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Unit Pricing Programs for Residential Municipal Solid Waste: An Assessment of the Literature

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EXECUTIVE SUMMARY

Residents of the United States generate an enormous amount of solid waste -- in quantities that have risen rapidly in the past several decades. While the absolute amount of waste generated has continued to grow, the rate of growth has started to slow down. The decline in per capita waste generation results in part from a concerted focus on waste reduction measures. One program that may affect both waste generation and materials diversion rates is unit pricing of residential solid waste. Unit pricing programs charge households per unit of waste collected. Today, as many as 2000 communities use some form of unit pricing. Many more communities are considering adopting such systems.

This paper analyzes the most significant literature on unit pricing programs to determine the degree to which unit pricing programs meet their stated goals. In doing so, the paper highlights those areas where analysts generally agree on the outcomes associated with unit pricing, as well as those areas where substantial controversy remains. This Executive Summary represents a condensed version of the more detailed analysis provided in the main text of the paper (Sections 1.0 - 5.0).

The major documented effect of unit pricing is that it results in increased recycling participation and may increase source reduction behavior. The system is also fairer to those who produce less garbage, and can provide positive aesthetic benefits to the community. However, the literature warns of potential problems with the system, including undesirable diversion, waste compaction, the impact of variable fees on low income residents, service to multi-unit housing, and unstable hauler revenues. Authors identify several issues that waste managers may wish to take into consideration when implementing variable rates, including: the system's specifications; the design of the rate structure; potential problems, like illegal disposal and the impact of fees on low income residents; the degree of popular and political support for unit pricing; and the need for education and enforcement mechanisms.

The Executive Summary presents an overview of unit pricing in three broad categories: features of unit pricing programs, outcomes associated with unit pricing, and unit pricing program design and implementation. Within these categories, specific issues of importance to practitioners are discussed, including recycling, source reduction, illegal disposal, waste compaction, and effects on low income households, among others.

Program Features

A variety of circumstances may encourage a community to consider unit pricing for residential waste collection: high disposal costs (tipping fees), increasing per capita waste generation, diminishing landfill capacity, changing labor costs, a desire to encourage recycling or reduce waste, statewide or regional diversion requirements, and grassroots lobbying efforts.

There are three main types of containers used by unit pricing communities: special bags; tags or stickers that must be attached to waste receptacles; and subscription cans of varying sizes. Variable rate

systems employ a variety of fee structures. Some programs utilize a completely variable fee, where the fixed costs of waste collection (equipment, overhead, etc.) are incorporated into the variable rate. A variant on this system is the multi-tier structure. Under such a system, the estimated fixed costs of collection and a basic level of service are financed by a flat fee or through property taxes. Residents pay variable fees for incremental service levels above the base level.

Most unit pricing communities have volume-based fees. However, a few areas have conducted trials with weight-based systems. They include: Seattle, Washington; Farmington and Minneapolis, Minnesota; Durham, North Carolina; Columbia, South Carolina; and Milwaukee, Wisconsin. Weight-based fees more closely represent the cost of waste disposal than do volume-based fees, since tipping fees are based on weight. They also provide a clearer and continuous pricing signal to household producers of garbage. Volume-based fees provide no additional waste reduction incentive below the lowest level of service (i.e., one bag or can per week). However, technology for weight-based systems, while evolving rapidly, is still significantly more expensive than that used for volume-based systems.

Unit pricing communities typically offer a variety of complementary programs. These include recycling drop-off centers, curbside recycling pickup, and drop-off, curbside or backyard composting programs. Most unit pricing municipalities offer some diversion alternative for their residents, and most place a heavy emphasis on education efforts. Not all unit pricing programs are municipally operated. Some communities choose to hire a private hauling firm to run their systems. Unit pricing programs are operated by local governments, by private haulers, or by some combination of the two.

Outcomes Associated with Unit Pricing

Increased Recycling

Virtually the entire unit pricing literature addresses the effect that variable rates have on recycling participation and the amount of municipal waste recycled. Most of the authors contend that variable fees increase recycling participation and recycling tonnages. Local waste officials seem to agree. In a survey of 1000 local recycling coordinators, the respondents identified variable collection rates as the most effective strategy to encourage recycling. Unit pricing may have similarly positive effects on composting. Participation in Seattle's backyard composting program is high, and in San Jose, California, unit pricing increased yard waste setouts by 61%. In the Tompkins County, New York survey, 16% of the respondents said they composted more because of variable waste collection rates.

Decreased Landfilled Waste and Source Reduction Behavior

The extent to which unit pricing encourages actual source reduction behavior, such as purchasing reduced packaging goods, is also a major topic in most of the literature. Source reduction is more difficult to measure than waste diversion, and there is less agreement as to the effects of variable rates. In general, communities utilizing variable rates have reported an average reduction in waste landfilled of 28%, with a range of 25% to 50%.

Several authors present preliminary evidence that part of the decrease in waste landfilled results from waste minimization behavior (over and above recycling participation) on the part of community residents. For example, the Miranda et. al. study of 21 unit pricing communities concludes that the observed average waste landfilled reduction level of 30% cannot be entirely accounted for by increased

recycling, composting, illegal disposal, and measurement error alone. Some of the reduction likely resulted from source reduction behavior. Their conclusion is supported by the Tompkins County, New York survey, which shows that, as a result of variable collection fees, 39% of the respondents are more attentive to product packaging when they shop. Adamec also found reductions in waste in her study of Lisle, Illinois that could not be solely explained by increased recycling. When city officials added yard waste, recycling, and refuse collections together, there was still a 31% decrease in the total volume of materials collected the year after variable rates were implemented.

Some authors take issue with the claim that unit pricing causes people to reduce their waste. These authors claim that there is no conclusive evidence that variable rates cause residents to purchase reduced packaging products, or pursue other source reduction activities. These authors suggest, instead, that observed levels of waste reduction are explained by garbage compaction and illegal disposal. For example, the Fullerton and Kinnaman study of a variable fee pilot program in Charlottesville, Virginia concluded that 28% of the observed reduction in waste was accounted for by illegal disposal. They based this figure on the percentage of survey respondents that indicated they used "other means," as opposed to recycling, composting, or purchasing goods with less packaging, to reduce their waste.

Source Reduction and Recycling Interaction

Another unit pricing issue on which there is disagreement is the question of how the incentives to recycle and source reduce interact. Some authors suggest that the two are complementary -- that unit pricing creates a greater awareness of the waste stream, inducing households to pursue both increased recycling and waste minimization techniques. Others raise the possibility that the two are substitutes for one another -- that households participating in a recycling program will be less likely to source reduce because they are already "doing something good" for the environment.

Undesirable Diversion

Undesirable diversion may take several forms. One is that residents put their garbage in commercial dumpsters. McHenry County, Illinois reports problems with commercial "dumpster dumping," and the 10 Illinois solid waste officials in Browning and Becker's survey rate dumping in commercial dumpsters the most serious problem with unit pricing in their communities. Residents may also dump their garbage on the side of the road. Roadside dumping was also cited in Browning and Becker's survey, and 51% of the residents in Reschovsky's study of Tompkins County reported some increase in littering after the county adopted variable fees. Backyard burning is another undesirable diversion option. Twenty percent of the Tompkins County survey respondents said they burn their trash, and Perkasié, Pennsylvania had some initial problems with burning. Finally, residents may misuse their recycling bins by throwing non-recyclable waste in them.

Some communities, including Mendham Township, New Jersey, Mt. Pleasant, Michigan, and Seattle, have reported very minimal problems with undesirable diversion. The literature contains many suggestions of measures to minimize illegal disposal, such as locks on commercial dumpsters, strictly and aggressively enforced littering and anti-burning ordinances, public education, and free drop-off days. In addition, disposal fees on products with refunds for proper disposal would create economic incentives countering undesirable diversion.

Waste Compaction

Residents tend to compact their garbage more under unit pricing systems. The Fullerton and Kinnaman study, for example, found that while the volume of garbage was reduced by an average of 37% among the households in the study, the weight of garbage was only reduced 14%. The authors conclude that trash compaction accounted for the difference. Some municipalities instruct haulers to not collect receptacles that are overloaded, or charge more for compacted garbage. Solid waste managers need to anticipate and estimate residential waste compaction, and set rates appropriately. As more and more cities have adopted unit pricing, the expected level of increased compaction has become clearer, making it easier to set unit prices correctly from the beginning.

Impact of Fees on Low Income Residents

Because low income individuals have less disposable income, waste collection fees represent a greater proportionate burden on them than on higher income households. However, several studies show that household waste generation is positively related to household income, so poorer families, in general, produce less trash and therefore are likely to face lower waste collection fees under a unit pricing system. Furthermore, some systems have built in protections for poor families, like lower rates for low income households.

Unstable Hauler Revenue

Since the exact effect of unit fees on residential setouts is somewhat unpredictable, it is difficult for waste haulers to estimate their monthly collection levels and their annual revenue. For example, Blazier Disposal in Harvard, Illinois set its rates based on an estimated pickup of 1.6 bags per household, but was left short of revenue when it only picked up 1.2 bags per household. Unstable revenue has also been cited as a problem by haulers in the Chicago metropolitan area, Bellevue, Washington, Lansing, Michigan, and the state of Rhode Island. Multi-tier fee structures help to stabilize hauler revenues.

Higher Costs

Unit pricing may result in higher administrative costs from added equipment, a complex billing system, education and enforcement, and increased recyclables collection. However, it has the potential for providing cost savings, as well. If residents reduce the amount of waste they set out and recycle more, haulers may lower their garbage collection and disposal costs, and may increase their income from the sale of recyclables. It is unclear whether the savings or the added costs will dominate in a given town, but when tipping fees are very high, the savings potential of unit pricing is correspondingly greater. Savas' survey of residents of unit pricing municipalities found that unit fees, whether flat or variable, increased billing costs relative to systems financed directly through property taxes. On the other hand, several cities, including Perkasié, Ilion, New York, Mendham Township, New Jersey, and St. Cloud, Minnesota reported overall cost savings.

Multi-Unit Housing

Several authors assert that it is hard to charge variable rates to residents of multi-unit housing complexes. Most multi-unit facilities have garbage chutes or common dumpsters, so it is difficult to measure each unit's waste generation level. Skumatz suggests that bag or tag systems could be used, or

the landlord could set a subscription level for the building as a whole. Wilkes-Barre and Carlisle, Pennsylvania, Plantation, Florida, Duluth, Georgia, and Grand Rapids, Michigan have all incorporated multi-unit residences into their unit pricing systems.

Customer Resistance

Unit pricing sometimes causes citizens to resist the loss of "free" garbage service. If people never realized they were paying for waste collection before, they could be hesitant to start paying directly for it. There is a great deal of evidence in the literature, however, that residents of unit pricing communities strongly support, at least in the long run, their towns' systems. For example, 93% of surveyed Perkasié, Pennsylvania residents approve of their variable rate system, and unit pricing has met with similar levels of satisfaction in Ilion and Seattle.

Political Feasibility

Policymakers may shy away from variable rates because they fear that they will be unpopular. Public officials may begin to lose that fear, however, when it becomes clear that residents of unit pricing communities support their systems, and recent legislative initiatives in 10 states recommending or requiring local municipalities to adopt unit pricing indicate that political support for variable fees is growing.

Other Issues

In addition to increased recycling and source reduction, the literature identifies several other potential effects of unit pricing. They include: lower labor costs for garbage collection; economies of scale in municipal recycling collection and in the production of recyclable goods; equity for low waste producers; aesthetic community benefits; and increased environmental awareness.

Designing the Unit Pricing Program

Waste management officials must consider many issues before implementing a unit pricing system. They include the community's demographic makeup, its waste management needs, the level of community environmental awareness, the compatibility of variable fees with the existing system, and the percentage of residents that would benefit from the system. When designing a unit pricing system, waste managers must set the rates, choose a container type and decide what complementary programs to offer, make necessary departmental changes, ensure community support, monitor the system and enforce compliance, educate the public, select special program characteristics for low-income residents, prevent illegal waste disposal, and come up with a method for dealing with multi-unit housing.

Despite the growing numbers of communities that are implementing unit pricing programs, many questions remain unanswered regarding the ability of the programs to achieve their objectives. This paper outlines the general areas of agreement and disagreement in addition to providing a comprehensive review of the literature on unit pricing. As outlined above, much research and analysis remains to be done.

Unit Pricing Programs for Residential Municipal Solid Waste:

An Assessment of the Literature

1.0 INTRODUCTION

Residents of the United States generate an enormous amount of solid waste -- in quantities that have risen rapidly in the past several decades. In 1960, the United States generated 87.8 million tons of waste across the residential, commercial, and industrial sectors; by 1990, this figure had risen to 198.0 million tons annually, with the Environmental Protection Agency (EPA) predicting that the figure would rise to 217.8 million tons by the year 2000.¹ While the absolute amount of waste generation has continued to grow, the rate of growth has started to slow down. In fact, the EPA is currently projecting that per capita waste generation will actually decline from its current rate of 4.4 pounds per person per day to 4.3 pounds per person per day by the year 2000.² While these new projections are encouraging, clearly much more work in learning to manage solid waste remains.

The decline in per capita waste generation results in part from a concerted focus on waste reduction measures. One program that affects both waste generation and materials diversion rates is unit pricing of residential solid waste. Traditional solid waste management systems charge residents a fixed annual fee for waste collection services. These programs provide residents with no financial incentive to minimize the total amount of waste that they produce and maximize the amount of waste they recycle. Unit pricing programs, on the other hand, charge households per unit of waste collected. Such programs use a variety of unit systems (bags, tags, stickers, cans), and may be priced according to weight or volume. In addition, some unit charges vary according to the type of material collected. For example, mixed waste destined for landfilling is charged at a higher rate than yard waste that will serve as feedstock to a community-wide composting program.

Unit pricing programs started as early as 1916, but did not reach widespread popularity until the early 1990's.³ Today, more than 1,000 communities use some form of unit pricing.⁴ Many more communities are considering adopting such systems. While the general microeconomic theory surrounding the incentives that unit pricing creates are fairly well understood, the actual outcomes regarding source reduction, materials diversion, and other important issues in solid waste management are still being evaluated. This paper analyzes the most significant literature on unit pricing programs to determine the degree to which unit pricing programs meet their stated goals. In doing so, the paper highlights those areas where analysts generally agree on the outcomes associated with unit pricing, as well as those areas where substantial controversy remains.

¹ Felton 1995.

² Felton 1995.

³ Skumatz and Zach, June 1993.

⁴ Based on the TrashTeam research, 1995.

1.1 Organization of the Paper

A significant portion of the existing unit pricing literature is for solid waste managers or other public officials that are considering variable rates as a municipal waste management tool.⁵ This literature tends to be very general, introducing the reader to the theory behind unit pricing, the various system design alternatives, the potential benefits of and problems with variable rates, and issues to consider when implementing unit pricing. Variable rates can be either volume-based or weight-based, and the rate structure varies from city to city. Volume-based systems, which are far more common than weight-based ones, generally use subscription cans, special bags, or tags/stickers, and charge by the container. Collection can be city-run, or the service can be contracted out to a private hauler. Municipalities offer a variety of complementary programs, including curbside recycling, backyard composting, and public education campaigns.

The major documented outcome associated with unit pricing is that it results in increased recycling participation and may increase source reduction behavior. The system is also fairer to those who produce less garbage, and may provide positive aesthetic benefits to the community. However, the introductory literature warns of potential problems with the system, including undesirable diversion, waste compaction, the impact of variable fees on low income residents, service to multi-unit housing, and unstable hauler revenues. The authors of the introductory literature identify several issues that waste managers may wish to take into consideration when implementing variable rates, including: the system's specifications; the design of the rate structure; potential problems, like undesirable diversion and the impact of fees on low income residents; the degree of popular and political support for unit pricing; and the need for education and enforcement mechanisms.

The remaining unit pricing literature studies variable rates and some of the issues mentioned above in greater detail. The authors of this literature base their findings on empirical studies of unit pricing communities, interviews with solid waste experts, or theoretical models of waste generation behavior.

After a brief discussion of the economics that underlies unit pricing, this paper presents an analysis of unit pricing in three broad categories: program features, the outcomes associated with unit pricing, and issues involved with designing and implementing the system. In addition to the textual analysis, Appendix A provides a matrix of the most significant articles and what the authors claim regarding the most important questions surrounding the feasibility and desirability of unit pricing. Appendix B provides an annotated bibliography of these same articles.

1.2 Economic Analysis of Unit Pricing Programs

Interest in unit pricing programs derives strongly from economic analysis that suggests that traditional systems for financing waste collection lead to inefficiently high levels of waste production. This section outlines the basic economic analysis that underlies this conclusion and provides a summary of the most significant theoretical modeling on the topic to date. In addition, the influence of various

⁵ Zak and Chartrand, February 1989; Skumatz and Breckinridge, June 1990; EPA, September 1990; EPA, February 1991; Project 88, May 1991; Fiske, March/April 1992; Lewis, June/July 1993; U.S. Conference of Mayors, June 1994; Canterbury, April, 1994; Guerrieri, September 1994; Lemoine, no date.

demographic factors on program outcomes is considered. This section may not be of particular use or interest to practitioners considering whether to implement a unit pricing program in their home community. Sections 2.0 - 6.0 focus directly on the less theoretical, more applied and results-oriented literature -- and thus may be more useful to practitioners.

1.2.A. Basic Economics⁶

Economic theory suggests that the traditional flat fee for collection services will lead people to generate inefficiently high levels of MSW. Because they face a zero price for increments in MSW collection services, residents will consume collection services out to point CS_{TS} in Figure 1 under the traditional system. To maximize economic efficiency, however, municipalities should charge according to marginal costs. As shown in Figure 1, this would entail charging P_{MCP} , with CS_{MCP} as the resulting level of collection services.

Economic theory argues in favor of marginal cost pricing. In practice, however, communities that have adopted some form of unit-pricing usually turn to average cost pricing or two-tier pricing. Average cost pricing sets the unit-price equal to the average total cost per unit. To calculate this cost, the community estimates the total amount of solid waste it expects to dispose of in the next year. It then computes the total cost incurred, and divides by the number of bags expected. This yields a unit price that includes the fixed and variable costs incurred by collecting each unit of MSW. If average costs are computed correctly, average cost pricing is more efficient than the traditional system, but less efficient than marginal cost pricing, as shown in Figure 2. The community will charge P_{ACP} , with CS_{ACP} as the resulting level of collection services.

