

Curbside Collection of Recyclable Materials:

Fifteen cases studies in the United States

by

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(ABSTRACT)

Fifteen curbside recycling programs in the United States, from communities representing a variety of economic, geographic, and political situations, were reviewed in this study. Case studies were analyzed and discussed with respect to four areas of interest to program planners: administration, operations, promotion and evaluation. No objective rating of the programs was attempted, but approaches were reviewed with respect to their ability to satisfy the goals of the programs. Comparisons of participation rates, waste diversion rates, and costs were used cautiously because of the inconsistencies in how the data were developed from program to program.

Administrative approaches found in the case studies included: (a) complete ownership of the collection and processing system by municipalities; (b) contracted service by private waste management firms; (c) contracted or subsidized service by non-profit organizations; and (d) combinations of municipal, private, and non-profit services.

Operational systems were examined with respect to the effectiveness of the service in stimulating participation, given the practical, political, and budgetary constraints. Variables of operation are closely related and include: (a) which materials are collected; (b) the degree of materials separation required; (c) the type of collection vehicle(s) used; (d)

collection frequency and coincidence with garbage collection; (e) the provision of in-home containers; and (f) the extent of post-collection materials processing.

Four categories of promotional techniques used in curbside recycling programs were discussed: (a) publicity and education; (b) personal contact; (c) economic incentives; and (d) ordinances mandating source-separation. The impacts of these techniques on participation in the case study programs were discussed.

Techniques for evaluating the efficacy of curbside recycling programs were also discussed. Participation rates, waste diversion rates, and cost were reviewed with respect to current usage and recommendations were made for increasing their usefulness as indicators of the success of programs or program elements.

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Chapter 1: Introduction

[Solid waste management is] a fundamental ecological issue. It illustrates, perhaps more clearly than any other environmental problem, that we must change many of our traditional attitudes and habits. It shows us very directly and concretely that we must work to adjust our institutions, both public and private, to the problems and opportunities posed by our traditional disregard for the pollution effects of disposal, and particularly for our misuse of natural resources [1].

From the waste disposal crisis of the 1980s, recycling has emerged as a strategy which many communities are pursuing as a way to divert municipal solid waste from landfilling and incineration. Curbside collection programs have been established, or existing programs subsidized, by several communities in response to the increase in disposal costs. These programs try to maximize the amount of recyclables recovered and diverted from landfilling by providing most residents the opportunity to place recyclables next to the curb for pickup, much like the collection service for regular trash.

This report does not attempt to develop a Procrustean "ideal program" for communities to follow to attain "success". Qualifications for a successful program are unique to a community and its own needs, skills, resources and values. Recently, waste disposal costs have reached critical levels in sections of the United States, yet some communities have been recycling for many years, motivated by strong citizen awareness of the need

to conserve natural resources. Some communities are insistent that recycling "pay its own way", others simply view it as the least-cost method of waste disposal. Frequently, communities find ways to incorporate a curbside recycling service with service to other community needs, such as employing the handicapped or motivating discouraged high school students to stay in school.

The programs reviewed in this report demonstrate some of the ways curbside recycling is being implemented in communities across the country. Some of the case study communities have been faced with immediate waste disposal problems; in other cases, recycling is being used to forestall potential problems. Leaders in recycling include not only municipal waste managers, but a variety of non-profit and for-profit companies which have entered the recycling business to achieve their own goals.

Objectives

Solid waste managers are in need of information about current practices concerning curbside recycling to assist them in developing programs for their communities. Study of currently-operating programs may help in examining the problems which arise in the course of planning a curbside recycling program. Limits to the use of analytical approaches are presented by the variability in program management and evaluation techniques between programs as well as changes in individual programs over time. As a result, statistical analysis of the progress of a program over time or correlations of program variables were not attempted. In spite of the limitations, there is much to be

gained by understanding the valuable experiences of the programs in the case studies.

Hence, the objectives of this research are to:

- discuss issues pertinent to the development and operation of curbside recycling programs as reflected in current literature;
- present case studies of curbside recycling programs which have been implemented in a variety of demographic, geographic and economic situations;
- examine current practices in program administration, operation, promotion, and evaluation used in the case studies and discuss their relevance to the development of other programs;
- recommend approaches to curbside recycling that appear to be most effective and suggest topics for further research.

Chapter 2: Background

The history of recycling

Recycling is not a new phenomenon. Yet, while the practice of reclaiming used materials for reuse is not unprecedented, the social context of its application in the late 1980s is vastly different from previous occasions in recent history when recycling of waste materials has been encouraged.

During World War II, when it was referred to as salvaging, it was done to "help the war effort." The motivation of patriotism worked quite well to encourage the reuse of materials. After the war, however, people resumed prior waste disposal habits, and began to generate waste at unprecedented rates. Melosi has estimated that, in the period from World War II to the present, the rate of waste generation has increased at a rate five times the population growth rate. In the early 1940s and early 1950s, incineration was the predominant method of waste disposal in the United States. In the late 1950s and

1960s, landfilling gained in preference because of air pollution concerns [2], but almost no effort was made to reuse waste materials.

In the 1970s, salvaging became known as "recycling." It was supported by environmental activists wanting to "save the environment," rather than the salvage industry, as in the 1940s [3]. Monetary gains from these small-scale recycling efforts were generally used to gain financial support for charitable causes. Recycling programs seldom had institutionalized public or professional support as a legitimate mechanism for waste management [4]; indeed, their small scale made little impact on the wastestream.

Recycling has reemerged in the 1980s, with new motivations-- to counter the rising cost of conventional waste disposal methods and respond to the economic need for material recovery. Landfills which were started in the 1960s are filling up, environmental impacts are becoming evident and communities are becoming resistant to accepting health risks. Costs of technological failures in the designs of landfills and incinerators (now known as "resource recovery facilities") are added to the costs of disposal. The new economics of waste disposal has launched a third wave of recycling [2]. Costs of landfilling have been driven up by unexpectedly high marginal costs,¹ brought on by: (a) increasingly stringent regulation, (b) decreased availability of suitable sites (partially due to the decreased tolerance of environmental risks by communities), and (c) the cost burden of technological failures (in both landfill and incinerator design). One of the most striking examples of the escalation of costs is in New Jersey, where landfill tipping fees increased from \$17 per ton in January 1987 to \$90 per ton in January 1988 [6].

¹ Tipping fees have traditionally ignored: (a) costs of replacing capacity -- that is, marginal cost of using landfill space; (b) value of the land if used for other purposes, in present and future terms, not just market conditions when the site was planned; and (c) costs of environmental impacts and mitigation measures [5].

Some of the programs that began during the 1970s survived by making the transition to new motivations and goals for recycling. Recycling must become an integral part of solid waste management if the programs of the 1980s are to be more than token efforts toward reform which disappear after a crisis has passed [7]. Solid waste managers are beginning to use recycling to help reduce the amount of waste going to conventional disposal sites. In addition to saving on disposal costs, recycling helps extend landfill life, which reduces siting problems and improves the efficiency of incineration projects by removing many non-combustibles from the wastestream [8].

"Source-separation" is the separation of recyclables from other waste before collection. Source-separation methods include curbside collection of recyclables and dropoff centers. Advantages of source separation include collection of cleaner recyclables (which bring a higher market price) and reduction of the amount of post-collection processing needed to make the materials usable again [9].

Capital and operational costs of curbside collection of recyclable materials are considerably more than for centralized dropoff facilities, but the waste diversion is also higher. While a depot system might divert 1 percent of the municipal wastestream, a curbside program can divert 5 to 50 percent (or more). As a result, curbside collection is being included more often in waste management plans as a way to divert waste from final disposal. When the avoidance of expensive disposal costs is taken into account, it becomes the least-cost waste disposal method in many areas of the country, even if market prices for materials are minimal. (Costs of disposal include not only monetary costs of collection and disposal but the social costs involved with siting additional landfill space [5].)

Issues in curbside recycling

It is not within the scope of this study to explore in depth how a community decides to do curbside recycling. Rather, this report seeks to examine options for the development of curbside recycling programs, with emphasis on the following topics:

- administration;
- operations;
- promotion; and
- evaluation.

When a program is developed, not only economic analysis but the social viability of a program plan must be considered. Values, attitudes, and social conditions within a community affect the success of a program and obstruct attempts by professionals to develop a set formula for designing curbside programs. This study encompasses programs set in a variety of situations in the hope that program planners may glean techniques that may be useful in a specific application [10].

Administration

Program administration options depend on the resources available in a community, especially economic. Economic influences include: (a) capital costs of installing the col-

lection and processing system (fixed cost), (b) costs of operation and maintenance (variable cost), and (c) potential net income from materials [11]. These factors will be affected by whether a suitable collection and processing infrastructure exists. Existing recycling efforts and garbage collection services may be able to provide the desired level of service economically. The municipality, private haulers, or non-profit groups may have a system in place or be able to develop one for a reasonable cost.

In a survey of state recycling directors, the National Solid Waste Management Association found that recyclables collection is quite frequently done by the agency which provides regular municipal garbage service, utilizing existing staff and equipment [12]. Municipal public works departments or private haulers under municipal or individual contract typically provide regular garbage collection. In addition to capital savings, advantages may be realized through the firm's prior experience in routing and collection in the community.

The selection of a program management method is an essential part of balancing the benefits of waste diversion, materials revenue, and indirect benefits against the cost of providing the service [3]. Indirect benefits to the community may include social benefits (e.g., employment of the handicapped), economic benefits (e.g., creation of materials processing businesses), and environmental (e.g., reduction of pollution from use of raw materials). Indirect benefits are difficult to quantify and are, therefore, often overlooked.

Curbside recycling can be provided completely by municipal public works departments, by private companies under contract to the municipality, or by non-profit companies under contract or supported by subsidies from the community. Programs may also include a combination of firms or agencies to perform different portions of the overall program.

Operations

Selection of materials to be collected

The economic viability of any source separation system depends on: (a) the availability of a consistent supply of marketable materials from the wastestream, (b) the presence of markets and end-uses for the materials, and (c) the cost of disposal methods [10]. Wastestream analysis is advisable, because wastestream composition varies among communities. Markets prices for materials vary from area to area according to supply and demand, but can also be negotiated on terms of quality, quantity, consistency of supply, and the form in which the material sold (e.g., baled newspaper brings a higher price than loose newspaper).

The materials selected for collection in the case studies demonstrate the balance between costs and benefits which must be considered. Generally speaking, the purer the material, the higher the market value and the smaller the fraction of the wastestream it represents. Pure newspaper, for example, makes up approximately 10 percent of the wastestream, while mixed paper (including newspaper) constitutes about 37 percent [13]. Newspaper has a stronger market and can be sold at a considerably higher price than mixed paper, but high disposal costs will begin to offset the price difference. In some instances, "markets" may even include outlets which do not pay for the material, but will accept it at no cost or at a cost lower than that of disposal. Also, the costs of additional processing to bring materials up to higher specifications may be high relative to the value of the material, making it more economical to sell lower-value materials (such as mixed glass or mixtures of glass and cans) than to meet the more stringent specifications for a higher-priced material.

Oregon's Recycling Opportunity Act defines a recyclable material to be one for which the cost of collection and recycling is less than collection and disposal costs. The act does not require recycling to be entirely self-supporting but views recycling as an alternate method of waste disposal. Each community can determine which materials are to be recycled in response to its own economic situation [14]. This definition of recycling is now more widely accepted as the purposes of recycling shift away from revenue production to disposal cost avoidance.

Care must be taken to ensure that source-separated materials reach viable markets. Unless they are reintroduced into manufacturing through marketing the only thing that is achieved is separate collection of waste, not recycling. Independent recyclers such as scrap metal dealers complain that programs that collect more material than the market demands make recycling unprofitable by driving prices down, putting small recyclers out of business [15].

Degree of materials separation required in the household

Separation of materials is typically necessary before shipping materials to market, unless an intermediate processor buys the comingled material for processing and marketing in a centralized facility. Materials separation can take place to varying degrees either before collection (by the household), during collection, or after collection at a processing facility. Whether to separate material during or after collection is a matter of labor cost differences, and the type of collection and processing facilities available. Requiring households to separate materials, however, may have an impact on participation. Other considerations for deciding on the degree of separation to be required include the design

of collection vehicles to be used, community awareness of disposal problems, and the extent to which post-collection processing is feasible.

Studies do not prove conclusively that increasing the separation requirements causes participation to decrease. Literature on curbside programs in Ontario, Canada suggest simple collection requirements are a factor in increased participation [16], but materials separation may not be the overriding factor in a resident's decision to participate. Pettit compared participation in Santa Rosa, California, and Islip, New York, and concluded that results suggest other factors are more significant [12].

Frequency and scheduling of collection

It is generally accepted that more frequent collection of recyclables encourages participation and increases the amount of the wastestream diverted from disposal [10]. A report by the Massachusetts Bureau of Solid Waste Disposal states that people are more willing to separate and store recyclables when they know they will be promptly removed (avoiding a perceived hygiene problem) [17]. Additionally, recyclables collection which coincides with regular garbage collection schedules has been shown to have a positive impact on participation and materials recovery [12].

Decisions concerning collection frequency and scheduling must be made in consideration of available resources. Availability of vehicles or labor may restrict the frequency of pickups. Multi-material collection vehicles may have to be shared with other communities, or a one-compartment vehicle may be required to pick up different materials from the same route on different days.

Provision of in-home containers

In-home containers increase the convenience of recycling, and their presence in the home and on the curb serves to remind households to recycle [18]. Budget constraints can make it difficult to provide containers to every home, so some programs have applied nominal charges or deposits to defray the costs of providing containers.

The type of container allowed for materials setout (putting recyclables on the curb for collection) must correspond to the type of vehicles used, materials separation needs, containers used for regular trash pickup, and the need for safe collection. Containers specified for use must complement the separation, sorting, and collection system and must be large enough to hold the recyclables generated between pickups. The collection vehicles must also be considered-- for instance, if current trash collection vehicles could be easily fitted with racks, closed plastic bags might be specified rather than open containers which would have to be emptied into bins [19].

Collection vehicles

The many types of collection vehicles available should be considered and selected with regard to the needs of collection and unloading-- maneuverability, volume, efficiency, and ease of loading and unloading-- and how they would work with existing equipment and facilities. Used vehicles may be available from other waste collection programs, or currently-used garbage collection vehicles may be suitably modified to include recyclables by the addition of external or internal bins or racks. The use of vehicles specially designed for curbside recycling is increasing, especially in high-volume programs; specialized vehicles offer increased efficiency in collection and unloading [16].

