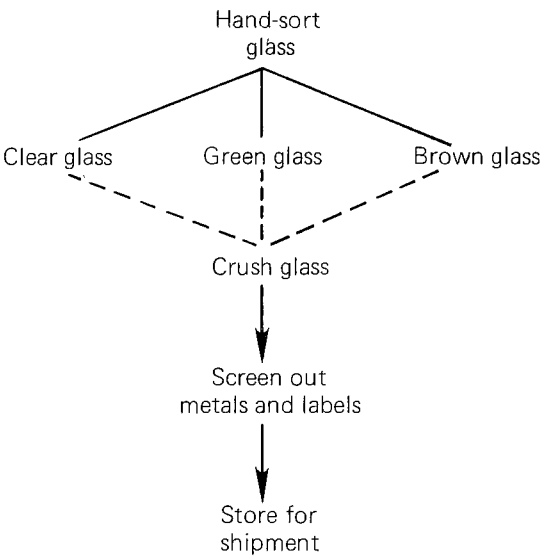
Paper Process Line

Newspapers are separated by hand from lower-grade materials such as magazines and nonpaper products and conveyed by belt or pneumatic tube to a shredder. Next the paper is baled and moved by a hand truck or forklift to storage. Alternatively, paper can be baled without shredding. Corrugated cardboard can be processed in the same manner as newspaper; however, it usually is not necessary to shred corrugated paper.



Mixed Glass Process Line

Glass is sorted by hand on a table or conveyor belt to separate colors and to remove contaminants. Each color is run through a crushing device that breaks the glass bottles into small pieces (cullet). The crushed glass is then put through a screen to remove metal caps, rings, and labels. The finished cullet is loaded directly into a hauling container or stored for later shipment.

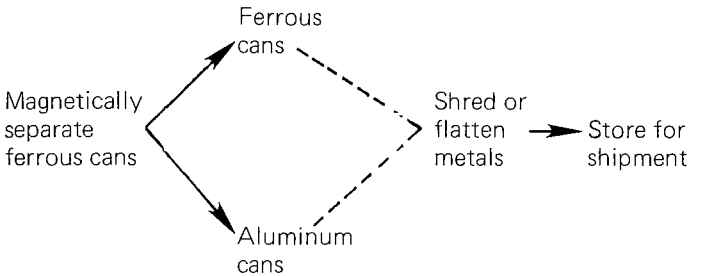


Mixed Cans Process Line

Ferrous cans are separated magnetically from aluminum cans and other objects (foil, pie tins, etc.). Both the ferrous cans and aluminum materials are shredded or flattened to increase their density for shipment. Industrial markets generally require aluminum to be shredded and ferrous cans to be flattened. Aluminum cans must also be shredded to release trapped moisture prior to resmelting.

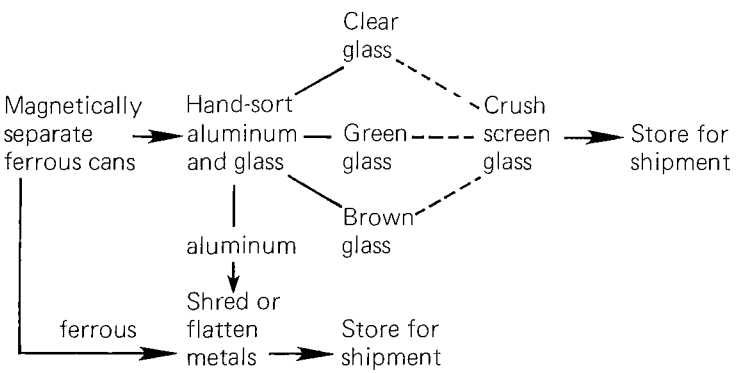
Bimetal cans, ferrous cans with aluminum tops, flow through the ferrous can line. In most areas of the country, the concentration of these cans in the waste stream is low. As the amounts of these cans increase, however, the contamination of the ferrous product

by bimetal cans may become a problem. Presently equipment to cut aluminum tops off ferrous cans is being tested; bimetal cans are not marketable as a separate product.



Mixed Glass and Cans Process Line

This line essentially combines the two previous process lines and requires no special equipment. As it separates cans from glass, this line makes it easier for residents to participate in a recycling program.



Ferrous cans are separated magnetically from a mixture of glass and cans and then shredded or flattened and stored for shipment. The mixture of glass and nonferrous cans is then sorted manually from a conveyor into streams of aluminum and clear, green, and brown glass. Aluminum is processed in the same manner as ferrous cans. Glass, sorted by color, is crushed, then screened and stored for shipment.

SELECTING PROCESSING EQUIPMENT

In designing a processing system, a community should consider the volume of materials it will process and the quality of materials its markets require. The stricter the market requirements, the more complex the equipment the processing center will need; the larger its volume of materials, the more advanced the equipment the center can afford. Figure 6 shows processing equipment typically used in various process lines.

The largest processing systems in the country (Figure 7) use equipment such as pit bales for paper, large crushers for glass, and expensive conveyance systems to purify source-separated materials. Their capital costs range from $50,000 to $100,000. Smaller processing systems, however, have made or adapted equipment. Several community processing programs have used buildings, trucks, and other equipment donated by their municipalities or by community service organizations.

Processing systems are new; even specially designed equipment needs to be refined to increase output and to improve working conditions and safety. In planning and designing a processing facility, officials should follow occupational health and safety standards and should consult a registered professional engineer or safety consultant. Common flaws with present systems are insufficient lighting, high noise levels, dust, and unsafe control mechanisms. All of these can be easily corrected.

Figure 6

Processing Equipment by Process Line

Equipment	Process Line Paper	Metals	Glass	Glass and Metals
Front-end loader	●	●	●	●
Forklift	●	○	○	○
Hand truck	●	○	○	○
Conveyor	○	○	●	●
Pneumatic systems	○	○		
Baler	●	○		○
Shredder	○	●		●
Glass crusher			●	●
Can flattener		●		●
Vibrating screen			●	●
Trommelscreen			●	●
Storage bins		●	●	●
Scale	●	●	●	●

● Commonly used ○ Sometimes used

SOURCE: Resource Planning Associates, Inc.