If solid waste managers underestimate average costs, then average cost pricing becomes relatively less efficient, as the community will end up somewhere to the right of CS_{ACP} . If, however, average costs are overestimated, the community will end up somewhere to the left of CS_{ACP} -- and closer to the efficiency maximizing point CS_{MCP} . If average costs are vastly overestimated, then the community will end up to the left of CS_{MCP} , and it will underproduce MSW from an economic efficiency standpoint.

Under multi-tier pricing, residents are charged two fees for MSW collection services. The first fee is flat and covers some minimum level of service; e.g., one can or one bag per week. The second fee is unit-based and varies with any additional bags or cans collected from the household during a particular week. This system leaves a residual demand curve for MSW collection services once the minimum level of service is subtracted from the total demand curve, as shown in Figure 2. The relative efficiency of this system depends on the minimum level of service provided and the manner in which the unit-price is set. If the minimum level of service is set equal to the distance AB, and the unit price is set equal to P_{ACP} , then two-tier pricing will be as efficient as average cost pricing. In general, the smaller is the minimum level of service, and the more closely the unit-price is based on marginal cost, the more likely two-tier pricing will maximize economic efficiency.

⁶ This section taken directly from Miranda et. al. 1994.

Figure 1. Demand for MSW collection services under the traditional system (CS_{TS}) and under marginal cost pricing (CS_{MCP}).

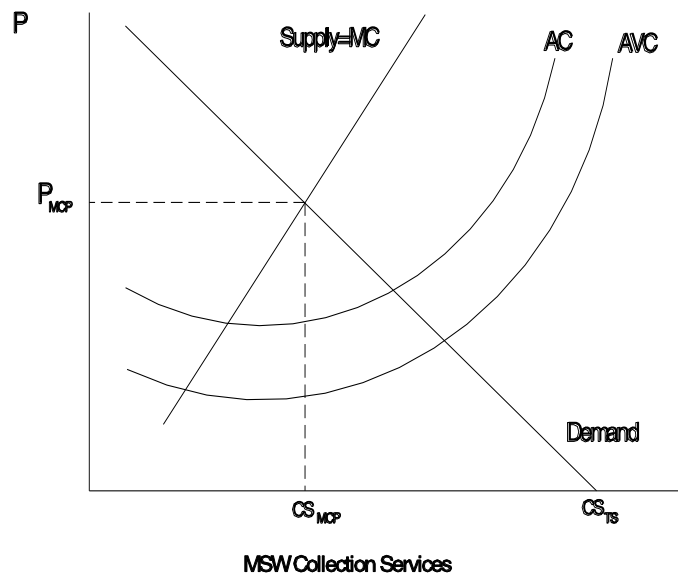
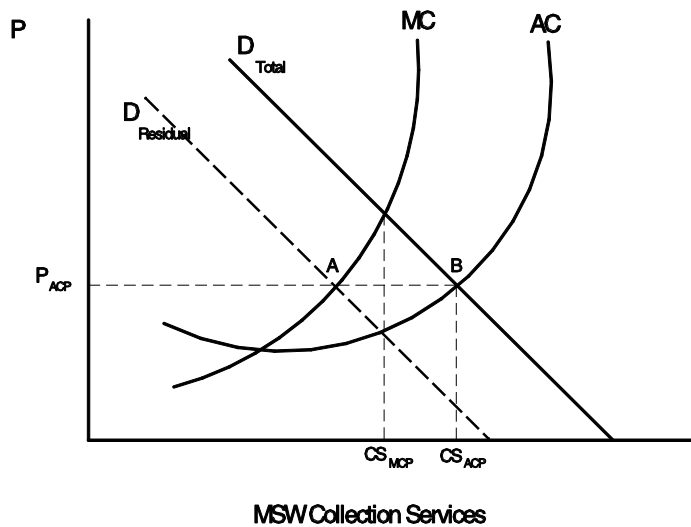


Figure 2. Demand for MSW collection services under average cost pricing (CS_{ACP}) and under marginal cost pricing (CS_{MCP}).



1.2.B. Modeling

A variety of researchers have built upon the intuitive economic analysis presented above in order to model how communities or individuals might respond to the implementation of unit pricing. Early research focused on broad questions of solid waste management with occasional particular attention given to unit pricing programs. Wertz⁷ uses a series of economic models to determine the impact of several waste collection service options on the level of household garbage generation. Similarly, Kemper and Quigley⁸ provide a general overview of the economic issues involved in waste collection. In a more focused study, Stevens⁹ uses an economic model of household waste generation behavior to predict the effect of unit prices on the demand for waste collection services.

In later work, Miedema¹⁰ develops a macroeconomic model to analyze the effects of user fees, recycling subsidies, disposal charges, and litter taxes on waste generation and waste diversion outcomes. According to Menell's¹¹ economic model, unit pricing and/or retail charges based on the disposal cost of different products are the best waste management strategies. Jenkins¹² presents a model for residential waste generation that shows that user fees can have a significant impact on the level of waste generation and that society's welfare gain from switching to unit pricing is substantial.

Fullerton and Kinnaman¹³ develop a purely theoretical economic model of household waste disposal behavior. Under this formulation, unit fees may lead to some burning or dumping. The authors go on to say, however, that a disposal tax on products coupled with rebates for proper waste disposal would encourage legal disposal of garbage. Morris and Holthausen¹⁴ design a model of household waste disposal behavior, taking into account various disposal options, including garbage pickup, recycling, and source reduction, and fee levels, both flat and variable. The simulation demonstrates that households' price elasticity of demand for solid waste collection services varies significantly with the price of that service.

1.2.C. Demographic Influences

Early work on the demographics of waste generation behavior has produced somewhat conflicting results. Cargo¹⁵ finds that solid waste generation is positively correlated with population and density and

⁷ Wertz, 1976.

⁸ Kemper and Quigley, 1976.

⁹ Stevens, 1977.

¹⁰ Miedema, 1983.

¹¹ Menell, 1990.

¹² Jenkins, 1991.

¹³ Fullerton and Kinnaman, 1993.

¹⁴ Morris and Holthausen, 1994.

¹⁵ Cargo, 1976.

is negatively correlated with income. Richardson and Havlicek¹⁶, on the other hand, find that waste generation is positively correlated with income, age, and household size, and negatively correlated with ethnic background (percentage of black households in a census tract).

2.0 PROGRAM FEATURES

The literature describes the following unit pricing program features: why communities adopt unit pricing systems, the type of container used by communities, the structure of the fee system, the basis of the fees, whether collection is publicly or privately run, and what complementary programs are typically offered.

2.1 Adopting the System

A variety of circumstances may encourage a community to consider unit pricing for residential waste collection: high disposal costs (tipping fees), increasing per capita waste generation, diminishing landfill capacity, changing labor costs, a desire to encourage recycling or reduce waste, statewide or regional diversion requirements, and grassroots lobbying efforts.¹⁷ Skumatz reports that implementing variable rates is easier if the municipality's hauling contract or billing system are up for renewal, there is a municipal landfill problem, there is a desire to increase recycling, citizens perceive the existing solid waste system as unfair, or the jurisdiction's tax system is up for reauthorization.¹⁸

2.2 Containers

There are three main types of containers used by unit pricing communities: special bags, tags or stickers that must be attached to waste receptacles, and subscription cans of varying sizes.¹⁹ Each type of container has advantages and disadvantages. Special bags have a low investment cost, and they ensure that residents will use uniform containers. However, bags can be overstuffed, torn into by dogs or rodents, and require a distribution system involving local merchants.²⁰ Subscription cans maintain the uniformity of bags without the danger of rodent infestation, and they do not require a distribution system. Cans do require, though, a significant capital investment, as well as a more complicated billing system.²¹ Tags are easier to distribute than bags -- they can be sent cheaply through the mail -- but allow residents to vary the size of their containers. They can also fall off.²²

¹⁶ Richardson and Havlicek, 1978.

¹⁷ Dinan, May/June 1992; Skumatz, June 1993; Lewis, June/July 1993; Bender et. al., January 1994.

¹⁸ Skumatz, January 1990.

¹⁹ Morris and Byrd, Fall 1990; EPA, September 1990; Browning and Becker, November 1990; Harder and Knox, April 1992; Canterbury, April 1994; Miller, September 1993.

²⁰ Harder and Knox, April 1992; Miller, September 1993.

²¹ Miller, September 1993.

²² Browning and Becker, November 1990; Harder and Knox, April 1992; Canterbury, April 1994; Miller, September 1993.

Table 2-1: Advantages and Disadvantages of Different Container Types

Container Type	Advantages	Disadvantages
Bags	uniform; easy billing system	overstuffing; susceptible to rodents and dogs; must be distributed
Stickers/Tags	easy to distribute (mail); easy billing system	no uniformity; can fall off
Cans	uniform; prevents rodents; no constant distribution	high initial investment; require billing system

A few authors present possible solutions to some of the container problems. Bag overstuffing can be prevented by strictly enforcing weight limits.²³ A computerized billing system, like that in Athens, Ohio, is easy to use and eliminates inaccuracies, thereby reducing the administrative costs of subscription cans.²⁴

2.3 Fee Structure

Unit pricing systems employ a variety of fee structures. Some programs utilize a completely variable fee, where the fixed costs of waste collection (equipment, overhead, etc.) are incorporated into the variable rate. A variant on this system is the multi-tier structure. Under such a system, the estimated fixed costs of collection and a basic level of service are financed by a flat fee or through property taxes. Residents pay variable fees for incremental service levels above the base level.²⁵ The multi-tier system provides some security to the hauler, in that it ensures that its fixed costs will be covered. For this reason, the Mendham Township, New Jersey recycling coordinator recommends hybrid systems for new unit pricing communities.²⁶ However, a hybrid system does not send as strong a pricing signal to household waste generators.²⁷ Miranda, et. al. studied 21 unit pricing communities, two of which had multi-tier pricing systems. They report that the average level of waste landfilled reduction in the cities using a

²³ EPA, September 1990; Browning, November 1990.

²⁴ Norris, February 1994.

²⁵ Blume, May 1991; Skumatz, November 1993; Miranda et. al., 1994.

²⁶ "New Jersey Town," February 1993.

²⁷ Skumatz, November 1993.

multi-tier system (18.5%) was less than the average level of reduction in the other 19 cities (42.5%).²⁸

Johnson and Carlson describe how a multi-tier fee can be computed. The first part of the fee is set by dividing the hauler's costs, excluding disposal fees, by the number of households served, and charging that amount as a base rate. The second part of the fee can be computed by converting the local tipping fee into dollars-per-pound and multiplying it by the weight of the residential service level (i.e., a 30-lb can).²⁹ Multi-tier systems are in place in: Glen Ellyn, Illinois; Northfield, Minnesota; and Platteville, Wisconsin. Glen Ellyn's landfilled waste fell by 59% after the system was adopted.³⁰ Lambert, in her rate proposal for a weight-based pricing system in the city of Durham, North Carolina, recommends a multi-tier fee structure.³¹

Table 2-2: Examples of Cities with Different Pricing Structures

Pricing Structure	Example Cities
Full variable rate	Woodstock, IL; Ilion, NY; Perkasi, PA
Multi-tier	Glen Ellyn, IL; Northfield, MN; Platteville, WI

2.4 Basis of Fees

Most unit pricing communities have volume-based fees. However, a few areas have conducted trials with weight-based systems. They include: Seattle, Washington; Farmington and Minneapolis, Minnesota; Durham, North Carolina; Columbia, South Carolina; and Milwaukee, Wisconsin.³² Weight-based fees more closely represent the cost of waste disposal than do volume-based fees, since tipping fees are based on weight.³³ They also provide a clearer and continuous pricing signal to household producers of garbage. Volume-based fees provide no additional waste reduction incentive below the lowest level of service (i.e. one bag or can per week).³⁴ Seattle's weight-based pilot system performed well, but did extend collection times by 10%. This would equate, city-wide, to an extra \$600,000 in labor collection

²⁸ Miranda et. al., 1994.

²⁹ Johnson and Carlson, February 1991.

³⁰ Skumatz, November 1993.

³¹ Lambert, 1991.

³² Andresen, November 1990; Skumatz et. al., November 1994.

³³ Tipping fees account for lost landfill capacity. The best measure of capacity impacts is compacted volume, which is difficult to measure. As a result, tipping fees are based on weight, which is considered a good proxy for compacted volume.

³⁴ Lambert, 1991; EPA, April 1991; Skumatz, July 1991; Canterbury, April 1994; Skumatz et. al., November 1994.

costs per year. There would also be a high initial investment cost for equipment and a computerized billing system. The system requires operators to hang the can on a scale mechanism and scan bar code labels on the receptacle, allowing for possible human error. The project did lower the weight of garbage collected by 15%.³⁵ Sixty percent of the residents surveyed said they were satisfied with the system.³⁶ In Columbia, South Carolina, collection times during the weight-based study were the same as normal collection rates.³⁷

Technological developments, like bar codes on cans, are alleviating some of the difficulties with weight-based systems. Concerns about accuracy can be addressed by forcing weighing mechanisms to meet strict accuracy tests, and through hauler education.³⁸ Skumatz points out that the investment costs of a weight-based system may be matched by long-term savings from reduced waste.³⁹

Table 2-3: Volume- vs. Weight-Based Systems

System Type	Advantages	Disadvantages
Volume-Based	easier to administer, while still providing some waste reduction incentive	pricing signal is not continuous, and does not provide any incentive below the lowest subscription level
Weight-Based	provides clearer and continuous pricing signal; similar to weight-based tipping fees	extends collection times; higher investment cost for equipment; requires computerized billing system; more possibility of human error

2.5 Privately vs. Publicly Run

Not all unit pricing programs are municipally operated. Some communities choose to hire a private hauling firm to run their systems. Unit pricing programs are operated by local governments, by

³⁵ Skumatz et. al., November 1994.

³⁶ EPA, April 1991; Skumatz, July 1991.

³⁷ Skumatz, November 1994.

³⁸ Andresen, November 1992; Skumatz, November 1994.

³⁹ Skumatz et. al., November 1994.

private haulers, or by some combination of the two.⁴⁰

2.6 Complementary Programs

Unit pricing communities typically offer a variety of complementary programs. These include recycling programs, either drop-off centers or curbside pickup, and drop-off, curbside or backyard composting programs.⁴¹ Most unit pricing municipalities offer some diversion alternative for their residents.⁴² Harder and Knox report that the failure of unit pricing in Nanticoke, Pennsylvania -- 68% of its municipal customers switched to private haulers -- was largely due to the lack of a curbside recycling program.⁴³ A few communities charge residents for recycling collection, but the price is generally less than that charged for garbage pickup.⁴⁴ Many communities also run public education programs to inform their residents about unit pricing.⁴⁵ Several authors say that education is vital to the success of unit pricing programs,⁴⁶ especially in large, urban areas.⁴⁷

3.0 OUTCOMES ASSOCIATED WITH UNIT PRICING

Many claims are made in the literature about the outcomes associated with variable rate pricing. The major effect cited is increased recycling and decreased waste (garbage that is sent to the landfill or incinerator). There is little disagreement among the authors about the positive effect that unit pricing has on recycling, but many disagree that variable fees lead to source reduction. Several other secondary outcomes are mentioned throughout the literature.

3.1 Increased Recycling Participation

Virtually every piece of unit pricing literature addresses the effect that variable rates have on recycling participation and the amount of municipal waste recycled. Most of the authors contend that variable fees increase recycling participation and recycling tonnages. Local waste officials seem to agree. In a survey of 1000 local recycling coordinators, the respondents identified variable collection rates as the most effective strategy to encourage recycling. Unit pricing received a 3.83 on a scale of 1 to 5 (5 being most effective at encouraging recycling).⁴⁸

⁴⁰ EPA, September 1990.

⁴¹ Morris and Byrd, Fall 1990; EPA, September 1990; Harder and Knox, April 1992; Canterbury, April 1994.

⁴² Skumatz, January 1990; Roy, 1992.

⁴³ Harder and Knox, April 1992.

⁴⁴ Morris and Byrd, Fall 1990; EPA, September 1990.

⁴⁵ Canterbury, April 1994; EPA, February 1994.

⁴⁶ Skumatz, January 1990; Harder and Knox, April 1992.

⁴⁷ EPA, February 1994.

⁴⁸ Khator and Huffman, October 1993.

Many authors provide statistics from unit pricing communities that show that variable fees do increase municipal recycling efforts. The city of Seattle, Washington, in particular, receives a lot of attention. Since the start of unit pricing in Seattle, recycling tonnages have increased 60%,⁴⁹ and the city has a recycling participation rate of 80%.⁵⁰ However, a recent Wall Street Journal article contends that Seattle will have difficulty reaching its 60% diversion goal, and that draconian measures will be required.⁵¹ In response to that article, Peter Grogan of R.W. Beck Associates in Seattle asserts that the city is steadily approaching its 60% goal.⁵²

In a survey of 36 unit pricing communities in Pennsylvania, municipalities report that recycling participation increased after variable fees were implemented.⁵³ Another study of eight unit pricing towns in Pennsylvania found that six of them have recycling rates greater than the statewide average of 16%.⁵⁴ One town in particular, Perkasié, now recycles 43% of its waste.⁵⁵ A study of unit pricing communities in Illinois found that they have higher recycling participation rates than flat fee communities, and more of their waste is recycled. For example, Hoffman Estates recycles 31% of its waste, and Downers Grove has a recycling rate of 28%. The statewide average is 18%.⁵⁶ Recycling participation in Woodstock is 88%, with an overall diversion rate of 4% to 8%.⁵⁷ Tacoma, Washington has a diversion rate of 14%, with 63% of its citizens participating in the city's recycling program.⁵⁸ After implementing variable rates, Mendham Township, New Jersey increased its recycling tonnage by 83%,⁵⁹ St. Paul, Minnesota has increased recycling participation from 15% to 32%,⁶⁰ and Mt. Pleasant, Michigan experienced a 50% increase in recycling participation.⁶¹ A study of 21 unit pricing cities found that recycling tonnages increased between 3% and 456%, with an average increase of 126%.⁶² Cuthbert's case studies of Portland, Oregon, Seattle and Tacoma, Washington, Wilkes-Barre, Pennsylvania, and Bothell and Minneapolis, Minnesota found that

⁴⁹ "Seattle Engineers," November 1985.