Post-collection materials processing

Recyclable materials typically require some post-collection treatment to make them marketable-- separation of materials, removal of contaminants, and volume reduction, for example. Markets for the materials have specifications which must be met. Transportation to markets is more efficient when the material is densified by baling, shredding or granulated. The amount invested in processing equipment and labor must be balanced with the expected contribution of the processing to the value of the material.

Program planners should investigate the possibility of selling mixed materials to an intermediate processor which can often process materials more economically because of the large scale operation [16]. Selling all materials to one intermediate processor eliminates the burden of dealing directly with three or four end users of the secondary materials.

Promotion

Ultimately, the success of a program depends on household participation. Some factors which contribute to participation are not within the control of a program manager. Socio-economic characteristics, for instance, tend to influence participation and recovery levels, with highest participation generally found among groups with high education and income levels [10].

Much can be done to encourage participation in a program. Simply providing well-managed, reliable service will encourage the participation of many people who "believe"

in recycling but want to do it conveniently. If public awareness of a waste disposal crisis is high, providing good service alone might attract sufficient participation. Typically, some form of education or persuasion is necessary to bring about an effective level of recycling. Getting people to recycle involves changing waste disposal habits. Behavioral change can be achieved using educational and promotional materials, personal influence, incentives (rewards or punishments), and source-separation ordinances.

Publicity and education

Publicity and education are basic approaches to changing behavior. The recycling coordinator's goal is to encourage "recycling" behavior and discourage "throwaway" behavior through the use of promotional and educational messages. The messages most likely to be effective will: (a) describe the behavior --recyclables separation-- clearly in a non-threatening way and (b) be presented in the spatial or temporal context in which the desired behavior usually occurs [20].

Brochures or flyers can be distributed directly to households through the mail or delivered door-hanging pieces (cardboard placards designed to be hung on a doorknob) to inform residents about what materials are accepted and how they must be prepared for collection. Ongoing publicity, including mailed messages on the progress and success of the program, comments from community leaders, and newspaper articles, may be used to maintain interest in the program [21]. Publicity can be used to increase the amount of marketable material recovered from participating households by politely reminding households of the correct procedures for cleaning and preparing materials for setout.

If it is within the program budget, publicity can be directed by a professional public relations firm. A number of successful programs use a coordinated theme of colors and logos to be incorporated into designs of trucks, containers, and publicity items. John Stormes, of Media Research Services, recommends that publicity be carefully planned, including a survey to assess public knowledge of recycling opportunities and current recycling practices, and that the recycling message be packaged in terms of the public's needs and interests, not just the needs of the solid waste manager [22].

In addition to communication with the public, program managers should make a point of informing workers of the program and seeking their input. The reliable functioning of the collection system is vital to participation [10].

Personal contact

The "block leader" concept, pioneered in Boulder, Colorado, by Eco-Cycle, Inc., has been adapted and widely used in many other programs [23]. Variously known as "block coordinators," "recycling volunteers," and by other titles, these volunteers are residents who commit some time within each collection period to reminding other residents in their community about the collection by delivering doorhangers, posting signs or other communication.

Educational programs in schools may be helpful in introducing recycling behaviors to a community's younger citizens, since prior exposure to recycling has been shown to have an impact on willingness to participate [3]. School-based programs may also increase the willingness of the parents of students to participate in recycling programs [24].

Economic incentives

An incentive is something that prompts action. If the innate incentives of recycling (reducing environmental impacts of raw material use, for example) do not evoke sufficient participation to meet waste diversion goals, other incentives can be introduced to increase participation. Economic incentives have been tested for their potential to change the public's behavior and increase recycling through systems of rewards or punishments rather than trying to increase the public's philosophical support for recycling. Positive incentives seek to increase the desired behavior (source-separation), while negative incentives attempt to decrease the incidence of undesired behavior (throwing away recyclables) [20].

Economic incentives are not limited to monetary reward (remuneration for the desired act) or punishment (monetary penalty for the undesired act). Examples of reward and punishment would be, respectively, provision of utility credit for recycling setouts and the additional cost of garbage collection under a variable garbage rate system if the volume is not reduced through source-separation [25]. Economic incentives can extend beyond rewards and punishments to motivate behavior through the chance of possible reward or punishment. For example, a household may be motivated to source-separate recyclables because there is a chance it may be selected in a lottery-style drawing that requires that its trash contain no recyclables in order that the household be awarded a cash prize.

Source-separation ordinances

Ordinances mandating source-separation of specified materials have been associated with high rates of participation in curbside recycling programs [12]. Communities with such ordinances do not typically devote a great deal of effort to enforcement, rather, the discussion involved in the passage of the ordinance and its presence in the community's code seem to produce sufficient awareness of the need for waste diversion to boost participation [26].

Source-separation ordinances may put the responsibility for materials separation on the household, the hauler, or the landfill. Households may be forbidden to put recyclables in the municipal garbage. Alternatively, the hauler or disposal company may be made responsible for not accepting designated materials, through, for example, a ban on landfilling of certain materials.

An additional legal mechanism to encourage recycling is mandating the provision of recycling services. Individuals are not required to participate, nor are the collection or disposal companies required to enforce source-separation. Oregon's so-called Recycling Opportunity Act is such a law.

Program evaluation techniques

A variety of approaches is used by communities to adapt curbside recycling to the unique conditions, values, and needs of the community. Evaluation of programs is done

in just as varied a manner, imposing limitations on comparison and analysis of program techniques. Standard methods for measuring program performance have not been developed to allow consistent comparisons of participation, waste diversion, and cost data.

The participation rate is the number of households eligible for the curbside service that actually set out recyclables for a specified minimum number of collection days. The number of setouts that constitute participation is not standardized, and the relationship between participation rates and setout rate, which is the percent of households on the route that actually set out recyclables on a given collection day, varies with collection frequency and by community. Ideally, participation data should reflect the percentage of households setting out recyclables over an extended period, allowing for less-than-perfect setout. Rates of participation can be: (a) measured directly by recording the addresses of households setting out materials, (b) calculated from the setout rate using a factor developed by direct measurement, (c) estimated using telephone or personal surveys, or (d) "eyeballed" by collection staff. Setout, though not exactly equivalent, is often used as an indicator of participation.

The rate of waste diversion is a potentially useful evaluation criterion from the perspective of maximizing landfill space. Waste diversion is the amount or percentage of the wastestream that is not landfilled or incinerated as a direct result of recycling. Simply put, it is the amount of recycled material divided by the total wastestream including the recyclables. Inconsistencies in this evaluation technique occur when: weights or volumes used are not comparable because of inconsistent weighing practices or obsolete volume-weight conversion factors, different components are included in calculations (for example, one community may exclude yard waste from the total wastestream if it is collected separately, another may include it), the recycled fraction may include materials

from several components of a broad-based recycling strategy that lumps curbside with other recycling projects.

Cost data is also of great interest in evaluating whether a program is worth doing and can be presented in infinite detail, which is sometimes helpful, but unfortunately, is also time-consuming. Types of synoptic cost data include net cost per household, gross costs and revenues, or net costs per ton. Increasingly, programs are reporting net cost of collection and recycling versus net cost of collection and disposal, which shows promise as a standard of comparison. Problems interpreting and comparing cost data are encountered because of differences in how programs: internalize costs and revenues; account for rebates, subsidies, or tonnage grants for recycling; and maintain separate accounts for various components of the recycling program.

Selection of case studies

The case studies were selected from approximately twenty-five multi-material, curbside recycling programs recommended to the author by professionals in the field of recycling. After preliminary discussions with program managers, fifteen programs were selected for further study, based on the programs' technical or fiscal soundness or the use of uncommon approaches in administration, operation, or promotion. Every attempt was made to select cases representing a variety of demographic, geographic, and economic situations. Programs in the planning stages or with no estimates of participation rates were excluded from the study. Programs included in the study have operated at least on a pilot scale for six months or more and appear to have a viable system.

Chapter 3: Case Studies

Fifteen case studies will be presented in this chapter to demonstrate how each program has been developed to fit the needs and resources of the community. Except where noted, information in the case studies was obtained from the program staff contact cited in the program summary, through either personal or telephone interviews or through reports and publications provided by the staff. Demographic data were derived from the 1980 Census of Population and Housing [27], except population, for which the most recent estimates were used. Summaries of selected program information can be found in Appendix A.

The terms that follow are used throughout the case studies and will be further qualified on a case-by-case basis. Setout is the number or percentage of households on a curbside recycling route that put recyclables on the curb on a given collection day. It is not equivalent to participation, but is sometimes used as an indicator of participation levels. Participation is the number or percentage of households on a curbside route that put out recyclables a designated minimum number of collection days within a survey period. Participation rates can be determined by: (a) direct measurement-- recording addresses

of setouts for a designated survey period, (b) calculation-- using a factor developed from direct measurement that links participation to setout rates, (c) surveys-- questioning households in an eligible area in person or by telephone, or (d) "eyeballed" estimates by program staff.

Cost data are presented in this report in the same format provided by the program representatives. Unless noted, cost represents the net cost of the curbside recycling service, which accounts for subsidies, revenues received from the sale of materials, and expenses included in the program's accounting. Variation occurs in how programs account for in-kind services, overhead, and indirect expenses or revenues. Non-monetary benefits such as aesthetics, health effects, or pollution reduction impacts are not included in any accounting of costs.

State-wide programs relating to recycling have been instituted in several states. Brief descriptions of state programs which affect the case studies are included in Appendix B.

Ann Arbor, Michigan

Ann Arbor is a college town. The population is educated (90 percent of adults are high school graduates), young (median age 25), and has a large number of multi-family dwellings (37.4 percent of structures have four or more housing units).

"Recycle Ann Arbor" is the curbside recycling service provided by the non-profit Ecology Center under contract with the city. The monthly curbside pickup is part of the Ecology Center's three-part program of recycling, which also includes dropoff centers

Table 1. Program Summary-- Ann Arbor, Michigan

<p>Recycle Ann Arbor, non-profit company on contract</p> <p>Contact: Brian Weinert 417 Detroit Street Ann Arbor, MI 48104 313/665-6398</p> <p>Starting date: 1978 Population: 106,600 Dwellings served: 20,046 single-family Vehicles: modified Maxon compactors with 6 internal bins Provider of regular garbage collection: municipality Materials collected (a): Paper: np,cc,grocery bags Metal: ac,tc Glass: cg,gg,bg Misc.: used oil, car batteries Collection frequency: monthly Degree of household sorting: complete separation Curbside sorting: no additional Same day as regular garbage collection? no Container specified? no Provided? no Container description: --</p> <p>Participation: 20-25% setout rate Reduction estimate: 4%residential,7%total Reduction target: not available Ordinances: none Volunteer activities: publicity, collection Economic Incentives: none</p> <p>Costs (b): Collection and disposal: not available Collection and recycling: \$53/ton (1986-87) Tipping fee: not available</p> <p>Other programs: dropoffs, commercial collection, backyard pickup for elderly/handicapped</p>
--

(a) np = newspaper, cc = corrugated cardboard, ac = aluminum cans, tc = tin-plated cans, cg = clear glass, gg = green glass, bg = brown glass, mg = mixed glass, PET = plastic soda bottles, HDPE = plastic milk jugs.

(b) Cost per ton is decreasing as volume of material increases.

and collections of recyclables from businesses (including high grade office paper). Additional information on the program is found in Table 1.

Participation in the curbside program is voluntary. There are currently two major barriers to increased community support of recycling: (a) the landfill tipping fee is still quite low; and (b) costs of waste disposal are absorbed by property tax revenues; therefore, residents have no direct knowledge of the household cost of solid waste disposal. The city is studying changes in the tipping fee structure and the institution of a user fee to discourage wasteful disposal practices.

Monthly setout rates average 20 to 25 percent. Recycle Ann Arbor is studying ways to increase participation by increasing collection frequency to weekly, increasing promotion of the program, and providing in-home containers. A pilot study in which in-home containers were provided to households showed increases in participation rates of between 25 to 50 percent. The cost of buying and distributing containers would be about \$7 per household, which is prohibitive at present. Funding alternatives for containers are being investigated [28].

Astoria, Oregon

Astoria is a small town in rural eastern Oregon. The populace is moderately educated (76.8 of the adults are high school graduates), and the median age is 31. Only 20 percent of the structures have four or more housing units.

Table 2. Program Summary-- Astoria, Oregon

<p>Astoria Recycling, private firm on contract</p> <p>Contact: Louis Ornelas 1095 Duane Street Astoria, OR 97103 503/325-5821</p> <p>Starting date: 1986 Population: 10,000 Dwellings served: 650 single-family Vehicles: flatbed truck with 6 containers Provider of regular garbage collection: franchise Materials collected (a): Paper: np,cc Metal: -- Glass: cg,gg,bg Misc.: used oil</p> <p>Collection frequency: biweekly Degree of household sorting: np/mg Additional curbside sorting: complete separation Same day as regular garbage collection? no Container specified? no Provided? yes, small deposit Container description: wooden crate</p> <p>Participation: 20% setout rate Reduction estimate: 120 T, 86/87 Reduction target: not available Ordinances: state law requires the provision of curbside recycling, but source-separation is not required Volunteer activities: publicity Economic Incentives: none</p> <p>Costs: Collection and disposal: \$140/T Collection and recycling: \$81/T Tipping fee: \$26/T</p> <p>Other programs: dropoffs (which also accept aluminum cans, steel cans, high-grade office paper, white goods, yard waste)</p>
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(a) np = newspaper, cc = corrugated cardboard, ac = aluminum cans, tc = tin-plated cans, cg = clear glass, gg = green glass, bg = brown glass, mg = mixed glass, PET = plastic soda bottles, HDPE = plastic milk jugs.

Curbside collection of recyclables is provided by a private hauler on contract to the city. Newspaper, corrugated cardboard, glass, and motor oil are included in the program, having met the definition of "recyclable material" set forth by state law. A recyclable material is defined in Oregon's Recycling Opportunity Act² as one for which the net costs of collection and recycling are less than or equal to the costs of collection and disposal. Any material meeting this definition must be included in a community's program [29]. Aluminum cans are not currently included in Astoria's curbside recycling because most are covered by the state container-deposit law [30], which does not exclude aluminum cans from the recycling law, but affects the economic definition of its recyclability.

