First United States Conference on Municipal Solid Waste Management

Solutions for the 90s

Proceedings
Volume I

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Proceedings of

First United States Conference on Municipal Solid Waste Management: Solutions for the 90s

June 13-16, 1990
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Foreword

The U.S. Environmental Protection Agency is pleased to present the proceedings for the First U.S. Conference on Municipal Solid Waste Management: Solutions for the 90s. The Agency particularly wants to thank all of the speakers who took the time to prepare and present papers for this national conference.

The Conference consisted of three plenary sessions: Opening Session, Reporters' Plenary: Solid Waste and the Media, and International Plenary. Conference sessions were organized around seven topic areas:

Integrated Planning

Source Reduction

Recycling and Composting

Combustion

Land Disposal

Public Education

Special Wastes

Separate proceedings have been developed for each of the seven topic areas and are available for purchase at cost from the conference management organization, GRCDA, P.O. Box 7219, Silver Spring, MD 20910, telephone 301/585-2898.

The two-volume set of the entire conference proceedings may also be purchased at cost.

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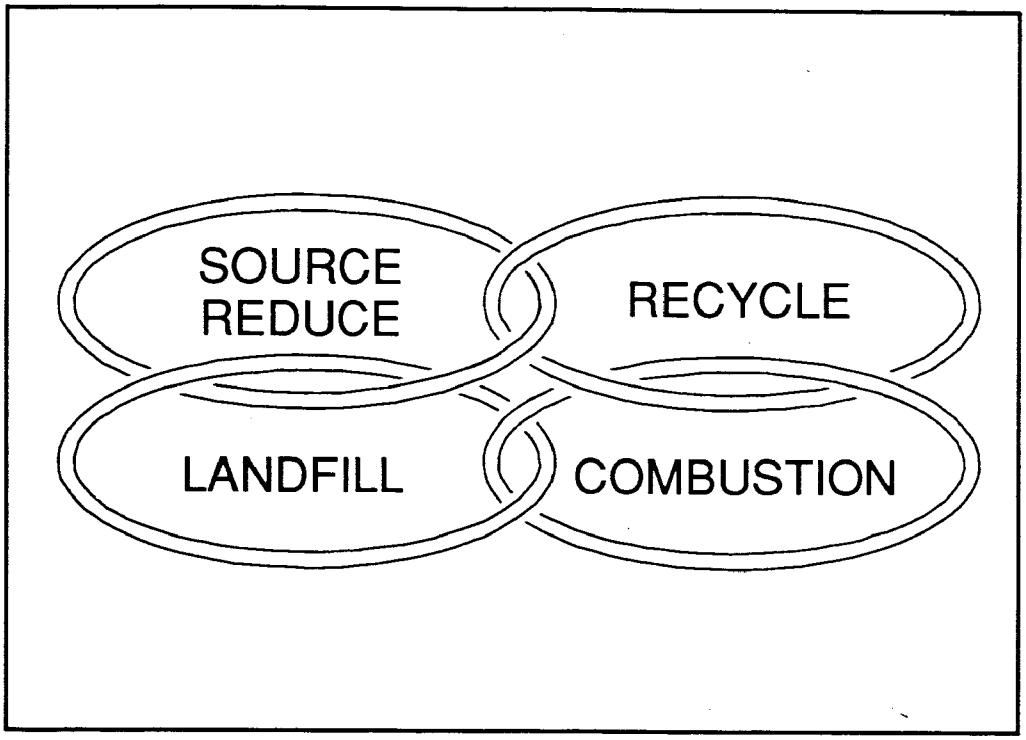

INTEGRATED PLANNING

ACCEPTING OUT-OF-STATE WASTE: TRUTH AND CONSEQUENCES

by
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Presented at the

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When your state is chosen as the receptacle for another state's garbage, the first question you ask is, "How could this happen?" The answer is not as simple as some would believe, and is directly related to a number of extraordinary changes taking place in solid waste management. Consider this:

* Seven years ago, Oregon pioneered the unheard-of concept of requiring curbside collection of recyclables. Today, curbside collection is commonplace, and participation is mandatory in many states.

* Five years ago, disposal rates in some parts of the eastern seaboard inched toward $60 per ton. Oregon and the rest of the country, with average disposal fees of less than $10 per ton, were horrified. Today, disposal rates have almost tripled and some parts of the country are paying disposal fees of more than $150 per ton.

* Four years ago, less than five percent of Oregon's municipal landfills had any bottom liner or leachate collection, a condition typical of most other states in the country. Today, composite lining systems, with leak detection, are the standard for new construction. In addition, gas and groundwater monitoring will likely be required at all landfills by new federal regulations.

* Three years ago, transport of garbage 35 miles for disposal was considered almost too far. Today, Portland, Oregon, ships its garbage 140 miles by truck to a regional landfill in eastern Oregon. A proposed landfill in New Mexico may begin receiving waste from Maryland, over 2000 miles away.

These examples suggest a fundamental shift in the way we think about and manage our solid waste. An integral, often controversial aspect of that shift is the trend toward regionalization and interstate transport of solid waste. This paper discusses the larger context within which the interstate transport of garbage is taking place, as well as some of the consequences to the receiving states. It is intended to provide a perspective from the regulatory agency, in this case the Oregon Department of Environmental Quality.

THE SOLID WASTE REVOLUTION

What is happening here? What are the reasons for the extraordinary changes taking place in solid waste management?

1. A Disposal Capacity Problem. The problem starts with garbage. We produce a lot of it. And, unfortunately, our rate of producing garbage is going up, not down. In 1960 the average U.S. citizen produced 2.65 lbs. per day of solid waste. By 1986, according to EPA, that figure had grown to

3.85 lbs. per day, and is expected to increase to nearly 4 lbs. per day by the year 2000.

We're also running out of places to put it. EPA estimates that one-third of the municipal landfills operating in 1987 will be closed by 1993. 75% will be closed by the year 2000. Growing public concerns about landfill impacts, whether it be NIMBY (not in my back yard) or NIMFE (not in my front yard either), make replacement of lost capacity difficult, if not impossible.

2. Environmental Problems - Groundwater Contamination. We have learned more about the environmental impacts from landfilling of garbage, and we have found past practices to be wanting. Old landfills were built in the wrong place, were designed and built with inadequate environmental controls, and were operated with little concern for the environment. Consequently, 200 of our national superfund sites are old solid waste landfills.

3. Increased Environmental Liability. One of the major forces driving the cost increases in solid waste management is environmental liability. We have made a societal decision to protect our groundwater resources not just for present uses, but also for use by future generations. We are therefore prepared to spend vast sums to protect it or clean it up, in some cases spending tens or even hundreds of

millions of dollars. Consequently, landfill operators now look at potential environmental liability as a major cost consideration in their operations.

4. New Environmental Standards for Disposal Sites. Because of the concern for groundwater and other environmental risks at landfills and incinerators, new state and federal standards have been proposed or adopted that represent a great leap forward in environmental protection, as well as disposal costs. In 1988 EPA proposed its Subtitle D regulations for municipal solid waste landfills. Although not finalized, these proposed regulations would require minimum standards for landfill design and operation. Many states, tired of waiting for EPA to finalize the Subtitle D regulations, are already requiring new landfills to meet standards as high or higher than proposed by EPA.

These new standards involve construction of liners, leachate collection systems, gas collection, groundwater monitoring, and better financial assurance; all of which add significantly to the cost of construction and operation. In addition, there is a new emphasis on siting landfills in appropriate locations that provide good natural environmental protection. In the past, landfill location was more a function of convenience. Today, location is dictated by potential impacts to people and the environment.

Rather than a political response by urban areas to ship their garbage "away" to rural areas, the increase in interstate transport of waste can be seen largely as a natural consequence of these combined changes. Transportation costs are rendered less significant in light of higher disposal costs. Disposal costs are skyrocketing not only because of new construction standards, but also because of the cost of cleanup of older problems. New federal and state regulations designed to prevent such problems in the future are causing many older landfills to close down, requiring transport to more distant sites. Private landfill operators are looking to decrease their liability and amortize their large capital costs over a longer period by siting larger facilities in fewer, better, and dryer locations.

The bottom line? There is both good news and bad news for the general public.

First, these changes will result in better environmental protection. Groundwater, surface water, and air quality will be better protected.

Second, the era of cheap disposal is over. Environmental protection comes at a cost, and disposal costs will continue to escalate for the foreseeable future. In Oregon, for example, the average disposal cost has doubled in the last two years, and is expected to double again within the next three years.

Third, with disposal costs higher, waste reduction and recycling will continue to increase and become an important component of our society.

Last, a natural consequence of the changes discussed above is a continued move to regionalization and interstate transport of waste. This regionalization in turn adds significantly to the cost of disposal. It also brings a host of new issues for state regulatory agencies.

INTERSTATE TRANSPORT OF WASTE TO OREGON

The state of Oregon faces the unenviable prospect of being on the receiving end of the interstate transport of garbage.

Oregon has two large regional landfills (one in operation and one under construction) in the arid, eastern region of the state, which are actively seeking waste from outside Oregon. One site is approximately 2000 acres in total size, and the other is 1000 acres. These landfills are located in an area with 9 inches of annual rainfall and a minimum depth of 200 feet to groundwater. They both employ state of the art technology (composite lining systems, leachate collection, and leak detection systems).

These landfills are located in communities with small populations and depressed local economies and were both developed with the strong support of the local governments. Although the landfills

(and the local governments) are now competing with a third large regional landfill being developed across the Columbia River in eastern Washington state, a substantial amount of Washington's solid waste has recently been committed to these landfills. The City of Seattle, Clark County, and Snohomish County have all indicated at least a strong interest in sending waste to one of these regional landfills in Oregon.

The total amount of waste from other states currently being considered for transport to Oregon is 700,000 tons per year, or a 40% increase over what is currently generated in Oregon. Because both of Oregon's regional sites are located along the Columbia River and major east-west rail lines, the long term potential for importation from other states could make that total much higher.

What has been Oregon's response?

Many states faced with similar circumstances have started with the question, "How can we keep this waste out?" So far, with waste coming primarily from the adjacent state of Washington, the Oregon legislature and Department of Environmental Quality (DEQ) have asked a different set of questions:

(1) What are the potential impacts to the state of Oregon?

(2) How do we protect the environment?

(3) How do we protect the residents and taxpayers of Oregon? (Should, for example, Oregon be compensated for accepting these wastes?)

In asking and answering these questions, Oregon has taken neither a passive approach to allowing the importation of solid waste, nor have we given in to parochial interests to "just say no." During the 1989 legislative session, Oregon passed three important laws relating to out-of-state waste.

- Establishment of a Solid Waste Regional Policy Commission, to identify the benefits and costs of importing solid waste into Oregon for disposal.

- Establishment of a per-ton surcharge on out-of-state waste, to cover the costs associated with accepting out-of-state waste.

- A requirement that communities sending wastes from outside Oregon be subject to similar waste reduction and recycling standards as applied to Oregon communities.

This legislation will not by itself "solve" the problems of interstate transport of waste, but it is a start. The Oregon Department of Environmental Quality has also been working with the Region X office of EPA to identify and address some of the problems. EPA prepared a Municipal Solid Waste Needs Assessment

in September 1989 which identified a number of issues related to interstate transport of waste. By July of this year EPA should complete a Region X study of the costs and benefits of interstate transport of solid waste.

REGULATORY AND PLANNING ISSUES

In attempting to answer the three questions listed above, the Oregon DEQ has attempted to steer a safe policy course between the expected political clamor to keep waste out of Oregon and the Federal constitutional protection of the right to interstate commerce. In trying to protect both Oregon's environment and the interests of its citizens, a number of specific issues have surfaced.

1. Impact on the Local Community. To the local community, these large regional landfills are often seen as economic development for what had been a depressed agriculture-based local economy. However, the landfills are not without potential impacts or costs to the local community. Environmental impacts, liability, and image have all been concerns. Oregon has addressed these concerns through three statutory requirements:

- First, any regional site accepting waste from outside the local jurisdiction must pay a "host fee" of up to $1.25 per ton to the host local government. The revenue from this fee can be used for any purpose.

- Second, a local citizens advisory committee is required to review the construction and operations of the landfill and report its findings to the Department of Environmental Quality.

- Third, special financial assurance requirements prevent a regional landfill operator from leaving a local government stuck with the bill for closure or environmental cleanup.

2. Land Use Impacts. With the tremendous size of these large regional landfills, there are land use impacts which need to be addressed. Oregon has a goal of preserving agricultural land in the state, and has passed a law requiring extensive waste reduction programs for communities in-state or out-of-state who are sending their waste to a landfill located in an Exclusive Farm Use zone. In addition, any proposed landfills must obtain land use approval, requiring public hearings and analysis of potential land use impacts.