⁵⁰ Kourik, November 1990.

⁵¹ Richards, August 1993.

⁵² Grogan, October 1993.

⁵³ Harder and Knox, April 1992.

⁵⁴ Guerrieri, September 1994.

⁵⁵ Katz, February 1989.

⁵⁶ Moriarty, January 1994.

⁵⁷ Riggle, February 1989.

⁵⁸ Woods, July 1993.

⁵⁹ "New Jersey Town," February 1993.

⁶⁰ Goldberg, February 1990.

⁶¹ Deisch, December 1989.

⁶² Miranda et. al., 1994.

unit pricing in these communities encourages recycling.⁶³ For example, after the adoption of unit pricing, Portland experienced a 349% increase in the amount of material recycled in the city.

Table 3-1: Impact of Unit Pricing on Municipal Recycling

City	Recycling Outcome
Downers Grove, Illinois	recycles 28% of its waste
Hoffman Estates, Illinois	recycles 31% of its waste
Woodstock, Illinois	88% recycling participation
Mt. Pleasant, Michigan	recycling participation increased 50%
St. Paul, Minnesota	increased recycling participation from 15% to 32%
Mendham Township, New Jersey	increased recycling tonnage by 83%
Portland, Oregon	349% increase in amount of material recycled
Perkasie, Pennsylvania	recycles 43% of its waste
Seattle, Washington	increased recycling tonnages by 60%; 80% recycling participation
Tacoma, Washington	recycles 14% of its waste; 63% recycling participation

Several articles examine the effect of variable fees at the household level. A survey of 75 households in Charlottesville, Virginia that participated in a unit pricing pilot study found that the amount of materials recycled increased, on average, by 15%.⁶⁴ A survey of 3,040 households in Tompkins County, New York, found that while variable rates alone may have only a minor impact on recycling behavior, variable rates in conjunction with curbside service and mandated participation significantly increase participation.⁶⁵ However, 51% of the respondents did say they recycle more because of variable rates.⁶⁶ Miranda et. al. observed that mandatory recycling provisions have little impact on overall waste reduction. The 3 communities in the study with mandatory programs decreased their landfill tonnage by

⁶³ Cuthbert, May 1994.

⁶⁴ Fullerton and Kinnaman, March 1994.

⁶⁵ Reschovsky and Stone, Winter 1994.

⁶⁶ Stone and Harrison, August 1991.

an average of 34% under variable rates, while 14 with voluntary programs reduced their landfilled waste by an average of 43.4%.⁶⁷ Before the implementation of unit fees in Dover, New Hampshire, there was a wide range of attitudes about recycling, but six months into the program, attitudes had converged and there is a more uniform level of commitment to recycling.⁶⁸ One study indicates that the positive effects of unit pricing on household recycling participation operate independently of income. The survey of 100 residents in Lisle, Illinois found that under unit pricing, recycling participation increased across all economic groups.⁶⁹

Unit pricing has similarly positive effects on composting. Participation in Seattle's backyard composting program is high,⁷⁰ with over 60% of the city's customers subscribing to the yard waste collection and composting program.⁷¹ In San Jose, California, unit pricing increased yard waste setouts by 61%.⁷² In the Tompkins County survey, 16% of the respondents said they composted more because of variable waste collection rates.⁷³

3.2 Decreased Waste Landfilled and Source Reduction

The extent to which unit pricing encourages actual source reduction behavior, such as purchasing reduced packaging goods, is also a major topic in most of the literature. Source reduction is more difficult to measure than decreases in waste landfilled and increases in waste diversion, resulting in less agreement as to the effects of variable rates. Some studies in the literature do not specifically discern between decreased waste landfilled and source reduction behavior in their review of unit pricing program outcomes.⁷⁴

3.2.A. Decreased Waste Landfilled

Many authors provide aggregate waste reduction figures based on decreased landfill tonnages from numerous unit pricing communities. Again, there is a great deal of attention focused on Seattle, Washington. Since adopting unit pricing, Seattle has reduced the amount of waste it landfills by 24%.⁷⁵

⁶⁷ Miranda et. al., 1994.

⁶⁸ Emmer and Neidhart, no date.

⁶⁹ Adamec, March 1991.

⁷⁰ "Pushing the Limits," March 1994.

⁷¹ Skumatz, March 1991.

⁷² Toomey, May 1994.

⁷³ Stone and Harrison, August 1991.

⁷⁴ "Seattle Engineers," November 1985; Guerrieri, September 1994; Cuthbert, May 1994; Riggle, February 1989; "New Jersey Town," February 1993; Alderden, November 1990.

⁷⁵ Skumatz, January 1990; Kourik, November 1990.

Per capita waste generation rates have climbed more slowly in Seattle than in other comparable areas.⁷⁶ Other cities report similar waste reduction figures. The Harder and Knox survey of Pennsylvania unit pricing communities shows that variable rates encourage household waste reduction,⁷⁷ and the Guerrieri study found that seven out of the eight towns studied have per capita waste generation rates less than the statewide average of 0.8 tons.⁷⁸ Perkasié reports that waste levels have fallen 41% since it adopted unit pricing,⁷⁹ and the weight of its garbage and recyclables has dropped 28.7%.⁸⁰ The amount of waste collected in Wilkes-Barre has fallen 15% under unit pricing.⁸¹ In Illinois, landfilled waste decreased by 53% in Lisle the year after unit pricing was implemented,⁸² by 50% in Downer's Grove, and by 15% in Woodstock.⁸³ In St. Charles, landfill waste tonnage decreased by 17%.⁸⁴ Waste tonnage in High Bridge, New Jersey has fallen by 24%.⁸⁵ Elsewhere in New Jersey, waste was reduced in Mendham Township by 55%.⁸⁶ In Lansing, Michigan, the amount of waste landfilled was reduced by 20%.⁸⁷ Sommersworth and Dover, New Hampshire reduced their residential waste by 50%.⁸⁸ Ilion, New York experienced a decrease in landfilled waste. One author reports that waste decreased by 29%,⁸⁹ and another says 37%.⁹⁰ Waste reduction has also been reported in Portland, Oregon, Tacoma Washington, and Bothel and Minneapolis, Minnesota.⁹¹ In general, communities utilizing variable rates have reported an average reduction in waste of 28%, with a range of 25% to 50%.⁹²

⁷⁶ "Seattle Engineers," November 1985.

⁷⁷ Harder and Knox, April 1992.

⁷⁸ Guerrieri, September 1994.

⁷⁹ Laplante and Luckert, October 1991.

⁸⁰ Katz, February 1989.

⁸¹ Cuthbert, May 1994.

⁸² Adamec, March 1991.

⁸³ Laplante and Luckert, October 1991.

⁸⁴ University of Illinois, May 1990.

⁸⁵ Katz, February 1989; Riggle, February 1989.

⁸⁶ "New Jersey Town," February 1993.

⁸⁷ Enos, February 1991.

⁸⁸ Hayes, December 1992.

⁸⁹ Morris and Byrd, Fall 1990.

⁹⁰ Laplante and Luckert, October 1991.

⁹¹ Cuthbert, May 1994.

⁹² Alderden, November 1990.

Table 3-2: Reported Waste Reduction Figures in Unit Pricing Cities

City	Waste Reduction Evidence
Downers Grove, Illinois	waste reduced 50%
Lisle, Illinois	waste reduced 53%
St. Charles, Illinois	landfill waste tonnage reduced 17%
Woodstock, Illinois	waste reduced 15%; bags/household/week down from 1.5 to 1.3
Lansing, Michigan	landfilled waste reduced 20%
Sommersworth and Dover, New Hampshire	waste reduced 50%
High Bridge, New Jersey	waste tonnage reduced 24%
Mendham Township, New Jersey	waste reduced 55%
Ilion, New York	waste reduced 29% / 37%
Perkasie, Pennsylvania	waste reduced 41%; weight of garbage and recyclables reduced 28%
Wilkes-Barre, Pennsylvania	waste reduced 15%
Olympia, Washington	50% increase in residents using smaller can
Seattle, Washington	landfilled waste reduced 24%; subscription level down from 3.5 cans/household/week to 1

Some authors present evidence of waste reduction in terms of reduced household levels of service. For example, in Seattle, the average residential subscription level since variable rates were implemented in 1981 has dropped from 3.5 cans per week to just over 1.⁹³ In Woodstock, the average number of bags of garbage per household has fallen from 1.5 to 1.3 each week.⁹⁴ In Olympia, Washington, there has been a 50% increase since 1988 in the number of residents utilizing the smaller-sized can,⁹⁵ and

⁹³ Skumatz, January 1990.

⁹⁴ Laplante and Luckert, October 1991.

⁹⁵ Goldberg, February 1990.

variable rates had a similar effect in Bellevue, Washington.⁹⁶

3.2.B. Source Reduction Behavior

Several authors claim that part of the observed levels of waste reduction result from waste minimization behavior (over and above recycling participation) on the part of community residents. For example, Miranda, et. al.'s study of 21 unit pricing communities concludes that the observed average waste reduction level of 30% can not be accounted for by increased recycling, composting, illegal disposal, and measurement error, alone. Some of the reduction likely resulted from source reduction behavior.⁹⁷ Their conclusion is supported by the Tompkins County survey, which shows that, as a result of variable collection fees, 39% of the respondents are more attentive to product packaging when they shopped.⁹⁸ Adamec also found reductions in waste in her study of Lisle, Illinois that could not be solely explained by increased recycling. When city officials added yard waste, recycling, and refuse collections together, there was still a 31% decrease in the total volume of materials collected the year after variable rates were implemented.⁹⁹

Some authors took issue with the claim that unit pricing causes people to reduce their waste. These authors claim that there is no conclusive evidence that variable rates cause residents to purchase reduced packaging products, or pursue other source reduction activities.¹⁰⁰ In one early survey, Savas compared household waste generation in communities with tax financed, flat fee, and variable fee collection systems. He found that variable rates have little effect on the amount of garbage generated by residents in municipalities with unit pricing,¹⁰¹ but changes in public opinion since 1977 could alter these findings. These authors suggest, instead, that observed levels of waste reduction are explained by garbage compaction and illegal disposal.¹⁰²

Economic modeling has not resolved the debate, either. There have been many attempts to estimate the responsiveness of waste generation and consumer demand for waste collection service to price. Some economists conclude that household waste generation is not very sensitive to changes in the price of collection service. A report based on five case studies -- Burbank and Sacramento, California; Provo, Utah; Grand Rapids, Michigan; and Tacoma, Washington -- concludes that while choices between types and levels of sanitation service may be sensitive to price (i.e., backdoor vs. curbside service, or twice vs. once per week collection), the quantity of waste generated at the household level is not.¹⁰³ In all three unit pricing communities -- Tacoma, Grand Rapids, and Sacramento -- the price elasticity of garbage

⁹⁶ Enos, February 1991.

⁹⁷ Miranda et. al., 1994.

⁹⁸ Stone and Harrison, August 1991.

⁹⁹ Adamec, March 1991.

¹⁰⁰ Miller, September, 1993.

¹⁰¹ Savas et. al., 1977.

¹⁰² Miller, September 1993; Fullerton and Kinnaman, March 1994.

¹⁰³ Efaw and Lanen, August 1979.

generation is not significantly different than zero. Another study uses an economic model of household waste generation and a survey of 93 variable fee communities to determine the effect of variable rates on waste generation. The author found that for a 10% increase in the price of collection, demand for service goes down 9%, but refuse generation only decreases .5% to 1.17%.¹⁰⁴ Again, because the study took place nearly 20 years ago, it would be useful to recompute the elasticities with modern data. A model of household waste generation behavior, applied to Portland, Oregon, shows that increasing the price of collection increases recycling participation, but does not significantly reduce the demand for garbage collection service.¹⁰⁵ The Miranda, et. al. study found that in the 21 cities surveyed, under both high (greater than \$1.25) and medium (between \$1 and \$1.25) per unit pricing levels, the average reduction in landfilled waste is around 41%, and that under low (less than \$1) per unit pricing levels, average reduction is 47.5%.¹⁰⁶

Other researchers, however, concluded that collection price levels can have a significant impact on waste generation. Jenkins argues that while individual household demand is inelastic, unit pricing can still create small reductions in waste at the household level that can add up to significant reductions in waste at the community level.¹⁰⁷ Morris' model of household waste disposal behavior shows that individuals' elasticity of demand for waste collection services with respect to price varies significantly with different price levels, but that household utility is higher with variable rates than with a flat rate system.¹⁰⁸ Finally, early research by Albrecht reports that a University of California study estimates the price elasticity of demand for solid waste service to be 0.44, significantly higher than the nearly zero price elasticity computed by others.¹⁰⁹

3.3 Source Reduction and Recycling Interaction

Another unit pricing issue on which there is disagreement is the question of how the incentives to recycle and source reduce interact. Some authors suggest that the two are complementary -- that unit pricing creates a greater awareness of the waste stream, inducing households to pursue both increased recycling and waste minimization techniques.¹¹⁰ Others raise the possibility that the two are substitutes for one another -- that households participating in a recycling program will be less likely to source reduce because they are already "doing something good" for the environment.¹¹¹ Morris and Holthausen conclude that as the user charge increases, households respond with more waste minimization behavior and less recycling.

¹⁰⁴ Stevens, January 1977.

¹⁰⁵ Hong, November 1991.

¹⁰⁶ Miranda et. al., 1994.

¹⁰⁷ Jenkins, 1991.

¹⁰⁸ Morris and Holthausen, 1994.

¹⁰⁹ Albrecht, 1976/1977.

¹¹⁰ EPA, February 1991; Miranda et. al., 1994.

¹¹¹ Morris and Holthausen, 1994; Miranda et. al., 1994.

Emphasizing one type of disposal option may dampen households' incentives to pursue another.¹¹² A roundtable discussion with four solid waste experts addressed the compatibility question. The group concluded that the two can be compatible, but that states may emphasize recycling to such an extreme that it precludes source reduction behavior.¹¹³ Providing recycling service free of charge may encourage households to recycle at more than an efficient level and source reduce at less than an efficient level. A unit price for recycling services (presumably set lower than the unit price for waste collection) might correct for this behavior and provide for more efficient recycling and source reduction activity.

Table 3-3: Are Incentives to Source Reduce and Recycle Complementary or Competitive?

Complementary	Competitive
unit pricing creates greater awareness of waste stream, inducing both source reduction and recycling; as user charge increase, household respond with more waste minimization	substitutes -- households that recycle are "already doing something good for the environment"; over-emphasizing one alternative could preclude the other

3.4 Undesirable Diversion

Much of the literature raises the possibility that unit pricing may induce citizens to dispose of their waste improperly.¹¹⁴ Fullerton and Kinnaman conclude that, based on economic theory, people will participate in illegal disposal under a unit pricing system.¹¹⁵ Their study of Charlottesville residents concluded that 28% of the observed reduction in waste was accounted for by undesirable diversion. They based this figure on the percentage of survey respondents who indicated they used "other means" (as opposed to recycling, composting, or purchasing goods with less packaging) to reduce their waste.¹¹⁶

Undesirable diversion may take several forms. Residents may place their garbage in commercial

¹¹² Morris and Holthausen, 1994.

¹¹³ Rabasca, April 1994.

¹¹⁴ EPA, September 1990; Browning and Becker, November 1990; Blume, May 1991; Harder and Knox, April 1992; Scarlett, May 1993; Skumatz, June 1993; Miller, September 1993; Miranda et. al., 1994; Bender, January 1994; Canterbury, April 1994; Guerrieri, September 1994; Reschovsky and Stone, Winter 1994.

¹¹⁵ Fullerton and Kinnaman, May 1993.

¹¹⁶ Fullerton and Kinnaman, March 1994.

dumpsters.¹¹⁷ McHenry County, Illinois reports this problem with commercial dumpster disposal in some of its unit pricing communities.¹¹⁸ The 10 Illinois solid waste officials in Browning and Becker's survey rate dumping in commercial dumpsters as the most serious problem with unit pricing in their communities, giving it an average rating of 2.9 on a scale of 1 to 5, where 1 indicates that the community definitely does not experience a problem and 5 indicates that the community definitely does experience a problem.¹¹⁹ Residents may also dump their garbage roadside. The average rating for roadside dumping in Browning and Becker's survey is 2.39.¹²⁰ Fifty-one percent of the residents in Reschovsky's survey of Tompkins County report some increase in littering after the county adopted variable fees.¹²¹ Backyard burning presents another disposal option. Twenty percent of the Tompkins County survey respondents said they burn their trash,¹²² and Perkasi initially had problems with burning.¹²³ Finally, residents may misuse their recycling bins by throwing non-recyclable waste in them.¹²⁴

Some authors cite unit pricing communities that do not have problems with improper disposal. They include: Mendham Township, New Jersey;¹²⁵ Mt. Pleasant, Michigan;¹²⁶ and Seattle, Washington.¹²⁷ The Bender study of unit pricing in Massachusetts reports that undesirable diversion is an issue of "unexpectedly low significance" in Massachusetts' variable rate communities.¹²⁸

The literature contains many suggestions of measures to alleviate undesirable diversion. They include locks on commercial dumpsters, strictly enforced littering and anti-burning ordinances, and public education,¹²⁹ as well as free drop-off days for bulky items, or garbage, in general.¹³⁰ In addition, disposal

¹¹⁷ Morris and Byrd, Fall 1990.

¹¹⁸ University of Illinois, May 1990; Alderden, November 1990.

¹¹⁹ Browning and Becker, November 1990.

¹²⁰ Browning and Becker, November 1990.

¹²¹ Reschovsky and Stone, Winter 1994.

¹²² Reschovsky and Stone, Winter 1994.

¹²³ Katz, February 1989; Morris and Byrd, Fall 1990.

¹²⁴ Miller, September 1993.

¹²⁵ "New Jersey Town," February 1993.

¹²⁶ Deisch, December 1989.

¹²⁷ Goldberg, February 1990.

¹²⁸ Bender et. al., January 1994.