Regular garbage collection has always been done by private haulers in Astoria, so it is quite natural that a private hauler provide curbside recycling. The community allowed the hauler to increase garbage collection rates to cover the cost of the recycling service. As shown in the program summary (Table 2), households are not required to completely separate materials for setout. Instead, materials are separated as they are loaded onto collection vehicles, thereby reducing centralized processing needs. Materials from curbside are processed and marketed along with material from the company's unsubsidized dropoff centers.

Collection is biweekly and about 20 percent of the eligible households set materials out on collection days. The state law requires a minimum of monthly collection to meet the law's requirement for "convenient" service. Wooden crates, which are purchased by the town through the local fire department, are available for use in the home for a one dollar charge.

² The Recycling Opportunity Act requires communities to provide convenient recycling service. It does not require residents to source-separate recyclables, nor does it ban disposal of recyclables.

Austin, Texas

Austin, the capital of Texas, has a fairly young population (median age, 26.2), with 74.8 percent of adults being high school graduates. The percentage of structures with four or more housing units is 32.8.

In 1977, faced with the impending closure of two area landfills, Austin adopted a Solid Waste Management Plan that included curbside recycling as a leading strategy for effecting a reduction in the amount of waste going to final disposal [31]. A summary of the program is provided in Table 3.

Materials, except newspaper, are not marketed directly but sent to Ecology Action Community Recycling, a non-profit agency for processing and marketing. Marketable jars and bottles, such as canning jars, are removed and sold; remaining glass and cans are processed and marketed as secondary materials.

Participation has been 10 to 50 percent in various neighborhoods phased into the program. Participation levels appear to be related to the demographic composition of the neighborhood and the length of time the neighborhood has been in the program. Instituting a volunteer "block leader" program and the use of standardized in-home containers in Fall 1983 effected marked increases in public awareness and participation in the program. Participation, defined as at least one setout by a household in one month, has been estimated by recording setouts on sample blocks for one month. The rate of overall participation was calculated to be approximately equal to 2.25 times the setout rate.

Table 3. Program Summary-- Austin, Texas

<p>Austin Public Works, municipality</p> <p>Contact: Richard Abramowitz PO Box 1088 Austin, TX 78767 512/479-6753</p> <p>Starting date: 2/82 (pilot) Population: 457,000 Dwellings served: 86,000 single-, multi-family Vehicles: Recycler 6 (Eager Beaver) trailers Provider of regular garbage collection: municipality Materials collected (a): Paper: np Metal: ac,tc,steel cans,aluminum scrap Glass: cg,gg,bg Collection frequency: weekly Degree of household sorting: complete separation Additional curbside sorting: no additional Same day as regular garbage collection? no Container specified? no Provided? yes Container description: bucket; no plastic bags accepted</p> <p>Participation (b): 25% participation (direct measurement) Reduction estimate: 4800 T,86/87 Reduction target: none Ordinances: none Volunteer activities: publicity Economic Incentives: none</p> <p>Costs: Collection and disposal: not available Collection and recycling (c): not available Tipping fee: \$7/T</p> <p>Other programs: dropoffs, yard waste, purchasing ordinance, composting education</p>
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(a) np = newspaper, cc = corrugated cardboard, ac = aluminum cans, tc = tin-plated cans, cg = clear glass, gg = green glass, bg = brown glass, mg = mixed glass, PET = plastic soda bottles, HDPE = plastic milk jugs.

(b) One setout per month constitutes participation.

(c) Funded by solid waste fee, plus \$100,000 from sales.

Curbside recycling is part of a multidimensional strategy to reduce the need for landfilling. Other aspects of the plan include establishment of office paper recycling programs and encouraging backyard composting.

Barrington, Rhode Island

Barrington is a small (population 16,174), well-educated (83.1 percent of adults are high school graduates), fairly affluent community (only 3.5 percent of adults live below the poverty level). The median age is 33.3. Very few multi-family complexes exist (only 0.2 percent of the structures have four or more housing units).

The town began recycling in 1973, when the Jaycees began a dropoff center. The following year, the municipality began providing curbside collection. There is a high level of citizen support for recycling, stemming from awareness of the need to minimize the town's disposal requirements. Since Barrington's landfill closed in the 1970s, the town's waste has been transported from the municipal transfer station to a neighboring town's landfill. Details of the curbside program are included in Table 4. In addition to curbside service, the dropoff center is still in operation, and Barrington provides free pickup of white goods (large appliances) as needed by residents. In the Fall and Spring, a separate leaf dump and yard waste collection area is maintained at the transfer station.

Recycling of mixed paper is mandatory. Mixed paper, rather than simply newspaper, is collected to maximize the diversion of waste paper from disposal. Marketing the paper

Table 4. Program Summary-- Barrington, Rhode Island

<p>Barrington Public Works, municipality</p> <p>Contact: Joseph Piccerelli Dept of Public Works Barrington, RI 02806 401/247-1907</p> <p>Starting date: 1974 Population: 17,500 Dwellings served: 5600 single-family Vehicles: 3-way dumper trucks Provider of regular garbage collection: municipality Materials collected (a): Paper: mixed Metal: ac Glass: cg,gg,bg Misc.: white goods (on "will call" basis) Collection frequency: monthly Degree of household sorting: complete separation Curbside sorting: no additional Same day as regular garbage collection? no Container specified? no Provided? no Container description: --</p> <p>Participation: 75% paper, 30% glass, setout rate Reduction estimate: 12% paper, 14% total wastestream Reduction target: none Ordinances: for paper only Volunteer activities: none Economic Incentives: none</p> <p>Costs: Collection and disposal: \$38/T Collection and recycling (b): \$38/T Tipping fee: \$26/T</p> <p>Other programs: dropoffs, yard waste (seasonal)</p>
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(a) np = newspaper, cc = corrugated cardboard, ac = aluminum cans, tc = tin-plated cans, cg = clear glass, gg = green glass, bg = brown glass, mg = mixed glass, PET = plastic soda bottles, HDPE = plastic milk jugs.

(b) Avoided tipping fees are not considered.

"as is" avoids post-collection processing, although the price of mixed paper is far less than the price of purer newspaper or office paper fractions.

The setout rate is approximately 75 percent for paper and 30 percent for other materials. Collection of paper is made on the first full week of the month, glass during the third week. Glass is to be separated by color, but if household separation is inadequate, the collectors separate it. Aluminum cans will be included as soon as the new three-way dump trucks are in service. Plastics (PET and HDPE)³ and tin cans may be added if markets or outlets are developed through the state recycling program [32].

Berkeley, California

Berkeley is dominated by a large state university. Most residents are high school graduates (86.4 percent of adults), and 21 percent of adults are below poverty level (including students who are legal residents of Berkeley). About 35 percent of the structures in Berkeley have four or more housing units.

The Ecology Center has been conducting curbside recyclables collection for approximately ten years. Curbside pickup of newspaper began in 1973; in 1980, service was expanded to include glass and aluminum and tin cans. California wine bottles are collected and processed through a program called Encore!, which sells the washed bottles back to California wineries. Since October 1985, the curbside service has been provided under contract to the city. A summary of the program is in Table 5.

³ PET, polyester terephthalate, is commonly used for plastic soda containers. HDPE, high-density polyethylene, is used in milk jugs and other household containers.

Table 5. Program Summary— Berkeley, California

Ecology Center, non-profit company on contract	
Contact: Kathy Evans Ecology Center 1403 Addison Street Berkeley, CA 94704 415/524-0114	Guy Guber City Recycling Office 2180 Milvia Street Berkeley, CA 94704 415/644-6523
Starting date: 1980	
Population: 103,328	
Dwellings served: 50,500 single- and multi-family	
Vehicles: flatbed truck with 5 containers	
Provider of regular garbage collection: municipality	
Materials collected (a):	
Paper: np	
Metal: ac,tc	
Glass: cg,gg,bg	
Misc.: --	
Collection frequency: monthly	
Degree of household separation: np/mg/cans	
Curbside sorting: complete separation	
Same day as regular garbage collection? no	
Container Specified? no Provided? yes, small fee	
Container description: waxed cardboard bins	
Participation (b): 13% participation (direct measurement)	
Reduction estimate: 7,300 T/yr	
Reduction target: 50% by 1991	
Ordinances: participation not required, but waste reduction has been mandated by voters	
Volunteer activities: none	
Economic Incentives: none	
Costs:	
Collection and disposal: \$95/T	
Collection and recycling: \$95/T (cost to city)	
Tipping fee: \$26/T	
Other programs: dropoffs, buybacks	

(a) np = newspaper, cc = corrugated cardboard, ac = aluminum cans, tc = tin-plated cans, cg = clear glass, gg = green glass, bg = brown glass, mg = mixed glass, PET = plastic soda bottles, HDPE = plastic milk jugs.

(b) Setouts 10 months of the year constitutes participation.

Participation in the curbside programs was directly measured by recording addresses of setouts and a factor was developed to allow participation to be calculated from setout data. Participation was calculated to be 13 percent using this method. The factor of 1.2 times the setout rate takes into account reasonable oversight of the monthly collections by participating households (i.e., 10 of the 12 monthly collections in a year) [33]. Three other recycling operations may affect participation in the city-sponsored curbside collection. A buyback center, opened in 1982, run in conjunction with the Ecology Center, may have a considerable impact among the many low-income residents of Berkeley. Another curbside recycling program, Resource Recycling, provides weekly backyard recyclables collection service for a fee. At the landfill, Urban Ore, a private, for-profit company, operates salvage and composting facilities.

Cost projections given in the 1986 Solid Waste Plan [34] show that the contract with the Ecology Center is cheaper (by \$100,000) than if the city provided the service, even if collection frequency is increased to weekly, as planned. The non-profit company is able to save on both vehicle and labor expenses.

Boulder, Colorado

Boulder is a moderately-sized town, dominated by a state university campus. Many of the residents (91.9 percent of adults) are high school graduates. Poverty is moderate, with 16.3 percent of adults living below the poverty level. Thirty-six percent of structures have four or more housing units.

Table 6. Program Summary-- Boulder, Colorado

<p>Eco-cycle, Inc., non-profit organization</p> <p>Contact: Jim Johnson PO Box 4193 Boulder, CO 80306 303/444-6634</p> <p>Starting date: 1976 Population: 76,685 Dwellings served: 22,000 single-,multi-family Vehicles: VW buses, school buses, trucks Provider of regular garbage collection: not available Materials collected (a): Paper: np,cc,office paper Metal: ac,aluminum scrap Glass: cg,gg,bg Misc.: used oil Frequency of collection: monthly Degree of household sorting: complete separation Curbside sorting: no additional Same day as regular garbage collection? no Container specified? no Provided? no Container description: --</p> <p>Participation: 30% setout Reduction estimate: 12% Reduction target: 60% Ordinances: none Volunteer activities: publicity Economic Incentives: none</p> <p>Costs: Collection and disposal: not available Collection and recycling (b): not available Tipping fee: \$6/T</p> <p>Other programs: office paper recycling</p>

(a) np = newspaper, cc = corrugated cardboard, ac = aluminum cans, tc = tin-plated cans, cg = clear glass, gg = green glass, bg = brown glass, mg = mixed glass, PET = plastic soda bottles, HDPE = plastic milk jugs.

(b) The \$1 million budget includes subsidies from city.

Eco-Cycle is a non-profit company which derives revenue from materials sales. Although the city provides subsidies during periods of low market values, there is no ongoing support from or contract with the city. The lack of support for recycling among community leaders may stem from the absence of an immediate landfill crisis in the Boulder area, but there is consistent citizen support. Citizen support motivated by environmental ethics has been sufficient to maintain the Eco-Cycle program for almost twelve years [35].

Eco-Cycle pioneered the use of volunteer "block leaders" to stimulate participation. These volunteers distribute information about the program to their neighbors and post reminders of pickup days for that neighborhood. These reminders can be especially important for monthly collections, as it is easy to forget infrequent collections [23].

Setout rates are monitored each month, although overall participation has not been measured. Currently, service is monthly, and materials must be separated, as described in the program summary (Table 6). Program managers are considering changes to try to increase participation, including the provision of in-home containers and increasing collection frequency to weekly. They may also phase out the use of community groups in collection to improve the consistency of service and are shifting to the use of specialized collection vehicles to replace the used school buses and trucks they now use.

Separate collection of highgrade office paper is provided weekly or on a "will call" basis. A fiber drum is provided for in-office accumulation of paper.

Charlotte, North Carolina

Charlotte is a center for commerce and industry for North and South Carolina. Adults with high school diplomas constitute 70.1 percent of the population and the median age is 29.3. Approximately 24 percent of structures have four or more housing units. Demographic data for Mecklenburg County, in which Charlotte is located, are similar.

The curbside collection program is operated jointly by Mecklenburg County and the City of Charlotte. The county, responsible for most of the planning, has provided specialized collection vehicles, and city employees staff the trucks. The city already provides the regular trash pickup service for city residents.

The current pilot program, summarized in Table 7, was implemented in February 1987 by the county in five demographically diverse communities around the city. When the program reaches countywide service in 1988, 80 percent of the county residents will be served. Any resident receiving backyard trash collection (including multi-family complexes not on dumpster service) will eventually receive the curbside recycling service. Approximately 75-80 percent of the households on curbside recycling routes are participating, as measured by setouts recorded by address for a four-month test period [36]. Participation is defined to be at least one setout per month.

The curbside program collects co-mingled rather than separated materials in order to make participation as easy as possible. Currently, some sorting is done by collectors at the curb, and additional processing is done at a centralized facility to prepare the materials for marketing. The efficiency of this technique will be tested against the efficiency of collection without sorting while the program is still in pilot-scale operation.