3. Impact on State Disposal Capacity and Planning. How does the state measure the cost of the disposal capacity lost from the receipt of waste generated out-of-state? Does the state have any claim to privately owned landfill space as a public resource? Or, as some would argue, is that capacity no more a state resource than the widgets produced by a privately-owned factory?

Regardless of the whether the landfill capacity is public or private, the economists would tell us that the cost of the lost capacity is the public cost of going through a planning and siting process to replace that disposal capacity. The politicians would tell us that siting a new landfill or incinerator is neither easy or predictable. It is not clear what the actual costs of replacement would be, or even if replacement is possible. And who can put a price tag on the political pain and suffering experienced by all sides in a siting process?

One method of estimating the cost of replacing the lost disposal capacity has been proposed by Oregon DEQ and borrows from models used by the energy industry during the energy crisis of the late 1970's. In effect, it assumes that one way of replacing lost disposal capacity is through recycling and waste reduction, thereby extending the existing disposal capacity by reducing the waste stream. The cost of "replacing" that capacity used by out-of-state waste can therefore be estimated by calculating the cost of increasing recycling and waste reduction programs.

Another concept that Oregon and other states are beginning to explore is a "convenience fee" that exporting states or communities would pay for the convenience of sending their wastes to another state. This convenience fee essentially would take into account the financial benefit to exporting states of not having to plan and site new disposal facilities. Some have proposed a Federal statutory change to allow states to establish such a fee, providing a basis for interstate agreements that would adequately compensate receiving states.

4. Impact on Solid Waste Planning. Most Oregon laws related to solid waste planning and permitting were written during a time when each county had at least one disposal site to serve the needs for its citizens. Consequently, each county was responsible for ensuring adequate disposal capacity, and each county was more or less independent from others in terms of solid waste management.

This system of independent county solid waste plans does not work in an era of regionalization and interstate transport of waste. As the 1989 EPA Region X Needs Assessment conducted by Ross and Associates states, "No longer is any community an 'island' with respect to municipal solid waste management". Impacts of the movement of waste are felt across city, county, and state boundaries. Flexibility of solid waste planning becomes limited as the number of disposal sites is reduced, and disposal is subject to controls from other states or communities. Yet no

overall state or regional planning mechanism currently exists.

5. The Need for Inter-state Coordination. With the interstate movement of large volumes of solid waste, the differences in regulations or regulatory standards can play a strong role in dictating the flow of waste. This has been particularly true with no minimum federal design and operational standards for municipal solid waste. Adoption of Subtitle D regulations by EPA should reduce that problem, but there are other state regulatory differences. For example, infectious waste is considered hazardous in California but not in Oregon, providing an incentive for infectious waste to be transported from California to Oregon for cheap disposal. In 1989 Oregon passed a rule which prohibits waste classified as "hazardous" in the state of origin from being disposed in municipal solid waste disposal facilities in Oregon.

6. Added Environmental Risk. Any solid waste disposal site, no matter how well designed or built, represents a potential environmental risk. Adding significant volumes of waste from out of state to that disposal site adds correspondingly to the environmental risk. How should the receiving state best protect itself from incurring additional environmental degradation or liability?

The best way, certainly, is to ensure that regional disposal sites are located, designed, and operated with the highest environmental standards. In addition, a thorough monitoring program should be

implemented to ensure that any problem that does occur is identified and addressed before it gets too big. Third, any disposal site receiving significant amounts of out-of-state waste should be required to provide environmental insurance or some other form of financial assurance that environmental problems will be addressed quickly.

Oregon has done each of these with respect to its regional landfills. However, even that may not be enough. Why? Environmental risk is a function of both the possible magnitude of cleanup costs and the probability that a problem will occur. Each increment of solid waste from out of state adds to both the probability and the potential magnitude of the problem. If the actual cost of cleanup or environmental damage exceeds the amount of financial assurance, Oregonians may end up paying for a problem created in part by another state.

Further inequities exist in preventing those problems from occurring in the first place. Oregon has a tax credit program that provides tax credits of up to 50% for facilities such as landfill liners that prevent air and water pollution. This tax credit works out to an equivalent "expenditure" by Oregon taxpayers, through lost income tax, of 15 cents for every ton of garbage disposed of. This represents an Oregon subsidy to out-of-state users of the disposal facility potentially totaling millions of dollars over the life of a facility.

SUMMARY

I have attempted to describe some of the reasons for the increase in interstate transport of solid waste, and some of the consequences to the receiving state. I have suggested that determining the "right" public policy involves asking tough questions about impacts to the environment and the citizens of the receiving state, rather than just saying "no."

Most of all, we must ensure that no state becomes that magical "away" that people send their garbage to, without taking responsibility for waste reduction, for the consequences of their disposal, or for the costs of proper environmental protection.

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BORDER WARS: INTERSTATE TRANSPORTATION AND DISPOSAL OF SOLID WASTE

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BORDER WARS: INTERSTATE TRANSPORTATION AND DISPOSAL OF SOLID WASTE

I. INTRODUCTION

An increasing number of states are taking actions to close the door to garbage imports from other states. States that house landfills and other disposal facilities are seeking to limit out-of-state trash shipments by forcing states to take care of their own solid waste problems and not rely on other states. Consequently, "NIMBY" has taken on interstate dimensions.

In response to these actions, exporting states have accelerated efforts to reduce garbage exports through source reduction, recycling and incineration. However, such efforts are not enough to satisfy the immediate need for waste disposal capacity. The need to export waste still remains because a number of states are still dependent on landfills and other disposal facilities in other states. Thus, actions to close the door to garbage imports pose serious problems for these states.

This paper will discuss the actions taken by receiving states to limit the import of solid waste and the constitutional issues that have been raised by exporting states in support of their actions.

II. OVERVIEW OF DISPOSAL ARRANGEMENTS WITH OUT-OF-STATE FACILITIES

Many solid waste collectors and solid waste facilities which export waste out-of-state have entered into long-term contracts with facilities in the receiving state for disposal of the waste.

The contracts often are between the owner/operator of a transfer station, who processes the waste for export or a solid waste collector and the out-of-state facility owner. In most cases, the out-of-state disposal facility is a sanitary landfill.

The disposal contract gives the transfer station owner or collector the right or a license to dispose of certain types of waste at the disposal facility for a set period of time and a specified fee. In essence, the transfer station owner or collector reserves capacity or air space at the facility for disposal of that state's waste.

Disposal contracts may require a guarantee of delivery of a minimum and sometimes a maximum average tonnage of waste to the facility. These contracts require the transfer station owner or collector to pay a minimum charge to the disposal facility in the event the transfer station owner or collector delivers less than the minimum tonnage required under the contract.

III. OVERVIEW OF THE COMMERCE CLAUSE

Article I, §8 of the U.S. Constitution, the Commerce Clause, grants to the Congress the power and authority "[t]o regulate commerce...among the several states..." The Commerce Clause not only operates as a grant of power to regulate interstate commerce, but also operates as a restriction on the authority of the states to regulate interstate trade. However, this does not mean that states are absolutely barred from erecting certain barriers to interstate trade.

The U.S. Supreme Court has held that if a statute regulates evenhandedly to effectuate a legitimate local public interest and its effects on interstate commerce are only incidental, the statute will be upheld. The extent of the burden that will be tolerated depends on the nature of the local interest involved and on whether it could be promoted as well with a lesser impact on interstate activities.

The U.S. Supreme Court has expanded this analysis when reviewing state statutes that ban the importation of solid waste. Specifically, an additional inquiry is raised concerning whether the legislation is designed to protect the state's environment or is motivated by financial concerns or economic protectionism. If the statute promotes the economic isolation of the state by discriminating against interstate commerce in favor of local interests, the statute will be per se unconstitutional. Thus, a state cannot isolate itself and

place the full burden of conserving its remaining landfill space on out-of-state commercial interests.

The Supreme Court's approach in determining whether a solid waste statute violates the Commerce Clause was established in the 1978 landmark case, City of Philadelphia v. State of New Jersey, 437 U.S. 617 (1978). In City of Philadelphia, a New Jersey law prohibited the importation of most solid or liquid waste from out-of-state. While the statute permitted four categories of waste to enter the state, it excluded all other waste. Operators of private landfills and cities from other states that had agreements with state landfill operators filed suit against New Jersey and the New Jersey Department of Environmental Protection arguing, among other things, that the New Jersey law was unconstitutional because it discriminated against interstate commerce.

The trial court struck down the statute as violative of interstate commerce but the New Jersey Supreme Court reversed the decision finding that the legislation advanced vital health and environmental objectives and did not unduly burden interstate commerce. However, on appeal, the United States Supreme Court ruled that the law was unconstitutional. First and foremost, the Court held that the interstate movement of solid waste constituted commerce for constitutional purposes. Secondly, the Court ruled that, even if the legislation was designed to protect New Jersey's environment or

was motivated by financial concerns or economic protectionism, the state must advance some reason other than the origin of the waste to prohibit its importation. Thus, a statute that overtly blocks the flow of interstate commerce at a state's borders will be deemed unconstitutional.

City of Philadelphia, is clearly an important Commerce Clause case. It establishes the Court's position that the Commerce Clause protects all states from the efforts by one state to isolate itself from problems shared by all. However, the case expressed no opinion with respect to a state's power, consistent with the Commerce Clause, to restrict to state residents access to state-owned resources or a state's power to spend state funds solely on behalf of state residents and businesses.

This issue was raised in a 1987 case, Lefrancois v. State of Rhode Island, 669 F. Supp. 1204 (D.R.I 1987). In Lefrancois, a Rhode Island statute imposed criminal sanctions upon any individual found dumping out-of-state waste at the state-subsidized landfill. A commercial handler of solid waste challenged the statute on Commerce Clause grounds.

The statute was subsequently upheld because the state of Rhode Island was deemed to be a market participant because it provided landfill services for a fee. It accepted waste, compacted it, and covered it with soil so that its final disposal complied with all applicable environmental and health

laws. The court determined that when a state acts as a "market participant" in the solid waste disposal market as opposed to a "market regulator", the state is not subject to the restrictions of the Commerce Clause. The Court said a state has a right to deal with whomever it chooses when it participates in the market. The state has a proprietorship right to conserve these resources for the benefit of the State's citizens. The Court also determined that the statute did not preclude any party from purchasing property upon which to construct a sanitary landfill open to all waste, regardless of origin. Thus, the court held a state may discriminate against out-of-state waste if the facility involved is publicly-owned.

IV. RECENT STATE ACTIONS TO BAN OUT-OF-STATE WASTE AND CONSTITUTIONAL CHALLENGES RAISED

Many receiving states have stepped up efforts to limit the amount of waste crossing their borders. These efforts usually involve legislation which prohibits the importation of all solid waste, limits or restricts the amount of waste that an in-state facility can receive from out-of-state, or prohibits or restricts the acceptance and/or review of permit applications for landfill use or expansion in the receiving state. These state actions and others which involve resource conservation, inevitably face Commerce Clause challenges. Few Contract Clause challenges are raised. However, the impairment of contract issue will have to be addressed.

A recent action occurred on October 28, 1989, when Pennsylvania's Governor Casey signed an Executive Order, which imposed an interim moratorium on new or expanded landfills in his state. The moratorium required the Pennsylvania Department of Environmental Resources ("DER") to immediately cease reviewing applications or issuing new permits for new municipal waste landfills unless the applicant demonstrates a need for additional capacity and could show that at least 70% of the municipal waste proposed to be received at the facility was generated in Pennsylvania. The Executive Order also provided that an applicant for expansion of an existing permitted municipal waste landfill facility had to demonstrate a need for additional capacity and show that at least 70% of the municipal waste proposed to be received at the facility was generated in Pennsylvania.

The Pennsylvania Executive Order had the immediate effect of restricting the importation of out-of-state solid waste, because the DER has stopped reviewing applications for permits for new landfills to accept such waste and will not grant modifications to existing permits to permit existing landfills to expand their capacity to accept out-of-state waste.

On January 5, 1990, the National Solid Waste Management Association ("NSWMA") filed an action in the Commonwealth Court of Pennsylvania challenging the Executive Order. National Solid Waste Management Association v. Robert

P. Casey, et al. Members of the Pennsylvania Chapter of NSWMA operate state permitted municipal waste landfill operations that receive out-of-state waste.

NSWMA argues, among other things, that the Order discriminates against the interstate flow of an article of commerce as a result of the DER's action in not processing and issuing permits for municipal waste landfills.