¹²⁹ Katz, February 1989; Deisch, December 1989; Skumatz, January 1990; Morris and Byrd, Fall 1990; EPA, September 1990; Andresen, November 1990; Browning and Becker, November 1990; Blume, May 1991; Harder and Knox, April 1992; Stavins, Spring 1993; Miranda et. al., 1994; Guerrieri, September 1994; Skumatz, undated.

¹³⁰ Andresen, November 1992.

fees on products with refunds for proper disposal would create economic incentives for proper disposal.¹³¹ Extensive complementary programs, such as recycling and composting, may provide a legal outlet for diversion of waste thereby decreasing undesirable diversion.

Table 3-4: Experiences with Undesirable Diversion Among Unit Pricing Communities

City	Experience with Illegal Disposal
McHenry County, Illinois	some residential dumping in commercial dumpsters
10 Illinois communities	on a scale of 1 to 5, residential dumping in commercial dumpsters was rated 2.9, and roadside dumping was rated 2.39
Mt. Pleasant, Michigan	no reported problems
Mendham Township, New Jersey	no reported problems
Tompkins County, New York	51% of surveyed residents said there was some increase in littering; 20% said they burned their trash
Perkasie, Pennsylvania	some initial backyard burning
Charlottesville, Virginia	Fullerton and Kinnaman estimated that 28% of the observed waste reductions was due to illegal disposal
Seattle, Washington	no reported problems

¹³¹ Dobbs, February 1991; Chua and Laplante, April 1991; Dinan, May/June 1992; Fullerton and Kinnaman, May 1993.

3.5 Waste Compaction

Most data indicate that residents compact their garbage to minimize per-container fees under unit pricing systems.¹³² The Fullerton and Kinnaman study in Charlottesville, for example, found that while the volume of garbage was reduced by an average of 37% among the households in the study, the weight of garbage was only reduced 14%. The authors conclude that trash compaction accounted for the difference.¹³³ Richards' reports that residents in Seattle stomp their garbage.¹³⁴

Weight-based systems may provide a more accurate price signal to households that compact their garbage.¹³⁵ Some municipalities instruct haulers to leave behind overloaded receptacles,¹³⁶ or charge more for compacted garbage.¹³⁷ Solid waste managers need to anticipate and estimate residential waste compaction to set rates appropriately from the beginning. As more and more cities have adopted unit pricing, the expected level of waste compaction has become clearer, making it easier to set unit prices correctly from the beginning.

3.6 Impact of Fees on Low Income Residents

Because low income individuals have less disposable income, waste collection fees represent a greater proportionate burden on them than on higher income households.¹³⁸ However, several studies show that household waste generation is positively related to household income, so poorer families, in general, produce less trash and therefore are likely to face lower waste collection fees under a unit pricing system.¹³⁹ Furthermore, some systems have built in protections for poor families, like lower rates for low income households.¹⁴⁰ Kemper and Quigley compared user fees to collection programs financed through property taxes, and found, given the regressive nature of property taxation, that user fees are relatively progressive.¹⁴¹

¹³² EPA, September 1990; Scarlett, May 1993; Miller, September 1993; "Seattle Stomp," Spring 1994.

¹³³ Fullerton and Kinnaman, March 1994.

¹³⁴ Richards, August 1993.

¹³⁵ Skumatz, July 1991; Miller, September 1993.

¹³⁶ "Seattle Stomp," Spring 1994.

¹³⁷ Skumatz, January 1990.

¹³⁸ Efaw and Lanen, August 1979; Morris and Byrd, Fall 1990; EPA, September, 1990; Jenkins, 1991; Scarlett, May 1993; Miller, September 1993; Reschovsky and Stone, Winter 1994.

¹³⁹ Albrecht, 1976/1977; Efaw and Lanen, August 1979; Hong, November 1991; Morris and Byrd, Fall 1990.

¹⁴⁰ Lambert, 1991; Stavins, Spring 1993; Woods, July 1993.

¹⁴¹ Kemper and Quigley, 1976.

3.7 Unstable Hauler Revenue

Waste haulers in a unit pricing system may face uncertain revenue streams.¹⁴² Since the exact effect of unit fees on residential setouts is somewhat unpredictable, it is difficult for waste haulers to estimate their monthly collection levels and set prices appropriately. For example, Blazier Disposal in Harvard, Illinois set its rates based on an estimated pickup of 1.6 bags per household, but was left short of revenue when it only picked up 1.2 bags per household.¹⁴³ Similarly, haulers in suburban Chicago unit pricing communities are concerned about insufficient revenue, and may have to raise collection fees.¹⁴⁴ Unstable hauler revenue is the only difficulty cited by waste managers in Bellevue, Washington, Lansing, Michigan, and the state of Rhode Island.¹⁴⁵ In the survey of Illinois managers, unstable revenue received a rating of 2.88 (on a scale of 1 to 5).¹⁴⁶

A few authors recommend the multi-tier fee system, which is the use of a base flat fee that covers a minimum level of service and overcomes revenue stability problems.¹⁴⁷ One author proposes a mechanism that would track the differences between expected and actual revenue for a given year, and adjust the next year's fees accordingly.¹⁴⁸ However, repeated fee changes may irritate residents. In his analysis of Brevard County, Florida's suitability for a unit pricing system, Angelo establishes a framework for measuring the economic feasibility of unit pricing, which includes revenue stability as a factor. Angelo's framework could be applied to other communities.¹⁴⁹

3.8 Cost Structure

Unit pricing has the potential for providing cost savings, as well as for creating additional expenditures.¹⁵⁰ If residents reduce the amount of waste they set out and recycle more, haulers will lower their garbage collection labor costs,¹⁵¹ and increase their income from the sale of the additional recyclables.¹⁵² However, additional administrative costs may occur from added equipment, billing

¹⁴² Guerrieri, September 1994; Reschovsky and Stone, Winter 1994.

¹⁴³ Alderden, November 1990.

¹⁴⁴ University of Illinois, May 1990.

¹⁴⁵ Enos, February 1991.

¹⁴⁶ Browning and Becker, November 1990.

¹⁴⁷ Browning and Becker, November 1990; Skumatz, November 1993; Guerrieri, September 1994.

¹⁴⁸ Fiske, March/April 1992.

¹⁴⁹ Angelo, April 1993.

¹⁵⁰ Canterbury, April 1994; Reschovsky and Stone, Winter 1994.

¹⁵¹ EPA, February 1991.

¹⁵² Morris, Fall 1990; "Taking," July 1993.

systems, education and enforcement, and increased recyclables collection.¹⁵³ It is unclear whether the savings or the added costs will dominate in a given town.¹⁵⁴ However, when tipping fees are very high, the savings potential of unit pricing is correspondingly greater.¹⁵⁵

A few authors give examples of cost increases or savings in actual unit pricing communities. For example, Savas' survey of residents of unit pricing municipalities found that unit fees, whether flat or variable, increased billing costs relative to systems financed directly through property taxes.¹⁵⁶ On the other hand, Morris reports that unit pricing reduced collection costs in Perkasié and Ilion by 10% to 15%, while costs in Seattle stayed relatively constant.¹⁵⁷ Collection costs in Mendham Township decreased.¹⁵⁸ Finally, a private hauler in St. Cloud, Minnesota reports that he saves money from decreased collection costs, and he brings in more revenue from the sale of recyclables.¹⁵⁹

3.9 Multi-Unit Housing

Charging variable rates to residents of multi-unit housing complexes is more complicated than for single-family residences.¹⁶⁰ Most multi-unit facilities have garbage chutes or common dumpsters, making it difficult to measure each unit's waste generation level. Skumatz suggests that bag or tag systems could be used, or the landlord could set a subscription level for the building as a whole.¹⁶¹ The Massachusetts communities in the Bender survey report that multi-unit housing is a problem of "unexpectedly low significance."¹⁶² Furthermore, Carlisle, Pennsylvania, Plantation, Florida, Duluth, Georgia, and Grand Rapids, Michigan are all incorporating multi-unit residences into their unit pricing systems. Wilkes-Barre, Pennsylvania has experienced a 15% drop in landfilled waste from a pay-per-bag program focused exclusively on apartment buildings with five or more units.¹⁶³

¹⁵³ Morris and Byrd, Fall 1990; EPA, September 1990; Blume, May 1991; Guerrieri, September 1994.

¹⁵⁴ Morris and Byrd, Fall 1990; Angelo, April 1993.

¹⁵⁵ Blume, May 1991.

¹⁵⁶ Savas et. al., 1977.

¹⁵⁷ Morris and Byrd, Fall 1990.

¹⁵⁸ "New Jersey Town," February 1993.

¹⁵⁹ "Taking," July 1993.

¹⁶⁰ Harder and Knox, April 1992; Canterbury, April 1994; Reschovsky and Stone, Winter 1994.

¹⁶¹ Skumatz, January 1990.

¹⁶² Bender et. al., January 1994.

¹⁶³ Riggle, February 1989.

3.10 Customer Resistance

Some citizens oppose unit pricing because of their perceived loss of "free" garbage service.¹⁶⁴ If people never realized they were paying for waste collection before, they may be hesitant to start paying directly for it. In addition to having to pay directly for waste collection, citizens may also be concerned about losing the federal income tax deduction associated with local property tax financing of waste collection.¹⁶⁵ A great deal of evidence in the literature, however, indicates that residents of unit pricing communities strongly support, at least in the long run, their towns' systems. Ninety-three percent of surveyed Perkasio, Pennsylvania residents, when asked for their opinion of the town's unit pricing system, approved of it.¹⁶⁶ Goldberg claims that variable rates meet with similar levels of satisfaction in other communities. Roughly 90% of the residents of Ilion, New York and Seattle, Washington approve of their systems,¹⁶⁷ and there have been few complaints about unit pricing in Woodstock, Illinois or High Bridge, New Jersey.¹⁶⁸ In the Reschovsky survey of Tompkins County, New York, two-thirds of the respondents said they favored unit pricing.¹⁶⁹

3.11 Political Feasibility

Policymakers may shy away from variable rates because they fear that they will be unpopular.¹⁷⁰ Public officials may begin to lose that fear, however, when it becomes clearer that residents of unit pricing communities support their systems. Furthermore, recent legislative initiatives in 10 states either recommend or require local municipalities to adopt unit pricing, indicating that political support for variable fees is growing.¹⁷¹ Angelo's thesis contains a framework for assessing the political feasibility of unit pricing in Brevard County, Florida. He concludes that it is politically feasible.¹⁷²

3.12 Other Issues

The literature identifies several other potential effects of unit pricing. Reduced amounts of garbage may lower labor costs for garbage collection.¹⁷³ Grogan claims that Seattle has experienced such

¹⁶⁴ Morris, Fall 1990; EPA, September 1990; Stone, August 1991; Scarlett, May 1993; Skumatz, June 1993; "Taking," July 1993; Miller, September 1993; Bender, January 1994; Canterbury, April 1994.

¹⁶⁵ Kemper and Quigley, 1976.

¹⁶⁶ Goldberg, February 1990.

¹⁶⁷ "Seattle Engineers," November 1985; Morris, Fall 1990.

¹⁶⁸ Riggle, February 1989.

¹⁶⁹ Stone, August 1991; Reschovsky, Winter 1994.

¹⁷⁰ Miller, September 1993; Reschovsky, Winter 1994.

¹⁷¹ Skumatz, June 1993.

¹⁷² Angelo, April 1993.

¹⁷³ Skumatz and Breckinridge, June 1990; Morris and Byrd, Fall 1990; EPA, September 1990; EPA, February 1991.

savings.¹⁷⁴ Also, if participation in recycling programs increases, an economies of scale effect may take place that would lower the average cost of providing such services.¹⁷⁵ Related to that point is the possibility that consumers will purchase more recycled or reduced packaging goods and create economies of scale in the production of those products, as well.¹⁷⁶

Some perceive unit pricing as being more equitable than flat rate systems since those individuals who use more collection services have to pay more.¹⁷⁷ Unit pricing may provide an aesthetic benefit in that the system reduces the amount of trash left along curbs in neighborhoods, and restricts garbage to uniform containers.¹⁷⁸ Some authors claim that the system makes people more aware of how their actions affect the environment, and may make citizens more supportive of environmental protection.¹⁷⁹

A few authors also mention difficulties with unit pricing systems, such as customer confusion¹⁸⁰ and setting the rate structure.¹⁸¹

4.0 DESIGNING THE UNIT PRICING PROGRAM

Much of the literature describes questions that waste management officials must consider before implementing a unit pricing system. They include the community's demographic makeup,¹⁸² its waste management needs,¹⁸³ the level of community environmental awareness,¹⁸⁴ the compatibility of variable fees with the existing system,¹⁸⁵ and whether a majority of residents would benefit from the system.¹⁸⁶

¹⁷⁴ Grogan, October 1993.

¹⁷⁵ Skumatz and Breckinridge, June 1990; Morris and Byrd, Fall 1990; EPA, September 1990; EPA, February 1991.

¹⁷⁶ Skumatz and Breckinridge, June 1990; Morris and Byrd, Fall 1990; EPA, September 1990; EPA, February 1991.

¹⁷⁷ Alderden, November 1990; EPA, February 1991; Fletcher, October 1992.

¹⁷⁸ EPA, February 1991; Morris and Byrd, Fall 1990.

¹⁷⁹ Skumatz and Breckinridge, June 1990; Morris and Byrd, Fall 1990; EPA, September 1990; EPA, February 1991; Miranda et. al., 1994.

¹⁸⁰ Bender et. al., January 1994; Guerrieri, September 1994.

¹⁸¹ Enos, February, 1991; Fiske, March/April 1992; Bender et. al., January 1994; Reschovsky and Stone, Winter 1994.

¹⁸² Alderden, November 1990; Cuthbert, June 1993; Skumatz, June 1993.

¹⁸³ Canterbury, April 1994.

¹⁸⁴ Alderden, November 1990.

¹⁸⁵ Skumatz, June 1993.

¹⁸⁶ "New Jersey Town," February 1993.

When designing a unit pricing system, waste managers must set the rates,¹⁸⁷ choose a container type and decide what complementary programs to offer,¹⁸⁸ make necessary departmental changes,¹⁸⁹ ensure community support,¹⁹⁰ monitor the system and enforce compliance,¹⁹¹ educate the public,¹⁹² select special program characteristics for low-income residents,¹⁹³ preempt undesirable diversion,¹⁹⁴ and come up with a method for dealing with multi-unit housing.¹⁹⁵

5.0 SUMMARY AND CONCLUSIONS

Since their inception, much has been written about unit pricing programs in communities across the United States. Perhaps the clearest outcome is that unit pricing does increase both recycling levels and recycling participation rates. The programs also likely increase backyard composting, but this is as yet unconfirmed by hard data. Communities that provide curbside pickup of yard waste do experience higher set-out rates with the implementation of unit pricing, even in those cases where a fee is charged (albeit lower than the fee for mixed waste destined for the landfill).

Communities have used a variety of containers with equal success, often choosing based on the experience of nearby communities that have already adopted unit pricing -- hence the tendency for West Coast cities to use cans, while East Coast cities tend toward bag, tag, or sticker systems. Fee structures also vary from community to community. Multi-tier systems are favored by communities especially worried about unstable hauler revenues. In theory, full variable rate pricing should provide stronger economic incentives to both source reduce and recycle and compost. Preliminary evidence indicates that multi-tier systems with high base levels of service are relatively ineffective. Further work needs to be done in this area to confirm whether full variable rate pricing does outperform multi-tier systems in general; and how multi-tier systems might be designed to help stabilize hauler revenues while still providing strong incentives to minimize waste generation rates.

Advances in technology (like bar coding of garbage cans and automated weighing systems) are making weight-based pricing more and more attractive. Volume-based systems will likely continue to predominate in communities using unit pricing until the costs of these new technologies are substantially reduced. Complementary programs are vital to the success of any type of unit pricing program. Managers

¹⁸⁷ EPA, February 1991; University of Illinois, December 1992; Canterbury, April 1994.

¹⁸⁸ Alderden, November 1990; University of Illinois, December 1992; Canterbury, April 1994.

¹⁸⁹ Lambert, 1991.

¹⁹⁰ EPA, February 1991; Lambert, 1991.

¹⁹¹ EPA, February 1991.

¹⁹² Lambert, 1991; U of Illinois, December 1992.

¹⁹³ Lambert, 1991; EPA, February 1991; University of Illinois, December 1992; Canterbury, April 1994.

¹⁹⁴ Lambert, 1991; University of Illinois, December 1992; Skumatz, June 1993; Canterbury, April 1994.

¹⁹⁵ Skumatz, June 1993; Canterbury, April 1994.

and residents alike tend to cite curbside recycling and public education as most important in ensuring the success of unit pricing programs.

Perhaps the most controversial question regarding unit pricing is whether or not it leads to decreases in total waste generation. In the EPA hierarchy of waste management methods ("reduce, reuse, recycle"), primary emphasis is given to policies that lead to source reduction on the part of residents and businesses. While economic theory suggests that unit pricing does provide an economic incentive to participate in source reduction activities, many researchers and solid waste managers doubt that residents actually act on this incentive. Empirical results are mixed, and are complicated by the poor quality of data that characterizes the field of solid waste in general. This issue needs serious attention if a comprehensive assessment of unit pricing programs is ever to be provided.

Related to the issue of source reduction is the question of how source reduction and materials diversion incentives and programs interact. On the one hand, the two programs may be complementary. Unit pricing may create a greater awareness of the waste stream and its impact on the environment, thus encouraging households to pursue both activities. On the other hand, the two may be substitutes. Households participating in a recycling program may feel they have already "done something good" for the environment. Again, data problems do not currently allow for a definitive analysis of the issue. A rigorous analysis of the levels of source reduction and materials diversion behaviors as well as the interaction between the two that result from implementation of unit pricing programs is perhaps the single most important research need.

Another area of considerable controversy is whether unit pricing leads to undesirable diversion of residential solid waste. Again the empirical evidence is mixed. Several in-depth case studies that explore all the possibilities for undesirable diversion and quantify some of the effects (e.g., how prevalent is diversion to commercial dumpsters?) would go far in addressing this question. In addition, careful analysis of the costs associated with the various undesirable diversion options would provide a clearer sense of the most-often-cited negative impact of unit pricing.