Table 7. Program Summary-- Charlotte, North Carolina

<p>Mecklenburg County Engineering Department, municipality</p> <p>Contact: Betsy Dorn 700 N. Tryon Street Charlotte, NC 28202 704/336-2770</p> <p>Starting date: 2/87 pilot Population: 400,000 Dwellings served: 12,000 homes with municipal trash pickup Vehicles: three-way dump trucks Provider of regular garbage collection: municipality Materials collected (a): Paper: np Metal: ac Glass: cg,gg,bg Misc.: PET Frequency of collection: weekly Degree of household sorting: np/ac + mg + PET Curbside sorting: np/glass/cans&PET Same day as regular garbage collection? no Container specified? yes Provided? yes Container description: single, plastic bins</p> <p>Participation (b): 75-80% participation (direct measurement) Reduction estimate: not available Reduction target: 30% by 1994 Ordinances: none Volunteer activities: none Economic Incentives: prize system is under study</p> <p>Costs: Collection and disposal: not available Collection and recycling: est. \$1.2 for citywide Tipping fee (c): \$4/cu. yd. capacity (compactor trucks)</p> <p>Other programs: dropoffs, office paper, yard waste (planned)</p>
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(a) np = newspaper, cc = corrugated cardboard, ac = aluminum cans, tc = tin-plated cans, cg = clear glass, gg = green glass, bg = brown glass, mg = mixed glass, PET = plastic soda bottles, HDPE = plastic milk jugs.

(b) One setout per month constitutes participation.

(c) No tip fee for municipal trucks.

Soft drink companies are providing assistance for the inclusion of PET (polyethylene terephthalate, predominantly used for soft drink containers). Recovery has been encouraging, and truck and container volumes have been more than adequate to collect this additional material. Comingling PET with glass helps to reduce glass breakage, which is important when glass is collected unseparated by color for separation at a central facility. The county is also experimenting with three types of specialized collection vehicles and three in-home container designs to ascertain their effects, if any, on participation and collection efficiencies.

A comprehensive publicity program has been implemented through a contract with a public relations firm, which uses a color scheme and logo carried through to containers and publicity information. Mailouts, doorhangers, press releases, brochures, and pamphlets are used to provide information on the curbside program and other recycling opportunities in the county. An economic incentive program is under consideration; it would allow households receiving curbside recycling service to qualify for a cash prize if they had set out recyclables.

Dropoff centers are being pursued as a way to involve residents who are not eligible for curbside recycling. Dropoffs were started in the 1970s at area high schools; in 1982, the city began leasing unused gasoline stations and "recycled" them as staffed and unstaffed dropoff centers. (Staffing is provided by Goodwill Industries, a training center for the handicapped, for centers which accept waste oil.) In addition, a dropoff center at the landfill accepts recyclables in lieu of tipping fees, which are \$3.75 per automobile load (or three bags of recyclables) or \$4 per cubic yard capacity for compactor trucks (free if half the load is recycled).

Two important elements of the success of the program have been the extensive support of county commissioners and enthusiastic public support, according to Mary McDaniel, chair of the county's Waste Management Advisory Committee [37].

El Cerrito, California

El Cerrito is a small community in the San Francisco Bay area of California. The population has a median age of 40.1; 83.7 percent of adults are high school graduates. Only 10.5 percent of the structures have four or more housing units. The percentage of adults living below the poverty line is 6.1.

E.C.Ology is a city program, and makes a small "profit," according to the program manager [38]. The program is summarized in Table 8. Operating funds come from in-kind services provided by the city (including the manager's salary), a voluntary \$.50 per month donation system administered through the utility billing department, and the substantial revenues from materials sales resulting from high participation and recovery rates. The donation system has shown that approximately 50 percent of the town's residents support the service enough to donate the full \$6 donation each year.

Weekly service was selected as a way to encourage participation, which has been estimated at 50 percent, in a one-month survey of selected routes. Setouts were recorded by address, and participation was defined as at least one setout in a one-month survey period. El Cerrito has a variable rate for trash collection at single-family dwellings,

Table 8. Program Summary— El Cerrito, California

<p>E.C.Ology, municipality</p> <p>Contact: Joel Wetherell Dept. of Community Services 10890 San Pablo Av. El Cerrito, CA 94530 415/234-7445</p> <p>Starting date: 1978 Population: 23,000 Dwellings served: 9,779 single-, multi-family Vehicles: Flatbed trucks with 6 bins Provider of regular garbage collection: private franchise Materials collected (a): Paper: np Metal: ac,tc Glass: mg Misc.: wine bottles Frequency of collection: weekly Degree of household sorting: np/mg/cans/magazines Curbside sorting: complete separation, except mixed glass Same day as regular garbage collection? no Container specified? no Provided? no Container description: plastic or paper bags preferred</p> <p>Participation (b): 50% participation (direct measurement) Reduction estimate: 20% from all programs Reduction target: none Ordinances: none Volunteer activities: none Economic Incentives: variable can rate for trash</p> <p>Costs: Collection and disposal: not available Collection and recycling: "profit" of \$5/ton Tipping fee: not available</p> <p>Other programs: dropoffs (including cc, mixed paper, scrap metal, motor oil)</p>

(a) np = newspaper, cc = corrugated cardboard, ac = aluminum cans, tc = tin-plated cans, cg = clear glass, gg = green glass, bg = brown glass, mg = mixed glass, PET = plastic soda bottles, HDPE = plastic milk jugs.

(b) One setout per month constitutes participation.

which is based on the number of garbage cans collected. The variable rate provides an economic incentive for residents to reduce their trash collection needs by recycling.

The regular city-paid route drivers/collectors are sometimes assisted by court-appointed community service workers, which shortens the time required for collection. Households partially sort the materials, and the collector completes the sorting at the curbside, eliminating centralized sorting at the processing center. A market for mixed glass reduces processing costs, but it brings a lower price than glass sorted by color.

Fresno, California

Fresno is a moderately-sized city located in the central San Joaquin Valley of California. The median age of residents is 28.1. Only 67.9 percent of adults are high school graduates, and 15.7 percent of adults live below the poverty level. Approximately one-fourth of the structures have four or more housing units.

Curbside recycling has been conducted by the city or private contractors since 1982. Initially, the municipality provided the service, using a well-accepted incentive program involving a forty-cent credit on a participating household's monthly utility bill. When the city turned the program over to Rice Roads Dump (a private, for-profit company) in 1987, participation fell from approximately 12 to 3 percent because of the removal of the popular incentive system.

To regain participation, the company increased collection frequency to weekly, and introduced a trademarked program called "Waste Watchers," which works with non-profit

Table 9. Program Summary-- Fresno, California

Waste Watchers (tm), private waste management company	
Contact: Tom Van Norwick 1060 Fulton Mall Suite 1502 Fresno, CA 93721 209/439-9211	Tom Volpa Waste Watchers 209/439-9211
Starting date: 1982 (Waste Watchers since 7/1987)	
Population: 250,000	
Dwellings served: 100,000 single-family	
Vehicles: Compartmental trucks	
Provider of regular garbage collection: municipality	
Materials collected (a):	
Paper: np,cc	
Metal: ac	
Glass: mg	
Misc.: PET, other plastics	
Frequency of collection: weekly	
Degree of household sorting: complete separation	
Curbside sorting: no additional	
Same day as regular garbage collection? no	
Container specified? no Provided? yes, small fee	
Container description: 4-in-1 bins, or dividers for 30-gal cans	
Participation (b): 5% participation	
Reduction estimate: not available	
Reduction target: 18-25%	
Ordinances: none	
Volunteer activities: assist with marketing	
Economic Incentives: tax deduction system, landfill passes	
Costs:	
Collection and disposal: \$30-40/ton	
Collection and recycling: not available	
Tipping fee: not available	
Other programs: buyback (at landfill)	

(a) np = newspaper, cc = corrugated cardboard, ac = aluminum cans, tc = tin-plated cans, cg = clear glass, gg = green glass, bg = brown glass, mg = mixed glass, PET = plastic soda bottles, HDPE = plastic milk jugs.

(b) Total subscribers divided by number of units eligible for service.

community groups on a profit-sharing basis. A summary of the Waste Watchers program is found in Table 9. The system, a type of "cause marketing," uses community groups which are part of the Fresno Community Council (FCC) to enlist subscribers to the service and remind them of collection days. Each quarter, the FCC receives 25 percent of the gross profits from recycling to distribute among the groups according to their effort. An additional 5 percent of gross profits are set aside to fund direct expenses of the publicity effort.

Setouts are recorded by address every week, and the recyclables are considered a donation to the non-profit group which signed the household up for the program. At year's end, a receipt is sent to each household as a tax deduction record. In addition to this incentive, a free pass for the disposal of bulky trash at the landfill is given to households with a six-month perfect setout record.

Response to the new incentive program has been encouraging, although actual effects of the new program on participation have not been measured yet. Local retailers have expressed interest in trying to work with the Waste Watchers program to boost participation so the retailers might be exempted from the state requirement to set up redemption centers for containers under the new recycling law. The recycling bill, Assembly Bill 2020, is further discussed in Appendix B.

Provision of in-home containers is being considered if funds are made available through the new recycling law. Currently, residents may purchase 4-in-1 containers or dividers for 30-gallon trash cans for storage of recyclables.

Two plastics--PET and HDPE (high-density polyethylene)-- have been included in collection, although little has been collected so far. The program manager expressed a

willingness to collect all plastics, regardless of market value, to divert them from land-filling.

Hillsborough, New Jersey

Hillsborough is a small but rapidly growing town (population 30,000). The 1980 census data shows a median age of 30.1, with 82.4 percent of adults having graduated from high school. Few adults (2.5 percent) were living below the poverty level. About 23 percent of structures had four or more housing units.

A mandatory county recycling ordinance was passed in December 1985, a year before the state law, in response to rapidly-rising disposal costs. The Hillsborough program began with biweekly service to single-family dwellings, then was expanded to include multi-family dwellings. The service is provided by the Association for Retarded Citizens, on contract to the city, which provides employment of the handicapped.

Delivery vans ("Step-Vans") are used in the interest of flexibility in reaching pickup sites and safety of operation. Use of the vans allows multi-family dwellings to be served through a "modified curbside" collection system in which households set materials out at either the closest curb to their front door or in a designated centralized collection area in the complex. No dumpsters are used [6]. Table 10 presents additional details of the program.

Material preparation requirements are also designed for easy and safe collection. Newspapers must be bundled, and other materials (co-mingled) must be placed in closed

Table 10. Program Summary-- Hillsborough, New Jersey

Association of Retarded Citizens, non-profit on contract	
Contact: Todd Teryek Recycling Coordinator 330 Amwell Rd. Neshanic, NJ 08853 201/369-4313	Wayne De Feo Somerset County P.O. Box 3000 Somerville, NJ 08876 201/231-7031
Starting date: 1/1987	
Population: 30,000	
Dwellings served: 11,000 single-, multi-family	
Vehicles: Step Vans	
Provider of regular garbage collection: private	
Materials collected (a):	
Paper: np and magazines (mixed), cc	
Metal: ac	
Glass: cg,gg,bg	
Misc.: --	
Frequency of collection: biweekly	
Degree of household sorting: np + magazines/ac + mg/cc	
Curbside sorting: no additional	
Same day as regular garbage collection? no	
Container specified? yes Provided? no	
Container description: plastic bags, newspaper bundled	
Participation (b): 50% setout rate	
Reduction estimate: 15% residential	
Reduction target: 25% residential, 15% commercial	
Ordinances: yes	
Volunteer activities: none	
Economic Incentives: none	
Costs:	
Collection and disposal: not available	
Collection and recycling: \$38/ton (net cost)	
Tipping fee: \$58/ton	
Other programs: commercial (also mandatory for cc, motor oil, office paper)	

(a) np = newspaper, cc = corrugated cardboard, ac = aluminum cans, tc = tin-plated cans, cg = clear glass, gg = green glass, bg = brown glass, mg = mixed glass, PET = plastic soda bottles, HDPE = plastic milk jugs.

(b) "Eyeballed" estimate of setouts.

plastic bags to facilitate stacking in the vehicles and minimize spillage. Because the program requires the use of plastic bags, the state has required that the plastic bags be recycled.

Future plans include adding collection of tin-plated food cans to the program next year. The community is also considering requiring the private trash collection companies, which provide regular trash collection for the community, to institute a per can rate for regular trash.

Minneapolis, Minnesota

The city of Minneapolis is a center of commerce for the North Central United States. The median age is 29.8, and 74.8 percent of adults have graduated from high school. Adults living below the poverty level represent 13.5 percent of the population. About 35 percent of the structures have four or more housing units.

Hennipin County mandated that all municipalities recycle 16 percent of their wastestream by 1990. Minneapolis selected two non-municipal operations to provide the service under contract. Supercycle, a subsidiary of a larger firm, already had the necessary capital equipment, and therefore could expand quickly to handle the program. Supercycle uses a mobile processing facility which reduces transportation costs, since transporting the denser, processed material is more cost-effective. Supercycle serves approximately three-fifths of the city's single-family homes. The remainder of single-family homes are served by the Education Recycling Center, a non-profit agency which

Table 11. Program Summary-- Minneapolis, Minnesota

**Supercycle, private;
Education Recycling Center, non-profit**

**Contact: Steve Beseke
Recycling Office
City Hall
Minneapolis, MN 55415
612/348-7564**

**Starting date: 1982
Population: 371,000
Dwellings served: 120,000 single-family
Vehicles: not available
Provider of regular garbage collection: private
Materials collected (a):
Paper: mixed,cc,flat cardboard
Metal: ac,tc
Glass: cg,gg,bg
Misc.: phone books (covers removed)
Frequency of collection: monthly
Degree of household sorting: complete separation
Curbside sorting: no additional
Same day as regular garbage collection? no
Container specified? yes Provided? no
Container description: plastic or paper bags**

**Participation: 25-30% setout
Reduction estimate: 5.1%
Reduction target: 14% by 1990
Ordinances: under consideration
Volunteer activities: publicity
Economic Incentives: none**

**Costs:
Collection and disposal: \$90/ton
Collection and recycling: \$35/ton
Tipping fee: not available**

Other programs: private dropoffs, pilot yard waste collection

(a) np = newspaper, cc = corrugated cardboard, ac = aluminum cans,
tc = tin-plated cans, cg = clear glass, gg = green glass, bg = brown glass,
mg = mixed glass, PET = plastic soda bottles, HDPE = plastic milk jugs.

works with high school dropouts or potential dropouts to encourage them to finish school by providing employment in its work-study program. Students go to classes four hours a day, and are paid to work four hours a day in the curbside or other recycling projects conducted by the Center. Employment is contingent on the students continuing in school. Secondary benefits to the community, such as reducing unemployment and crime rates, may be long-range results of helping students to stay in school.