Figure 7

Processing Systems and Their Characteristics

Location/ Operator	Number of Employees	Products	Throughput (tons/month)	Equipment	Capacity/ Hour	Capital Cost ($)
El Cerrito, California/ Municipality	7	Shredded aluminum	49.0	Can shredder	1,000	13,000
				Magnetic separator		2,500
				Conveyor		2,500
				Forklift		8,000
				Scale		2,000
				Building		4,500
Modesto, California/ Ecology Action Institute	5	Baled newspaper	140.0	Baler	4,000	6,000
		Shredded aluminum	25.0	Can shredder	700	2,300
				Magnetic separator	3,000	1,800 (plus $85 wiring)
				Forklift		14,000 (used)
				Scale		4,000
				3-Large storage containers		2,000 (each)
				20-Rotatable yard bins		170 (each)
Santa Rosa, California/ Redwood Empire Disposal	2	Baled newspaper	115.0	Pit baler		40,000
		Baled corrugated	600.0	Forklift		9,000
				Loading ramp		5,000
				20 cu yd storage		2,000
				30 cu yd storage		3,000
Boulder, Colorado/ Eco-Cycle, Inc.	3	Baled newspaper	125.0	Pit baler	600	3,500 (plus $2,000 installation)
				Forklift		
				Trailer		
		Baled corrugated	35.0	Ramp		
				Loading dock		
Wellesley, Massachusetts/ Municipality	1	Baled newspaper	50.0	Baler	4,000	1,300
		Baled corrugated	10.0	Scale		5,000 (plus $2,000 installation)
		Baled magazines	17.0	Loading areas		5,000
				Roll-off truck		56,000
				30 cu yd roll-off box		3,000
				40 cu yd roll-off box		4,000
				50 cu yd roll-off box		5,000

Figure 7 (continued)

Processing Systems and Their Characteristics

Location/ Operator	Number of Employees	Products	Throughput (tons/month)	Equipment	Capacity/ Hour	Capital Cost ($)
Grand Rapids, Michigan/ Recycling Unlimited, Inc.	12	Flattened ferrous metals	7.5	Can flattener		NA
		Flattened aluminum metals	2.0	Can conveyor		NA
				Glass crusher		NA
		Crushed glass	65.0	Glass conveyor		5,000
				Facility		NA
				Gravel truck		NA
Carmel, New York/ Municipality	5	Baled newspaper	64.0	Baler (used)		1,200
		Baled corrugated		Front-end loader		1,500
		Baled specialty paper		Demolition trailer		4,000
Seattle, Washington/ Seattle Recycling, Inc.	2	Crushed glass cullet	20.0	Glass crusher	4,000	1,040 (plus $500 installation)
		Flattened ferrous cans	4.0	Can flattener	4,000	4,500 (plus $240 delivery, $320 installation)
		Flattened aluminum cans	1.0			
				Magnetic separator	500	1,775 (plus $120 delivery, $200 wiring, $120 modification)
				Can conveyor		200 (plus $60 modification)
				Glass conveyor		250 (plus $500 installation, $250 modification)
				Forklift		5,200
				Pallet jack		300
				Site development		4,200
				Scale		1,650 (plus $40 installation)
				5-Storage bins		450 (each)
				Storage cart		40

SOURCE: Resource Planning Associates, Inc.

PROCESSING EQUIPMENT CATALOGUE

The following catalogue is designed to help officials select processing equipment and design effective processing systems.

It illustrates pieces of equipment currently being used and describes their application, design specifications, advantages, and disadvantages. It also discusses design and selection issues and lists communities using the equipment. A list of manufacturers of processing equipment is contained in Appendix C.

The catalogue is organized in order of the major steps in all process lines: receiving, conveying, and processing. Equipment to store processed materials is included in Chapter 1.

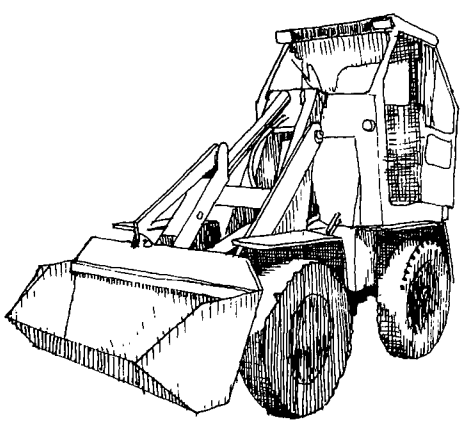
RECEIVING EQUIPMENT

Front-End Loader

A front-end loader is a small powered vehicle with a bucket on the front end which is used to scoop up materials. Front-end loaders and forklifts are used to move materials in bulk within a processing facility. Front-end loaders are better suited than forklifts to lifting loose materials off the ground. However, concrete or blacktop pavement or flooring is needed to keep materials lifted by front-end loaders free from dust.

Small front-end loaders are the most useful for processing operations because they are easily maneuvered. Smaller models can be powered by propane. This minimizes exhaust fumes, which can be a problem indoors.

Several programs have shared the use of municipally owned front-end loaders with the other municipal departments.