Some policy analysts and community leaders fear that unit pricing has a disproportionate impact on lower income households. Data do indicate that lower income households tend to produce less waste than higher income households, but the pricing system may still be regressive in impact. Household-level analysis of waste generation rates and costs for waste collection services would help to resolve this question. An alternative perspective on the equity question is that unit pricing programs are perceived by residents and solid waste managers alike as being more fair in the sense that individuals who generate a lot of waste must pay more for their solid waste collection services.

Solid waste managers must also concern themselves with whether unit pricing leads to higher service and administrative costs, and if so, whether savings in landfill tipping fees make up for the higher costs. Again, current data does not allow for a definitive analysis of this question. Analysis should focus on communities that implemented unit pricing some number of years ago in order to incorporate adjustments in the unit pricing program as well as the supporting complementary programs. In addition, the two sets of costs may change as solid waste personnel and residents become more accustomed to the system.

Multi-unit housing provides special challenges to communities interested in adopting unit pricing programs. Technology may provide easier and less expensive ways to handle multi-unit dwelling units.

Alternatively, communities may choose to exempt them from the unit pricing program. The literature also indicates that customer resistance may play a role in the outcomes associated with unit pricing programs. Clearly, solid waste managers must anticipate this resistance and plan public education and outreach programs.

Despite the growing numbers of communities that are implementing unit pricing programs, many questions remain unanswered regarding the ability of the programs to achieve their objectives. This paper outlines the general areas of agreement and disagreement in addition to providing a comprehensive review of the literature on unit pricing. As outlined above, much research and analysis remains to be done.

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APPENDIX A: UNIT PRICING MATRIX
(Please Contact Author of Report for a Copy)

APPENDIX B: ANNOTATED BIBLIOGRAPHY

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Adamec, Barbara. "Volume-Based Collection Fees: A Success Story." Resource Recycling. March, 1991.

A review of the unit pricing program in Lisle, Illinois. The community's variable rate system has successfully increased recycling participation and reduced waste generation without significant problems. The author based her conclusions on a survey of 100 residents. She divided the respondents into 4 socioeconomic groups and found that recycling participation was high across all groups, but that average set-out levels seemed to roughly increase with income. She also found that the average decrease in garbage from 1989 to 1990 was 53%, with 63% in the highest month (August) and 38% in the lowest (October). The average loss in total volume was 31%, with 46% in the highest month (August) and 8% in the lowest (October).

Albrecht, Oscar W. "An Evaluation of User Charges for Solid Waste Collection and Disposal." Resource, Recovery and Conservation. Vol. 2. 1976/1977.

An early introduction to the concept of user fees for waste collection services. Variable rates, like effluent charges for air and water pollutants, provide a pricing incentive to reduce the amount of garbage generated. A University of California study estimated the price elasticity of demand for solid waste service at .44, and an analysis by the City of Chicago found that waste production had a per capita income elasticity of .53. The key question with unit pricing is will it result in lower system costs and higher net benefits than other pricing systems. Other questions include: does unit pricing lead to less waste generation and how does the composition of the waste change; does unit pricing encourage recycling, and if so what are the effects on recovery systems; does unit pricing lead to greater efficiency in the waste collection system; does unit pricing lead to other disposal activities, including burning and littering; and, does unit pricing affect household choices of service levels?

Alderden, Jim. "Volume-Based Rates, Dream or Nightmare?" Recycling Today. November, 1990.

Unit pricing has been shown to encourage recycling and reduce the amount of municipal waste collected. Communities utilizing variable rates have reported an average reduction in garbage of 28%, with a range of 25% to 50%. It is also fairer to those that produce less waste. The down-side of unit pricing is that it can encourage illegal dumping, especially at the beginning of the program, and lead to insufficient revenue for waste haulers. McHenry County, Illinois had problems with residential garbage being thrown into commercial dumpsters. Blazier Disposal in Harvard, Illinois set its rates based on an estimated pickup of 1.6 bags per household and it only got 1.2 bags, leaving it short of revenue. Issues to consider include the demographic mix of the community, whether it is urban or rural, the level of community environmental awareness, the recyclables that will be collected, whether adequate revenue will be generated, and whether the program will be voluntary or mandatory.

Andresen, Katya. "Communities Weigh Merits of Variable Rates: Residents' Fees for Garbage Disposals." World Wastes. November, 1992.

A review of volume-based programs, experiments with weight-based fees, and technological innovations in waste collection. The author spoke with several solid waste professionals and academics who have studied variable rates, including Lisa Skumatz and Glen Morris. She summarized different system options, and reported on the successes of unit pricing in Santa Maria, California, Seattle, Washington, Perkasio, Pennsylvania, and Ilion, New York. Weight-based systems have been tested in Seattle, Farmington, Minnesota, and Durham, North Carolina. Charging by weight, while more difficult to implement, would provide a more accurate pricing signal to residents than volume-based fees. Illegal disposal is a significant concern with unit pricing, but the problem can be headed off by providing free drop-off days, locking commercial dumpsters, and strictly enforcing anti-dumping ordinances. Technological developments, like bar coding cans, make waste collection easier and cheaper. Concerns about accuracy can be addressed by high standards and hauler education.

Angelo, James J. Should Brevard County, Florida Adopt a Unit Pricing Program for Municipal Solid Waste? Undergraduate Honors Project, Sanford Institute of Public Policy, Duke University. April, 1993.

In determining whether Brevard County, Florida should adopt unit pricing, the author analyzed both the economic and political feasibility of implementing variable rates. He set up a framework for conducting this analysis. The economic feasibility was determined by weighing the costs of implementing such a system against the benefits it would accrue to the community. The political feasibility was determined by assessing the county's legal authority to enact such a system and whether the political environment in the county would allow for it. The paper concluded that unit pricing seemed to be both economically and politically feasible, but that the county should engage in a more rigorous analysis of the potential effects of a variable rate pricing system.

Bender, Rodd; Briggs, Wyman; and De Witt, Diane. Toward Statewide Unit Pricing in Massachusetts: Influencing the Policy Cycle. Master's Degree Project. John F. Kennedy School of Government. January, 1994.

The Massachusetts Executive Office of Environmental Affairs advocates unit pricing for municipal solid waste collection, but the decision to implement variable rates is up to localities. This study is an effort to judge community perceptions of unit pricing. The authors found that financial concerns, like the cost of waste disposal or the solvency of the collection service, a desire to encourage recycling and reduce waste, and grassroots lobbying efforts are all factors that can put unit pricing on a community's agenda. Adoption of variable rates is impeded by citizen perceptions that trash service should be free, failure to recognize the benefits of unit pricing, and fears about negative side effects, like illegal dumping and customer resistance. The study showed that the three biggest problems with unit pricing in Massachusetts communities had been customer confusion, selecting an appropriate system structure, and resistance to the loss of "free" service. Multi-unit housing, illegal dumping, and rate setting were of unexpectedly low significance. The authors presented an action plan for the Massachusetts Department of Environmental Protection and MassRecycle to aid in the passage of unit pricing at the community level by, among other

things, functioning as an information clearinghouse and addressing community concerns in statewide seminars.

Blume, Daniel. Under What Conditions Should Cities Adopt Volume-Based Pricing for Residential Solid Waste Collection? Master's Memo, Institute of Policy Sciences and Public Affairs, Duke University. May, 1991.

A study of 14 communities with unit pricing programs. The study showed that such a system reduced the amount of garbage produced in those cities and increased recycling activity with few significant problems. The paper also explored different features of unit pricing and their effectiveness, and assessed factors that would determine whether unit pricing was appropriate for a given community.

Browning, Marilyn and Becker, Jeanne. Volume-Based Garbage Collection Fees: An Analysis of Ten Illinois Programs. A Report Prepared by Becker Associates, Inc. November, 1990.

A summary of the structure and components of ten unit pricing programs in Illinois. A survey of solid waste officials in each of the ten communities found that the use of commercial dumpsters for residential waste was, on average, the most significant problem, receiving an average score of 2.9 on a scale of 1 to 5. The next most significant problem was insufficient revenue, followed by roadside dumping, uneven cash flow, and excessive garbage compaction. These problems can be addressed through better citizen education, locks on commercial dumpsters, the use of a minimum fee to cover fixed expenses, tougher enforcement of anti-littering provisions, and strict limits on the weight of a subscription container or bag.

Canterbury, Janice. Pay-As-You-Throw: Lessons Learned About Unit Pricing of Municipal Solid Waste. EPA Office of Solid Waste report # EPA530-R-94-004. April, 1994.

In December 1992, the EPA's Unit Pricing Roundtable met to discuss variable rates for waste collection. The result of that meeting is this guide for communities considering unit pricing. Before adopting variable rates, a community needs to consider its waste management needs and whether the potential benefits of unit pricing, reduced waste, increased recycling, pricing equity, and greater environmental awareness, will meet those needs. A community also must be aware of potential problems with unit pricing, including illegal dumping, higher costs, service to multi-unit housing complexes, and citizen resistance. When designing a unit pricing system, a community must decide among container options, set a pricing structure, create a billing system, and design program options. Implementation of unit pricing must be accompanied by public education and outreach, and program monitoring. The report contains a number of brief case studies and information about specific programs, and a roundtable discussion with a number of unit pricing experts.

Cargo, Douglas R. Solid Wastes: Factors Influencing Generation Rates. Research Paper No. 174. Chicago, IL: University of Chicago Department of Geography.

The author analyzed the 1968 National Survey of Community Solid Waste Practices to determine actual amounts of waste generation. The survey assessed household and commercial waste generation. Cargo found that the actual amounts of waste generation were larger than EPA estimates. After employing regression analysis to determine the effects of socio-economic variables on waste generation, he found that "greater solid waste generation rates occur in areas with large populations, with high densities, and occupied by lower-income groups". While

generation rates increase with city density and city population size, they decrease with income.

Chua, Dale H.H. and Laplante, Benoit. Litter and Waste Management: Disposal Taxes, User Charges, and Penalties. April, 1991.

The authors expand upon Ian Dobbs' 1991 report, which recommended a combination of disposal fees on commercial products that would incorporate the potential cost of littering, and refunds for proper disposal of product waste. This report advocates the addition of penalties for littering to further encourage the proper disposal of waste. It is a completely theoretical piece which bases its findings on an economic model.

Cuthbert, Richard. "Variable Disposal Fee Impact." Biocycle. May, 1994.

Six case studies of unit pricing programs in Portland, Oregon, Seattle and Tacoma, Washington, Wilkes-Barre, Pennsylvania, and Bothel and Minneapolis, Minnesota. The article described the structure of each program. The case studies were the result of a random 80 city survey conducted by the author. 40 of the survey cities were large (100,000 +) and 40 had populations between 50,000 and 100,000. 68% had city-run waste service, and 32% contracted out to a private hauler. 35% financed their service from property taxes. The other 65% used fees, and 13 of those, or 16% of the survey, had variable rates. The general conclusions of the case studies were that unit pricing encourages waste reduction, that residents were accepting of the variable rate systems, and that variable rates supported other waste reduction activities, like recycling.

Cuthbert, Richard. "Variable Disposal Fees Reduce Waste." American City and County. June, 1993.

The author summarizes the findings of the study he reported on in his Biocycle article. Upon switching to unit pricing, Portland, Oregon experienced a 349% increase in the amount of material recycled, and Wilkes-Barre, Pennsylvania recorded a 15% reduction in the amount of waste collected. The author cautions that the specific effects of variable rates depend on local community social, demographic, and economic characteristics. Despite the increasing attention that unit pricing has received recently, few municipalities have adopted the pricing system. There has also been little effort to quantitatively determine either the effect that variable rate pricing has on waste generation or the interaction of variable rates and other waste reduction programs.

Deisch, Mitchell. "Mt. Pleasant 'Goes Green': A User Fee Success Story." Resource Recovery. December, 1989.

Mt. Pleasant, Michigan adopted unit pricing for residential waste collection when the county-owned landfill it had been using closed, and disposal costs increased from \$5 per ton to \$14 per ton. The town uses bags and tags priced at 10 for \$6, and yard waste bags priced at 10 for \$2.50. Recycling participation has increased 50%. Potential problems with illegal dumping have been averted by enforcing strict fines and conducting an extensive citizen education campaign.

Dinan, Terry. "Solid Waste: Incentives That Could Lighten the Load." EPA Journal. May/June, 1992.

Faced with increasing per capita waste generation and growing waste disposal costs, the U.S. should consider pricing systems that provide an incentive to reduce garbage. Unit pricing and disposal taxes are two such systems. Unit pricing enables households to save money by limiting the amount of garbage they put out for collection. A study of three variable rate programs in Perkasi, Pennsylvania, Ilion, New York, and Seattle, Washington found that the amount of waste landfilled or incinerated could significantly decrease. The author provided no specific figures.

Dobbs, Ian M. "Litter and Waste Management: Disposal Taxes Versus User Charges." Canadian Journal of Economics. February, 1991.

An examination of user charges and disposal taxes as waste management techniques. The author recommends a strategy that employs a combination of each. A user fee would recover the marginal cost of waste disposal, while a disposal tax with a refund for proper disposal would eliminate the threat of illegal dumping. The article is completely theoretical and bases its conclusions on an economic model.

Efaw, Fritz and Lanen, William. Impact of User Charges on Management of Household Solid Waste. Report prepared by Mattech, Inc. August, 1979.

The authors conducted case studies of five communities, Burbank and Sacramento, California, Provo, Utah, Grand Rapids, Michigan, and Tacoma, Washington, to determine the effect of particular pricing systems for solid waste collection on waste generation. The report contains in-depth descriptions of each community's system, three of which, those in Sacramento, Grand Rapids, and Tacoma, have some variable rate component. The authors concluded that while choices between types and levels of sanitation service may be sensitive to price, the quantity of waste generated at the household level may not be sensitive to price. In Tacoma, residents had a high price elasticity of demand with respect to the number of cans or the choice of backdoor pickup, but because of the availability of waste drop-off centers, the price elasticity of garbage production was not significantly different than zero. The same was true in Grand Rapids and Sacramento. The report also found that as household income increases, so does the quantity of garbage produced.

Emmer, Terri and Neidhart, Jim. An Analysis of the Effects of Volume-Based Waste Disposal Fees on Consumer Behavior. Department of Resource Economics, University of New Hampshire.

The authors of this report surveyed residents of Dover, New Hampshire to determine the effect of Dover's variable rate system on consumer behavior. The report concluded that unit pricing led to higher recycling participation rates and lower waste generation in Dover. The survey also found that while there was initially a wide range of consumer attitudes about recycling, six months into the program there was a convergence of attitudes and a more uniform level of commitment to the program's goals.

Enos, Gary. "Residents Clean Up With Waste-Cutting Incentive." City and State. February 25, 1991.

A study of three areas, Bellevue, Washington, Lansing, Michigan, and the state of Rhode Island, that have either implemented or are considering implementing a variable rate system. Bellevue and Lansing reported success with their systems. In Bellevue, more residents switched to a smaller can, and in Lansing, the amount of waste sent to the city landfill fell by nearly 20%. The only difficulties with the system in either city were setting the rate structure, and concern that if too many customers reduced their waste too much, the waste haulers would not receive enough revenue to operate.

EPA brochure. Unit Pricing: Providing an Incentive to Reduce Municipal Solid Waste. Report # EPA/530-SW-91-005. February, 1991.

The EPA put out this small, informational brochure for any city solid waste manager interested in unit pricing for municipal solid waste collection. The brochure describes unit-based pricing and the economic theory behind it. Some of the potential benefits of unit pricing include reduced waste generation, extended landfill life, reduced labor costs for collection, greater recycling participation, and increased resource conservation. When implementing unit pricing, a community must select a rate, ensure community support, monitor and enforce compliance, chose a system design, and determine special rate options for low income residents, senior citizens, or other people with special needs. Communities have generally embraced unit pricing because they perceive it as fairer than a flat rate system, and because it contributes positively to the cleanliness of the town.

EPA report. Charging Households for Waste Collection and Disposals: The Effects of Weight or Volume-Based Pricing on Solid Waste Management. Report # . September, 1990.

This report examined the effects of unit pricing on waste generation, household disposal behavior, and waste management costs. It also examined particular features of unit pricing and their interaction with other waste disposal program, like recycling. The study used three case studies, Seattle, Washington, Perkasio, Pennsylvania, and Ilion, New York, to draw its conclusions. Ilion and Perkasio experienced waste reduction and increased recycling, while Seattle's program, for a variety of reasons, showed less success.

EPA report. Seattle Solid Waste Utility Garbage by the Pound Pilot Project Summary. Draft Report. April, 1991.

The EPA funded a one-year pilot project in Seattle that tested a weight-based unit pricing system for municipal garbage collection. This report describes the system, and relates the findings of the study. The system performed well, with few technical problems, but it did extend collection times by about 10%. City-wide, that would translate to an extra \$600,000 in labor collection costs per year. There would also be a high initial investment cost for equipment and a computerized billing system. The weight-based system also required operators to hang the can on the scale mechanism and scan the bar code label on the receptacle, allowing for the potential of human error. The project did appear to lower (by weight) the amount of garbage put out for collection by an average of 15%, and 60% of the residents in the study said they were satisfied

with the system.

EPA report. Waste Prevention, Recycling, and Composting Options: Lessons Learned from 30 Communities. Report # EPA/530-R-92-015. February, 1994.

This report focused on various strategies for municipalities to reduce net waste through composting, recycling and education. The report details approaches to increase levels of composting and recycling, as well as improving materials recovery from commercial activities and construction. The report provides a brief overview of variable refuse rates, and further comments on the positive effects of variable rate pricing on recycling participation and source reduction. Three additional volumes provide case studies on rural areas, suburbs and small cities and urban areas.

Felton, Mary K. "A Snapshot of Waste Generation and Recovery." Resource Recycling. January 1995.

This article provides an overview on the EPA's 1994 update of *The Characterization of Municipal Solid Waste in the United States, 1960 to 2000*. The author discusses trends in generation, recovery, and discards. The article focuses on waste diversion behavior, especially recycling.

Fiske, Gary S. "Rates: A Powerful Tool to Reduce the Waste Stream." Solid Waste and Power. March/April, 1992.