The Commonwealth of Pennsylvania filed preliminary objections to the action raising issues such as standing and jurisdiction of the court. Oral argument on the preliminary objections is scheduled for early May, 1990.

Another recent state action involves legislation passed in Alabama, in September, 1989. The legislation, Act No. 89-788, which is known as the "Holley Bill" amends Alabama Code Section 22-30-11(b) 1975. The Act prohibits commercial hazardous waste treatment or disposal facilities from accepting hazardous waste generated in states which prohibit the treatment, storage or disposal of hazardous waste within its own borders or which refuse or fail to comply with the provisions of the Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. s9604(c)(9) (the "Act"). The Act requires each state to adequately treat and dispose of all hazardous waste reasonably expected to be generated within that state over the next twenty (20) years through the establishment of a hazardous waste treatment or

disposal facility within the state or through the use of a hazardous waste treatment or disposal facility located outside the state in accordance with an interstate agreement or regional agreement or authority.

The waste management industry challenged the Act on Commerce Clause grounds because it placed restrictions on waste moving throughout interstate commerce. The District Court upheld the law as constitutional for several reasons. First, the District Court determined that the ban, while prohibiting importation of hazardous waste from some 22 states and the District of Columbia, nevertheless affected less than three tenths of one percent (.3%) of the waste previously disposed of in Alabama. Second, the Court, having scrutinized the Alabama statute, opined that the Alabama law was directed to a legitimate state concern which was an effort to comply with the twenty-year capacity assurance directive and more importantly to assure that all hazardous waste buried in Alabama is treated and disposed of in the most environmentally protective manner as is the hazardous waste generated instate. Thus, the Court held that the law was not an effort to isolate Alabama from the national economy.

According to the Court, the effect of the Act was not to confer a significant benefit on instate economic interest or impose a significant burden on out-of-state economic interest. Rather, the ban was directed toward protection of health and

welfare of the people and preservation of the environment by preventing Alabama from becoming the dumping ground for those states that refused to clean up their act under federal law. Also, the Alabama statute did not close its borders to all out-of-state waste but only to out-of-state waste from states that were not in compliance with federal law. Accordingly, the borders of Alabama would be open to those states as they came into compliance. Therefore, its impact on interstate commerce was incidental and not excessive in relation to the local benefits.

The Alabama case is currently pending appeal in the Federal Appeals Court in Atlanta. The U.S. Justice Department has joined the waste management industry in this action. In addition, eleven states (Arizona, Illinois, Indiana, Louisiana, Nebraska, Nevada, New Mexico, North Carolina, Ohio, South Carolina and Utah) filed a motion to participate which was granted on March 27, 1990.

The Justice Department maintains that the Alabama law should be overturned to protect the free interstate market in products and services and prevent Alabama from interfering with interstate commerce. The Justice Department believes that if the Alabama law is allowed to stand, other states will also ban out-of-state waste and the effect will be the "Balkanization" of the national market in hazardous waste disposal. The government further argues that Congress amended Superfund in

1986 to foster a national waste management system and not to give the state's unilateral power to regulate waste disposal within their borders. Thus, Alabama's ban imperils Superfund because it prohibits the use of a waste management site in Alabama that is important from a nationwide perspective.

The State of Ohio also has aggressively pursued action to stem the flow of out-of-state waste into its borders. In 1988 Ohio passed HB-592, which was intended to stem the flow of out-of-state waste, particularly from Pennsylvania, New York and New Jersey. The legislation mandates statewide and regional waste management planning and specifically mandates the formation of single- or multi-county solid waste management districts, each of which is responsible for comprehensive solid waste management and planning within their respective jurisdictions. Each district must adopt a district-wide solid waste management plan, which may include, among other things, a limit or prohibition on waste from outside its district. Ohio intends to stop the flow of out-of-state waste to its landfills through this process.

On January 26, 1990 Ohio's Attorney General testified before a congressional committee that states have developed strong solid waste management plans assuring future capacity for their own waste are in a good position to prohibit out-of-state waste. He asked the Committee to pass legislation to fortify a state's ability to limit the importation of

foreign waste or out-of-state waste that would override the Commerce Clause. He argued that Congress is not bound by the restrictions applicable to states and thus, if Congress authorized state restrictions on long-haul waste, such restrictions would withstand the waste industry's Commerce Clause challenges.

The State of Kentucky has recently attempted to limit the importation of waste from other states by increased disposal costs. Kentucky has witnessed increased public opposition to the importation of out-of-state trash, particularly since the landfill industry is an emerging business in that state. Disposal costs are expected to increase as a result of new solid waste regulations. Specifically, Kentucky will require new landfills to have two plastic liners with a 3-foot-thick clay layer in between. Until recently only one liner and a 2-foot-thick clay layer were required.

Finally, a recent New Jersey case presents the out-of-state disposal issue from another perspective. In re Long-Term Out-of-State Waste Disposal Agreement Between the County of Hunterdon and Glendon Energy Company of Glendon, Pennsylvania, 237 N.J. Super. 516 (App. Div. 1990), the County of Hunterdon had submitted a contract between Hunterdon County and the Glendon Energy Company to the Department of

Environmental Protection (the "DEP") for approval. The contract was for twenty years and called for Glendon to provide for disposal of solid waste generated in Hunterdon County at a proposed resource recovery incinerator which Glendon intended to build in Pennsylvania. DEP disapproved the contract.

Hunterdon County filed an appeal of the agency's decision with the Appellate Division in New Jersey and asserted several challenges to the DEP action. One challenge was that the DEP's disapproval of the contract violated the Commerce Clause.

The DEP maintained that the use of out-of-state disposal facilities was inappropriate as a long-range solid waste management option because these facilities are subject to control by a range of state, regional and local agencies over which the state has little influence and no regulatory control. Further, DEP maintained that there is considerable uncertainty regarding reliance upon the capacity at out-of-state disposal facilities for short-, medium- or long-term use. Although the DEP acknowledged that it has allowed several districts to rely on out-of-state facilities as a short-term option it argued that it is crucial that districts which do rely on out-of-state disposal capacity secure enforceable assurances from those facilities in order to ensure continued use until in-state facilities can be brought on line.

The Appellate Division agreed with the DEP. Also, the Court found no violation with respect to the Commerce Clause challenge. The Court said states retain significant power to regulate in the areas of environmental protection and resource conservation. Also, the Court held that this was not a case of economic protectionism or patent economic discrimination. In fact, the DEP policy effectuated legitimate local interests, subsumed by the police powers and invoked to ensure health and safety. Thus, the thrust of New Jersey's policy was to protect the environment over the long term by ensuring the existence of an essential public service -- solid waste disposal -- when the critical time and need arrives. The DEP's policy did not burden citizens of other states in any way nor did it discriminate against others. The Court further stated that reasonable local regulation of solid waste disposal will be upheld in the face of Commerce Clause claims where the failure of state government to act would result in a crisis.

VI. CONCLUSION

The law appears to be well-established that states may not ban the importation of out-of-state waste. However, receiving states continue to take actions to limit the amount of waste entering their borders. States apparently are encouraged by recent court decisions which have upheld states' actions in some cases based upon legitimate state concerns. Thus, one can probably anticipate more states enacting barriers

to importation of solid waste. Therefore, states that export waste must take actions to provide for their own disposal and reduce exports to other states through source reduction, recycling, incineration and landfill development and not rely on other states. Each state must see to its own solution.

COMMUNICATING RISKS ASSOCIATED WITH EXISTING & NEW MUNICIPAL SOLID WASTE FACILITIES

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INTRODUCTION

In part because of inappropriate practices in the past, and despite more sophisticated controls in recent years, there are risks associated with both existing and new municipal solid waste (MSW) facilities. Some existing landfills, for example, are considered so hazardous -- generally because of their contamination of water -- that they have been declared Superfund sites. Despite increasingly stringent controls, even the most modern waste combustion units cannot be considered fail-safe; unanticipated variations in the incoming waste stream, mechanical failures, and human errors are among the possible causes of emissions that may be harmful to human health and the environment. In recent years, citizens have developed a growing awareness of, and concern for, a variety of environmental risks, including those assoicated with solid waste facilities. Given this concern, experience has shown repeatedly that failure to provide risk information is likely to lead to resentment, distress, and resistance to future proposals.

This paper explores several aspects of risk and risk communication relevant to the management of MSW. We begin by briefly discussing the "expert" view of risks associated with solid waste facilities and the techniques used to reduce these risks. We then consider how public concerns might differ. Finally, we describe an approach that may be effective in addressing public concerns about solid waste risks.

EXPERT ASSESSMENT & PUBLIC CONCERN ABOUT SOLID WASTE RISKS

As discussed in a later section, it is not clear that members of the public in practice necessarily base their concerns regarding an existing MSW facility or to a proposed new facility on the results of formalized risk assessments performed by "experts"; nor (some would argue) is it self-evident that they should. Nevertheless, we shall focus initially on the process involved in risk assessment and some of the results obtained for MSW facilities. Although there are other risks associated with these facilities (such as those resulting from truck traffic, contaminated runoff, landfill gas, disease transmission by rodents, etc.), the principal concerns of the public appear to relate in large part to the potential health effects of ***leachate*** from landfills and of ***atmospheric***

emissions and ***residual ash*** from combustion units. Consequently, we shall focus on these particular risks.

A risk assessment typically seeks, in a systematic manner: (1) to identify the potential hazards (here, the release from MSW facilities of health-threatening pollutants); (2) to assess the likely exposure (taking into account, for example, the potential for the release of these pollutants into the environment, their transport and fate once released, and the doses ultimately received by humans); and (3) to estimate the impact of these doses on human health. A number of such assessments have been performed on leachate from landfills as well as on flue gas and ash from combustors.

ASSESSMENT AND REDUCTION OF RISKS

Leachate from Landfills: Prior to the 1980s, relatively little attention was paid to potential leachate problems in the siting, design, and operation of most landfills. At that time, also, it was not uncommon for a variety of hazardous wastes to be deposited in municipal landfills, which almost certainly contributed to the toxic constituents in the leachate. In many instances, contaminated leachate was allowed to seep out and degrade ground and/or surface waters. One result is that many of the sites presently on the Superfund National Priorities List are old MSW landfills.

The extent of the risk actually posed by leachate from old MSW landfills is impossible to determine because groundwater has been monitored at only about 25 percent of them. However, based on a model predicting the release, transport, fate, and impacts of eight pollutants typically found in leachate, the US Environmental Protection Agency (EPA) has estimated that 5.5% of existing MSW landfills pose a lifetime cancer risk of between 1 in 10,000 and 1 in 100,000, while the estimate for 11.6% of the landfills lies between 1 in 100,000 and 1 in 1,000,000. The level normally used by EPA as a "trigger" for regulation is 1 in 10,000. (EPA 1988; OTA 1989)

A move toward tighter leachate controls at the federal level began with the issuance of sanitary landfill criteria in 1979; much stricter controls appear in new federal regulations that are currently pending. In the meantime, many new landfills have been constructed to stricter standards imposed by states or as a pre-condition to obtaining local siting permission. In general,

landfills constructed today are likely to be sited in more suitable locations than those often used in the past, and to incorporate a variety of engineering controls intended both to minimize the amount of leachate generated (by keeping moisture out of the landfill) and to prevent any leachate from seeping out (by trapping and collecting it). A greater effort is likely to be made to keep (or to take) hazardous constituents out of the incoming waste stream.

Nevertheless, some leachate-related risk still remains. Hazardous wastes are still likely to enter the landfill, both legally (since in many states, hazardous wastes from households and very small quantity generators are not excluded) and illegally (due to imperfect enforcement of existing controls). It has been suggested that natural anerobic processes may convert some nonhazardous wastes (such as lignin in paper) into hazardous substances. Even in the absence of substances specifically identified as "hazardous," leachate from an MSW landfill is likely to be a potent pollutant, generating many times the Biological Oxygen Demand of settled sewage.

In addition, mechanical failure of the engineered controls may occur; for example, a synthetic liner may ultimately degrade, particularly after a long period of exposure to contaminated leachate within the landfill. Human error may also cause a failure of the engineered controls: the liner may be inadequately installed; the leachate collection/treatment system may be operated improperly; inadequate safeguards may be taken at closure; or there may be subsequent disturbance of the site. It may be noted that the very success of the controls in reducing risk in the short- to medium- term may extend the time over which the risk remains significant, since the absence of moisture tends to slow down the rate at which the waste undergoes natural degradation.