The current program is summarized in Table 11. A pilot-scale study of biweekly collection showed significant increases in participation and tonnage. Other plans for city-sponsored recycling include a composting program which should divert an additional 6 to 7 percent of the wastestream. Biodegradable plastic bags for yard waste are being distributed free on an experimental basis to assess their usefulness. Buyback centers are not being emphasized because of the relatively low materials prices in the area due to an abundant supply. An incinerator, expected to be on line by 1990, is being built and operated by a private firm under contract to the County. The 1000 ton per day capacity was planned in conjunction with the County's effort to encourage source-separation of recyclables.

Rockford, Illinois

Rockford is a largely residential town in the Chicago metropolitan area. The median age is 29.9, and 66.8 percent of adults are high school graduates. Only 8.3 percent of adults live below the poverty level. About 16 percent of structures have four or more housing units.

Table 12. Program Summary-- Rockford, Illinois

Rockford Public Works, private hauler on contract	
Contact: John Cratty Cratty & Company 1639 N. Alpine Road Rockford, IL 61107 815/229-7944	Tom Tullock City Hall 425 E. State Street Rockford, IL 61104 815/987-5570
Starting date: 1985	
Population: 139,000	
Dwellings served: 47,000 (up to quadplexes)	
Vehicles: regular sideload trucks with internal racks	
Provider of regular garbage collection: municipality	
Materials collected (a):	
Paper: np	
Metal: ac	
Glass: cg,gg,bg	
Misc.: --	
Frequency of collection: weekly	
Degree of household sorting: np/ac/mg	
Curbside sorting: no additional	
Same day as regular garbage collection? yes	
Container specified? yes Provided? no	
Container description: clear plastic bags	
Participation (b): 52% (phone survey)	
Reduction estimate: 5%	
Reduction target: none	
Ordinances: none	
Volunteer activities: none	
Economic Incentives: "Cash for Trash" (tm) prize system	
Costs:	
Collection and disposal: not available	
Collection and recycling: not available	
Tipping fee: not available	
Other programs: private buybacks, yard waste (planning)	

(a) np = newspaper, cc = corrugated cardboard, ac = aluminum cans, tc = tin-plated cans, cg = clear glass, gg = green glass, bg = brown glass, mg = mixed glass, PET = plastic soda bottles, HDPE = plastic milk jugs.

(b) Participation was defined as a household setting materials out 90 percent of collection days.

Curbside collection is conducted by the city, with the assistance of a public relations firm. The city had previously modified the garbage collection vehicles and conducted curbside recyclables collection but had very low participation. In 1986, Cratty & Company began marketing the program. Their "Cash for Trash" (trademark) promotional scheme awards cash prizes each week to a qualifying household. A household is randomly selected each week, and, if no recyclable materials are present in its regular trash, the household receives \$1000, awarded by the private hauler and landfill (not the municipality). If the household selected fails to qualify, the prize money accumulates until a household does qualify. Including revenues from glass (which has just been added to the collection), materials sales are expected to more than cover the prize money. The curbside recycling program has not caused any increases in garbage collection rates, owing largely to terms of the contracts for collection and disposal. Contracts specify that a portion of the tipping fee must be contributed to an independent research consortium called Rockford Refuse Research, which researches new techniques for waste disposal, including recycling programs.

A telephone survey indicated that 52 percent of respondents reported setting out their recyclables 90 percent of the time. This rate may be exaggerated by the effects of self-reporting, which occurs when people are asked to report their own behavior, and by the 22 percent non-response rate. Non-respondents, who were not included in the calculations, probably include a high number of non-participants, which would lower the participation rate.

A summary of the current program is included in Table 12. There are no plans to expand curbside service to residents living in buildings with four or more units. These

residents are felt to be adequately served by the two private buyback operations in the area. An anti-scavenging ordinance is in place but is not enforced.

San Jose, California

San Jose is located in the Silicon Valley of California, a center of high technology industry. The median age is 27.4, with 76.4 percent of adults having graduated from high school. The percent of adults living below the poverty level is 8.2. Approximately 19 percent of structures have four or more housing units.

The curbside recycling service is provided by a private hauler with an exclusive contract with the city secured through a competitive bidding process in 1984-1985. The company had capital resources available which allowed a quick program start-up in response to a mandate by the city council to reduce waste going to final disposal by 32 percent by 1994. Competitive bidding for the garbage collection and disposal contracts will save San Jose an estimated \$62 million over the 30 years of the contract. These savings, along with the rebate of disposal costs avoided by recycling which is required in the new contract, will fund the six-year, \$19 million recycling strategy [39].

A pilot program was begun in May 1985, and several operational techniques were used. Participation, defined as one setout per month, was highest in areas provided three-tiered stacking containers that received curbside recyclables collection on the same day as regular trash service, so the program now provides this type of service city-wide. Participation was determined to be approximately 64 percent, based on a survey in which

Table 13. Program Summary-- San Jose, California

<p>Recycle America, Inc., private firm on contract</p> <p>Contact:Christine Velez City Hall, Room 460 801 N. First Street San Jose, CA 95110 408/277-4000</p> <p>Starting date: 1985 Population: 713,000 Dwellings served: 60,000 (up to quadplexes) Vehicles: 3-bin hydraulic dumper trucks Provider of regular garbage collection: private franchise Materials collected (a): Paper: np Metal: ac,tc Glass: cg,gg,bg Misc.: -- Frequency of collection: weekly Degree of household sorting: np/mg/cans Curbside sorting: no additional Same day as regular garbage collection? yes Container specified? yes Provided? yes Container description: 3 stackable bins</p> <p>Participation (b): 64% participation (calculated) Reduction estimate: 7% Reduction target: 32% by 1994 Ordinances: none Volunteer activities: publicity Economic Incentives: none</p> <p>Costs: Collection and disposal: \$50/ton Collection and recycling: \$30/ton Tipping fee: \$8/ton</p> <p>Other programs: none</p>

(a) np = newspaper, cc = corrugated cardboard, ac = aluminum cans, tc = tin-plated cans, cg = clear glass, gg = green glass, bg = brown glass, mg = mixed glass, PET = plastic soda bottles, HDPE = plastic milk jugs.

(b) Factor developed from direct measurement.

addresses of households setting out recyclables were recorded for one month. Participation rates appear to correspond to 2.5 times the weekly setout rate.

The program currently serves single-family homes and multifamily dwellings of up to four units. Condominiums which receive municipal garbage service will soon be included [40]. Additional details of the collection program are shown in Table 13.

Seattle, Washington

Seattle, a major city in the Pacific Northwest, has a population with a median age 32.4, and 79.7 percent are high school graduates; 11.2 percent of adults live below the poverty level. One-third of the city's structures have four or more housing units.

Two private waste collection firms provide curbside recyclables collection for Seattle, each firm having an exclusive franchise for half of the city. Although the two franchises have different ways of providing service, the city felt that both provided equivalent convenience to residents. The northern half of the city receives weekly pickup of separated recyclables, and is provided with 3-in-1 containers. The southern half of the city receives monthly collection of co-mingled recyclables, and is provided 30-gallon, wheeled containers.

The curbside program was conducted on a pilot scale between November 1986 and April 1987, collecting only mixed paper and tin-plated food cans. City-wide operation began in February 1988, adding newspaper, glass, and aluminum cans [41]. A summary of the program is in Table 14.

Table 14. Program Summary-- Seattle, Washington

<p>City of Seattle, two private franchises on contract</p> <p>Contact: Don Kneass Seattle Engineering Department 710 Second Av., Room 750 Seattle, WA 98104 206/684-7649</p> <p>Starting date: 11/1986 pilot Population: 500,000 Dwellings served: 3,765 single-family (pilot) Vehicles: varies Provider of regular garbage collection: private Materials collected (a): Paper: np,mp Metal: ac,tc Glass: cg,gg,bg Misc.: -- Frequency of collection: weekly or monthly Degree of household sorting: np/mp/cans/mg or none Curbside sorting: no additional Same day as regular garbage collection? no Container specified? yes Provided? yes Container description: 3-in-1 bins or 30-gal wheeled cans</p> <p>Participation (b): 52% participation (direct measurement) Reduction estimate: not available Reduction target: 24% from curbside Ordinances: none Volunteer activities: none Economic Incentives: variable can rate for trash</p> <p>Costs: Collection and disposal: not available Collection and recycling: \$24/ton (includes avoided cost) Tipping fee: \$31.50/ton</p> <p>Other programs: dropoffs, composting information, office paper collection, Christmas tree collection, zoo manure compost</p>
--

(a) np = newspaper, cc = corrugated cardboard, ac = aluminum cans, tc = tin-plated cans, cg = clear glass, gg = green glass, bg = brown glass, mg = mixed glass, PET = plastic soda bottles, HDPE = plastic milk jugs.

(b) Participation was defined as one setout per month.

Rates for regular trash service are based on the number of cans a household needs for disposal ("variable can rate"), a system that provides an economic incentive for waste reduction. A study of the new rate system found that a large majority of customers favor the variable rate. City-wide recycling tonnage had increased significantly since the variable rate was instituted in 1982, and the amount of garbage produced has declined [25]. Direct saving from the variable rate has not yet been realized by the municipality because the current waste disposal contract is based on a fixed, per household rate, so reduction in total volume or tonnage does not translate into decreased costs. Future contracts will allow cost adjustments for waste reduction.

Somerville, New Jersey

Somerville, a town in southern New Jersey, has a population with a median age of 32.9; 73.6 percent of adults are high school graduates. Only 7.5 percent of adults live below the poverty level. About 26 percent of structures have four or more housing units.

Somerville began providing curbside recycling service in 1984, a year before it was mandated by state law. Initially the borough contracted the service to private firms, which proved unsatisfactory for both political and economic reasons.⁴ After the borough's landfill closed, the borough quit providing garbage collection, contracted garbage collection to a private firm, and reassigned garbage collection staff and equipment to curbside recyclables collection. The packer trucks formerly used for municipal

⁴ Political support at that time was limited and local leaders expected the program to be self-supporting. Since then, rapid increases in tipping fees have led to greater acceptance of recycling as a waste disposal option. Tipping fees increased from \$17 per ton in January 1987 to \$97 per ton in January 1988.

Table 15. Program Summary-- Somerville, New Jersey

<p>Borough of Somerville, municipality</p> <p>Contact: Jeanne Moore Borough of Somerville P.O.Box 399 Somerville, NJ 08876 201/725-2300</p> <p>Starting date: 1984 Population: 34,000 Dwellings served: 12,000 single-family Vehicles: Old packer trucks with external bins Provider of regular garbage collection: municipality Materials collected (a): Paper: np, cc(commercial) Metal: ac Glass: cg,gg,bg Misc.: leaves Frequency of collection: biweekly Degree of household sorting: complete separation Curbside sorting: no additional Same day as regular garbage collection? no Container specified? no Provided? no Container description: --</p> <p>Participation: 90+ % participation ("eyeballed") Reduction estimate: 1.6 million lbs. news (1985) Reduction target: 25% Ordinances: yes Volunteer activities: none Economic Incentives: fines for repeated non-compliance</p> <p>Costs: Collection and disposal: \$70/ton Collection and recycling (b): \$20/ton Tipping fee: \$97 (1/88)</p> <p>Other programs: dropoffs (including cc,aluminum scrap)</p>
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(a) np = newspaper, cc = corrugated cardboard, ac = aluminum cans, tc = tin-plated cans, cg = clear glass, gg = green glass, bg = brown glass, mg = mixed glass, PET = plastic soda bottles, HDPE = plastic milk jugs.

(b) Includes avoided costs (in January 1987) of \$17/ton.

garbage collection have been fitted with external bins to accommodate the separately-collected materials. Collections are roughly twice a month on Wednesdays. (Half of the households are serviced on odd dates, half on even dates.) No attempt is made to coordinate collection with garbage collection. Further details of the program are included in the summary, Table 15.

The program was initially voluntary, but Source-separation was mandated in December 1986. Girl Scouts act as "block leaders" to promote participation. Participation has been estimated by the program spokesman to be above 90 percent, based on observation of setouts. A high degree of public awareness is attributable to the now-infamous "garbage barge" from Islip, New York., as well as increasing waste disposal costs in the community.

The current waste disposal contract is based on a "standard load" basis, so the municipality is unable to realize savings from waste reduction except by negotiating the size of a standard load. Future contracts may allow disposal costs to be adjusted according to waste amounts.

Commercial establishments are also required to source-separate not only newspaper, glass and aluminum cans, but also corrugated cardboard, which is handled on separate collection routes. Corrugated cardboard from commercial sources has been banned from the landfill. Many haulers, faced with having to prove the origin of the cardboard, have stopped collecting it from residential sources as well. Aluminum scrap and white goods are collected by the municipal recycling staff on an "will call" basis.

Chapter 4: Discussion and Analysis

The case studies included in this report represent a wide range of situations in which curbside recycling is currently conducted. The purpose of this chapter is to examine curbside recycling strategies used in the case studies and provide insight into why a particular technique is used, its effectiveness, and the transferability of an approach. Discussion will address aspects of the case studies pertinent to four areas-- administrative systems, collection and processing systems, promotional systems, and program evaluation techniques.

Administration

Examples of four types of administrative systems were found in the case studies:

- municipal;
- private firms on contract;

- non-profit organizations on contract or subsidy; and,
- mixtures of the above systems.

Municipalities

If existing recycling services are not adequate, or simply not available, the municipality may be able to provide the service. If the municipality also provides regular garbage collection, existing capital equipment or facilities might be modified to accommodate the needs of the developing curbside recycling service.

Curbside recycling programs are operated completely by the local public works department in Barrington, Rhode Island, and Charlotte (Mecklenburg County), North Carolina. In these communities, no existing services were available, and garbage collection has traditionally been done by the municipality. Mecklenburg County purchased specialized trucks for collection and has leased existing warehouse for an interim processing center. An interlocal agreement with the City of Charlotte allows the use of City personnel for collection, while the County owns and maintains the vehicles. Barrington, Rhode Island, has operated its program with municipal staff since the beginning of the program in 1974.