A general introduction to unit pricing. Variable rates for garbage collection, like user charges for water, gas and other utilities, provide a more accurate pricing signal to household producers of waste than does the more traditional flat rate scheme. It has the potential of encouraging waste reduction and greater recycling participation. However, rate setting under a unit pricing structure is more difficult, and revenues to the waste hauler are more uncertain. These problems can be overcome by setting up a regulatory mechanism that would track the differences between expected and actual revenue for a given year and adjust the next year's fees accordingly. A variable rate system should also have a readily available diversion alternative, like curbside recycling, and have enough different service levels to ensure significant waste reduction. Community officials should consider variable rates, but make sure that they work closely with their constituencies during the implementation of unit pricing.

Fletcher, Jeff. "Why Unit Pricing Makes Sense for Solid Waste: Environmental Protection Agency Project." Nation's Cities Weekly. October 19, 1992

The EPA is going to run a unit pricing demonstration project and is looking for communities interested in participating. Variable rates send a more accurate pricing signal to waste generators than traditional flat rate systems, and encourage garbage reduction. They are also fairer than flat rate systems, in that the residents that produce less garbage pay lower collection costs.

Folz, David H. "Recycling Program Design, Management, and Participation: A National Survey of Municipal Experience," Public Administration Review. May/June, 1991.

The author conducted a survey of 264 recycling coordinators to determine what factors

influence citizen participation in recycling programs. The study identified eleven specific operational policies, of which variable rates for garbage collection was not one. The survey showed that allowing public input during the planning and design process, mandating recycling participation, providing curbside service and free bins, and utilizing public education programs all contributed to higher participation rates. Same-day recycling and garbage pickup, and permitting commingling did not seem to significantly impact participation rates.

Fullerton, Don and Kinnaman, Thomas. Garbage, Recycling, and Illicit Burning or Dumping. National Bureau of Economic Research Working Paper # 4374. May, 1993.

Analysis of an economic model of household waste disposal behavior shows that given three disposal options, collection, recycling, and illicit disposal, a unit fee would lead to some burning or dumping. However, a disposal tax on products, coupled with rebates for proper waste disposal, would encourage legal disposal of garbage. The study is purely theoretical and involves no empirical data.

Fullerton, Don and Kinnaman, Thomas. Household Demand for Garbage and Recycling Collection with the Start of a Price per Bag. National Bureau of Economic Research working paper # 4670. March, 1994.

A survey of a random sample of 75 Charlottesville, Virginia households measured household garbage generation before and after the city implemented a unit pricing system. The survey found that while recycling increased 15% and the volume of garbage was reduced by an average of 37%, the weight of garbage was only reduced 14%. The authors concluded that residential trash compaction accounted for the difference between the volume reduction and the weight reduction. The survey also showed that approximately 28% of the total reduction was accounted for by illegal disposal. The authors based this figure on respondents that indicated they used "other means," as opposed to recycling, composting, and demanding less packaging at stores, to reduce their waste.

Glenn, Jim. "Financing Recycling Programs." Biocycle. November, 1989.

A review of financing options for recycling programs. One option is funds generated from the sale of recovered materials. It is an obvious source of funds, but because of the low market value of some recyclables, it may not be enough to cover all the costs of the recycling program. Another option is service charges for the use of the municipal waste processing facility. This option is only available to those communities with such a facility, and that provide service to other towns. A third source of funds for recycling programs are rebates collected from waste haulers for avoided costs due to material diversion. Municipalities could also fund their recycling programs by charging residents for the service. The fee could be flat, or vary with the level of participation. Finally, communities could simply make their recycling programs part of their overall waste collection service, and fund the entire system as a whole.

Goldberg, Dan. "The Magic of Volume Reduction." Waste Age. February, 1990.

Unit pricing has led to reduced levels of garbage and increased recycling participation in several communities that have adopted the pricing system. In St. Paul, Minnesota, household

participation in the recycling program increased on average from 15% to 32%. In Olympia, Washington, there was a 50% increase in the number of residents utilizing a smaller can. Illegal dumping is a potential concern with a unit pricing system, but it has not been a problem in Perkasio, Pennsylvania or Seattle, Washington. Generally, problems with the system appear when it is first implemented, and they can be quickly corrected for. Finally, 93% of Perkasio residents who were asked their opinion of unit pricing approved of the system. It has met with similar citizen satisfaction in other communities.

Gottlieb, Robert; Davis, Gary; and Wolf, Sidney. Solid Waste Management: Planning Issues and Opportunities.

This report examines the current solid waste crisis, some strategies for addressing it, the composition of the waste stream and methods for dealing with garbage, examples of solid waste legislation, and four case studies: Seattle, Perkasio, Queen Village in Philadelphia, and North Hempstead, NY. At least Seattle and Perkasio use unit pricing.

Grogan, Peter L. "Target Seattle." Biocycle. October, 1993.

A response to the August 3 *Wall Street Journal* article that was critical of Seattle's variable rate and recycling programs. The article contended that the city's recycling effort had stalled, and that variable rates were encouraging some unintended citizen responses, like garbage stomping. Grogan demonstrates that corporate and residential recycling participation continues to increase, and that Seattle is steadily approaching its diversion goal of 60%. He also states that unit pricing has saved both the city and residents money through lower collection costs and reduced service rates.

Guerrieri, Tony M. An Assessment of Unit Pricing for Municipal Solid Waste. A Report for the Pennsylvania Joint Legislative Air and Water Pollution Control and Conservation Committee. September, 1994.

Pennsylvania is one of seven states that encourage the use of unit pricing by localities. Pennsylvania has a statewide 25% 1997 recycling goal. Unit pricing provides a more accurate pricing signal than flat rates to the producers of solid waste. It encourages waste reduction and is fairer to those than produce less garbage. The report examined eight unit pricing communities in Pennsylvania: Carlisle, Elizabethtown, Grove City, Indiana, Latrobe, Perkasio, Quakertown, and Wilkes-Barre. Six of the eight had recycling rates greater than the statewide average of 16%, and seven of the eight had annual per capita waste generation rates less than the state average of .8 tons. Switching to a unit pricing program may present initial administrative difficulties, and increased costs from education programs and anti-dumping efforts. Communities considering unit pricing need to be prepared for homeowner confusion with the new system, potential illegal dumping and trash stomping, and hauler concerns about unstable revenue. These problems can be averted with public education programs, strict enforcement of anti-dumping measures, locks on commercial dumpsters, and base-level service fees that cover the fixed costs of garbage collection.

Harder, Greg and Knox, Linda. "Implementing Variable Trash Collection Rates." Biocycle. April, 1992.

Variable rate systems in 36 Pennsylvania communities have shown success at reducing garbage generation and encouraging recycling. Citizen education at the outset of a unit pricing program is a very important element of the system. Communities should also be aware of the potential for backyard burning or illegal dumping, and take proactive steps to prevent such behavior. Other problems common to the 36 municipalities in this report were: bags that tear or are attacked by animals, tags that fall off, illegal grass dumping, service to apartments, and the use of counterfeit bags. The authors present case studies of Carlisle, Perkasie, and Forest City. They also describe the failure of unit pricing in Nanticoke, which lost 68% of its municipal customers when it switched to variable rates. The failure seemed largely due to the lack of a curbside recycling program in the town.

Hayes, Jeffrey. "Let the Market Replace the Madness: How to Control Rising Solid Waste." Public Works. December, 1992.

The author advocates variable rate pricing as a tool to reduce waste. Variable rates not only encourage recycling, but they also induce garbage reduction, a preferable waste management strategy. Under unit pricing, Somersworth and Dover, New Hampshire have reduced their residential waste by 50%. The structure of variable rate systems vary, with different receptacles and different pricing schemes.

Hong, Seonghoon. An Economic Analysis of Household Recycling of Solid Wastes: The Case of Portland, Oregon. PhD Dissertation. Department of Agriculture and Resource Economics. Ohio State University. November 21, 1991.

The author designs a model of household waste generation behavior. The model is applied to Portland to see how a marginal pricing system, as well as other socio-economic factors, affect recycling behavior and the demand for garbage collection services. The analysis showed that increasing the price of collection increased household recycling participation, but did not significantly reduce demand for garbage collection services. Education level and value of time were also significant factors influencing households' degree of recycling participation. Income was a determinant of total waste generation, but demand for collection services was inelastic with respect to income.

Inside EPA. "EPA Probe of Household Waste Reduction to Focus on Per Volume Charge." August 10, 1990.

The EPA is evaluating the pros and cons of variable rate pricing to determine if the Agency should recommend it as a waste reduction incentive. The Agency will weigh the costs and benefits of unit pricing, as compared to flat rate pricing for garbage collection service. Unit pricing provides a clearer pricing signal to households, but it could also lead to illegal waste disposal and higher administrative costs. The Agency is unlikely to seek national unit pricing legislation, but may incorporate variable rates into its waste reduction guidelines for localities.

Jantze, Monica F. "Seattle's Two-Contractor Recycling Approach." Waste Age. August, 1988.

Seattle's recycling program is run by two private firms, one with jurisdiction over the northern half of the city and the other over the south. Their contracts with the city expire after 5 years, at which point Seattle can choose one, continue with both, or search for another contractor. The system creates competitive incentives for cost-savings and better service provisions. The city uses the same two-contractor approach for its composting program. Although the costs of the recycling program and the composting program are greater than the city landfill's tipping fees, Seattle expects the programs to become cost efficient in the future. The city is also exploring long-term disposal options, including a possible waste-to-energy plant.

Jenkins, Robin. The Economics of Solid Waste Reduction. Edward Elgar Publishing, Ltd. 1993

This book grew out of Jenkins' dissertation on the same subject. The author presents a model for residential waste generation that shows that user fees can have a significant impact on the level of waste generation, and that society's welfare gain from switching to unit pricing is substantial. The book also looks at commercial generation of solid waste and concludes that increasing already existing unit fees can have a big impact on waste generation levels. The book contains a literature review, models of household and firm waste generation behavior, demand equations for residential and commercial waste collection services, descriptions of the elements of the model, and the results of manipulating the model. The author studied five unit pricing communities (San Francisco, California, Estherville, Highbridge, New Jersey, and Seattle and Spokane, Washington) and four flat fee communities (Hillsborough County and St. Petersburg, Florida, Howard County, Maryland, and Bernalillo County, New Mexico).

Jenkins, Robin. Municipal Demand for Solid Waste Disposal Services: The Impact of User Fees. PhD Dissertation, Department of Economics, University of Maryland. 1991.

The author creates a model of household solid waste disposal behavior in the presence of unit pricing and tests the model with empirical data collected from five unit pricing communities and four non-unit pricing communities. She concludes that although individuals' demand for solid waste collection services is inelastic with respect to price, unit fees would cause small reductions in household waste generation, which would add up to significant reductions in the amount of waste at the community level. Society's welfare gain from unit pricing is positive.

Johnson, Margit and Carlson, William L. "Calculating Volume-Based Garbage Fees." Biocycle. February, 1991.

The authors design a method for calculating unit pricing fees. The fee should consist of two parts. The first part covers the hauler's costs, excluding disposal fees. This part of the fee is calculated by dividing the total collection costs by the number of households served. The second part of the fee, based on landfill or other disposal facility costs, is computed by converting the local tipping fee into dollars-per-pound and multiplying it by the weight of the residential service level (i.e. a 30-lb can). There are four variable rate options a community can choose: weight-based rates, variable cans or bags, pre-paid bags, or pre-paid stickers or tags.

Katz, Marvin. "Collection Strategies of the Nineties?" Waste Age. February, 1989.

Solid waste management goals today include saving money, extending the life of landfills, reducing litter, encouraging recycling and source reduction, and reducing employee injuries. Four management techniques geared toward these goals include variable rate pricing, recycling rebates, biodegradable garbage bags, and automated collection systems. Perkasi, Pennsylvania recycles 43% of its garbage under a unit pricing structure, and the weight of its garbage and recyclables collections has dropped 28.7%. In a 1988 survey, almost 90% of the town's residents rated the program "good" or "very good." Backyard burning, which was a problem at first, will be addressed by an anti-burning ordinance. High Bridge, New Jersey reduced its solid waste tonnage by 24% after the implementation of variable rates. Holland, Michigan and Seattle, Washington also have successful unit pricing programs.

Kemper, Peter and Quigley, John M. The Economics of Refuse Collection. Cambridge, MA: Ballinger Publishing Company. 1976.

The authors provide a general overview of the economic issues in waste collection. Chapter five surveys the issues involved in a system employing user charges. They compare user charges to two other financing mechanisms: general revenues and service fees. The chapter addresses efficiency in theory, equity, federal income tax deductibility, revenue from tax-exempt institutions, and efficiency in practice. The authors note that "true user charges are rare" and do not provide many empirical evidence of the issues they discussed.

Khator, Renu and Huffman, John. "A Survey of Recycling Coordinators." Biocycle. October, 1993.

A survey of 1000 local recycling coordinators sought to identify effective strategies for encouraging recycling participation. The respondents rated variable collection rates as the most effective strategy, although only 44% of them had variable fees in their communities. It earned a mean score of 3.83 on a scale of 1 to 5. Other strategies, in descending order of success, included subsidies for recyclable materials, public education, privatization, sanctions against non-participation, tax incentives, and buy back centers.

Kies, Delyn and Kramer, Susan. "Recycling is Jumping in the City of Roses." Resource Recycling. July, 1994.

Oregon state law requires the Portland metropolitan area to achieve a 45% recycling rate by 1995. Its current rate is 35%, and the city has its own goal of 60% by 1997. The city has 59 franchised haulers for residential waste collection. It also has variable collection fees, and some localities in the area are considering weight-based systems. All recyclable processing is handled by the private sector, and there are regional markets for most recovered materials. The article does not provide any evidence of the impact of variable rates on the level of city recycling. It describes different components of Portland's extensive recycling program.

Kourik, Robert. "What's So Great About Seattle?" Garbage. November, 1990.

Seattle has reduced the amount of waste it landfills by 24%, and has a recycling participation rate of 80%. The city first adopted variable rates in 1981, but the program was accelerated in 1989 when the city's two landfills were close to capacity. Rather than building a waste incinerator, the city decided to significantly increase recycling, and haul its leftover waste to a landfill in Oregon. It set a 60% 1998 recycling goal and is already halfway there. Two private companies run Seattle's recycling program, and the city also contracts with a centralized composting firm, in addition to providing a city-run backyard composting program.

Lambert, Abigail F. Rate Proposal for a Weight-Based Pricing System for Residential Waste Collection in Durham, North Carolina. Master's Project, School of the Environment, Duke University. 1991.

The author contends that the city of Durham, North Carolina, which currently funds residential garbage collection through general property tax revenues, ought to consider implementing weight-based rates to finance its collection service. Weight-based rates would send a more accurate pricing signal to city residents, and might reduce waste and encourage recycling. Five issues that the city ought to be aware of before implementing a variable rate system are: the need for political support and aggressive public education, the impact of variable fees on low-income residents, potential problems with illegal dumping, and necessary departmental changes. Lambert conducted an economic analysis of Durham's waste management system, considering collection costs, disposal costs, the added costs of a weight-based system, and estimated environmental and social costs. Based on this analysis, Lambert presented five options for a weight-based rate structure. She recommended a system that uses variable fees to cover landfill disposal costs, including environmental and social costs, and continues to finance the other costs of waste collection through property taxes. Such a system would give some price incentive to residents, but would still provide a stable revenue stream for the collection system. The author also recommended reduced rates for lower income residents.

Laplante, Benoit and Luckert, Martin. The Wastepaper Dilemma: Can Newsprint Recycling Legislation Kill Two Birds with One Stone? Department of Economics, Laval University. October, 1991.

The authors conclude that appropriate pricing mechanisms for waste disposal and forest harvesting are better waste management policies to encourage newspaper recycling than content requirements. Unit pricing for solid waste collection is an example of one such pricing mechanism. Under unit pricing, the amount of municipal waste collected in Perkasié, Pennsylvania fell by 41%, and it fell in Ilion, New York by 37%. Other waste reductions figures include 50% in Downers Grove, Illinois, 60% in Lisle, Illinois, and 15% in Woodstock, Illinois. None of these communities reported any serious problems with littering.

Lemoine, Pam. "Recovering the Costs of Solid Waste Management." Solid Waste Issues and Answers.

A basic introduction to unit pricing. Municipal rate-making principles include long-term rate stability, systematic stability and strength, communicating the true cost of service, compliance with local, state, and federal requirements, and simple procedures for changing rates. Added considerations include encouraging waste reduction and recycling, and funding community recycling and yard waste programs. Variable rates meet all of these criteria, but have the potential of encouraging illegal dumping, and require greater enforcement efforts.

Lewis, Thomas A. "Waste Not, Want Not." National Wildlife. June/July, 1993.

As landfills across the country approach capacity, disposal costs rise, and per capita waste generation continues to increase, source reduction has become a top priority for solid waste managers. Recycling is gaining popularity, both among solid waste officials and private citizens. Unit pricing provides an inducement to recycle, and to reduce the amount of waste put out for collection. Seattle, Washington and Perkasi, Pennsylvania have both had successful variable rate systems.

Menell, Peter S. "Beyond the Throwaway Society: An Incentive Approach to Regulating Municipal Solid Waste." Ecology Law Quarterly. Vol. 17, 655. 1990.

Traditional pricing systems for garbage collection do not provide incentives for reducing waste or manufacturing products that produce less waste. The authors use an economic framework to analyze a variety of policy options for correcting this market distortion. The article provides an overview of the waste stream and available technologies for collecting and regulating waste, describes traditional flat rate or tax financed systems for funding waste disposal, and examines alternative methods, including curbside charges, retail disposal charges, and two-tier charges. According to the economic model, variable rate pricing and/or retail charges based on the disposal cost of different products are the best waste management strategies. They provide an accurate pricing signal to households and product suppliers. Local governments are best suited for designing the ideal solid waste regulatory system for their specific localities. The federal government can provide information and correct macroeconomic distortions, and the states can coordinate various local policies. The article is primarily theoretical, although it does briefly describe unit pricing systems in Seattle, Washington and Perkasi, Pennsylvania.

Miedema, Allen K. "Fundamental Economic Comparisons of Solid Waste Policy Options." Resources and Energy. Vol. 5. 1983.