Front-End Loader

Advantages

- A variety of models is commercially available
- Are suitable for use with any recyclable material
- Can be shared with other organizations for other uses

Disadvantages

- Initial cost is high - $15,000 to $25,000
- Are not designed specifically for recycling programs

Design Issues

Appropriate size
Driver visibility
Ease of operation and maintenance

Communities Using the Equipment

East Hartford, Connecticut
Newton, Massachusetts
Temple Terrace, Florida
Santa Rosa, California

General Specifications

Capacity of bucket:	1/4 to 3/4 cu yd
Engine:	diesel, gasoline, propane

Forklift Truck

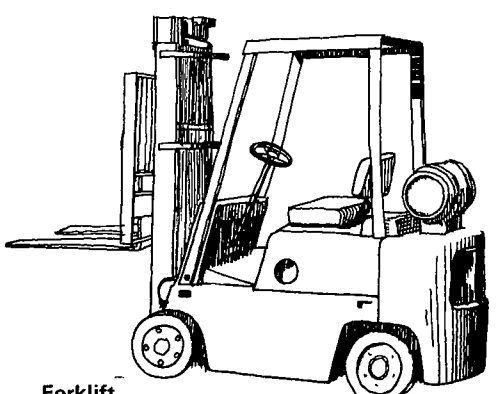
Many processing facilities use standard forklift trucks to move containers onto and off of vehicles and around the facility. There are many varieties of forklift trucks. Some have forks that fit under newspaper bales or pallets or into containers. Others have grippers that fit around barrels or drums, rotating forks that turn containers over from dumping, or side-shifting heads that move containers sideways.

Forklifts are most valuable to processing facilities that spend much of each day moving containers. Because the cost of a forklift can be high (up to $15,000), a program should determine the amount of use the equipment will have and the weight of the materials and containers to be moved prior to buying the equipment. A municipal processing program should consider sharing the forklift with other community programs.

The Modesto, California, recycling program uses a two-ton capacity forklift with a rotating head fork. The forklift removes bins from collection trucks and dumps materials directly into the processing equipment (e.g., cans into the can shredder).

There are many forklift models available, new and used. Propane-powered models create fewer exhaust fumes and may be more suitable for indoor use than gasoline-powered models. A forklift with a lifting capacity of one ton should be sufficient for most processing facilities.

Front-end loaders cannot transport containers; they transport materials that have been dumped out of containers. If a front-end loader is available to a processing program, however, officials should consider using it to save the cost of purchasing a forklift.



Forklift

If the full containers are not larger than a cubic yard in volume and do not weigh more than three tons, a program might use pallet trucks for moving containers around the facility.

Advantages

- Are available commercially
- Are able to lift considerable weight
- Have many uses
- Can raise and lower containers
- With rotating head forks can dump materials

Disadvantage

- Are more expensive than pallet trucks

Communities Using the Equipment

Santa Rosa, California
Modesto, California
Seattle, Washington
El Cerrito, California
Grand Rapids, Michigan

General Specifications

Capacity:	up to 5 tons or higher with extended forks
Height with extended forks:	10′ 12′
Width:	3′ - 4′
Length:	7′ - 9′
Cost:	$3,000 - $15,000

Pallet Trucks

Standard warehouse pallet trucks can move recyclables on pallets (e.g., baled newspaper) or in bins with lift pockets. The trucks also can load pallets or bins into vehicles from loading docks. Pallet trucks can maneuver heavy quantities of recyclables safely

and efficiently. But they cannot dump materials from bins because they are unable to lift bins to the necessary height.

Most pallet trucks use a manual hydraulic system to lift bins or pallets off the floor. To aid the trucks, the processing facility should have a level and smooth floor. The length of each fork should be at least equal to that of the bins. Otherwise, bins might tilt or roll off the pallet truck. The Seattle, Washington, multi-material program currently uses a pallet truck to unload collection bins and to move them into the processing facility.

Advantages

- Are readily available
- Are safe to use
- Can be maneuvered in tight spaces
- Are easy to operate
- Are durable
- Cost is low

Disadvantages

- Require smooth flooring
- Are compatible only with bins or pallets
- Are unable to lift bins to dumping height

Community Using the Equipment

Seattle, Washington

General Specifications

Capacity:	up to 3 tons
Height:	2' - 3'
Width:	20" - 34"
Length:	30" - 70"
Cost:	$425 to $750
Construction materials:	welded steel with metal or polyurethane wheels

CONVEYING EQUIPMENT

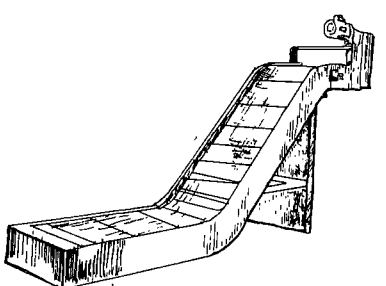
Conveyor Belts

Conveyor belts serve a variety of purposes in processing facilities. Grand Rapids, Michigan, uses conveyor belts to sort recyclables manually before they are further processed. Many facilities use conveyor belts to move recyclables from in-feed hoppers to processing equipment such as magnetic separators, can flatteners, and glass crushers.

Conveyor belts may also move processed recyclables to storage bins and hauling vehicles. After bottles are crushed at the processing facility in Seattle, Washington, a short conveyor belt passes the cullet through the facility wall to a roll-off container located in the truck yard.

New and used conveyor belts are available commercially at low costs. They also may be manufactured for specific uses or adapted to meet particular needs.

An agricultural grain conveyor, for example, could be adapted to move bottles to crushing and screening equipment. In selecting conveyor systems, special attention should be given to the belt material and to the motor size. Conveyance of metals often requires a PVC belt and a motor with 0.5 horsepower.



Conveyor Belt

Advantages

- Cost is low
- Are available used
- Provide mobility
- Easy to operate
- Are flexible

Disadvantages

- Require repair and maintenance
- Cannot move considerable weight at one time

Design Issues

Belt material
Motor size
Belt width and length

Communities Using the Equipment

Seattle, Washington
Grand Rapids, Michigan
Sessler, Inc., Norwalk, California
Recycling Enterprises, Oxford, Massachusetts

General Specifications

Capacity:	variable
Height:	3' - 5'
Width:	1' - 5'
Length:	variable
Cost:	$100 - $2,000 (Price varies according to material, length, and width.)
Power requirements:	110 - 220 volts

Conveyance of glass requires a heavier belt made from steel or rubber and a motor with 0.5 1.0 horsepower. If large volumes of cullet are to be handled, a belt that can withstand the abrasive and chemical actions of glass should be selected. The length and width of the belt should be selected to maximize system capacity and throughput. Extra belting and fasteners are a useful purchase; belts often tear or break and require on-site repair.