Although all of these possibilities are recognized, it is virtually impossible to develop a precise estimate of the resulting risk. All that can be said is that the risk (at least in the short- to medium- term) is likely to be considerably less than it was in the past, when few if any leachate-related precautions were used.

Atmospheric Emissions from Combustors: Uncontrolled flue gas from an MSW combustor is likely to contain many different substances, some potentially very hazardous. These substances may be uncombusted residues of wastes entering the furnace or products formed during or after

combustion itself. The substances typically of greatest concern are (1) toxic metals such as cadmium, lead, and mercury (e.g., from batteries, plastics, and newsprint) and chromium, tin, and zinc (e.g., from surface coatings, galvanized metals, and solders), and (2) complex organic molecules present in the incoming waste or formed from partially combusted organics, especially the polychlorodibenzo-p-dioxins (PCDDs) and polychlorodibenzofurans (PCDFs), as well polynuclear aromatic hydrocarbons such as benzo(a)pyrene. Based largely on laboratory studies involving animals, the PCDDs and PCDFs are thought by many people to include some of the most highly toxic compounds in existence. (Washburn, 1989; OTA 1989)

It is widely acknowledged that older, uncontrolled MSW incinerators have relatively high emissions of these and other pollutants, although some have been retrofitted successfully, reducing dioxin emissions by as much as two orders of magnitude. Exposure to these emissions may take place directly (e.g., by inhalation) or indirectly (e.g., by ingestion of contaminated milk or other food). Based on analyses of direct exposure via inhalation, EPA (1987) estimated that the upper risk limits are about 2 to 40 additional cancers per year in populations exposed to PCDD an PCDF emissions from all existing MSW incinerators, corresponding to a maximum individual lifetime cancer risk that falls between 1 in 1,000 and 1 in 10,000. The cancer risks due to metals in existing MSW incinerator emissions were thought to be much less. Because of reductions in emissions due to the introduction of stringent controls, it would be expected that considerably lower risks would be associated with combustors built today, assuming proper operation. These estimates, however, do not take into account exposure to the emissions via indirect pathways, which some people argue are at least as important as the direct pathways (epecially in view of the possibility of bioaccumulation).

Residual Ash from Combustors: Various hazardous substances, including metals and organics such as PCDDs and PCDFs, have been identified in the ash from MSW combustors. Fly ash by itself almost always fails the EP toxicity test for lead and/or cadmium, while combined fly and bottom ash often fails this test. Wastes failing the test are normally classified as "hazardous waste" under RCRA Subtitle C (meaning that they should be disposed of in specially permitted facilities) but there remains some ambiguity about the residues from combustors burning only MSW since

it is claimed that they are excluded from regulation as "waste derived from households." It is expected that Congress will ultimately resolve the issue by declaring these residues to be "special wastes," subject to controls somewhat less stringent than those imposed on hazardous wastes; in practice, they will probably have to be reused in some manner or deposited in specially constructed monofills (as many of them already are).

Human exposure to the pollutants in ash may result from ingestion of groundwater contaminated by leachate from the ash; inhalation, ingestion in food crops, or dermal exposure may also result from airborne and waterborne transport of ash during handling or land disposal. However, according to OTA (1989), quantitative risk assessments regarding ash do not exist.

PUBLIC CONCERNS REGARDING SOLID WASTE RISKS

As previously mentioned, it is not clear that the public's concerns about an existing or proposed MSW facility are necessarily determined solely or even at all by the results of a formalized risk assessment, if available. There are at least three possible reasons: (1) the public may not know or understand the results of the risk assessment; (2) the public may dispute the assumptions used in the assessment; and/or (3) the public may know and understand the results, but may ***choose*** to be moved by concerns that, to the experts who prepared the assessment, may seem to be "irrational." If the first reason applies, the potential role of risk communication is obvious: to effectively communicate the results of the assessment so that the public can use these results -- if it chooses -- in determining its reaction. The second and third reasons require a little more discussion.

Disputed Assumptions: Most risk assessments on MSW facilities have been performed with incomplete data and inadequate knowledge about the processes that produce the hazardous pollutants, about the mechanisms for their release to the environment, about the pathways that ultimately lead to human exposure, and about the human response to the exposure. Risk assessors have had to rely heavily on predictive models as well as on a variety of assumptions needed to run the models. Typically, the models are programmed to determine a "worst-case"

scenario involving a "maximally-exposed" individual (that is, someone exposed to high concentrations of a given pollutant over a 70 year lifetime). Some people consider that this is an overly conservative approach, while others -- in view of the uncertainties and what is at stake (human lives) -- consider it appropriate (OTA, 1989).

Some important assumptions may be especially difficult for the public to accept, particularly in view of certain well-publicized incidents that have threatened or produced environmental damage in the past (e.g., the accident at Three Mile Island, the Valdez collision, etc.). Risk assessments performed to date on proposed MSW facilities have typically been based on technologies constructed precisely to design specifications, undeteriorated by the passage of time, and operated without human error. In practice, both mechanical failure and human error are likely to decrease performance and increase risks. The control of atmospheric emissions and ash generation in MSW combustors, for example, requires a high degree of maintenance and operational vigilence. It has been reported that dioxin emissions have increased by 5 to 50 times in a test involving the non-optimal operation of a combustor (OTA, 1989). Furthermore, although some states impose their own requirements, there presently exist no federal regulations requiring specific training or certification of even the most essential workers in an MSW combustion facility (Hershkowitz, 1989). Even without the potential for human error, the ability of new combustors to achieve low levels of emissions over a twenty year period is presently unknown. Adding to the complications is that, due to its heterogeneity, MSW is a "bizarre" fuel, over whose composition (and resulting combustion products) the facility operators have little or no control.

The observation that "experts" frequently disagree among themselves presents an additional difficulty to the public. For example, in a dispute over the proposed construction of a new MSW combustion facility at the Brooklyn Navy Yard, the consultants hired by the New York City Department of Sanitation estimated that the plant would result in 6 excess cases of cancer per million people exposed over a lifetime to the projected dioxin emissions. An expert hired by those opposed to the facility, however, produced an estimate of the cancer risk that was three orders of magnitude higher (1430 excess cases). The difference, it appears, was largely attributable to different projections of the rate of dioxin emissions from the plant, which in turn resulted from

different assumptions about those existing facilities at which comparable emissions might be expected. (Konkel, 1987)

Alleged Irrationality: It is widely recognized that different people, having been presented with the same information about a particular risk, may appear to see that risk very differently. Proponents seeking to gain approval for a new MSW landfill or combustion unit have often expressed frustration over their seeming inability to assuage public concerns over risks (such as those associated with leachate, atmospheric emissions, or residual ash) which -- according to the risk assessment experts -- may be small in relation to other risks voluntarily accepted by many members of the same public each day.

Although the public is sometimes accused of being "irrational" in this situation, there are several reasons why the description may be totally inappropriate. Psychologists and others have suggested that the way in which a risk is perceived is a function not only of the risk's magnitude (even if this is thought to be determined "objectively") but also of a variety of other factors -- such as whether the risk is voluntary, whether it invokes dread, etc., -- that Sandman has labelled collectively as "outrage." More generally, it seems to be a mistake to assume that people can consider the magnitude of a risk in isolation from its cultural and social ***context***. One researcher has even offered the intriguing suggestion that the passion for cleanliness displayed by many Americans is a factor in determining how they view the risks posed by a facility handling "dirty" garbage (Simon quoted in Michaels, 1988).

Some members of the public also believe, it seems, that the task which risk assessors set out to achieve -- seeking to take account of every possible contingency -- is intrinsically so fraught with difficulty that they have little or no confidence in the results. It is not simply that they question particular assumptions; rather, given the fundamental uncertainty involved, they lack faith that the numbers can ever be reliable. To the contrary, some would argue, they may create an impression of reliability that is undeserved. At a meeting reported by Ehrenfeld (1989), an environmental representative commented that deficiencies are "so significant that that risk assessments are 'meaningless,' and that 'quantitative risk assessment is just a fancy way of developing a standard. It's an esoteric form of magic.'"

ADDRESSING PUBLIC CONCERNS ABOUT MUNICIPAL SOLID WASTE RISKS

In developing an approach to addressing public concerns regarding risks associated with solid waste facilities, an important consideration is what might be called the context of risk communication. That is, risk communication efforts should be part of a larger risk management strategy that includes vigorous efforts to reduce risk. The challenges of communicating information about risk are so substantial, however, that it is possible to lose sight of the idea that risk reduction goes hand-in-hand with risk communication. Those municipal solid waste planners and managers who do lose sight of this idea may unwittingly project the image that they believe all of the risk issues associated with solid waste can be resolved by providing more and better information. The community, however, may well be looking for further risk ***reduction*** in addition to risk ***information***.

Viewing risk communication as closely related to risk reduction can also avoid the problem of equating risk communication with correcting misperceptions. Indeed, as noted earlier, concerns about risk may be well-informed, but based upon a perception of the acceptable level of risk that is different from the experts. In such instances, the only effective and appropriate response may be to provide for a higher degree of protection. For example, as part of the siting process in Fulton County, New York, the decision was made to include monitoring wells even though the hydrogeological study concluded that there was no risk of groundwater contamination. (EPA 1990 p.22)

The approach to risk assessment procedures can also help to create an appropriate context for risk communication; in this sense, risk assessment can be an important first step in risk communication. If the risk assessment process does not provide for adequate community information and involvement, it may be poorly received for reasons quite apart from its technical charactersitics. For example, in 1986 five Philadelphia area physicians, appointed by the mayor, supervised a trash-to-steam plant risk assessment conducted by a Washington, D.C.-based consulting firm. The team of physicians, none of whom were from the section of Philadelphia where the proposed facility was to located, lacked experience with environmental protection and com-

munity participation; and community and environmental groups were excluded from the risk assessment process. These factors apparently contributed to the rejection, by some segments of the community, of the risk assessment results. (Nash)

Individuals charged with the task of communicating information about the risks associated with solid waste facilities face several recurring problems. One is that some of the substances involved have (and justifiably so) a frightening reputation. Dioxin, for example, as discussed earlier, is present in measurable quantities in the ash from combustion facilities; and some people believe that any amount of dioxin is unacceptable. Another problem that communicators of risk information face is that risk assessment experts often disagree with each other and frequently do not provide hard and fast answers. Risk communicators must therefore often address a public -- hungry for straight talk -- with equivocal statements.

Given these challenges, municipal solid waste planners and managers are well-advised to plan a risk communication program. Ideally, this should be done as early as possible to avoid the weakness inherent in a hastily constructed response to a confrontational situation. In planning a program, it is frequently important to obtain assistance from communication experts. Those who have mastered the demanding technical skills necessary to manage municipal solid waste properly may not also be experienced communicators. In obtaining assistance, a special effort should be made to enlist the help of individuals who have experience facilitating an interactive exchange of risk information. Such assistance is increasingly available in the private sector, as well as in government agencies and universities.

Coordination of the planning effort among the various segments of the community can also be important. Local government, community organizations, and environmental groups may want to play a part in determining how risk issues will be discussed. In some communities there may also be an ongoing risk communication program, perhaps addressing risks associated with hazardous materials or natural disasters. Organizers of such a program could provide valuable assistance.

Among the characteristics of a well-planned solid waste risk communication effort is that it is tailored to the unique characteristics of the community in which it is to be carried out. Risk communication activities that are unscuccessful in certain areas because of a tradition of lack of

concern for environmental issues, could very well be successful in communities that have high levels of concern for these issues and a tradition of environmental activism. By the same token, risk communication activities that have proven to be successful in one community might prove to be less than successful in another.

One factor that should be considered is the nature of the community organizations. It is important to know not only what organizations exist in a community and the extent of their membership, but also what their traditions are in terms of becoming involved with controversial matters -- especially matters of environmental concern. Another factor to consider is the customary level of citizen participation in the community.

In considering the characteristics that make a community unique, it may be necessary to use particular avenues of communication in order to reach the community. For example, it may be important to use local doctors in order to communicate certain types of health effects information (as compared to using public officials or doctors from outside the community), or to combine the comments of solid waste industry spokespersons with those of experts who might be regarded as more objective.

A risk communication program should also be responsive to the patterns of activity and communication in a community. For example, when it is important to discuss risk issues with a broader segment of the community than those residents who live near an existing or proposed facility, it may be necessary to focus some of the communication efforts in areas of community-wide significance. If many residents in the community tend to frequent a certain commercial area on Saturdays, an information booth could be set up in that area. If churches are an important part of the community's life, risk communicators could work with churches and church groups. Similarly, understanding which newspapers, radio stations, or TV stations are most commonly read or viewed by the general public is important in determining where to place effective advertisements or announcements.