The author developed a macroeconomic model to analyze the effects of several waste management policy mechanisms. Miedema compared user fees, recycling subsidies, disposal charges and litter taxes to the status quo (i.e., none of these policy mechanisms in effect). He analyzed the real income effects, net waste effects, waste generation and resource recovery effects and recycling rate effects for these four policy tools given three different policy scenarios (these scenarios varied according to hypothesized changes in the diseconomies of scale for recycled materials suppliers and virgin materials suppliers). He found that user fees and litter taxes always had the same effects. The disposal charge always had a larger real income effect and the smallest net waste collected and disposed. In two out of the three simulations, the disposal charge had the highest recycling rate, while the recycling subsidy had the highest recycling rate in the simulation characterized by greater diseconomies to scale for virgin materials suppliers.

Miller, Chaz. "Pay as You Throw: Less Weight? More Stuffing!" Waste Age. September, 1993.

Unit pricing has been touted as way for municipalities to encourage higher recycling participation and reduce household waste generation. However, the system can also encourage overstuffing of garbage receptacles, illegal burning and dumping, and contamination of recycling receptacles with non-recyclable material. Can-based systems have complicated billing requirements. On the other hand, bags can tear and tags can be separated from set-outs. Furthermore, variable rates may be unfair to lower income residents, and political support for unit pricing is lacking in many areas. The author contends that there is no conclusive evidence that variable fees reduce residential waste generation. He bases most of his conclusions on anecdotal evidence and interviews with a few solid waste professionals.

Miranda, Marie Lynn. "Managing Residential Municipal Solid Waste: The Unit Pricing Approach." Resource Recycling. November, 1993.

This article is just a brief report on Miranda's unit pricing study (see next entry).

Miranda, Marie Lynn; Everett, Jess W.; Blume, Daniel; and Roy, Barbeau A., Jr. "Market-Based Incentives and Residential Municipal Solid Waste." Journal of Policy Analysis and Management. Vol. 13, No. 4. 1994.

The authors gathered waste generation data from 21 unit pricing communities. The data showed municipal waste generation before and after the implementation of variable rates. The average reduction in tonnage of waste landfilled was 40%, with a high of 74% and a low of 17%. Recycling increased, on average, by 126%, with a high of 456% and a low of 3%. The average reduction in overall waste generation was 30%, with an average recycling rate of 19%. Even accounting for illegal disposal and measurement error, the authors concluded that some of the waste reduction must have resulted from source reduction behavior. There were few problems among the 21 municipalities with illegal dumping. Burning was a problem in three of the cities, but it seemed to only account for about 20% of the total waste reduction. Burning stopped in Perkasié, Pennsylvania when the city adopted an anti-burning ordinance.

Minnesota Pollution Control Agency. State Solid Waste Policy Report: A Focus on Greater Minnesota.

A review of Minnesota's waste management system. The report examines historical and contemporary state-wide programs, county initiatives, industrial and residential waste generation trends, waste collection and transportation systems, and collection system costs. The report also highlights public education efforts, and waste reduction, recycling, composting, waste-to-energy, and land disposal programs. Unit pricing is reviewed briefly, and St. Louis Park, a unit pricing town, is mentioned in the report.

Moriarty, Patrick. "Financing Waste Collection for Maximum Diversion." Biocycle. January, 1994.

Illinois has set a statewide waste diversion mandate of 25% by 1996. The author surveys 23 municipalities in the Chicago area to determine how localities are responding to the mandate. Seven of the 23 communities have changed their rate structures since 1988, six of them adopting some form of variable collection fees. The average fee among the flat rate communities was \$11.60, while the average per-bag fee in Downers Grove, Hoffman Estates, and LaGrange Park was \$1.40. Thus, a household that put out less than two bags of garbage per week under the variable fee systems would spend less for waste collection than they would have under a flat rate system. The unit pricing communities also had higher recycling participation rates than the flat fee communities, and higher percentages of total waste recycled. The average tonnage recycled for flat fee communities was 18%, while for Hoffman Estates it was 31% and for Downers Grove it was 28%. The author also provided a case study of Hoffman Estates that described that community's program.

Morris, Glenn E. and Byrd, Denise C. "Unit Pricing for Solid Waste Collection." Popular Government. Fall, 1990.

Unit pricing, in theory, sends an accurate pricing signal to the producers of residential waste, and it adheres to the "user pays" principle. However, it can also have a negative impact on lower income residents. Unit pricing can save waste management systems money by reducing garbage collection levels and increasing revenue from the sale of recyclables. It has additional costs, though, of higher collection costs for recyclables, higher costs for litter prevention, higher waste monitoring costs, higher enforcement costs, and higher administrative costs. Households that generate little waste will reduce their collection costs, while households with high generation rates will pay more. Residents will also lose some of the value of their property tax deductions for federal income tax. Unit pricing can enhance community health and cleanliness if it does not lead to increased burning and littering. The authors summarized the program components of 16 unit pricing municipalities. These components included the type of receptacle, the fee structure, and complementary programs offered. In three cities, Perkasio, Pennsylvania, Ilion, New York, and Seattle, Washington, unit pricing received nearly 90% popular support. Ilion and Perkasio reduced their waste by 29% and 18%, respectively. Seattle's waste generation increased, but solid waste officials believe it would have gone up faster without variable rates. The authors estimated that Perkasio residents diverted 410 tons of waste (out of 2300) through improper means, but a yard burning ban has eliminated much of that illicit diversion. Other communities reported problems with residential garbage in commercial dumpsters. Perkasio and Ilion reduced

their collection costs by 10% to 15%, while Seattle's stayed relatively constant. Households, in general, saved money from reduced collection costs, but spent more time sorting their waste.

Morris, Glenn E. and Holthausen, Duncan M., Jr. "The Economics of Household Solid Waste Generation and Disposal." Journal of Environmental Economics and Management. Vol. 26. 1994.

The authors design a model of household waste disposal behavior, taking into account various disposal options, including garbage pickup, recycling, and source reduction, and fee levels, both flat and variable. The simulation showed that households' elasticity of demand with respect to price for solid waste collection services varied significantly with the price of that service. Supported by actual waste and demographic data from Perkasi, Pennsylvania, the model showed that a typical household's utility was higher with variable rates than with a fixed rate system. Furthermore, as the user charge increased, households responded with greater waste minimization behavior and less recycling. Emphasizing one type of disposal option, recycling, for example, could dampen households' incentive to pursue another type, like source reduction.

"New Jersey Town Weighs in on Trash by the Pound: Mendham, New Jersey." World Wastes. February, 1993.

An interview with the recycling coordinator of Mendham Township, New Jersey. Mendham switched to variable rates after their successful recycling program reduced residents' need for garbage collection service. The town went from two collections to one each week and residents saved an average of \$200 annually. Recycling increased 83%, garbage was reduced 55%, and the town has saved money. The town has not experienced dumping or other significant problems. According to the coordinator, before adopting unit pricing, a municipality should consider whether a majority of residents will benefit financially from the system. The community might also want to consider having a base charge to cover fixed collection costs, and basing the variable rates on the city's disposal costs.

Norris, James L. "Recycling and computerized garbage tracking cut city's costs." Public Works. February, 1994.

Athens, Ohio, facing a state-mandated 25% waste reduction goal, adopted a multi-tiered rate system for garbage collection to induce greater participation in the town's recycling program. Since its inception in 1982, the curbside recycling program has already reduced waste by as much as 50%. Athens also has a computerized billing system that keeps track of the amount of garbage each resident puts out for collection each week. The system is easy to use and has eliminated inaccuracies resulting from human error.

Owen, Melissa. "Integrated Waste Minimization (With Composting)." Biocycle. April, 1994.

Plano, Texas has an aggressive yard waste diversion program. The program includes a "Don't Bag It" Lawn Care Plan, which reduced yard trimmings collection by 50% from 1991 to 1993, a backyard composting program, and biodegradable collection bags (20 for \$5). Collected yard waste goes to a centralized composting facility. Plano's waste management system also includes a higher garbage collection fee for household waste in excess of the city-provided 95 lb. container.

"Pay As You Throw Shows Rapid Growth." Biocycle. August, 1993.

A recent Reason Foundation study shows that over 1,000 communities have adopted some form of variable rate pricing for garbage collection, and the number is rapidly increasing. Moreover, the towns report 25% to 45% reductions in the amount of waste sent to disposal facilities.

Project 88 -- Round II. Incentives for Action: Designing Market-Based Environmental Strategies. A Policy Symposium Sponsored by Senator Timothy Wirth and Senator John Heinz. May, 1991.

The symposium explored market-based solutions to environmental problems. Unit pricing was examined as a way to reduce waste generation by providing a better pricing signal to residents than traditional flat rate systems. While variable rates are implemented at the local level, the federal government can act as a information clearinghouse and can facilitate local efforts to implement unit pricing. Seattle, Washington and Perkasie, Pennsylvania have both experienced success with unit pricing, and problems like illegal dumping and the disparate impact of variable fees can be alleviated with proactive efforts on the part of the municipality. Perkasie reduced billing costs by using bags instead of varying subscription can sizes.

"Pushing the Limits of Backyard Composting." Biocycle. March, 1994.

Seattle, Washington has a home composting program with two components -- yard trimmings and food waste. The city has distributed 30,000 backyard yard waste bins and 2000 food waste bins. The city has demonstration sites and home instructional visits. Officials estimate that 7% of all green waste was composted in backyard bins last year. They feel the cost of the program is worth it. Backyard composting costs \$88 per ton, but avoided costs last year were nearly \$94 per ton. Participation rates are high, with 85% to 90% of bin owners using them. Incentives for participation include free compost for gardening and trash collection savings. Grasscycling is next on Seattle's agenda, along with targeting the city's commercial sector.

Rabasca, Lisa. "Source Reduction and Recycling: Are They Compatible or at Odds?" Waste Age. April, 1994.

A roundtable discussion with four individuals working in the solid waste field. The participants addressed six questions: (1) how can source reduction be measured; (2) are recycling and source reduction compatible; (3) should source reduction count towards state recycling goals; (4) how does source reduction affect the economy; (5) is less packaging or recycled packaging preferable; and (6) how can consumers be convinced to buy reduced packaged products? Measuring source reduction is a challenge, but it can be done at the household level, and facilitated at the macro level with community-wide measurement standards and accurate waste composition figures. Source reduction and recycling should be compatible, unless states stress recycling to such an extreme that it precludes other reduction efforts. States should adopt overall reduction goals, not necessarily just recycling goals, but the two can work together. Source reduction can cause shifts in the economy, but overall, it has a positive effect. Less packaging and recycled packaging are both good -- the mix depends on the local market. Finally, consumers need to be educated about source reduction and the concrete steps they can take to achieve it.

Reschovsky, James D. and Stone, Sarah E. "Market Incentives to Encourage Household Waste Recycling: Paying for What You Throw Away." Journal of Policy Analysis and Management. Vol. 13, No. 1. Winter, 1994

Unit pricing, which sends a more accurate pricing signal to households than traditional flat collection fees, has reduced waste and encouraged recycling in cities like Seattle, Washington and High Bridge, New Jersey. There are, however, practical concerns with unit pricing: rates are difficult to set, revenues are hard to predict, illegal dumping could occur, administrative costs may be high, variable fees could have a regressive impact on low income residents, common receptacles in multi-unit housing complexes preclude application of variable rates, and politicians may be unwilling to risk unpopularity. The authors studied unit pricing in Tompkins County, New York. They surveyed 3040 random households, and statistical analysis of the survey results found that curbside service had the greatest impact on recycling participation. While variable rates, alone, seemed to have only a minor impact, the combination of unit fees, curbside service, and mandatory recycling had the largest impact on participation. The survey was unclear on the potentially regressive impact of variable fees, and it found no evidence that the pricing system encouraged illegal dumping, although 51% of the residents surveyed said littering had increased, and 20% said they burned their trash. Two-thirds of the respondents said they favored unit pricing.

Richards, Bill. "Recycling in Seattle Sets National Standard but is Hitting Snags." Wall Street Journal. August 3, 1993.

The author contends that Seattle will have trouble reaching its 60% recycling goal. According to the article, most avenues for increasing the rate of recycling have been exhausted, and it will require draconian measures to make 60%. The article also questioned the savings the city was receiving from recycling, and said there was a glut in the market for recyclables. Finally, the author provided anecdotal evidence that residents were stomping on their garbage, rather than actually reducing it or recycling more.

Richardson, Robert A. and Havlicek, Jr., Joseph. "Economic Analysis of the Composition of Household Solid Wastes." Journal of Environmental Economics and Management. Vol. 5. 1978.

The authors analyze the social and economic factors that affect the quantity and composition of the household solid waste stream. The weekly per capita and per household quantities of eleven household waste components were analyzed: clear glass, green glass, brown glass, aluminum, other metals, newsprint, other paper, textiles, plastics, grass, and garbage/other. Waste generation is positively correlated with income, age and household size, and negatively correlated with ethnic background (percentage of black households in a census tract). Results indicate that if glass, plastics, textiles, paper and metals were recovered through recycling and incineration for energy production, around 53% of the summer household waste stream could be diverted from landfills. The economic feasibility of such resource recovery was not discussed.

Riggle, David. "Only Pay for What You Throw Away." Biocycle. February, 1989.

The author examines variable pricing systems in three communities: High Bridge, New Jersey, Perkasio, Pennsylvania, and Woodstock, Illinois. All three communities have reported citizen satisfaction with the systems, a reduction in the amount of waste generated, an increase in recycling participation, and lower collection costs for the community. In Woodstock, the recycling participation rate is 88%, the diversion rate is 4% to 8%, residents are paying \$2 per month less for waste collection than citizens of neighboring towns, and there were few complaints after the first six months. 93% of surveyed Perkasio residents said the town should keep its unit pricing system, and nearly 80% said they were paying less than they had with flat rates. Perkasio has reduced its landfill tonnage by 40%, and the town has saved \$70,000 in avoided landfill costs. High Bridge trash tonnage is down 24%, and the town has saved money and received few complaints from residents. All three states are supportive of the localities' programs. Other communities are experimenting with new waste management techniques: Lansing, Michigan is using biodegradable bags; Carlisle, Pennsylvania, Plantation, Florida, Duluth Georgia, and Grand Rapids, Michigan are incorporating multi-unit housing complexes into their systems, and Wilkes-Barre, Pennsylvania has experienced a 15% drop in landfilled waste from a pay-per-bag program that focuses exclusively on apartment buildings with five or more units.

Roy, Barbeau A. Unit-Based Pricing for Municipal Solid Waste Collection. Undergraduate Thesis, Department of Economics, Duke University. 1992.

Marginal pricing for solid waste collection sends a more accurate pricing signal to the producers of solid waste. It encourages households to divert waste through recycling, or to reduce the amount of waste they produce by composting or buying products with reduced packaging. The author collected data from a number of unit pricing communities to attempt to verify the theoretical performance of a variable rate system. She found that the demand for conventional waste disposal had a price elasticity of -.26, recycling had a price elasticity of .34, and total garbage generation had a price elasticity of -.18. Therefore, unit pricing can have an impact on the level of household waste generation. To prevent unintended disposal practices, like dumping or burning, communities should provide easily accessible diversion options, like curbside recycling and yard waste collection.

Savas, E.S.; Baumol, Daniel; and Wells, William. "Financing Solid Waste Collection." The Organization and Efficiency of Solid Waste Collection. Lexington Books. 1977.

A chapter in Savas' book. The authors examined the effect of different methods of financing solid waste collection on the amount of residential waste generated and the cost of the collection service. They employed a survey of private citizens living in communities with a variety of collection systems. According to the survey, variable rates had little effect on either the amount of waste generated or the level of service requested. They also found that unit fees, whether flat or variable, increased billing costs for municipalities. Finally, they found that because local taxes are deductible from federal income tax returns, there was an incentive for communities to raise taxes to pay for garbage collection rather than institute user fees. These findings were based on comparisons of waste generation figures, service levels, and collection costs across tax financed, flat fee, and variable fee collection systems.

Scarlett, Lynn. Mandates or Incentives? Comparing Packaging Regulations with User Fees for Trash Collection. Reason Foundation publication No. 158. May, 1993.

U.S. and Massachusetts solid waste management policy is beginning to address the nation's growing garbage crisis by stressing source reduction and recycling. Massachusetts is considering a state-level initiative that would set recycled content requirements for consumer products, and require reusable, reduced, or recycled packaging. An alternative market-based solution is unit pricing for residential waste collection. Unit pricing would create an incentive among consumers to source reduce, and that demand would cause producers to respond with reduced or recyclable packaging and products. The author reviews problems with recycling markets, and reports on the success of unit pricing in communities like Perkasi, Pennsylvania and Seattle, Washington. She identifies illegal disposal, garbage compaction, citizen resistance, and the impact of variable fees on low income residents as outstanding issues. The author conducts a cost-benefit comparison of packaging mandates and user fees for trash collection. She compares the reduced waste benefits of each system and their implementation costs. The author concludes that unit pricing can have a greater impact on the waste stream than packaging mandates, and it would be \$210 to \$215 cheaper per household each year.

"Seattle Engineers Say: Variable Can Rate Encourages Recycling." Waste Age. November, 1985.

Since the start of unit pricing in Seattle in 1980, recycling tonnage has increased 60%. Also, the city's per capita waste generation rate climbed more slowly than other cities' rates. Moreover, 80% of the city's residents favor the system, and it had a 91.5% compliance rate.

"Seattle Stomp." Garbage. Spring, 1994.

A short description of the "Seattle stomp" phenomenon. Residents in Seattle and other unit pricing communities compact their trash to avoid higher collection fees. The author makes no effort to quantify the problem. Strategies to combat the "stomp" include weight-based fees, and instructing haulers to not collect receptacles that are overloaded.

Shanoff, Barry. "Communities Switch to By-the-Bag Billing System." World Wastes. October, 1992.

A report on the successes of unit pricing in several communities with variable rate systems. Utica, New York, Chester Township, New Jersey, Stonington, Connecticut, and Seattle, Washington have all adopted unit pricing. Each community's system has different features and different fee schedules. Proponents of variable rates argue that it is fairer than flat fees: those that produce less trash should be able to pay less. In some unit pricing communities, residents that reduce their waste pay significantly lower garbage collection fees than they did under a flat rate system. Unit pricing can also encourage illegal dumping, but localities have responded by locking commercial dumpsters.

Sherman, Steven. "Local Government Approaches to Source Reduction." Resource Recycling. September, 1991.