Pneumatic Tubes

Pneumatic tubes are used to convey flattened or shredded cans and shredded paper to storage and transport containers. The major advantage of using pneumatic tubes is that they eliminate manual handling of the processed materials.

Recycling programs have experienced some problems with using pneumatic tubes to transport cans. Because most tubes are constructed of steel, metal cans create a severe noise problem when blown through them. Sound retardation components are being developed to lessen this problem. Another problem is clogging; depending on the size of the pieces and the rate at which they are fed into the tube, cans may get stuck.

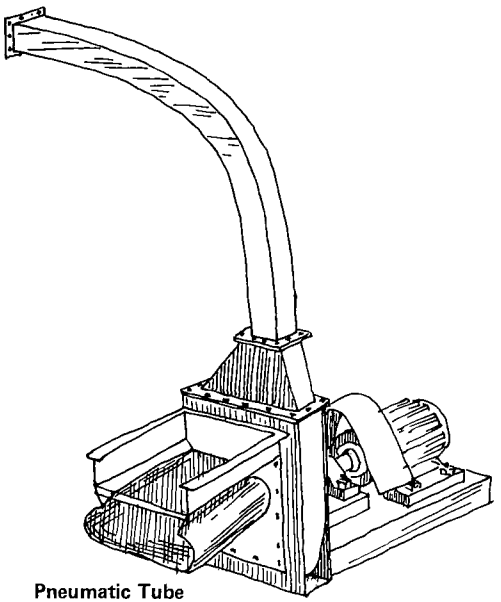
In Seattle, Washington, mixed cans are separated magnetically and steel cans are conveyed by belt to a can flattener. The flattened cans drop into a receiving pit of a pneumatic tube; the processed cans are blown into a self-dumping hopper. The tube is adjustable in length and height.

Advantages

- Are durable
- Are available commercially
- Are easy to operate and maintain

Disadvantages

- May jam flattened cans
- Metal cans cause noise



Pneumatic Tube

Communities Using the Equipment

Seattle, Washington
El Cerrito, California
Modesto, California

General Specifications

Height:	3' 7'
Length:	7' - 20'
Width:	2' - 3'
Weight:	1,200 - 1,800 lbs
Power requirements:	4 6 h.p. motor, 220 or 240 volts, 3 phase
Cost:	$500 - $2,000

PROCESSING EQUIPMENT

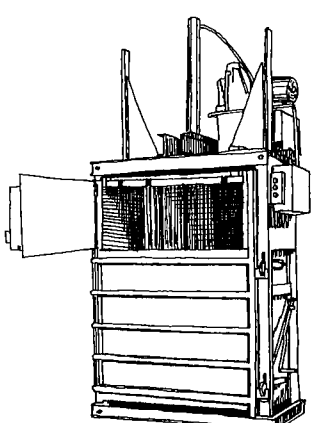
Balers

There are two basic systems that bale paper and aluminum:

- Downstroke balers. Magazines and corrugated cartons collected by the recycling effort in El Cerrito, California, are baled in a vertical downstroke chain-drive baler. Newspapers can also be baled with this equipment.
- Upstroke (pit) balers. Newsprint collected in Santa Rosa, California, is unloaded from collection bins and scooped into the pit of an upstroke hydraulic baler. The half-ton bales are loaded into transport trailers for shipment to a mill.

Paper balers are manufactured with many options. Balers are either hydraulically driven or electrically powered. Some models eject bales while others require manual bale removal.

Some balers have pressure systems that can adjust to varying bale densities to accommodate the grade of paper being processed.



Baler

Advantages

- Many types are available new or used
- Require little maintenance
- Have high resale value
- Reduce volume 3:1 for whole paper and 10-15:1 for shredded paper when blown into baler

Disadvantage

- Have high initial cost

Communities Using the Equipment

Santa Rosa, California
Modesto, California
El Cerrito, California
Boulder, Colorado
Wellesley, Massachusetts
Carmel, New York

General Specifications

Height:	4' 10'
Length:	4' - 20'
Width:	2½' - 4'
Weight:	1 ton - 15 tons
Power requirements:	220 - 440

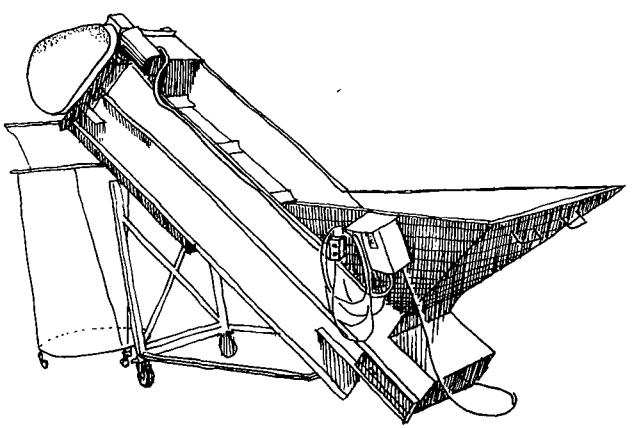
Capacity of downstroke baler: 500-650 pound bales
Cost of downstroke baler: $3,000 (used) - $6,000 (new)
Capacity of upstroke (pit) baler: 600 - 1,000 pound bales
Capacity of horizontal baler: 600 - 1,500 pound bales
Cost of horizontal baler: $20,000 - $60,000

In many cases, the paper buyer will determine the size of baler used. For instance, paper to be shipped long distances or to be exported may need to be baled at a greater density than paper to be sold to a local user.

Magnetic Separators

Commercially available magnetic separators can separate ferrous and bimetal cans from aluminum cans and glass easily. Two generic types of magnetic separators are available:

- The magnetic head pulley can separate ferrous metals from whole, flattened or shredded cans. When mixed materials are conveyed over a rotating magnetic pulley, nonferrous materials fall forward and ferrous materials fall below the pulley into a bin or another conveyor. The width of the head pulley and the width and incline of the conveyor belt determine the system's capacity.
- The magnetic belt system is used for shredded metals. A magnetic conveyor lifts ferrous metals off a conveyor belt. Of the two kinds of separators, the magnetic head pulley is the the simplest and most versatile. It can be adjusted to work effectively at many capacities and is easily operated and maintained. Most magnetic head pulleys are mounted on a frame with wheels and can be moved easily.