Public forums are generally an important component of a risk communication program. Information about the presence of environmental risks often evokes significant emotional reactions (Wandersman et al., 1989). People may feel fear, frustration, concern about what to do, and even anger that they and their families have been, or may be, exposed to some danger. For this rea-

son, information about risk is usually best delivered in a forum format rather than through the media, in fliers, in speeches, or in any other format that involves only one-way communication. In a forum, there are opportunities: (1) to quiet fears based on misunderstandings, by answering questions, (2) to put a human face on the problem by giving the messenger a chance to express empathy and to show understanding, (3) for members of the community to offer each other social support as they face difficult choices, and (4) for the community to begin the process of problem-solving as participants think collectively of ways to respond to the dangers rather than facing these risks in isolation.

Those who present information at a forum should be persons skilled in ***communication*** and ***not*** merely technical experts. It is important to reduce information to terms that lay persons will understand, and to present it in a manner that stresses its relevance to citizens. Highly technical discussions will transmit little information and will not hold citizens' interest.

There are a number of important points regarding the way these meetings should be organized and conducted. It may be necessary to set up a ***series*** of meetings since a fairly large volume of sometimes complicated information may have to be covered. Any given meeting should present only the amount of information that a citizen can absorb well in a reasonable amount of time, and still allow enough time for discussion. In practice this may mean holding one meeting to discuss the condition of or proposed plans for a solid waste facility in general terms, while addressing in another meeting the nature and extent of risk to environmental and human health.

In designing these meetings, it is important to take into consideration well established practices for making them as effective as possible. The meetings normally should be scheduled for early evening during the week or on Saturday morning, and should not take longer than two hours (at the very most). They should be held in convenient locations, and should be organized so that attendees will be confident that the meeting organizers are interested in hearing their questions and comments as well as providing information. It is essential that these meetings allow for meaningful question-and-answer sessions.

Advertisements for these types of meetings should make it clear to members of the community that they will obtain information at the meeting that (1) is directly relevant to them, and (2) will assist them to understand the nature of the risks associated with solid waste management in

the community. Direct mail may well be an effective strategy for this, but it can be very expensive and time consuming. Other possibilities include working through community organizations such as the Parent Teachers Association, civic organizations, the Chamber of Commerce, and the League of Women Voters.

As part of a risk communication program, an effort should be made to designate and advertise sources of risk information. While it may not be possible or advisable to designate one individual or organization as the sole source of risk information, it can be important to identify those sources for the media and the public.

Finally, a mechanism for addressing concerns about risks associated with municipal solid waste management should be ongoing. Even where the risk communication program is initially established as part of an effort to site a new facility, the importance of that program extends beyond the siting decision because during the course of operation some members of the community will almost certainly be concerned about risk. An ongoing risk communication program can serve as a forum for discussing those concerns ***and*** for considering new proposals for further risk reduction.

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"DESIGN AND ANALYSIS OF NEW YORK CITY'S WASTE COMPOSITION STUDY"

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The Context of the Study

At 2.4 lbs per capita per day, New Yorkers discard 3.1 million tons of waste per year; an additional 3.5 million tons per year are discarded by the commercial and institution sectors of the city. Waste reduction and recycling are at the top of New York City's and New York State's waste management strategies. By providing data on the discard behavior of all waste generators, the Waste Composition Study is the primary tool for the planning process and for the formulation of alternatives.

Historically, waste composition studies have been driven by the needs of their users (see Exhibit 1). In the 1970s and early 1980s, emphasis on incineration required data on the physical characteristics of waste components. In the mid to late 1980s, emphasis shifted to recycling. This required data on the concentration of recyclable materials in the municipal solid waste. In the 1990s, comprehensive waste management strategies will require ever more accurate data on waste generation and composition at a great degree of detail in order to identify problems: relationships between quantities of waste and groups of generators; applicable standards of waste generation and reduction needs in light of existing and planned facilities and their costs.

The complexity of waste management requires the integration of analytical methodologies and of deterministic and probabilistic models (i.e., input/output analyses and sampling).

The comprehensiveness of the Input/Output approach lends itself to macro and to micro studies. The relevant data are estimated by the Commerce Department, but the calculations are very cumbersome. As a consequence, the data are available with a considerable delay. In addition, the aggregation of such data may be ill-suited to the specific requirements of individual waste management plans.

Waste composition studies based on direct sampling can be random or stratified. In the first case, relevant information on relationships between waste and waste generators is largely lost: we will know our waste, but we will have very little ability to plan, except at the most aggregated level, through trend analyses for entire cities.

Stratified sampling is the approach followed by the NYC Department of Sanitation (DOS): quantity and composition of waste are related to specific population groups generating it, thus tracing back relationships between specific groups of waste generators and specific waste, even at the block level. The degree of detail is considerable and can be tailored to individual needs and

plans. Waste management plans can be formulated for the short- and long term. Forecasts of waste generation and composition will be integrated with economic forecasts and predictions of demographic shifts, the drivers of consumption and discards.

Purposes of the Study

The project relates waste generation and composition to the economics and demographics of the city. Specifically, the assumptions of the Study hold that household waste reflects consumption patterns which vary by socio-economic group; that different institutional categories generate different proportions of waste according to their activities; that waste generated by commercial and industrial establishments reflect their sizes and types of business; and that waste and its components grow at different rates as the demographics and the economics of the city evolve.

The quantification of such relationships in a stratified sample and the configuration of the discard patterns of the city's major waste generators will allow short- and long term planning of waste management.

Short term planning. The quantity of waste collected is at its peak early in the week and declines thereafter. Further, many waste components (the most obvious being yard waste and school waste) are clearly seasonal; others, primarily hazardous waste, are more volatile. The classification of waste components by relevant characteristics, the determination of their concentration in the waste stream and the quantification of their weekly and season fluctuations will allow smoother operations and cost savings citywide.

Long term planning. Assuming that the discard habits and lifestyles of different socio-economic groups change only slowly over time, the estimates of the waste composition study will be used to evaluate waste management alternatives encompassing primarily recycling, waste reduction, landfilling and resource recovery.

The materials selected for the Study (see Exhibit 2) reflect the goals above and the relative data needs. Therefore, the selection was dictated by the following criteria: a) high concentration of the materials in the city's waste stream; b) consideration for inclusion in our recycling programs; c) consideration for inclusion in waste reduction plans; d) threats to general health (for hazardous waste).

Residential Samples.

The indicators selected for the demographic samples are median household income and housing density, from the 1980 Census of Population (see Exhibit 3).

Income is assumed to be the major determinant of spending patterns and, as a consequence, of discards. It is also a "proxy" for a variety of demographic characteristics, primarily, age, education, and professional status. Population density - in the Study, number of persons per acre - allows to determine the relationship between growth in waste and growth in population, and whether such relationship is linear. Together, income and population density provide a compact profile of the different areas of the city that can be easily related to waste production.

Having stratified the residential sector into nine categories, the 20 Census Tracts included in the sample (two for each stratum except for the medium-medium group, which includes four Census Tracts to enhance the overall accuracy of the model) were picked according to the rules listed above.

Institutional Samples.

The sectors of the institutional samples reflect the respective sizes; the parameters reflect the activities of the individual institutions (see Exhibit 4).

The institutions sampled include public and private secondary schools, hospitals, skilled nursing facilities, public offices, universities and colleges, correctional facilities and transportation hubs. Such categories were picked because they produce the majority of the waste collected by Department of Sanitation in the sector. Examples of the sampling design are reported below for schools and hospitals.

Schools. Only schools serviced by DOS were considered for inclusion in the sample. The schools themselves were broken down into two broad categories - public and private. By grade level, public schools were further grouped into elementary, junior high and senior high. Private schools were stratified in two categories: kindergarten through 8th grade, and 6th through 12th grade.

The sample's parameters belong in two distinct groups number and demographic characteristics of students - providing a representative profile of the schools' characteristics.

Hospitals. Considered for inclusion in the sample were all the hospitals serviced by DOS. The hospitals themselves were grouped in the following categories: teaching; municipal; psychiatric and not-for-profit.

The variables originally considered in the sample design included: number of certified beds; in-patient days; number of deliveries; outpatient visits; emergency visits and total employment. They were all found to be highly inter-correlated. Quantity of waste per bed was the parameter eventually selected.

In the second step, distribution of tonnage by method of collection and by hospital categories were estimated to ensure, for each category in the sample, representativeness proportional to waste tonnage produced, and also to determine the number of stops per category, to be equal to the number of hospitals in the respective group.

Commercial/Industrial Samples

Given the high degree of diversification of New York City's economic base, the selection criteria for the individual sectors dictated that: a) the sectors themselves be large and healthy, and b) their waste be representative of discards from sectors not included in the Study. This resulted in the selection of 10 groups: FIRE (finance, insurance and real estate), business and professional services, (all grouped in the offices sector), the hospitality industry (hotels, motels and eating places), food and general retail, the entire wholesale industry, and printing, publishing and clothing in the manufacturing sector (see Exhibit 5). According to our preliminary estimates, these sectors account for 80% of all the waste generated by the aggregated industrial/commercial industry.

In the Study, waste is related to sector-specific employment; however, projections will be based on the evolving configuration of the individual sectors and on their underlying economics, as mentioned above.

Private haulers collect waste generated in the for-profit sectors; therefore, DOS selected the categories for the Study but not the individual establishments, which were picked by

cooperating haulers instead. Consultants hired for the purpose are ensuring that we get as representative and random a sample as possible, given the constraints. The sample will be done this coming June.

The Sampling Procedures.

The sampling procedures were designed so as to provide an unbiased and comprehensive representation of the city's waste suitable for short- and long term planning. Accordingly, the sampling design is based on a number of rules, as follows:

* equal number of loads in each residential stratum, except for the medium/medium group;

* separate samples for the winter, spring, summer and fall seasons of the selected institutions and Census Tract areas, to remain unchanged throughout the study;

* in each load sample and stratum, separate count for bulk waste;

* sampling removed from major holidays;
* within each demographic stratum, selection of those Census Tracts that:

a) have equal frequency of waste collection,

b) do not straddle across different DOS sections,

c) have no recycling programs through the end of the samples of the Study (spring 1990).

* within the individual segments of the project, simultaneous sampling, with sampling loads collected throughout the week so as to capture changes in waste quantity and, possibly, composition in different days of the week;

* within each sample, a number of sorts adequate to measure the statistical significance of the samples at the desired (90%) confidence levels.

* sorting of waste collected by DOS trucks performed in DOS facilities.

Preliminary Results.

For each of the sampled categories, we derive the following information:

* Amount of waste generated daily and weekly - total and scaled by relevant factors (e.g., number of housing units, enrolled students, number of patients, etc);

* Composition of such waste by major categories - paper, plastics, organic materials, yard waste, glass, ferrous and non-ferrous metals, and hazardous waste - and by relevant sub-categories, with particular emphasis on materials that DOS has targeted for its recycling programs;
* Changes in the quantity and composition of waste during the week and in the course of the four seasons in each of the sampled categories and strata;
* Variability of the quantity and composition of waste produced by the different populations sampled, reflected in the quantity and composition of waste in different areas of the city (see Exhibit 6);

The analyses will be refined so as to identify the determinants of waste generation and composition according to relevant economic and demographics events. As mentioned previously, analysis of these findings will allow DOS to plan operations in the long - and short run, and by suitable geographic areas.

Based on broad aggregates, paper and organics are the two largest groups of materials found in the waste stream, followed by plastics, metal and glass, yard waste, bulk waste, inorganic materials and hazardous waste (see Exhibit 7). The composition

of plastics, metal and glass is of major interest to DOS for the market and waste reduction potential of these materials; therefore, in the course of the Study, special subsorts in representative geographic areas were made to determine their concentration in the MSW. Plastics are a major packaging material, as such, a potential target for waste reduction policies. The high concentration of mixed glass and metals increases the costs of separation at our IPCs and of processing; however, such costs may be justifiable if markets are available or can be created.

Turning to waste generation in the residential segment of the Study (see Exhibit 8), it is highest in the high income/low density stratum; the lowest rate appears in the medium income/high density stratum. Spring and summer are the peak waste "producing" periods of the year,

Analogous comparisons in the institutional segment are of limited significance, given the heterogeneity of the sectors sampled: in this segment, the revealed generation and composition rates need to analyzed individually.

Residential Segment. Newspapers, magazines and mixed paper, food, miscellaneous organics, yard waste and bulk are the most

seasonal components of the waste stream (see Exhibit 9), although the seasonality factor varies widely among different materials and may turn out to be negligible for some of them. For instance, the high rate of newspaper discards in the fall may have reflected intensified newspapers' purchases at the time of local elections; the discards of mixed paper, purchases for the approaching holiday season.