Somerville, New Jersey, has placed the responsibility for curbside recycling on the municipal department which previously provided garbage collection. In 1984, the borough of Somerville began contracting with a private collection firm to provide curbside recycling. At that time, Somerville owned and operated its own landfill and garbage collection. After a year and a half of unsuccessful operation (and coincident with the

closing of the borough landfill), the borough assumed operation of the curbside recycling program and began to contract a private firm for garbage service. The municipal staff and equipment that previously did the garbage collection would be used to conduct the curbside recycling service, and the old packer trucks were fitted with external bins to accommodate the separately-collected materials. Economic and political factors have played a part in the changing success of the program. When the program was started with private firms, political support was limited and the program was expected to be self-supporting. Now, costs of disposal have increased geometrically (partially because the closing of the borough landfill resulted in increases in hauling distances and tipping fees), swaying political support for providing the service.

Private collection firms under contract

Garbage collection by a private firm under contract to the city was the administrative arrangement familiar to residents of San Jose, California. It was also the method to be used in the curbside recycling program, but city solid waste management officials wanted to do more than simply add recycling to the existing contract for garbage collection. The city implemented a competitive bidding process for the garbage collection and disposal contracts, which applied to the new contract for curbside recycling as well. Because of savings from the competitively-bid contracts, the city was able to lower monthly garbage rates by \$0.80 per household (to \$5.81) while budgeting over a million dollars for the expansion of recycling activities.

San Jose's success with increasing the competitive nature of contracting private haulers benefitted all aspects of waste management in that city by reducing costs [42]. To im-

prove long-range planning, disposal contract conditions require that scales be installed and every truck weighed and that the disposal company provide a location for waste analysis every five years. Contracts also specify that tipping fees (\$8 per ton) avoided as a result of recycling be rebated to the city.

Seattle, Washington, is accustomed to free competition among many waste haulers in the city that contract with individual households within a franchise system. Rather than award one contract for curbside recycling services, the city divided the service area in half and awarded exclusive franchises to two companies. A pilot study was done using only newspaper and tin-plated cans. City-wide service began in Fall 1987. The benefits of using two private collection firms will not be evident until the program has operated longer.

Non-profit organizations under contract or subsidy

Programs in Ann Arbor, Michigan, and Berkeley, California, are conducted by non-profit environmental organizations which had provided curbside recycling service prior to community sponsorship. The non-profit programs began out of environmental concern; awareness of environmental issues has been abundant in these university towns. The community was able to take advantage of the momentum of these existing operations when municipal officials became interested in encouraging recycling to reduce waste disposal needs. The city of Berkeley estimates that contracting with the Ecology Center to provide the curbside recycling service saves the city approximately \$100,000 per year compared to the city providing the service with municipal staff and equipment. Cost savings result primarily from lower labor costs [34].

Citizens in Berkeley have defined a goal of recycling 50 percent of the wastestream by 1991. Such an ambitious goal is a noteworthy indication of the serious intention of the community to recycle. Ann Arbor is limited by two significant disincentives to setting more urgent recycling goals-- a low landfill tipping fee and the absence of user's fees for garbage collection (which is financed through general tax funds).

Berkeley has recorded overall participation of 13 percent in the monthly collection program, and Ann Arbor has an average monthly setout rate of 20-25 percent. Money from city contracts has helped the programs improve their services, and further improvements are planned, including weekly collection and provision of containers, which are expected to improve participation.

Combination administrative systems

Quite often a mixture of administrative approaches was encountered in the cases studies. In Austin, Texas, private firms have not been used for garbage collection in the past, and there are no non-profit agencies operating curbside recycling programs already. Providing the pickup through the municipal solid waste management system is a ready option. However, only collection is handled by the municipality; processing and marketing of all materials except newspaper is done by a non-profit organization. In this way, Austin is able to avoid the capital expense of building, owning, and operating a processing center and can provide community support for the non-profit processing center which provides jobs for the handicapped.

Minneapolis, Minnesota, divides curbside recycling responsibilities between two types of organizations--a private firm collects and processes recyclables from about three-fifths

of the city, a non-profit organization services the remaining two-fifths of the city's households. Both organizations provide complete collection, processing, and marketing services for their designated service area. The private firm is a subsidiary of a larger company which had available capital and expertise which could be used to provide an efficient operation in a short amount of time. The non-profit organization, the Education Recycling Center, is a work-study program for potential high school drop-outs.

Operations

Separate analysis of every operational variable in each case study would exceed the scope of this report; therefore approaches used in selected programs are discussed. Because of the interrelatedness of variables of collection, processing, and marketing, discussion will focus on the following groups of related variables:

- materials collected, degree of separation required, and post-collection materials processing techniques;
- collection frequency, coincidence with garbage collection ("same day" collection), provision of in-home containers; and,
- collection vehicles.

Materials collected, separation requirements, processing

Minneapolis, Minnesota, is aggressively working to recycle a large portion of the wastestream, including virtually every household waste item but plastic and food waste. Collection and recycling costs only \$35 per ton compared to \$90 per ton for collection and disposal, so market prices of materials become relatively unimportant. Mixed paper, corrugated and flat cardboard, aluminum and tin cans, glass, and even phone books (covers removed) are included in collection. Households are required to separate materials completely for the monthly collection. Supercycle, the private firm that services three-fifths of the city's households, uses a mobile processing center that reduces centralized processing and improves the efficiency of transporting material. Materials processing, such as magnetic sorting and densifying of cans or baling of paper, can be done near the point of collection. Transportation of the denser, processed materials is more cost-effective.

Austin's collection includes aluminum cans and scrap, steel cans, tin cans, and all colors of glass. Households are required to separate materials into six components, which are collected in six-section collection trailers. A 25 cubic yard packer truck serves as a transfer truck for the newspaper, which marketed directly by the municipality. Other materials are taken to a processing center owned and operated by Ecology Action Community Recycling. Austin's contract with this non-profit organization eliminates the need for the municipality to build and operate its own processing center or to market the materials.

Mecklenburg County (Charlotte), North Carolina's, program includes newspaper, glass, and aluminum cans--materials with steady markets and relatively high value-- and PET.

Polyethylene terephthalate, a plastic commonly used for carbonated beverages, does not have a high market value, nor does it comprise a large portion of the total wastestream, but its use is increasing rapidly and the common plastic soda bottle is easily identified by the public. Markets for PET are developing rapidly and there is pressure on soft drink manufacturers to provide for the recycling of PET.

Households in Charlotte's program are not required to separate materials for setout, except that newspaper should not be mixed in with the other recyclables. Currently, collection staff separates materials into three sections of the specialized, three-compartment dumper truck. Studies are being done to determine the most effective combination of curbside and post-collection sorting. (Because collection labor is more expensive than processing labor, intermediate sorting at the curb may be curtailed.) Materials are taken to the County's processing center for further sorting and processing, which includes grinding of color-sorted PET, color-sorting and breaking glass, and crushing aluminum cans. Newspaper is sold unbaled at this time. The County arranges for the marketing of all materials.

The E.C.Ology program, a service of the El Cerrito, California, municipal government, clearly demonstrates the interconnectedness of collection and processing decisions. Selection of materials collected in this program was affected by some unusual local markets-- for mixed glass and California wine bottles⁵ --and includes a mixture of high and low value items. No revenue is produced from magazines or used motor oil, but it is the policy of the City Council to continue to collect these materials. Recyclables are separated by the household into four components-- newspaper, magazines, mixed glass, and cans. Collectors further separate wine bottles from the glass and tin cans from alumi-

⁵ The bottles are sold to a reprocessing firm named Encore! which washes and sterilizes them and sells them back to California wineries. Encore! operates in several California communities.

num cans, into six 1.5 cubic yard containers on a flatbed collection truck. This system increases labor during collection but decreases the labor and equipment required for post-collection handling. The containers from the collection vehicle are emptied by rotating-head fork lifts directly into larger storage containers to await marketing.

The collection of materials of little or no market value is hotly debated. It is sometimes suggested that the materials should be collected and saved in anticipation of the development of future markets, if no market currently exists. Markets are essential to reintroduce secondary materials into the manufacturing process, and if this does not happen recycling has not occurred. Stockpiling of materials without a current market is unlikely to bring about recycling unless an aggressive market development strategy is being pursued. Seattle is one community that is attempting to stimulate the demand for secondary material through purchasing policies that favor the acquisition of products using recycled material.

Collection frequency, "same day" collection, in-home containers

Somerville, New Jersey, changed from municipal to private garbage service and assumed operation of the curbside recycling service when its landfill closed in 1985. Existing municipal garbage collection staff was reassigned to curbside recycling collection and processing. Collections are approximately twice a month (half of the homes are serviced on Wednesdays with odd dates, the remainder on Wednesdays with even dates) and is not coordinated with garbage collection days. Separation of all materials is required and containers are not provided. Participation is mandated and is estimated to be in the range of 90 percent.

Ann Arbor, Michigan, currently collects recyclables once a month and makes no attempt to coordinate recycling with garbage collections. In-home containers are not provided, but a pilot-scale study in which households were given containers showed increases in participation [43]. Efforts are being made to finance in-home containers for all households served and increase collection frequency, which is also expected to increase participation.

San Jose, California, contracts with a private firm for curbside recycling. Several collection schemes were tried on a pilot scale and participation was found to be highest in neighborhoods provided with in-home containers and weekly collection on the same day as garbage collection [40]. The containers are three-tiered, stacking containers in the thematic colors of the publicity campaign. The three bins accommodate newspaper, mixed aluminum and tin cans, and mixed glass. No separation is done by collectors at the curb but additional sorting and processing is centralized.

Austin, Texas, initially charged a small fee to offset the cost of in-home containers but found participation increased notably when the fee was abolished [44]. The containers are nesting buckets which can be stored compactly. The weekly collections are not coordinated with garbage collection although both are municipal services.

Collection vehicles

Rockford, Illinois, has been able to use its regular garbage trucks for simultaneous collection of garbage and recyclables. The conventional side-loading garbage trucks were fitted with racks in the rear section to accommodate bundled newspapers and plastic bags of aluminum cans and mixed glass. Clear plastic bags were found to be necessary

for the collectors to distinguish recyclables from garbage, since many residents use garbage bags rather than cans for all garbage.⁶

Curbside recycling in Boulder, Colorado, is provided by an independent, non-profit service, without a contract with the town. EcoCycle was begun in the 1970s, using used school buses and vans and volunteer labor. Support for the program by community residents has allowed the agency to provide increasingly professional service on a very modest budget. EcoCycle has developed a system of "tandem routes" which helps use equipment not specifically designed for recycling. The same route may be run by more than one truck, each collecting one or more particular material. Old packer trucks are used to collect newspapers; a variety of trucks and buses are used for other materials. Effort must be made to publicize the tandem collection method, to avert confusion of residents when materials are collected at different times during the collection day. Nevertheless, tandem routing has been found to increase processing efficiency (especially in unloading operations), while allowing practical use of a variety of vehicle types.

Increasing the use of specialized collection vehicles and paid staff, and reducing the use of volunteer labor for collection have made the curbside service more reliable. Efforts are being made to enable the program to provide in-home containers and weekly collection as ways of increasing participation.

Hillsborough, New Jersey, is participating in a county-organized program contracts with the Association for Retarded Citizens (ARC) to provide both collection and processing services. Decisions about capital equipment and collections methods were made with

⁶ Clear bags were not currently available in the marketplace, so program managers worked with manufacturers to arrange retail distribution of suitable bags at a reasonable price. Clear bags also facilitate sorting the recyclables, which is done by a private recycling firm that also markets the materials.

the needs of the handicapped workers in mind. Delivery vans were selected as collection vehicles because of their flexibility and ease of operation, although they are less efficient to operate than larger, specialized vehicles. Using the vans and plastic bags (which do not have to be returned to the household) enables the ARC to provide "modified curbside" service to multifamily dwellings with the same equipment and very little change in the curbside pickup technique.⁷ Specifications for setout of material are designed to minimize risk of injury to the ARC workers. Comingled materials must be put out in closed plastic bags, which minimizes handling and the risk of spilled, loose materials in the truck. Newspapers must be tied in bundles to facilitate stacking.

Charlotte, North Carolina, was able to begin its pilot program with two specialized recycling collection vehicles. After testing the two styles for operating efficiency and convenience of loading and unloading, county staff was able to work with a manufacturer on a customized design that combined the best features of both designs. The customized vehicles will be used in city-wide implementation. Increased efficiency and convenient loading and unloading features can be significant for high-volume programs, but specifications should be carefully considered with respect to program needs.

Promotional systems

Three types of promotional methods were encountered in the case studies. Discussion of selected programs provide examples of:

⁷ Few other programs attempt service to multifamily dwellings of more than four units; those that do typically use centralized dumpster systems, which require different collection equipment. Often, households in multifamily complexes are simply encouraged to use dropoff or buyback centers.

- publicity;
- personal contact;
- economic incentives; and
- mandatory ordinances.

Publicity

Printed information and media announcements are basic promotional tools; almost every case study used some form of instructional material informing residents about how to participate. Charlotte, North Carolina, is one of the case study programs to have a professionally-developed promotional program which includes high-quality graphic work, a logo, and a color theme which is carried through promotional material and even to the in-home containers. The promotional campaign has been developed by a public relations consultant to Mecklenburg County. The consultant has been working with the recycling program since its inception, helping to select the "warm red" color scheme and designing the logo. Mailouts, public service announcements, and press releases are overseen by the public relations firm. The public relations consultant also devotes time to pursuing human interest stories to pass along to the newspaper for additional press exposure. Among the printed materials developed for the program are door-hangers (cardboard pieces designed to be hung on doorknobs), which allow residents to hang the reminder close to the place they do the recycling in their homes. A tag was designed to be placed in in-home containers when inappropriate material is found in the recycling

container. These pieces are designed to present recycling information to the residents in close proximity to the location where the desired recycling behavior occurs.

Mecklenburg County's promotional approach was developed along with the program, so it is not possible to judge its effectiveness in a "before-after" analysis. However, because the program is still in pilot stages, setouts have been monitored closely, and it was noticed that setouts increased by 5 to 8 percent on weeks following specific mailouts to the pilot neighborhoods. Findings of the El Cerrito, California, program indicate that direct mail with instructive messages were most effective in increasing curbside participation. Paid advertisements were most effective for promoting buyback centers [3].

Personal contact

Publicity can be very effective when personal contact is involved. EcoCycle, the curbside recycler in Boulder, Colorado, pioneered the use of volunteers to boost participation by personal reminders. A network of these volunteers, called block leaders, post reminders of pickup days and distribute information about the program to people on their block.