Magnetic Separator

Advantages

- Are operated and maintained easily
- Are faster and more reliable than hand separation

Disadvantages

- Have high initial cost
- Are unable to distinguish bimetal cans from ferrous cans

Design Issues

Width of pulley head
Durable belt material
Take-up bearings to adjust belt tension
Adjustable conveyor incline

Communities Using Magnetic Head Pulley Type

Modesto, California
Seattle, Washington
El Cerrito, California
Davis, California

General Specifications for Magnetic Head Pulley

Motor:	electric, ½ hp, 220 volts
Width of head pulley:	12" - 36"
Cost:	$2,000 - $3,000

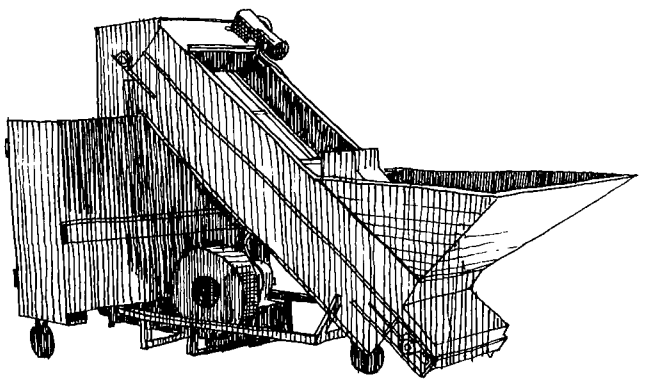
Can Flatteners

Can flatteners are used to reduce the volume of cans as required by market, storage, or transportation conditions. Aluminum and ferrous cans should be separated before flattening.

A can flattener presses cans between a drum and a wheel and pushes them into storage or transport containers or into a pneumatic tube that conveys them to containers. Flatteners reduce the volume of cans by 400 percent and can handle between 2,000 - 3,000 lbs of material per hour.

Cans should be checked inside for materials such as nuts and bolts, which could harm the flattener or shredder. Large metal items can jam the flattening mechanism; a spring flattening wheel may be needed to process containers larger than a ¾-gallon can. Miller Manufacturing has developed a special flattener which can process one-gallon cans.

Seattle, Washington uses a can flattener to decrease the cost of hauling cans to market to meet purchase specifications. Ferrous cans enter the feed hopper of the flattener and fall between a powered rubber wheel and a free spinning steel wheel. The flattened metals are conveyed pneumatically into self-dumping hoppers to be shipped to market.



Can Flattener

Advantages

- Have capacity of 2,000 and 3,000 lbs per hour
- Reduce volume by 400 percent
- Are available commercially

Disadvantages

- May be jammed
- Initial cost is high

Design Issues

Request weathertight electrical panels
Purchase additional belting
Include a volume reduction specification

Communities Using the Equipment

Seattle, Washington
Modesto, California
Fresno, California

General Specifications

Height:	6' - 7'
Length:	6' - 15'
Width:	4' - 5'
Weight:	1,000 - 2,200 lbs
Power requirements:	220 - 440 3-phase
Cost:	$3,000 - $5,000

Can Shredders

Aluminum and ferrous cans may be shredded mechanically to reduce their volume and to increase their marketability. Aluminum cans should be shredded to release trapped moisture before resmelting. Shredded materials are easier to handle, require less storage space, and can be transported in greater volumes to market.

Aluminum is the more common metal to be shredded. Ferrous cans generally have to be flattened before shredding, whereas aluminum cans do not. The same can shredder can be used for both ferrous and aluminum cans; however, the equipment must be opened and the grinding screens changed each time the material is switched, as different shred sizes are required for each material.

Cans are fed into the shredder's hopper; from there they fall between a rotating shredder plate and a firm exterior plate. The kind of shredder plate varies with the kind of metal being processed. After the metal has been shredded, it is blown or dropped into a storage or transport container.

Advantages

- Reduce volume of recyclables
- Are commercially available
- Can shred high volumes of cans
- *Increase value of cans*

Disadvantages

- Create noise and dust problems
- Have high initial cost

Communities Using the Equipment

El Cerrito, California
Modesto, California

General Specifications

Height:	5' 7'
Width:	4' - 6'
Length:	8' - 15'
Weight:	one-two tons
Power requirements:	220 - 440 3-phase
Cost:	$8,000 - $20,000
Throughput per hour:	500, 1,000, 2,000, 3,000, 4,000 lbs

Although can shredders are generally manufactured for use by high-volume commercial recyclers, smaller units are beginning to be developed to meet the needs of community programs. Modesto, California, uses a can shredder that processes 700 lbs of aluminum cans per hour. The shredder reduces the volume of the cans by a ratio of eight to one.

Glass Crushers

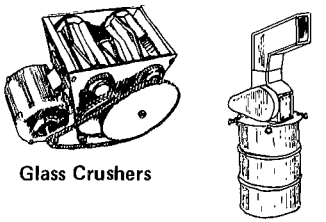
Crushing increases the density of glass. Crushed glass has a volume six times less than that of uncrushed glass, and is more easily shipped. The most common glass crusher system is the hammermill. Its rotating steel arms smash glass bottles at a high speed into crushed glass particles, called cullet. Vibrating or trommel screens made of wire mesh then separate labels and metal caps from the glass.

Glass is highly abrasive and tends to wear metal components quickly. Glass dust can be a problem unless strictly controlled; it wears down bearings and may be a hazard to personnel.

A wide variety of crushers is available. A small portable crusher can be mounted on top of a 55-gallon steel drum. The crusher motor is about ½ horsepower and can crush 400 lbs of glass per hour. The portable crusher works well on most glass bottles except champagne bottles.