Food, newspapers, mixed paper and plastics are the biggest waste categories for all demographic groups. At this early stage, we have not yet determined whether income or population density is the driving force. This topic is, actually, the thrust of the Study.

Institutional Segment (See Exhibit 10). Paper is the dominant material virtually across the board. Organics dominate in nursing homes and are the second most important category in hospitals, schools and correction facilities. As in the residential sector, the seasonal factor varies widely by subcategories of materials, however. We would have expected the seasonal factor in waste generation to be strongest in schools because of their periodic holidays and their closure or vastly reduced activities in summer. As it turned out, waste generation from hospitals and nursing homes also revealed a high degree of seasonality.

Commercial Sector. As mentioned, the commercial samples will be carried out at the end of this month.

Conclusions

The Waste Composition Study reflects DOS concerns that anticipated Local 19 enacted in Spring 1989, requiring DOS to recycle 700 tons per day in 1990, a quantity to rise gradually to 4,250 tons per day by 1994. Concurrently, New York State mandates the implementation of a solid waste management plan calling for 8 to 10 percent waste reduction; recycling of 50 percent, and the construction of environmentally sound waste - to - energy plants for waste that cannot be recycled, all by 1997.

As we deepen our expertise in waste management, there is little doubt that future legislation will be even more encompassing than at present. Merely monitoring current waste quantity is not sufficient for systematic and cost-efficient waste management. We must be able to forecast the growth of waste following economic and demographic growth and shifts, and following technological growth also, for the latter will eventually introduce new products in consumer markets and new materials in the products we buy. We anticipate that, in the not too distant future, the government will work with industries in the design of more environmentally manageable products.

In the process, properly designed waste management schemes may give birth to entirely new industries in the city itself and contribute to economic growth through job creation and the enlargement of the tax base: according to many experts, recycling and all activities related to the defense of the environment will give birth to the growth industries of the 1990's, replacing the electronics of the 1980's.

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EXHIBIT I

METHODS OF WASTE COMPOSITION STUDIES

METHODS	APPROACHES	EVALUATION CRITERIA				EXAMPLE
		PLANNING HORIZON	COSTS	ACCURACY	LEVEL	
DETERMINISTIC	SUPPLY/MACRO	MEDIUM-LONG	MEDIUM	LOW	STATE AND UP	FRANKLIN ASSOC. (1988)
	DEMAND/MICRO	MEDIUM-LONG	MEDIUM	LOW	CITY	MARKETING STUDIES
STOCHASTIC	RANDOM SAMPLING	SHORT/MEDIUM	LOW	MEDIUM	CITY	RHODE ISLAND, 1989
	STRATIFIED SAMPLING	SHORT/MEDIUM	MED./HIGH	HIGH	CITY BLOCK	NEW YORK CITY, 1989-90

EXHIBIT II

MATERIALS IN WASTE COMPOSITION STUDY

PRIMARY CATEGORIES	SUBCATEGORIES	PRIMARY CATEGORIES	SUBCATEGORIES
PAPER	CORRUGATED	ORGANICS	LUMBER
	NEWSPAPERS		TEXTILES
	OFFICE PAPER		RUBBER
	MAGAZINES		FINES
	BOOKS		DISPOSABLE DIAPERS
	NON CORRUGATED		FOOD WASTE
	MIXED PAPER		MISC. ORGANICS
METALS	METAL CONTAINERS	YARD WASTE	GRASS AND LEAVES
	OTHER		BRUSH
ALUMINUM	ALUMINUM CONTAINERS	INORGANICS	BIMETAL CONTAINERS
	BEVERAGE CONTAINERS		CERAMIC
	MISC. CONTAINERS		MISC. CONTAINERS
GLASS	CLEAR	HAZARDOUS WASTE	PESTICIDES
	GREEN		NON PESTICIDES
	BROWN		PAINT
	MISC. GLASS		DRY CELL BATTERIES
			MEDICAL WASTE
			MISC. HAZARDOUS
PLASTICS	CLEAR HDPE		
	COLOR HDPE		
	LDPE		
	FILM		
	GREEN PET		
	CLEAR PET		
	PVC		
	POLYPROPILENE		
	POLYSTYRENE		
	MISC. PLASTICS		

EXHIBIT III

STRATA SAMPLED IN THE WASTE COMPOSITION STUDY
DEMOGRAPHIC SEGMENT

STRATUM INCOME/DENSITY	MED. INC. $(K)	DENSITY	%POP.	#CT	#LOADS	#SAMPLES
LOW/LOW	10 - 11	32 - 43	4	2	16	124
LOW/MED	9 - 11	62 - 64	9	2	16	117
LOW/HIGH	8 - 9	123 - 176	10	2	16	150
MED/LOW	13 - 15	42 - 46	6	2	16	129
MED/MED	13 - 16	66 - 94	10	4	36	260
MED/HIGH	13 - 16	150 - 171	7	2	16	132
HIGH/LOW	17 - 19	29 - 49	12	2	16	134
HIGH/MED	16 - 18	89 - 98	5	2	16	114
HIGH/HIGH	17 - 18	109 - 124	3	2	20	139

EXHIBIT IV

INSTITUTIONS SAMPLED IN THE WASTE COMPOSITION STUDY

INSTITUTIONAL SEGMENT	NO. INST.	%INST. WASTE	PARAMETER	NO.	LOADS	SAMPLES
HOSPITALS	98	9	BEDS	1758	36	302
PUBLIC AND PRIVATESECONDARY SCHOOLS	592	53	STUDENTS	32846	60	361
COLLEGES	28	2	STUDENTS	15345	12	87
NURSING HOMES	48	4	RESIDENTS	1369	20	108
CORRECTION FACILITIES	9	1	RESIDENTS	1387	16	92
MUNICIPAL BULDINGS	91	8	SQUARE FEET	468000	28	132
TRANSPORTATION HUBS	6	1	COMMUTERS	N/A	21	138

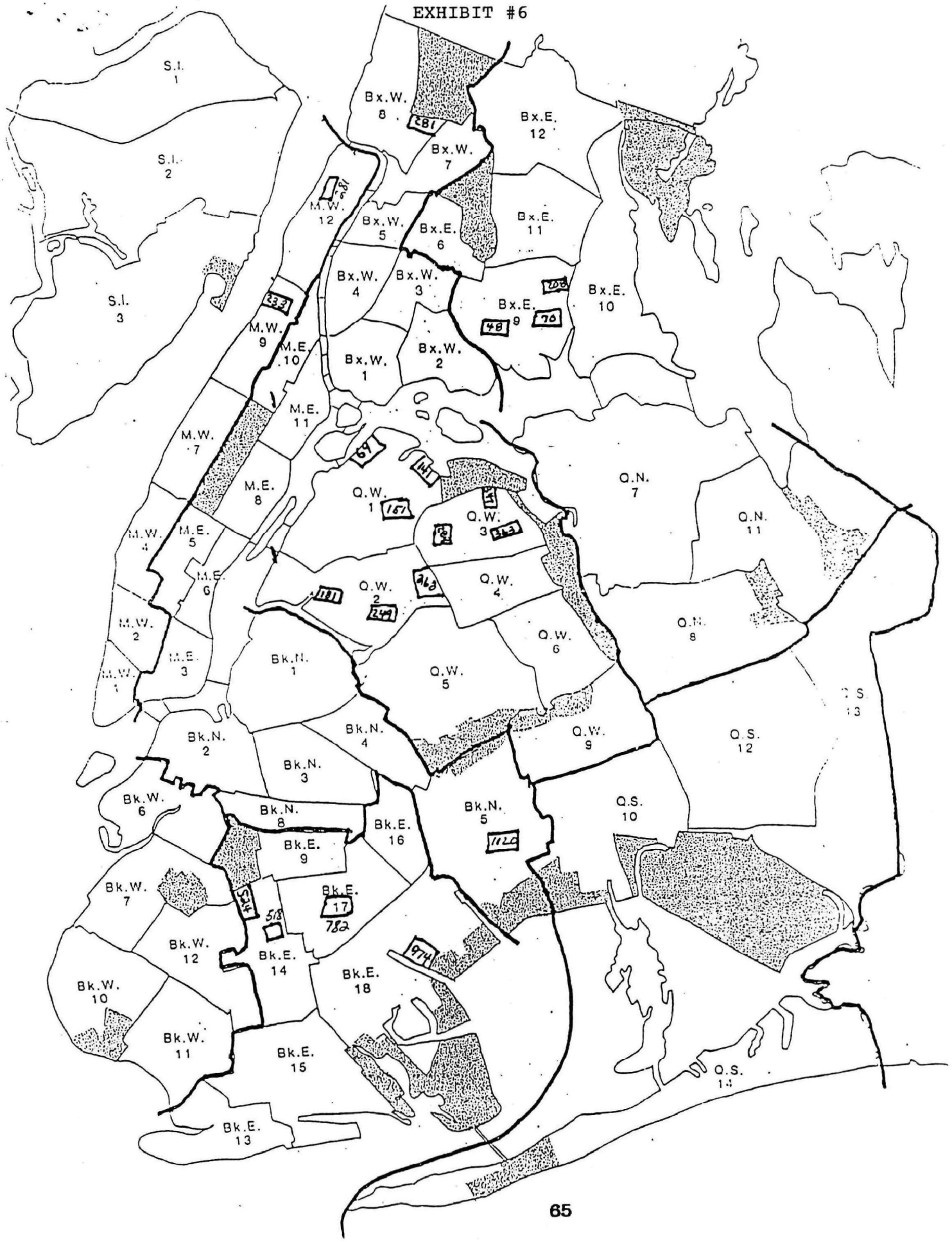
EXHIBIT V

COMMERCIAL/INDUSTRIAL SECTORS SAMPLED IN THE WASTE COMPOSITION STUDY

SECTOR	SIC#	% EMPL.	% COMMERCIAL INDUSTRIAL WASTE	NUMBER ROUTES
OFFICES	60 - 67,73,81,86,89	35	13	2
EATING AND DRINKING ESTABLISHMENTS	5812	4	11	2
FOOD RETAIL	54	2	14	1
GENERAL RETAIL	52,53,56,57,59	5	16	1
APPAREL AND TEXTILES MANUFACTURES	22,23	4	3	1
PAPER, PRINTING AND PUBLISHING	26,27	3	2	1
WHOLESALE TRADE	50,51	7	5	1
HOTELS AND MOTELS	70	1	2	1

4119Q

EXHIBIT #6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Bx.E. 10
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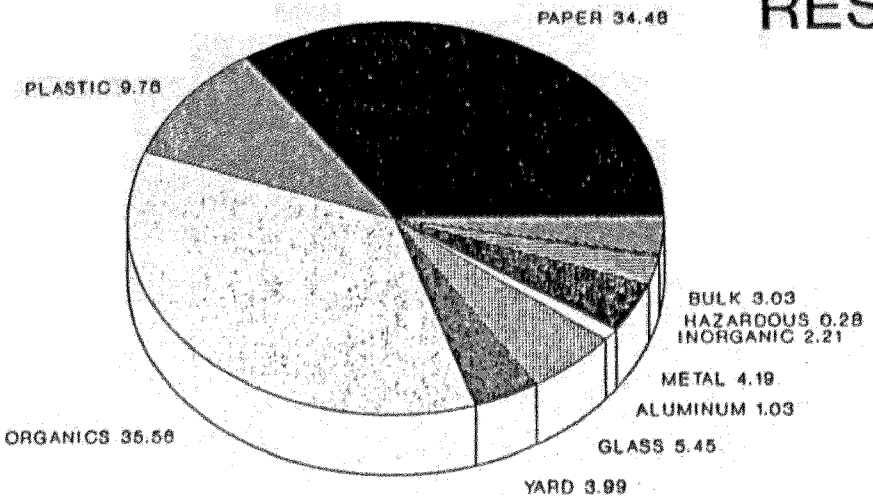
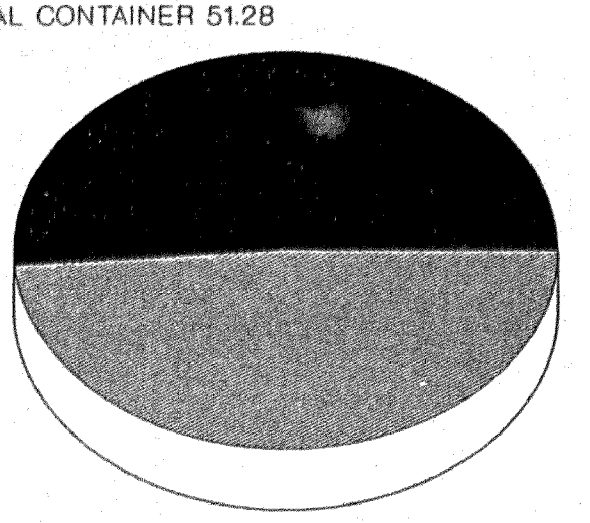
EXHIBIT 7
RESIDENTIAL