The impact of volunteer "block leaders" on participation was first observed during a 1980 drive for city grant funding. A group of interested citizens was contacting neighbors to solicit signatures for petitions, and during that period of personal contact in the neighborhood, participation in the recycling program rose from an average of 20 percent to 50 to 100 percent in some neighborhoods. As a result, the block leader program was instituted as an ongoing project. In 1982, Atlantic-Richfield supplied matching funds for a Volunteer Coordinator position on the EcoCycle staff. By early 1987, 800 Block

Leaders work with EcoCycle, and the block leader concept has been applied in approximately 35 cities in the United States [23].

The use of block leaders was shown to increase participation in a study of the San Jose, California, program [45] and has been widely emulated because it can be adapted to a variety of management situations. For example, Austin, Texas, (a municipally-run program) uses publicity volunteers; Ann Arbor, Michigan, is a non-profit organization on city contract, and uses block leader-type volunteers; Astoria, Oregon, uses volunteers to publicize its privately-operated operation. Volunteers for publicity can also be used in conjunction with other types of publicity techniques. With a relatively low start-up cost, block leader programs can be implemented on a pilot scale in selected neighborhoods of a community to test its effectiveness.

Economic incentives

Economic incentives are used in several case studies as a way to encourage participation. Examples of economic incentives found in the cases include tax deductions, utility bill credits, cash bonuses, and garbage rates which vary with the level of service.

Fresno, California, ran its recycling program as a municipal service for several years prior to 1987, when a private company (operator of the Rice Roads Dump) assumed operation of the program. The municipality had provided a \$.40 credit of the monthly utility bill of any household which participated in the monthly pickup. The new firm was not able to continue the utility credit plan, so began to look for other methods to bolster participation, which had fallen to an estimated 5 percent. Collection frequency was increased to weekly, and the for-profit company introduced the trademarked "Waste

Watchers" system of profit-sharing with non-profit community groups, a type of "cause marketing." The groups contribute members' time toward enrolling subscribers in the program, and every quarter the group receives a percentage of the gross profits, based on the groups' contribution to subscriber enrollment. The recyclables can be considered a donation to the non-profit group the participant designates, which is an additional motivation for residents to cooperate in the program. In this way, non-profit groups that use recycling to raise funds can continue to benefit from recycling. Setouts are recorded by address, and a receipt for tax purposes is sent to the participant, based on a fixed value per setout. A six-month perfect setout record is additionally rewarded by a free pass to the landfill for dumping of bulky trash.

Participation showed a drop from about 12 percent to 3 percent after an incentive system of utility bill credits for participation in the monthly collection was discontinued [46]. The complete impact of the new incentive program on participation can not be determined until more time has elapsed. Results of the first few weeks of the program (during July 1987) showed a promising level of public interest, with residents enrolling in the curbside program at the rate of 200 per day. If the target of 100,000 subscribers is reached, 66 percent of the eligible households will be enrolled.

The purpose of Seattle's variable can rate for trash is to motivate people to reduce the amount of trash they produce. Because the rate is based on the number of cans picked up, a household will save money by minimizing the number of cans needed. The curbside recycling program is provided as a convenient way to reduce trash collection needs.

A detailed report on the efficacy of the variable can rate done by Seattle's Engineering Department [25], states that the program does indeed serve to reduce trash production.

Few households failed to comply with the level of contracted service. As for the impact of the variable rate on recycling, answers are not yet available. The curbside program has only been in city-wide operation three months, and impacts of other variables will have to be discerned from the effects of the variable can rate for trash if possible.

Rockford, Illinois, has a municipally-operated program which operated for several years with little publicity and a negligible level of participation. A public relations firm was awarded a contract in 1986 to implement a publicity program of their design, called "Cash for Trash." The polka-dot truck of the Trash Man is a now-familiar sight; he inspects, each week, the garbage of one randomly-selected household for that week. If there are no recyclable materials in the garbage, the household receives \$1000. This reward system does not penalize households who may donate their recyclables to charitable organizations or recycle for income. The objective of the "Cash for Trash" program is not necessarily to gain participants in the city-sponsored program, but to keep recyclables out of the wastestream by any means a household chooses to use. After more than a year of "Cash for Trash," participation in the recycling program is estimated to be 52 percent, as reflected in a telephone survey in which participation was defined as setting materials out 90 percent of the time.

Mandatory source-separation

Another motivating tool is the source-separation ordinance. Several states and towns have passed laws requiring source-separation of recyclables or banning disposal of designated materials. In Barrington, Rhode Island, source-separation of mixed paper was mandated by a local ordinance passed in 1974. Mixed paper is collected in the first week

of each month, and a 75 percent rate of participation has been recorded. Other materials-- glass and aluminum cans-- are collected the third week of the month; participation is only 30 percent. The cans must be separated from the glass and glass must be separated by color. It is not clear whether the difference in participation is a result of the varying amount of materials separation involved or due to the mandatory ordinance for mixed paper recycling.

Somerville, New Jersey, also has mandatory recycling, required by a local ordinance passed a year before the state mandated recycling. Materials separation requirements are extensive; nevertheless, participation is near 90 percent, according to "eyeballed" estimates by program staff.

Astoria, Oregon, provides curbside recycling in response to the state law requiring the community to provide curbside recycling service. Source-separation by residents or waste haulers is not required, and there is no restriction on disposal of recyclables. The setout rate for the biweekly collections is approximately 20 percent, which is not comparable to programs with source-separation ordinances.

Evaluation

Techniques used by case study programs to evaluate the effectiveness of curbside recycling consisted mainly of three criteria:

- participation,

- waste reduction, and
- cost.

Participation

The presence of participation data was a criterion for the selection of case studies for this report, so all programs had some type of indicator. Setout rates, though not exactly equivalent to participation rates, were used in several programs to monitor the use of the curbside service. Programs using setout data in lieu of participation data included Ann Arbor, Michigan; Astoria, Oregon; Boulder, Colorado; Hillsborough, New Jersey; and Minneapolis, Minnesota. With the exception of Astoria and Hillsborough, which are biweekly, these programs are monthly collections.

The most common method of measuring participation was direct measurement by recording addresses of households setting out recyclables over a period of several collection days. Austin, Texas; Berkeley, California; Charlotte, North Carolina; El Cerrito, California; and Seattle, Washington, conducted such surveys for periods of one to four months. All of the weekly collection programs defined participation as one setout per month.

San Jose and Berkeley, California, have previously measured participation directly, and have developed factors that relate participation to setout so that participation could be monitored more closely with less effort. San Jose, a weekly collection that defines participation to be one setout a month, has found that participation equals 2.5 times the

setout rate. Berkeley's definition of participation would be met by ten setouts in a year of monthly collections.

Other ways of determining participation include estimations using subscription records, telephone surveys, and "eyeballed" estimates. Subscription records would be a fairly good indicator, since people would be unlikely to sign up if they did not intend to use the service, but use of this method is restricted to programs which only serve homes that subscribe. Most of the case studies provided curbside recycling to any home on the route that chose to set materials out for collection. Telephone surveys are subject to problems associated with any survey-- people reporting on their own behavior tend to over-estimate their actual performance and some people selected for the survey decline to answer any questions. The extent to which these errors affect the results is uncertain. "Eyeballed" estimates may be fairly representative of participation, and if they are done consistently, they may be useful in following changes within a program over time. Consistency would be difficult to ensure between two or more programs, though, so such estimates are of limited usefulness.

Waste diversion

Twelve of the case study programs kept records of the amount or percentage of the wastestream that is diverted from final disposal (i.e., landfilling or incineration) as a result of the curbside recycling program. Total amounts diverted are helpful in tracking progress within a program, but the percentage of the wastestream diverted is more useful for comparisons between programs. Comparison of waste diversion rates is hindered by inconsistencies in calculations. For instance, is the percentage based on weight of

volume? What waste components are included in the calculation? In the numerator, are only materials from the curbside program included, or are materials from dropoff centers, yard waste collection, or other special-material programs included? Does the denominator refer to the residential or the total municipal wastestream? Barrington, Rhode Island, records the waste diversion in just the paper fraction of the wastestream, a technique that provides the clearest statement of the impact of recycling a material.

Cost

Three cost indicators were used in the case studies, although not all were available for all programs: collection and disposal, cost of collection and recycling, and tipping fees. Some programs provided copious detail on program finances, which can be quite useful, but for purposes of this report more synoptic data were used.

Almost all programs reported tipping fees, which are sometimes calculated as an "avoided cost," and considered as a revenue to reduce the recycling program cost. Some programs, such as Somerville, New Jersey's, cannot consider avoided disposal cost as a source of revenue because of the terms of the existing waste disposal contract, which is based on a fixed number of loads. Reduction in the number of loads does not result in saving waste disposal costs.

Many programs calculate the cost of collection and disposal and the cost of collection and recycling on a "per ton" basis. These cost data are quite helpful in showing the comparative costs. In interpreting these costs, care should be taken not to oversimplify their relationship-- increased recycling will not necessarily lead to a unit-for-unit reduction in waste disposal because the capital requirements for waste disposal might not

be reduced. For example, if collection and disposal costs are \$90 per ton and collection and recycling costs are \$30 per ton, recycling one ton of material does not necessarily save \$60. The one ton reduction of waste may not reduce the number of trucks or crew or supervisors needed to carry out regular waste disposal, so the savings realized by the first ton recycled is something less than \$60. The marginal savings will increase as a larger portion of the wastestream is recycled.

Any cost data must also be scrutinized with respect to what costs and revenues are included. El Cerrito, California, calculates a small "profit" of about \$5 per ton from their recycling program, E.C.Ology. Because of its administrative arrangement, however, it is able to exclude many costs that other programs would have to include, such as administrative staff salaries and overhead, accounting and payroll services, staff fringe benefits, land for the processing center, equipment replacement and some maintenance costs. These items are provided as in-kind services by the municipality. Internalizing as many costs and revenues into program budgets would provide for better comparisons of the net costs of curbside recycling.

Chapter 5: Summary and Conclusions

In this study, review of the literature and case studies were used to examine current practices in curbside recycling in the United States. Four areas of interest to program planners were discussed-- administrative arrangement of the program, operational systems, promotional methodologies, and evaluation techniques. Summary and conclusions for each area of interest follow.

Administration

The selection of an administrative system should serve to maximize service within the political and financial constraints of the community. Program administration practices in the case studies included: (a) complete ownership and operation of all program components by municipal public works departments, (b) contracting the program to a waste management firm, (c) contracting with or subsidizing a non-profit organization that currently provides curbside recycling, and, (d) contracting individual components of the

program separately, combining the above approaches. Although none of the systems was found to be completely inadequate, there were differences in the effectiveness of certain strategies, as stated below.

- Higher levels of service were provided by municipal, non-profit, or private service providers that used paid collection staff than by agencies using volunteer collection labor.
- Lower levels of service were generally, but not always, associated with lower participation rates.
- Program effectiveness was not substantially linked to whether the curbside service was operated by the provider of regular garbage collection for the community.
- Use of private firms in competitive market conditions provided substantial cost reductions in case study programs where competitive, private collection was used.
- Contracting services for separate components of a program proved beneficial in reducing both capital and labor costs while maintaining high levels of service in case studies that subcontracted post-collection processing services.

Operations

Exact detailing of all processes and equipment involved in the collection, processing, and marketing of recyclables was not within the scope of this report. Overviews of the op-

erational systems used in the case studies showed a broad spectrum of methods used and levels of service provided, which reflects the various practical and political constraints of the programs. Operational variables examined in this report included: (a) choice of materials to be collected, (b) degree of materials separation required of the household, (c) type of collection vehicle, (d) collection frequency and coincidence with garbage collection, (e) provision of in-home containers, and (f) extent and method of post-collection materials processing. These variables were evaluated based on the case studies in this report, which support the following conclusions.

- The practicality of accepting low-value materials increases as the cost of waste disposal increases, as the cost-avoidance benefits of maximizing waste diversion overtake the revenues from materials sales.
- Case studies suggest that materials separation is not the dominant factor in a household's decision to participate.
- Use of available, used garbage collection vehicles, suitably modified, was regarded by program coordinators as beneficial in reducing program start-up costs, although specialized collection vehicles were generally preferred for use in high-volume programs.
- Increasing collection frequency and providing specialized containers for use by the household were shown to increase participation.
- Experience in one case study suggests that collection of recyclables on the same day as regular garbage pick-up encourages participation, although the extent of the impact could not be estimated.

- Methods of materials separation and processing during and after collection varied greatly among the case study programs, suggesting that additional evaluation is needed with regard to efficiency of techniques and the impacts of local markets for materials and labor.

Promotion

The effects of various promotional ideas on participation were more pronounced than operational factors, and generally were better documented. Methods used in the case studies to encourage participation fell into four categories: (a) publicity and education, (b) personal contact, (c) economic incentives, and (d) source-separation ordinances. Review of the case studies support the following conclusions.

- Publicity and public education were essential for getting and maintaining participation in the curbside recycling programs. As a minimum, information about the mechanics of the program was disseminated, but publicity was most effective at boosting participation when it was on-going, when messages were targeted at the location of the recycling (i.e., the home) and when specific recycling behaviors were clearly described.
- Personal contact in conjunction with publicity was effective in encouraging participation and worked well in a variety of administrative and promotional contexts.
- Economic incentives demonstrated significant impacts in encouraging recycling and discouraging wasteful disposal habits, as reflected in participation rates.

- Ordinances mandating source-separation were associated with high participation rates, although none of the programs with such ordinances were found to enforce them.
- Mandating the provision of curbside recycling service did not appear to encourage the same levels of participation that source-separation ordinances, but participation was comparable to voluntary programs with a similar service level.

Evaluation

Techniques for evaluating the effectiveness of curbside recycling programs were not standardized, which made comparison of programs difficult. Evaluation tools that were discussed were indicators of: (a) participation, (b) waste diversion, and (c) cost. Conclusions are stated below.

- Of the methods used to determine participation, direct measurement (recording addresses of households that set out materials over a survey period) appears to be most precise and reproducible. Calculations derived from direct measurement show promise for close monitoring of fluctuations in participation.
- Programs with weekly collection generally defined participation to be one setout per month and were more inclined to measure participation directly by the recording of setout addresses. Monthly collection programs generally used setout rates in lieu of participation rate, or defined participation to be relatively close to setout (1.2 times setout).