Large hammermill systems can crush over 8 tons per hour. These machines have powerful 10-15 horsepower electric motors and breaker arms made of high-quality hard-faced steel. Although these systems are more durable than portable systems, they are expensive and are economical only if they process high volumes of glass. Hammermill crushers operate at high speeds and present potential safety hazards.

Market requirements for cullet particle size vary from 2" pieces to sand-like particles. Some crushers can be adjusted to produce a range of particle sizes; others produce only one size.



Glass Crushers

Advantages

- Reduce volume of glass 6 to 1
- Remove labels, caps, and rings mechanically
- Increase market value of glass
- Are available commercially

Disadvantages

- Cause noise and dust problems
- Require much maintenance
- Have high initial cost

Communities Using the Equipment

Seattle, Washington
Grand Rapids, Michigan
Norwalk, California (Sessler, Inc.)
Oxford, Massachusetts (Recycling Enterprises, Inc.)
Montclair, New Jersey

General Specifications

Power requirements:	110, 220, or 400 volts
Cost of portable crusher:	$300 - $600
Cost of hammermill crusher:	$1,000 - $21,000

Scales

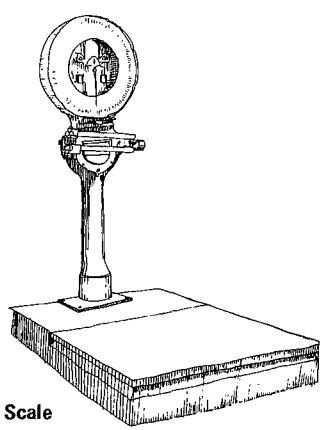
A recycling program or recycling center can determine its effectiveness and efficiency by weighing the materials it collects or processes. Many programs also use scales to verify the weights of recyclables that are reported by haulers and markets.

New and used scales are available commercially in a wide variety of sizes. A basic portable scale is often used to weigh individual containers of recyclables averaging 1,000 pounds. This scale is particularly useful to weigh recyclables being purchased from the public; recyclables can easily be lifted onto the scale by hand or with a forklift.

Truck or "platform" scales have larger capacities than portable scales and are used to weigh refuse in collection vehicles at municipal transfer stations or landfills. These scales can also be used to weigh recyclables delivered by citizens.

Staff of the El Cerrito, California, program unload collection bins at their processing facility and weigh the bins on a platform scale.

The calibration equipment and the springs under scale platforms can be easily damaged, especially if a forklift hits the scale or drops heavy bins onto the platform. The cost of scale maintenance and repair may be very high. In selecting scales, officials can minimize equipment repair costs by paying special attention to capacity limitations, construction materials, and platform size.



Scale

Advantages

- Provide exact measure of program impact and efficiency
- Are available commercially
- Have high resale value
- Are flexible

Disadvantages

- Are easily damaged
- Have high maintenance and repair costs
- Capacity

Design Issues

Capacity
Construction materials
Platform size
Calibration gradients
Maintenance and repair

Communities Using the Equipment

Modesto, California
Seattle, Washington
El Cerrito, California
Wellesley, Massachusetts
Larchmont-Mamaroneck, New York
Recycling Enterprises, Oxford, Massachusetts
Sessler, Inc., Norwalk, California

General Specifications for Truck Scale

Length:	20' - 60'
Width:	10' - 14'
Capacity:	1 150 tons
Construction materials:	steel or wood
Cost of small platform scales:	$500
Cost of large platform scales:	up to $10,000

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APPENDIX B: SAMPLE NEWSPAPER SUPPLY AGREEMENT

This agreement, made this _____ day of January, 1980, between the City of Anywhere, U.S.A. (seller), and Paper Company (buyer).

The Parties Mutually Agree As Follows:

Section 1:
Purchase and Sale.
Buyer shall purchase from Seller and Seller shall sell exclusively to Buyer all salvageable newspaper meeting the specifications set forth in Section 3 hereof that Seller or any other entity acting on the behalf of Seller collects in the City.

Section 2:
Term.
This Agreement shall extend from the first day of the month following the date of this Agreement until _____.

Section 3:
Specifications.
All salvageable newspaper delivered by Seller to Buyer's plant shall be collected and handled separately from regularly collected City solid waste, and shall be packed loose as received. No other papers shall be included and moisture content shall not be more than eight (8%) percent. Buyer shall have no obligations to pay for any newspaper delivered to Buyer's plant which does not meet these specifications.

Section 4:
Shipments.
All shipments shall be made by Seller Free on Board (F.O.B.) at the location(s) designated by the Seller on truck-trailers provided by the Buyer. The Buyer agrees to provide empty containers or truck-trailers at the Seller's designated location(s) within forty-eight (48) hours, upon notification of the City.

Section 5:
Purchase Price.
Buyer shall pay Seller, F.O.B., a net price of ten ($10) dollars below the Chicago Number 1 News market price for newspaper as indicated in the second monthly issue of the "Official Board Markets." In no event shall the net price to the Seller be less than twenty ($20) dollars per ton.

Section 6:
Terms of Payment.
Buyer shall make settlements with and payments to Seller on a monthly basis.

APPENDIX C: SAMPLE INVITATION FOR BIDS FORM FOR SELF—DUMPING TRAILERS

Section 1:
Proposals
Proposals must be enclosed in a sealed envelope addressed to the Director of Finance, City Hall, Anywhere, U.S.A. Brochures indicating equipment proposed to be furnished shall be supplied by all bidders.

Section 2:
Occupational Safety and Health Act Requirements
All equipment to be supplied and installed must comply with the requirements of the Occupational Safety and Health Act.

Section 3:
Certified Check or Bond Bid to Accompany Proposal
Bidders are required to furnish with their proposal a bid, in the form of a certified check or legal tender, for five (5%) percent of the amount of the bid.

Section 4:
Delivery
Delivery shall be made Free on Board (F.O.B.) to the Town of Anywhere, U.S.A., complete and ready for use. Proposals must provide a guaranteed delivery date.