MAJOR CATEGORIES



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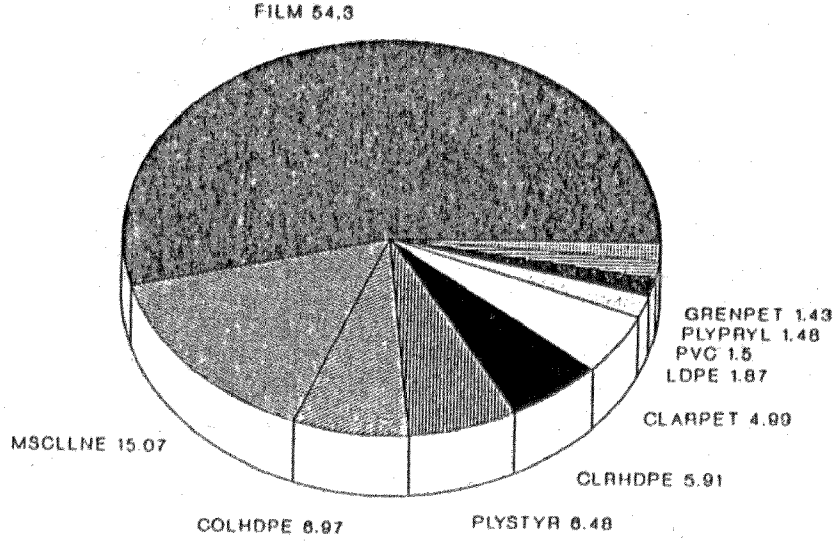

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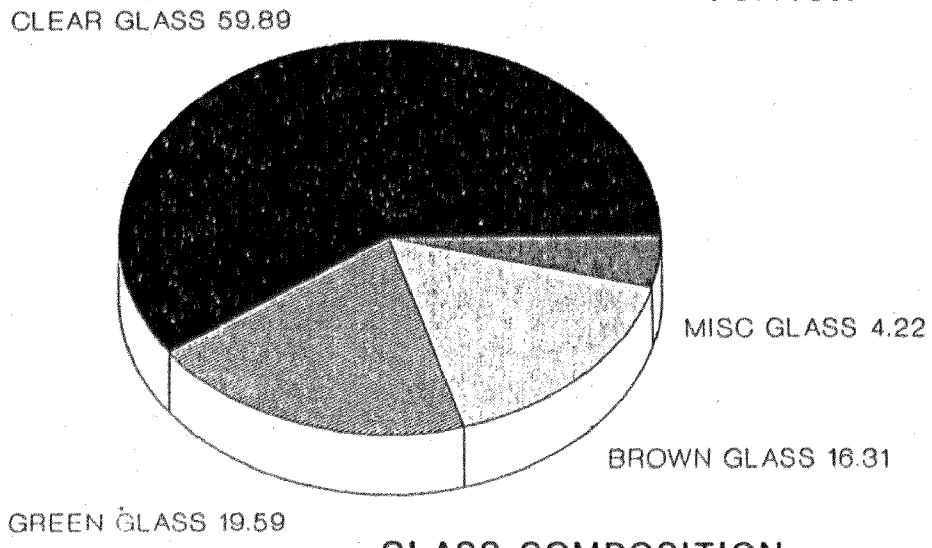
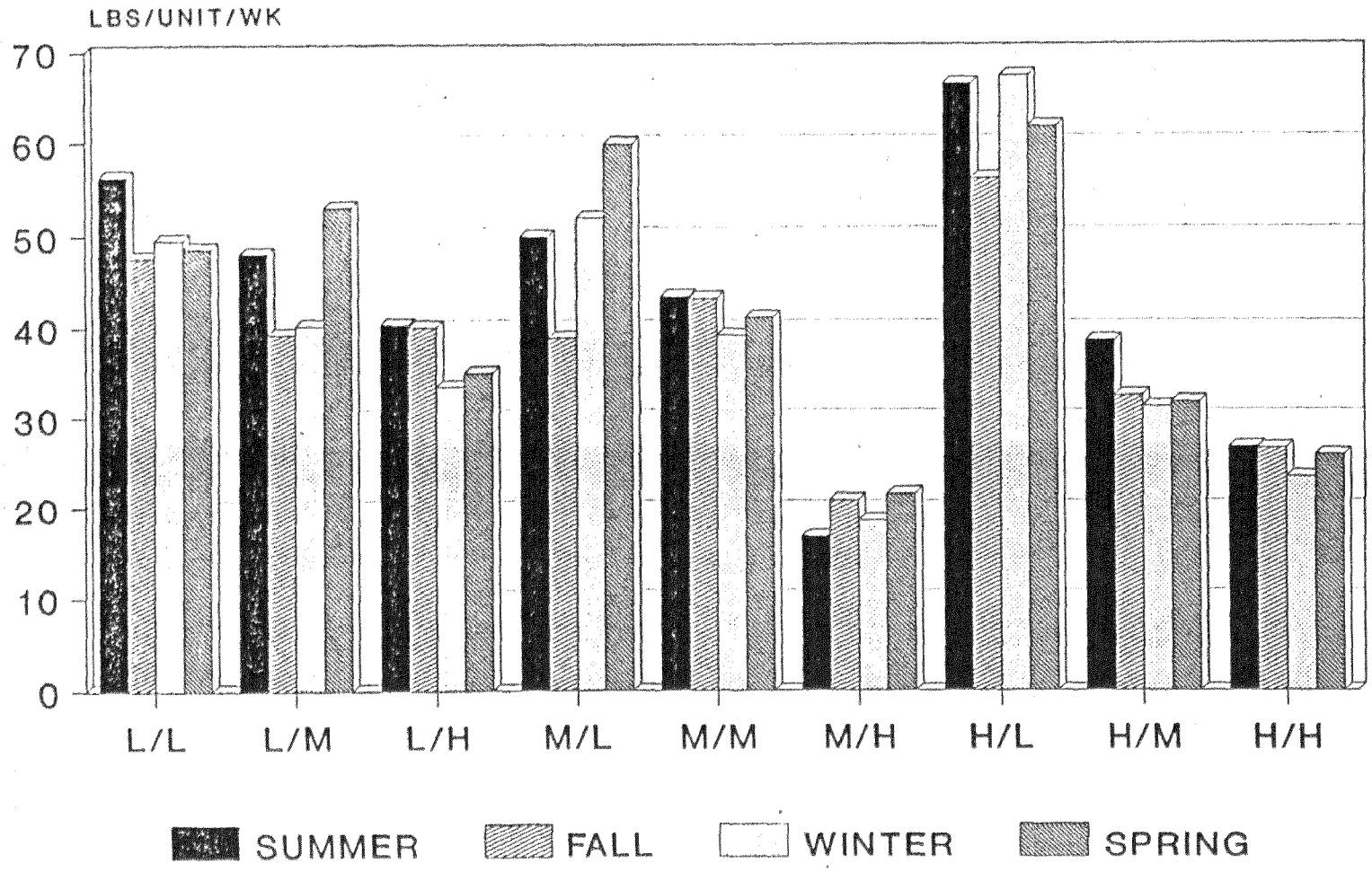


GLASS COMPOSITION

99

EXHIBIT 8
WASTE GENERATION BY RESIDENTIAL STRATA



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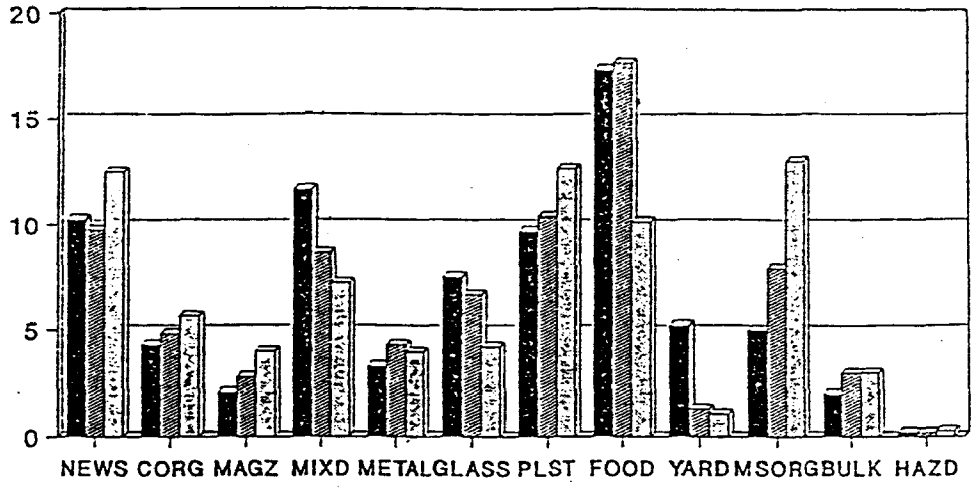

SUMMER DATA

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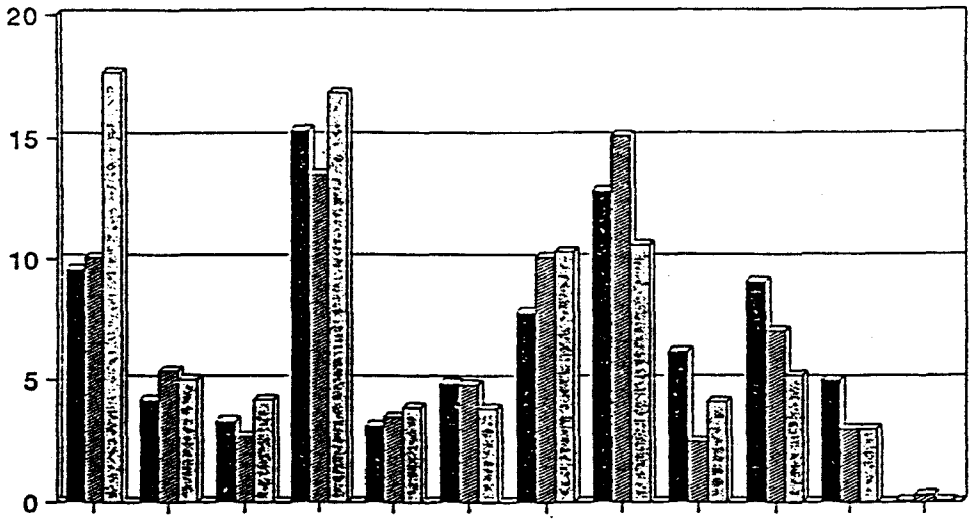

FALL DATA

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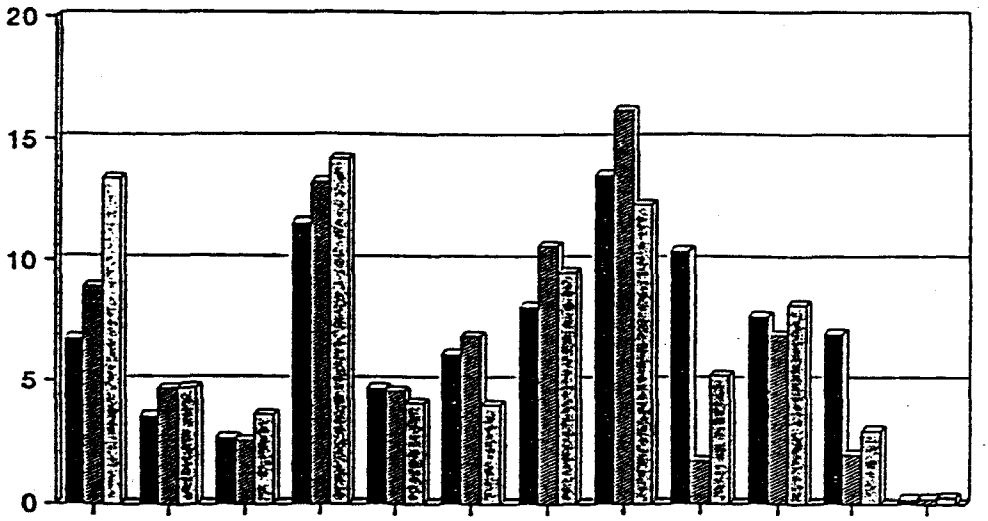