In recent years, solid waste management policy has emphasized source reduction as a waste management strategy. Decreased solid waste generation can be accomplished by: reduced product weight or volume, reduced packaging, increased product durability, alterations in consumer purchasing patterns, greater efficiency in manufacturing processes, composting and other organic waste reduction techniques, and changes in the waste stream making it less hazardous. Strategies available to local governments to encourage waste reduction include public education, economic incentives, legislative mandates, on-site composting, and hazardous waste reduction. One of the economic incentives the author mentions is unit pricing. Unit pricing can be implemented by using metered bags or tags, or subscription containers. It provides a clear pricing signal to households that can lead to source reduction and increased recycling participation. It also influences consumer behavior, which will cause producers to respond with reduced packaging products.

Skumatz, Lisa A. "The Buck is Mightier Than The Can." Biocycle. January, 1990.

Volume-based rates were introduced in Seattle in 1981. Since then, the average residential subscription level has dropped from 3.5 cans to just over 1, and the amount of waste tonnage has decreased by 24%. Community adoption of variable rates is made simpler if hauling contracts or billing systems are up for renewal, there is a landfill problem, there is a desire to increase recycling, citizens perceive the existing system as unfair, or the jurisdiction is running out of tax authority. Implementation of unit pricing is made simpler through extensive public education to alleviate customer confusion with the system. Staff increases might be necessary. Municipalities should also implement strict anti-dumping and burning ordinances, and provide residents with an easy diversion alternative, like curbside recycling pickup. Other design considerations include the choice of the subscription system, the steepness of the rate structure, fees for extra put-outs, charges for recycling or other diversion programs, service to multi-unit housing, higher rates for compacted waste, and assistance for low income residents.

Skumatz, Lisa A. "Garbage by the Pound: The Potential of Weight-Based Rates." Resource Recycling. July, 1991.

Municipalities almost always implement unit pricing by charging residents volume-based fees. However, the effectiveness of such fees may be limited because residents have no incentive to set out less waste than their subscription level, they have no incentive to reduce garbage by more than the minimum level of service, service-level increments are too large, and bag/tag or can systems can be confusing. Weight-based systems provide a constant incentive to reduce waste across all levels of service. They also more accurately measure the true cost of waste disposal, since most landfills and other disposal facilities charge by weight. The EPA sponsored a one-year weight-based pilot project in Seattle involving 1,000 households. The equipment, which cost \$5,000 to \$10,000, performed well, and collection times only increased about 10%. The participating households reduced their garbage by about 15%, and 59% of them said they were "moderately" or "completely satisfied" with the program.

Skumatz, Lisa; Van Dusen, Hans; and Carton, Jennie. "Garbage By The Pound: Ready to Roll with Weight Based Fees." Biocycle. November 1994.

Several communities across the country have run weight-based pricing pilot programs. They include Seattle, Washington, Columbia, South Carolina, Durham, North Carolina, Milwaukee, Wisconsin, and Farmington and Minneapolis, Minnesota. Residents participating in Seattle's program reduced their waste, by weight, an extra 15%. Collection times did not increase in Columbia during its pilot study. The scales used in Durham's test did not meet some accuracy standards, but those deficiencies have since been corrected by the manufacturer. Milwaukee will be running a test in the fall of 1994, and Farmington and Minneapolis, though their pilot studies went well, have put plans to fully implement weight-based rates on hold. Though weight-based systems incur high initial costs, communities can achieve long-term savings from reduced waste.

Skumatz, Lisa A. "Garbage by the Pound: Seattle Tests Garbage Rate Alternative." Resource Recovery. December, 1989.

The city of Seattle will soon test a weight-based fee for garbage collection. Weight-based rates provide a more continuous pricing incentive to residents, and they more closely approximate the costs of waste disposal.

Skumatz, Lisa A. "Introducing the Hybrid Variable Rate System." Biocycle. November, 1993.

The hybrid unit pricing system (also referred to as multi-tiered systems) can serve as a transitional phase between flat fees and variable rates. Under a hybrid system, residents are charged a flat fee for a basic level of service, and charged a variable rate for greater service levels. The system provides revenue stability for the hauler. It guarantees that all fixed service costs will be covered. It also prevents residents that stick to the basic service level from experiencing rate increases. Hybrid pricing systems do reduce the impact of pricing incentives on household producers of waste, and may, therefore, not result in waste reduction that is as high as that under a regular unit pricing system. Hybrid systems are in use in Glen Ellyn, Illinois, Northfield, Minnesota, and Platteville, Wisconsin. In Glen Ellyn, the amount of compacted waste sent to the landfill fell by 59% after the system was implemented.

Skumatz, Lisa A. Variable Rates for Municipal Solid Waste: Implementation Experience, Economics, and Legislation. Reason Foundation Publication No. 160. June, 1993.

Unit pricing programs have a variety of different features. They can use bags, tags, or subscription cans, they may be city-run or contracted out to a private hauler, they are often accompanied by various complementary programs, including curbside recycling and backyard composting, and they sometimes have special features for servicing multi-unit housing, or helping low income residents. Successfully implementing unit pricing requires political support, the involvement of all concerned parties, citizen education, and program flexibility. Variable rates in cities like Seattle, Washington and Perkasie, Pennsylvania, have reduced landfilled waste and increased recycling participation. Concerns about the program include illegal dumping, backyard burning, and unstable hauler revenue. Three states, Washington, Minnesota, and Wisconsin, have laws requiring variable fees for waste collection. Indiana, Oregon, Pennsylvania, Missouri, Vermont, Illinois, and Montana all encourage local authorities to use unit pricing. The author concludes by laying out four steps for evaluating the performance of a unit pricing program. They are: 1) determine the level of participation; 2) measure any changes in residential waste disposal patterns; 3) assess the linkage between variable rates and the observed changes in disposal behavior; and 4) identify the net benefit and cost-effectiveness of the program.

Skumatz, Lisa A. "Variable Rates for Solid Waste Can Be Your Most Effective Recycling Program." Journal of Resource Management and Technology. Vol. 19, No. 1. March, 1991.

The article discusses how volume-based variable rates for solid waste disposal provide economic incentives for customers to source reduce and recycle their waste. Skumatz discusses: 1) the potential costs and savings of implementing a variable rate system; 2) implementation suggestions (including how communities can anticipate and address problems that arise in a variable rate system); 3) problems such as customer confusion and opposition; 4) illegal diversions; and, 5) equity concerns. Additional system design considerations and their potential tradeoffs are evaluated, as is the concept of a weight-based approach to waste disposal.

Skumatz, Lisa. Variable Rates: Using Your Rate Structure to Encourage Waste Reduction and Recycling. Draft Paper.

Traditional solutions to the increasing need for waste disposal space are new landfills, waste incinerators, or recycling programs. Another option is unit pricing. Unit pricing gives households an incentive to reduce their garbage. Seattle adopted variable rates in 1981. Since then, the average weekly customer service level in the city has dropped from 3.5 cans to just over 1. Recycling participation is also high. Variable rates are fair, and they help to educate consumers about the cost waste disposal. They can also save municipalities money by reducing landfill costs and cutting back on service levels. To implement variable rates, localities should engage political support, provide disposal alternatives, educate the public, perform a rate study to determine the proper fees, decide on the design of the system, and make the necessary administrative changes. Potential problems include customer confusion and billing complaints, illegal dumping or burning, and administrative complications.

Skumatz, Lisa A. "Volume-Based Rates: Your Best Recycling Program." Resource Recovery. October, 1989.

Variable fees for garbage collection can reduce waste and encourage recycling participation. In Seattle, weekly customer service levels have dropped from 3.5 cans to just over 1 can. The city diverts 24% of its waste, and 70% of the city's residents participate in its curbside recycling program.

Skumatz, Lisa and Breckinridge, Cabell. Variable Rates in Solid Waste: Handbook for Solid Waste Officials, Vol. I and II. Report funded by the EPA and City of Seattle Solid Waste Utility. June, 1990.

A guide to unit pricing for municipal solid waste managers. Unit pricing can encourage waste reduction and increased recycling participation. It is also fairer to low-level waste producers than flat rate systems, and it makes consumers more aware of the environmental costs of their actions. Local factors that make variable rates more feasible are: hauling contracts or billing systems are up for a change, the jurisdiction faces landfill or other disposal problems, the community wants to increase recycling participation, the existing system is perceived as unfair, and the locality is running out of tax authority. Medium or large cities can spread costs over more customers, while smaller towns can implement systematic changes more easily. Costs will be incurred from contractual changes, public information efforts, billing system redesign, design costs for the rate system, and staffing increases. Savings will result from deferred disposal costs, extended landfill life, labor reductions, and increased use of recycling programs. The steps for implementing variable rates are verify statutory authority, mandate solid waste service, ban dumping and burning of waste, provide diversion alternatives, design a sensible rate system, disseminate public information, and allow for programmatic changes. Potential problems are customer confusion and resistance, illegal disposal, enforcement, the impact of variable rates on low income residents, and administrative complications. There are various design choices for a unit pricing system, including the type of receptacle and different complementary programs. Volume II of the report provides detailed methods for setting variable rates and designing a system that meets individual community specifications. It also presents a case study of Seattle, Washington, and information about 15 other unit pricing programs in the country.

Skumatz, Lisa A. and Zach, Philip A. "Community Adoption of Variable Rates: An Update." Resource Recycling. June, 1993.

Spread across 26 states, variable rate systems are often adopted in response to increasing tipping fees, a desire to increase recycling efforts, and statewide or regional diversion requirements. Some of the issues involved with implementing a variable rate system include its compatibility with the existing collection system, the size of the community, illegal dumping, and multi-family housing facilities. Political support for the system is crucial, design planning is important, and the system should include a strong citizen education effort.

Sproule, Kimberly A. and Cosulich, Jeanne M. "Higher Recovery Rates: The Answer's in the Bag." Resource Recycling. November/December, 1988.

The authors surveyed 12 per-unit fee systems, and the article describes five of them: Holland, Michigan, Perkasio, Pennsylvania, Woodstock, Illinois, Newport, New York, and High Bridge, New Jersey. It also provides basic information, like container type, fee, and complementary programs offered, for all 12. The five cities described in the article all reported success with their systems, although reduction rates are not given for all of them.

Stavins, Robert N. "Market Forces Can Help Lower Waste Volumes." Forum for Applied Research and Public Policy. Spring, 1993.

In response to tougher federal regulations and the need for more effective waste management strategies, communities have experimented with a number of innovative systems. They include different pricing schemes for waste collection services, including unit pricing, retail disposal charges and virgin material charges, tradeable permits for industry-wide recycling mandates, and a deposit/refund system for discouraging illegal disposal of waste. The author uses Seattle's unit pricing system as an example.

Stevens, Barbara. Pricing Schemes for Refuse Collection Services: The Impact on Refuse Generation. Research Paper # 154. Columbia University Graduate School of Business. January, 1977.

A variable rate pricing scheme is administratively feasible, and it would convey to consumers the true cost of waste disposal. The author uses an economic model of household waste generation behavior to predict the effect of variable rates for refuse collection on the demand for those services. She also conducted a survey of 93 cities with variable fee systems. She found that for a 10% increase in the price of collection, demand for service went down 9%. However, refuse generation only decreased by .5% to 1.17%.

Stone, Sarah and Harrison, Ellen. "Residents Favor User Fees." Biocycle. August, 1991.

Tompkins County, New York has a county-wide unit pricing program for waste collection. The authors surveyed 3,034 randomly selected household in the county and received a 49% response rate. 63% of the respondents were "very much in favor" or "somewhat in favor" of the county's variable fee system. 51% said they recycled more because of the program, 16% said they composted more, and 39% said they were more attentive to product packaging when they shopped.

"Taking the Innovative Approach to Waste Hauling." Biocycle. July, 1993.

Tom Kraemer Sanitation Co. provides collection service to a half-dozen small towns in Minnesota near St. Cloud. The hauler charges a flat base rate, and sells tags for each 30-gallon container put out for collection. It also uses a truck-based co-collection system for garbage and curbside recycling. The hauler saves money from reduced disposal costs, and brings in increased revenue from the sale of recyclables.

Toomey, William A. "Meeting the Challenges of Yard Trimmings Diversion." Biocycle. May, 1994.

San Jose, California has an ambitious yard waste collection program. The system was put in place to meet the city's 25% waste diversion goal. Unit pricing for garbage collection encourages residents to participate in the program. In fact, yard trimmings set-outs increased 61% after variable fees were put in place. Variable rates for yard waste collection provide an incentive for residents to minimize the amount of trimmings they put out through backyard composting and other means.

University of Illinois Solid Waste Management Newsletter. "Volume-Based Garbage Rates." May, 1990.

Several suburban Chicago communities have adopted unit pricing as a waste management technique, including Woodstock, Harvard, St. Charles, and Downers Grove. Officials from all four towns say waste has decreased and recycling has increased as a result of the programs. The average number of bags per household in Woodstock went from 1.5 per week to 1.3. In St. Charles, landfill waste tonnage fell by 17%. Woodstock and Harvard officials said citizens were resistant to variable rates at first, but have grown more enthusiastic. None of the towns have experienced a significant problem with illegal dumping, but there were some reports of residents putting garbage in commercial dumpsters. Haulers in the area are somewhat concerned over the potential loss in revenue from reduced collections, and they say collection fees may have to be raised.

University of Illinois at Chicago Solid Waste Management Newsletter. "Volume-Based Rates." December, 1992.

As of May, 1992, 40 Illinois communities were using some form of variable rates for municipal waste collection. Before implementing unit pricing, a community must choose a base unit, set the size and weight limits for the containers, design the payment method, establish a curbside recycling program to complement the rate system, educate residents, and deal with the potential problems of illegal dumping and the impact of the fees on low income citizens.

U.S. Conference of Mayors. A Primer on Variable Rate Pricing for Solid Waste Services. June, 1994.

A general introductory brochure for municipalities considering a unit pricing system. Unit pricing passes variable waste disposal costs onto the household producers of garbage. It encourages waste reduction and increased recycling. It is fair, it helps to conserve landfill space, and it increases collection efficiency. Unit pricing systems can use subscription cans, bags, or tags, and can be weight-based, volume-based, or a hybrid of flat rates and variable rates. Implementation issues include assuring sufficient revenues, the impact on poor residents, illegal dumping, public acceptance, recycling contamination, and service to multi-unit housing. To develop a successful program, localities must clearly define their goals, develop a complete plan, start with a pilot study, obtain political support, and develop a public education strategy.

"Variable Garbage Pickup Rates Used by 1,500 Communities, EPA Official Says." Bureau of National Affairs report. September 30, 1993.

Jan Canterbury reported that over 1,500 communities had adopted variable rates, and that a recent survey of 14 cities showed that unit pricing reduced waste by 44%.

Watson, Tom. "New Yard Waste Strategy: Pay-by-the-Bag." Resource Recycling. February, 1990.

St. Charles, Illinois, Albany, New York, Edison Township, New Jersey, and several towns outside St. Paul, Minnesota have adopted pay-by-the-bag yard waste systems. The systems use biodegradable bags that are available in retail stores for a fee. The system creates an incentive for residents to practice backyard composting or leave their grass clippings on the lawn.

Watson, Tom. "Seattle Blazes New Ground with Diverse Approach." Resource Recycling. November, 1989.

Facing high waste disposal costs, the city of Seattle has developed a multi-faceted waste management system, and has set a 60% waste diversion goal for 1998. The city's recycling rate was 34% as of mid-1989. Residents are charged variable rates for collection service, and they are provided free curbside recycling pickup. Yard waste is banned from the general waste stream, and the city offers curbside pickup. Initial administrative problems with the system were quickly cleared up, and citizen support is reportedly strong.

Wertz, Kenneth. "Economic Factors Influencing Households' Production of Refuse." Journal of Environmental Economics and Management. Vol. 2. 1976.

The author uses a series of economic models to determine the impact of several waste collection service options on the level of household garbage generation. He also surveys six communities in the Detroit, Michigan area, and studies the collection system in San Francisco. There is an economic externality associated with traditional flat rate pricing systems for waste collection. Flat rates do not take into account the marginal disposal cost of incremental levels of garbage. Increasing flat rates somewhat decrease waste generation, but only through an income effect. There will be no substitution to lower waste generating behavior. However, variable rate pricing will more directly encourage waste reduction. The author also concluded that waste generation increases with income, with more frequent municipal collection service, and with less convenient collection sites (i.e. curbside rather than backdoor).

Woods, Randy. "Puget Sound's Other Success Story." Waste Age. July, 1993.

Tacoma, Washington employs a variable rate system for waste collection. In 1992, the city's diversion rate was 14%, with 63% citizen participation in its recycling program. The city has a very comprehensive and profitable municipal recycling program, which is due to the city's close proximity to a number of markets for recyclables.

Zak, Stephanie and Chartrand, Douglas. An Introduction to User Fees. Report prepared for the Rutland Regional Commission. February, 1989.

The state of Vermont encourages the use of variable rates for municipal garbage collection. The cost of implementing such a system can vary, but unit pricing requires increased staffing, more detailed accounting and billing services, and new equipment costs. Localities must choose the percentage of total costs that variable fees will cover, and address special needs, like bulky item collection. The authors provide descriptions of ten unit pricing communities in Vermont, and four national examples: High Bridge, New Jersey, Perkasi, Pennsylvania, Holland, Michigan, and Seattle, Washington.

Zimmerman, Elliott. Solid Waste Management Alternatives: Review of Policy Options to Encourage Waste Reduction. A Report to the Illinois Department of Energy and Natural Resources, Energy and Environmental Affairs Division. February, 1988.

Waste reduction should be a top priority for the state of Illinois. Three policy approaches that encourage waste reduction are mandates, financial incentives and disincentives, and research and education. Unit pricing is one financial incentive that could be used by localities to encourage households to reduce garbage putouts and increase waste reduction and diversion efforts. There are three potential drawbacks to this pricing method. First of all, a 1979 EPA study found no statistically significant relationship between variable rates and garbage generation, so unit pricing might not have an impact on residential waste. Also, user fees, unlike property taxes, are not deductible from federal tax returns, so residents could lose money in increased tax payments. Finally, federal revenue sharing arrangements do not take into account user fees as local tax revenue, so municipalities could lose federal support by lowering property taxes in favor of variable rates.