Section 5:
Guarantee
The Manufacturer warrants his products for one (1) year after the date of delivery.

Section 6:
Demonstration
Bidders may be asked to demonstrate their equipment as part of the bid evaluation.

Section 7:
Specifications

Trailer type	Self-dumping
Overall length	17'
Overall width	6'
Inside box length	114"
Inside box width	69"
Inside box height	36"
Total trailer height	59"
Axles	Single, 2-3 tons
Fenders	2-piece, welded type
Tires	8 - 14.5 heavy duty
Hitch	Dico Surgomatic with towing eye
Brakes	Hydraulically operated by hitch
ICC equipment	All ICC lights, reflectors, stop, tail, license
Spare tires and rims	With each trailer, heavy-duty type
12-volt battery	Adjustable wheel type with crank
Trailer tailgate	Removable double-acting tailgate of 10-gauge steel, reinforced, with top hinges and bottom locking hooks, tailgate trip handle designed for loading equipment as well as dumping load
Hoist	Hydraulic cylinder with 2.5" bore, 30" stroke, that raises bed 60" and has a rod diameter of 1-3/8"; lifting capacity of 5,000 lbs, with a 45° dump angle and 13° loading angle
Dumping operation	12-volt electric hydraulic pump tank combination, push-button-operated, with disconnects
Trailer subframe	5" structural channel ties, with 3" formed channel cross members

APPENDIX D: MANUFACTURERS AND SUPPLIERS

Refuse Containers

Accurate Industries, Inc.
Williamstown, New Jersey

American Environment Products
Sewell, New Jersey

Capital Industries, Inc.
Seattle, Washington

Cobey Waste Control
Gallion, Ohio

County Plastics Corp.
North Babylon, New York

Crown Rotational Molded Products, Inc.
Marked Tree, Arkansas

Dempster Dumpster Systems
Knoxville, Tennessee

DeWald, Northwest
Albany, Oregon

Duncan Equipment, Inc.
South Arlington, Texas

Galbreath, Inc.
Winamac, Indiana

Marathon Equipment Company
Vernon, Alabama

Paker Industries, Inc.
Silver Lake, Indiana

Peabody Solid Waste Management
Gallion, Ohio

P.P.I. Industries
Goddard, Kansas

Quality Steel Fabricators, Inc.
Hopkins, Michigan

Rayfo, Inc.
Rosemount, Minnesota

Rubbermaid Applied Products, Inc.
Statesville, North Carolina

SCI Equipment Corp.
Commack, New York

Scott and Hill Steel Corp.
Bartlesville, Oklahoma

Teem Enterprises, Inc.
Sioux Falls, South Dakota

The Heil Company
Chattanooga, Tennessee

Tri-Pak Systems Company
Louisville, Kentucky

Universal Handling Equipment Company Limited
Hamilton, Ontario, Canada

Zarn, Inc.
Reidsville, North Carolina

Trucks

Broyhill Manufacturing Company
Dakota City, Nebraska

Cobey Waste Control
Gallion, Ohio

Crane Carrier Company
Tulsa, Oklahoma

Drew-It Corporation
Hampton, New Hampshire

Duncan Equipment, Inc.
South Arlington, Texas

Ebeling Manufacturing Corporation
Plainview, Texas

Elgin-Leach Corporation
Chicago, Illinois

Ford Division - Ford Motor Company
Detroit, Michigan

GMC Truck
Pontiac, Michigan

Mercedes-Benz of North America
Montvale, New Jersey

International Harvester Truck Group
Chicago, Illinois

Iveco Trucks of North America, Inc.
Blue Bell, Pennsylvania

LoDal, Inc.
Kingsford, Michigan

Mack Trucks, Inc.
Allentown, Pennsylvania

Maxon Industries, Inc.
Commerce, California

Pak-Mor Manufacturing Company
San Antonio, Texas

Peabody Solid Wastes Management
Gallion, Ohio

Recycling and Conservation, Inc.
Kittery, Maine

Shu Pak
City of Commerce, California

The Heil Company
Milwaukee, Wisconsin

Truxmore Industries, Inc.
Richmond, Virginia

Wayne Engineering Corporation
Cedar Falls, Iowa

Balers

Accurate Industries
Williamstown, New Jersey

American Baler
Bellevue, Ohio

American Designed Products
Wayne, Pennsylvania

American Environmental Products Company
Baton Rouge, Louisiana

American Hoist & Derrick
St. Paul, Minnesota

Balemaster
East Chicago, Indiana

Consolidated Baling Machine
Brooklyn, New York

Economy-Lake Baler Division; Enterprise Company
Santa Ana, California

Hesston Corp.
Jacksonville, Florida

International Baler Corporation
Jacksonville, Florida

Logemann Brother Company
Milwaukee, Wisconsin

Marathon Equipment Company
Vernon, Alabama

McClain Industries
Utica, Michigan

National Baling Press Company, Inc.
Brooklyn, New York

National Compactor & Technology Systems, Inc.
Jacksonville, Florida

Newell Manufacturing Company
San Antonio, Texas

Peabody Solid Waste Management
Gallion, Ohio

Philadelphia Tramrail Company
Philadelphia, Pennsylvania

Union Environment Corp.
Old Forge, Pennsylvania

Collection Trailers

Gladco Compactors, Inc.
Taylor, Michigan

Midway Fishing Tool Company
Bakersville, California

Northern Truck Equipment Company
East Hartford, Connecticut

Swacars
Valdosta, Georgia

Other Collection Vehicles

Cushman/OMC-Lincoln
Lincoln, Nebraska

Transfer Trailers

American Carrier Equipment Company
Fresno, California

Anchorpac
Jackson, Michigan

Dempster Dumpster Systems
Knoxville, Tennessee

LoDal, Inc.
Kingsford, Michigan

McClain Industries
Sterling Heights, Michigan

Pak-Mor Manufacturing
San Antonio, Texas

Peabody
Gallion, Ohio

Steco Sales, Inc.
Pottsville, Pennsylvania

The Heil Company
Chattanooga, Tennessee

Tri-Pak Systems Company
Louisville, Kentudky

Universal Handling Equipment Company
Hamilton, Ontario, Canada

Processing Equipment (General)