- Telephone surveys are of limited applicability in measuring participation because of uncertainties related to self-reporting of behavior and non-responses.
- "Eyeballed" estimates by staff, regardless of the accuracy of estimates within a particular program, show little promise as a method of comparing participation between programs because of the subjectivity inherent in the method.
- Waste diversion, when it was recorded, seldom delineated clearly the exact waste components included in the calculation. The most useful diversion rates specified a particular wastestream fraction (such as the percentage reduction in the mixed paper fraction of the residential wastestream).
- The usefulness of cost data was impaired by inconsistency in calculating and reporting certain types of costs and revenues, such as in-kind services, rebates, or avoided costs.

Chapter 6: Recommendations

In response to problems encountered in the analysis of the cases studies and issues discussed by recycling professionals incidental to this research, the following recommendations are put forward to encourage the continued refinement of recycling as a professional waste management endeavor.

- More research and information transfer should be done concerning operational procedures, particularly the issues of materials separation by the household versus centralized sorting and the effect of coordinating recycling with garbage collection. Practicing professionals should write and publish articles about experiences in existing programs. The paucity of basic literature behooves recycling professionals to interact through professional channels to share insights and findings.
- Use of volunteer labor for collection should be minimized in order to increase the consistency of service and the potential for increased levels of service.

- Preliminary studies, including wastestream and market analysis, should be conducted more often in the course of developing new curbside programs because characteristics of the wastestream and materials markets are often local in nature.
- Markets must be developed for low-value materials, including plastics. As more communities face higher disposal costs they will be willing to source-separate materials that are currently not recycled for economic reasons, but markets must exist for source-separated material in order for recycling to occur. Market development includes research for new uses for secondary materials and new treatment or re-refining techniques, which would make the quality of secondary materials more competitive with primary materials. Municipal policies to encourage the purchase of recycled materials are useful in stimulating secondary materials demand and as a role model to the private sector.
- Public education about waste disposal issues and options is basic to modifying not only short-term behavior but for increasing the likelihood of intelligent long-term solutions.
- Economic incentives should be incorporated into the promotion of curbside recycling programs. The success of innovative techniques that were explored in the case studies suggests that many opportunities exist to introduce economic incentives to enhance other programs.
- Measurements of participation, waste diversion, and costs need to be standardized to facilitate evaluation among programs.

- Direct measurement of participation and the development of a mathematical relationship between setout and participation is most useful for providing precise data and allowing the on-going monitoring of fluctuations in participation.
 - For weekly collection programs, defining participation as one setout per month is recommended because of the prevalence and apparent usefulness of the definition. Definitions of participation for monthly and biweekly programs need to be developed to reflect a level of effort by the household that is in keeping with the weekly definition.
 - Terms referring to the wastestream and waste diversion should be as specific as possible to assist in comparison of data. For example, waste diversion recorded in terms of individual wastestream components (the reduction of the paper component of the residential wastestream, for instance) leaves no room for confusion about which components of the wastestream are included in the calculation.
 - A cost index should be developed to normalize budgetary data for purposes of comparing programs. Costs and revenues that some programs can exclude from their budget (such as in-kind services) could be included in such an evaluation tool.
- Additional academic and professional training needs to be made available. Problems in recycling and waste management have changed drastically in the last decade and both new and established professionals are often inadequately equipped to deal with them. Two approaches should be taken simultaneously-- to provide in-service training and short courses in practical recycling knowledge and skills for practicing

professionals and to increase the number of courses in university programs dealing with solid waste and recycling.

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Appendix A. Program Summary Tables

The following tables represent a summary of selected program information for each of the fifteen case studies included in this report.

Table 16. Operational Information Summary

Community	Collection Frequency	Same Day?	Container Provided?	Container Description	Vehicle Description
Ann Arbor, MI	monthly	no	no	not applicable	(leased from city)
Astoria, OR	biweekly	no	available, small fee	wooden crate	flatbed with 6 containers
Austin, TX	weekly	no	available	bucket, no plastic bags	Recycler 6 Eager Beavers
Barrington, RI	monthly	no	no	not applicable	3-bin dumper trucks
Berkeley, CA	monthly	no	available, small fee	waxed cardboard	flatbed with 5 bins
Boulder, CO	monthly	no	no	not applicable	VW buses, school buses, trucks
Charlotte, NC	weekly	no	yes	single plastic bin	3-bin dumper trucks
El Cerrito, CA	weekly	no	no	plastic or grocery bags	flatbed with 6 bins
Fresno, CA	weekly	no	available, small fee	4-in-1 or dividers	compartmental trucks
Hillsborough, NJ	biweekly	no	no	plastic bags	step vans (no trucks, dumpsters)
Minneapolis, MN	monthly	no	no	paper or plastic bags	not available
Rockford, IL	weekly	yes	no, but required	clear plastic bags	sideload trash truck with racks
San Jose, CA	weekly	yes	yes	3 bins	3-bin dumper trucks
Seattle, WA	weekly or monthly	no	yes	3-in-1 or 30-gallon	varies
Somerville, NJ	approx. biweekly	no	no	not applicable	packer trucks, external bins

Table 17. Materials collected in curbside programs

Community	Paper	Metals	Glass	Miscellaneous
Ann Arbor, MI	np,cc,gro.bag	ac,tc	cg,gg,bg	oil,batteries
Astoria, OR	np,cc	(none)	cg,gg,bg	used oil
Austin, TX	np	ac,as,sc,tc	cg,gg,bg	
Barrington, RI	mp	ac	cg,gg,bg	white goods
Berkeley, CA	np	ac,tc	cg,gg,bg	
Boulder, CO	np,cc,hg	ac,as	cg,gg,bg	used oil
Charlotte, NC	np	ac	cg,gg,bg	PET
El Cerrito, CA	np	ac,tc	cg,gg,bg	wine bottles
Fresno, CA	np,cc	ac	mg	plastics
Hillsborough, NJ	np + mags,cc	ac	cg,gg,bg	
Minneapolis, MN	mp,cc,fc	ac,tc	cg,gg,bg	phone books
Rockford, IL	np	ac	mixed	
San Jose, CA	np	ac,tc	cg,gg,bg	
Seattle, WA	np,mp	ac,tc	cg,gg,bg	
Somerville, NJ	np	ac	cg,gg,bg	leaves

Note: np = newspaper, cc = corrugated cardboard, hg = high-grade paper
 ac = aluminum cans, as = aluminum scrap, sc = steel cans, tc = tin-plated cans,
 cg = clear glass, gg = green glass, bg = brown glass, mg = mixed glass,
 PET = plastic soda bottles, HDPE = plastic milk jugs.

Table 18. Sorting requirement summary

Community	Household Sorting	Additional Curbside Sorting
Ann Arbor, MI	np/cc/ac/tc/cg/gg/bg	no additional
Astoria, OR	np/mg	np/cg/gg/bg
Austin, TX	np/ac/ac/sc/tc/cg/gg/bg	no additional
Barrington, RI	mp/ac/cg/gg/bg	no additional
Berkeley, CA	np/mg/cans	np/ac/tc/cg/gg/bg
Boulder, CO	np/cc/hg/ac/as/cg/gg/bg	no additional
Charlotte, NC	np/ac + mg + PET	np/glass/cans&PET
El Cerrito, CA	np/mg/cans/magazines	np/ac/tc/mg/wine bottles
Fresno, CA	np/cc/ac/mg	no additional
Hillsborough, NJ	np/ac + mg	no additional
Minneapolis, MN	mp/ac/tc/cg/gg/bg/phone books	no additional
Rockford, IL	np/ac/mg	no additional
San Jose, CA	np/cans/mg	no additional
Seattle, WA	np/mp/cans/mg or none	no additional
Somerville, NJ	np/cc/ac/cg/gg/bg	no additional

Note: np = newspaper, cc = corrugated cardboard, hg = high-grade paper
 ac = aluminum cans, as = aluminum scrap, sc = steel cans, tc = tin-plated cans,
 cg = clear glass, gg = green glass, bg = brown glass, mg = mixed glass,
 PET = plastic soda bottles, HDPE = plastic milk jugs.

Table 19. Selected Data from the 1980 Census

Community	1980 Pop'n	Median age, yrs	H.S. grads., %	Below poverty level, %	Non- English speaking adults, %	Owner- occupied homes, %	Structures w/ > 4 units, %
Ann Arbor, MI	107966	25.2	90.7	14.7	6.5	42	37.4
Astoria, OR	9998	31.4	76.8	11.4	6.4	54	20.0
Austin, TX	345496	26.2	74.8	15.8	9.3	46	32.8
Barrington, RI	16174	33.3	83.1	3.5	6.7	89	0.2
Berkeley, CA	103328	29.1	86.4	21.0	9.6	38	34.6
Boulder, CO	76685	25.9	91.9	16.3	8.0	47	36.0
Charlotte, NC	314447	29.3	70.1	12.4	9.2	42	23.6
El Cerrito, CA	22731	40.1	83.7	6.1	15.2	66	10.5
Fresno, CA	218202	28.1	67.9	15.7	11.9	54	25.3
Hillsborough, NJ	19061	30.1	82.4	2.5	3.1	75	22.9
Minneapolis, MN	370951	29.8	74.8	13.5	8.1	50	34.2
Rockford, IL	139712	29.9	66.8	8.3	9.0	61	15.8
San Jose, CA	629442	27.4	76.4	8.2	13.4	62	18.6
Seattle, WA	493846	32.4	79.7	11.2	13.3	51	33.3
Somerville, NJ	11973	32.9	73.6	7.5	7.5	50	26.3

Appendix B. State Recycling Programs

Several states have enacted programs which directly affect recycling. The following brief discussion covers programs which impact the cases studies discussed in this report. Legislation includes mandatory recycling bills, bills to encourage the use of recycled materials, and grant programs to initiate private and municipal recycling programs.

California

State Programs Assembly Bill 2020 (AB2020) is considered a compromise "bottle bill" by many. The bill, recently approved for statewide implementation, is not a deposit law because it does not define a system of deposits paid by consumers and redeemed in supermarkets. It does require wholesale distributors of targeted beverage containers to pay one cent per container to a state fund for recycling/redemption centers. Centers must be set up by beverage

retailers in their marketing areas around the state. Beverage consumers redeeming a targeted beverage container receive the one cent paid by the container distributor, plus the market value of the material.

The recycling/redemption centers may be set up to accept any recyclable material. It is possible that retailers in an area could be granted exemptions from the requirement to establish redemption centers if they prove that existing recycling operations are adequate [47].

A statewide recycling information hotline is provided by the California Waste Management Board. The service is operated by a private firm on contract.

Illinois

The State has developed priority guidelines for solid waste disposal planning, which gives landfills a low priority and recycling a high priority. Practical implications of this policy are not clear [48]. State funds are available for multi-material recycling programs, including grants for start-up, technical assistance, education, and market development. These funds come from a surcharge on landfill disposal [49].

Michigan

The Michigan Department of Natural Resources has administered a grant program since 1985 which is used to promote alternatives to landfilling. The State also has a deposit program for beer and soft drink containers which diverts 80 to 90 percent of the deposit containers, or approximately 7 percent of the wastestream, from disposal [43].

Minnesota

Grant money is available from the Minnesota Waste Management Board and the Pollution Control Agency for "low technology" resource recovery projects, which would include curbside recycling. Available funding includes: \$300,000 for project grants, \$200,000 for development of secondary materials markets, and \$500,000 for tire recycling [50]. These two state agencies also operate a toll-free recycling information hotline.

New Jersey

New Jersey's new mandatory recycling law establishes statewide source separation and recycling. The State provides tonnage grants to municipalities based

on the amount of recyclables diverted from conventional disposal through any means-- curbside, dropoffs and commercial or municipal buyback operations. Each county is required to submit a recycling plan for approval by the State Department of Environmental Protection. The County Plan could be anything from a comprehensive county-run program to the county simply telling the municipalities they must recycle on their own. In addition to mandatory recycling and funding for the programs, the law (a) commits the state to a schedule of goals for increasing the purchase of products made with recycled materials, (b) provides exemptions for materials for which no market can be found, while creating incentives for secondary materials buyers, (c) authorizes enforcement of local recycling plans, (d) controls the disposal of used motor oil, (e) requires re-evaluation of the recycling potential of plastic and bi-metal containers. The state-mandated target for diversion of wastes through recycling is 25 percent of the wastestream by 1990 [6].

Oregon

Oregon's Recycling Opportunity Act stipulates that, effective July 1, 1987, any resident of a town of 4,000 or more be provided the opportunity to recycle conveniently. It specifies that (a) recycling centers be established at disposal sites or other locations convenient to the residents, (b) on-route (curbside) recyclables collection be provided at least once a month in towns of 4,000 or more, and (c) education, promotion, and notification of programs must be provided [29]. All materials defined to be recyclable according to the definition

set forth in the law must be included. A recyclable material is defined to be a material for which the net costs of collection and recycling are less than or equal to the costs of collection and disposal. This definition avoids placing an economic hardship on communities which lie farther from secondary materials markets. It also allows for market fluctuations and the establishment of new markets [51].

Oregon has had a beverage container deposit law since 1971. A survey indicated that 90 percent of the state's citizens support the deposit law [52].

Rhode Island

The Department of Environmental Management administers financial and technical assistance to municipalities as required by the Rhode Island Recycling Act (1987). The state hopes to reduce the flow to state-owned landfills by requiring source separation before waste will be accepted for disposal after an established date. The goal is to recycle at least 15% of the wastestream through mandatory recycling, and several programs were provided to assist municipalities meet this goal.

Municipalities must separate materials the State designates as recyclable (aluminum, glass and metal food and beverage containers, newspaper and white goods). This designation may change in response to economic, environmental or technological factors. Disposal plans must be approved by the State, and

within three years, municipalities are required to contract with the state for landfill or resource recovery disposal. Subsidized municipal tip fees will be offered up to a limit set by State. Amounts over that will be assessed the commercial rate [49].

The state is required to provide recycling facilities for municipal waste at or near each resource recovery facility. In addition, state funds will be used to reimburse localities the reasonable costs of developing and adapting waste collection procedures for recycling. The state has contracted with a private firm to build a materials recovery facility at the state's centralized landfill facility as a way to assist communities in marketing their materials [32].

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