CP Manufacturing Inc.
National City, California

Drew-It Corporation
Hampton, New Hampshire

J.A. Freeman and Sons
Portland, Oregon

Miller Manufacturing - United Farm Tools, Inc.
Turlock, California

Newell Manufacturing
San Antonio, Texas

Resource Recovery Systems, Inc.
Branford, Connecticut

Triple/S Dynamics, Inc.
Dallas, Texas

Conveyors

Allis Chalmers
Milwaukee, Wisconsin

Barber-Green
Aurora, Illinois

Beaumont Birch Company
Pennsauken, New Jersey

Better Machines, Inc.
Fantaintown, Indiana

Bonded Scale Machine Company
Columbus, Ohio

Fairfield Engineering Company
Marion, Ohio

FEECO International Corp.
Green Bay, Wisconsin

FMC Corporation
Colman, Pennsylvania

General Conveyor Company, Inc.
Long Island City, New York

General Kinematics Corporation
Berrington, Illinois

Gruendler Crusher & Pulverizer Company
St. Louis, Missouri

Hammermills
Cedar Rapids, Iowa

Heil Company
Milwaukee, Wisconsin

Jeffrey Manufacturing Division, Dresser Industries
Columbus, Ohio

Link Belt Company
Honer City, Pennsylvania

Mayfran, Inc.
Cleveland, Ohio

Montgomery Industries, Inc.
Jacksonville, Florida

Rexnord, Inc.
Milwaukee, Wisconsin

Rust Engineering, Inc.
Birmingham, Alabama

Stephens-Adamson
Aurora, Illinois

Triple/S Dynamics Systems, Inc.
Dallas, Texas

Williams Patent Crusher & Pulverizer Company
St. Louis, Missouri

Shredders

American Pulverizer
St. Louis, Missouri

Iowa Manufacturing Company
Cedar Rapids, Iowa

Miller Manufacturing
Turlock, California

Newell Manufacturing Company
San Antonio, Texas

Pennsylvania Crusher
Broomall, Pennsylvania

Saturn Shredders
Wilsonville, Oregon

Shred-Tech, Inc.
Cocoa, Florida

Williams Crusher and Pulverizer
St. Louis, Missouri

Scales

Cardinal Scale Manufacturing Company
Webb City, Missouri

Eldec Corporation
Lynwood, Washington

Fairbanks Weighing Division - Colt Industries
St. Johnsburg, Vermont

Howe Richardson Scale
Clifton, New Jersey

Streeter-Amet
Grayslake, Illinois

Toledo Scale
Worthington, Ohio

Magnetic Separators

American Pulverizer
St. Louis, Missouri

Dings Company
Milwaukee, Wisconsin

Eriez Magnetics
Erie, Pennsylvania

Martin Podren, Inc.
Lynn, Massachusetts

McNally Pittsburg Corporation
Pittsburg, Kansas

Roberts & Schaefer, Inc.
Rolling Meadows, Illinois

Shred-Tech, Inc.
Cocoa, Florida

Stearns Magnetics
Cudahy, Wisconsin

Wemco Division, Envirotech Corporation
Sacramento, California

Glass Crushers

American Pulverizer
St. Louis, Missouri

Central Steel Contractors
Kaukauna, Wisconsin

Cleveland Range Company
Cleveland, Ohio

Columbia Machine
Vancouver, Washington

Franklin Miller, Inc.
East Orange, New Jersey

Greundler Crusher
St. Louis, Missouri

Heil Company
Milwaukee, Wisconsin

Jacobsen Machine Works
Minneapolis, Minnesota

Jeffrey Manufacturing
Columbus, Ohio

Pennsylvania Crusher
Broomall, Pennsylvania

Qualheim, Inc.
Racine, Wisconsin

Rescor Industries
Mt. Vernon, New York

Snyder Machine
Saugas, Massachusetts

Syrall Manufacturing
Syracuse, New York

Williams Patent Crusher
St. Louis, Missouri

APPENDIX E: GLOSSARY

Baling:
Compressing materials, most commonly newspaper, into bales.

Buy-Back Programs:
Programs to purchase recyclable materials from the public.

Color Sorting of Glass:
Techniques for sorting recovered glass by color. Although glass is commonly sorted by hand, several other techniques are being tested. An optical sorting device compares light reflected from each piece of glass with light reflected from a standard background. High-intensity magnetic forces also can separate small pieces of glass.

Corrugated Paper:
Heavy paperboard, molded into parallel ridges and grooves.

Contaminant:
Foreign material that makes a primary material impure.

Cullet:
Small, uniform pieces of scrap glass.

Ferrous:
Containing iron.

Intermediate Processor:
A company that purchases source-separated materials from municipalities and private sanitation companies, processes the materials, and sells them to an industrial market, where the materials are used as a feedstock in manufacturing.

Materials Recovery:
Extracting recyclable materials from waste for sale.

Mixed Paper:
Waste paper of mixed type and quality.

Nonferrous:
Containing no iron. Aluminum, copper, and zinc are nonferrous metals.

Recycling:
Extracting product from the waste stream and reusing it to manufacture the same or a similar product.

Resource Conservation:
The conservation of raw materials. Materials are conserved by consuming less of them and by recovering them from waste to be reused.

Resource Recovery:
Extraction and use of materials from the waste stream. Uses include recycling, fuel for energy production, and feedstock in chemical processes.

Source Separation:
The setting aside of recyclable materials at their point of generation (home, place of business, etc.) by the generator.

Transfer Station:
A facility where waste materials are transferred from collection vehicles to larger transportation units. The larger units move the materials to disposal areas or, in the case of recyclable materials, to processing facilities.

Volume Reduction:
The reduction of partial size to decrease the amount of space a material occupies.