WINTER DATA

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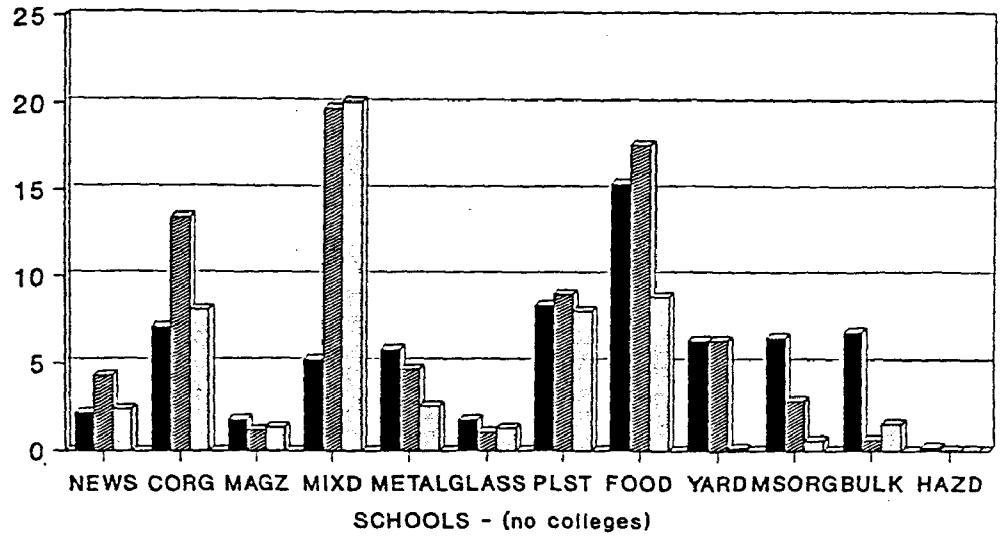
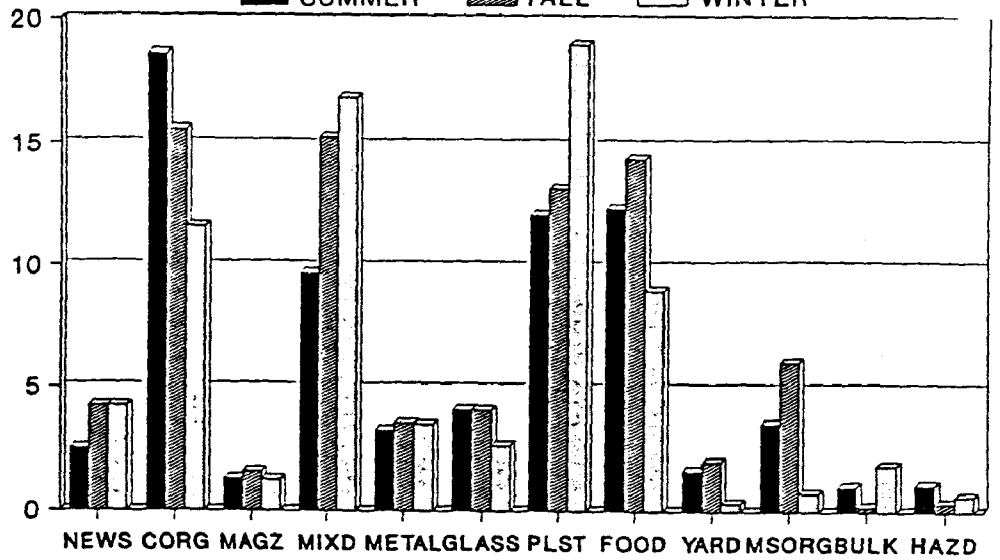
INSTITUTIONAL



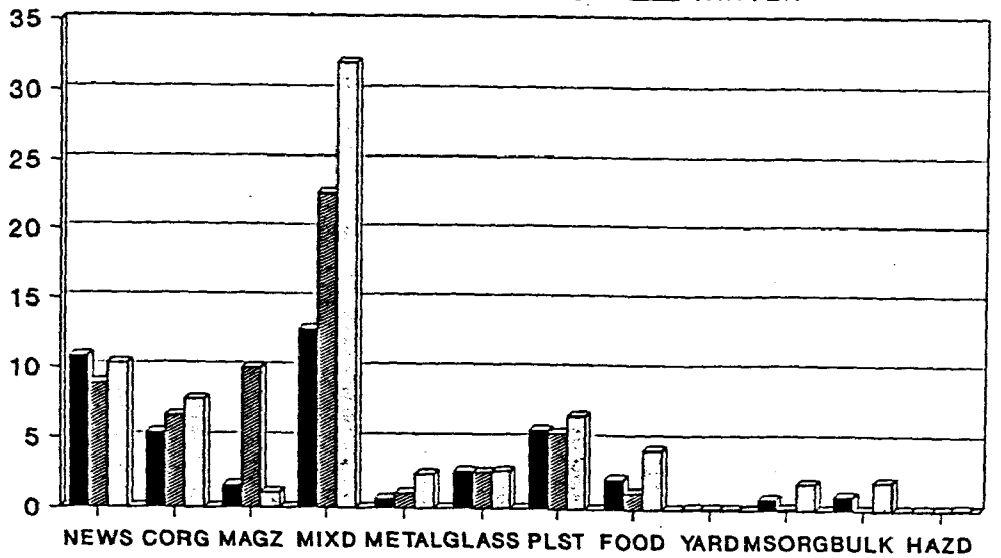
SCHOOLS - (no colleges)

SUMMER FALL WINTER



HOSPITALS

SUMMER FALL WINTER



MUNICIPAL BUILDING

SUMMER FALL WINTER

ECONOMIC INCENTIVES AND TRENDS FOR REGIONALIZATION OF MUNICIPAL SOLID WASTE LANDFILLS

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Temple, Barker & Sloane, Inc. and Economic Analysis Staff, Office of Solid Waste, US EPA

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ECONOMIC INCENTIVES AND TRENDS FOR REGIONALIZATION OF MUNICIPAL SOLID WASTE LANDFILLS

Overview

This paper provides an economic explanation for the declining number and potentially increased size of municipal solid waste landfills (landfills) and discusses economic incentives that will reinforce those trends as more and more landfills close and communities design new municipal waste disposal systems. Disposal costs have increased substantially in the past decade as the number of landfills has diminished. One reason for the increase is the recognition that landfills have traditionally been underpriced (i.e., users have not paid the full life-cycle costs of building and operating a landfill). A second is that siting new facilities has become extremely difficult and expensive. The economic manifestations of the "not in my backyard" or NIMBY syndrome appear as extensive site selection processes, high permitting costs, and long lead times in design and construction. Finally, more stringent state regulatory requirements are already driving up costs in many states and soon EPA will promulgate revised federal criteria for landfill design and operation that will increase costs even further.

Rather than focusing on the magnitude of these costs, we take those costs as given and analyze the incentives for regionalization (i.e., consolidation of disposal capacity from more numerous, smaller landfills to fewer, larger units) that the costs provide. First we discuss trends in the number of landfills and then introduce several economic and demographic factors that affect future landfill planning decisions. Next we model these factors to estimate the magnitude of incentives to regionalize and

project future shifts in the number and size of landfills. While these shifts have consequences for the total cost of disposal (e.g., gains in economic efficiency) and may affect human health and the environment, these effects are not addressed.

Landfill Trends

In this section we describe the declining number of landfills and then identify several factors that are responsible for the pattern of landfill size and distribution, principally the low cost of landfills in the past and the increasing costs evident today.

Trends in the Number of Landfills

The trend toward larger, regional landfills has been quite evident over the past decade. In 1977 *Waste Age* magazine reported 18,539 municipal waste disposal units in the United States (as of 1974) including sanitary landfills and open dumps.[1] Over the next several years, the estimates declined. A 1984 estimate placed the number of landfills at 10,467[2] and a census of state Subtitle D programs in 1985 found 7,645.[3] By 1986, that number had dropped to just over 6,000 landfills, and the number continues to drop today because the number of landfills closing each year continues to far exceed the number of new units.[4]

At the same time, the volume of municipal solid waste disposed in landfills has held steady, increasing only four percent between 1980 and 1986.[5] This means that the average amount of waste handled per landfill is climbing and regionalization is occurring as communities share a dwindling number of facilities.

Factors Behind These Trends

The initial, large number of landfills was the result of economic signals that promoted the location of landfills (or dumps) according to convenience. The cost of making undesirable land into a dump or open burning area was very low, and, by comparison, the cost to transport waste to that facility was large. In order to minimize that transportation cost, dumps were common.

In 1979 EPA promulgated criteria for landfills restricting open burning and forcing the closure of dumps that did not comply with the criteria. At that time, disposal cost became more of a factor in siting and planning because compliance with the criteria cost communities money and shut down a large number of facilities. Today disposal costs continue to increase as the number of landfills declines and the supply of landfill capacity shrinks.

Regulatory compliance costs are continuing to increase as many states strengthen their landfill regulations to require more stringent monitoring at landfills, better designs, and extended care and maintenance after closure. Federal regulations will soon add to disposal costs as well.

Evidence of increasing costs is everywhere and has been well publicized. Even though particular regions have been more affected than others, even national estimates show significant increases. For example the annual tip fee survey conducted by *Waste Age* magazine indicated a nominal increase of 52 percent in landfill tip fees between 1986 and 1987 and 32 percent between 1987 and 1988.[6]

One way for communities to mitigate the increasing disposal costs is to take advantage of the economies of scale in the design and operation of landfills (i.e., the

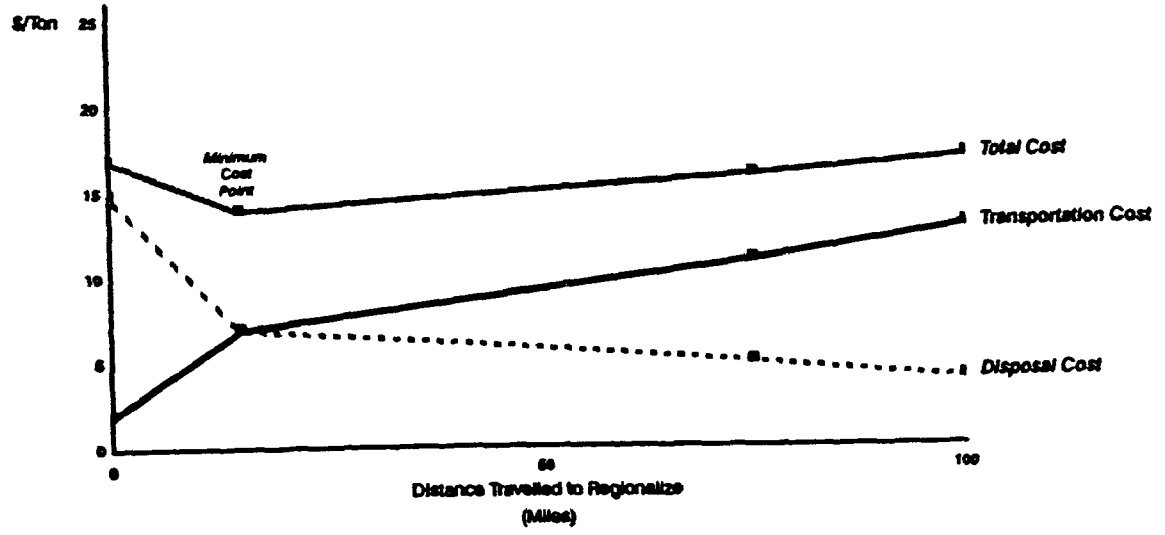
principal that larger operations are more efficient and can handle waste for a lower cost per ton). Landfill costs exhibit these scale economies because fixed costs associated with the construction and operation of a landfill can be spread across more users as the scale of the operation increases. In addition, more efficient equipment and operating practices are possible for larger units leading to significant positive returns to scale.

Given these positive returns to scale, communities may have an incentive to haul waste longer distances (pay more for transportation) and pay less for disposal. The tradeoff between transportation costs and disposal costs is illustrated in Figure 1. The figure shows the underlying patterns in disposal and transportation cost as hauling distance increases. Transportation costs climb steeply at first as collection vehicles or private citizens incur substantial costs as they are called upon to transport waste a longer distance. Eventually, the rate of increase slows as transfer facilities become economical "depots" for waste collection; transportation from transfer facilities is typically much more efficient than collection, so the transportation costs increase more slowly.

Figure 1

Economic Model for Regionalization

Base Case



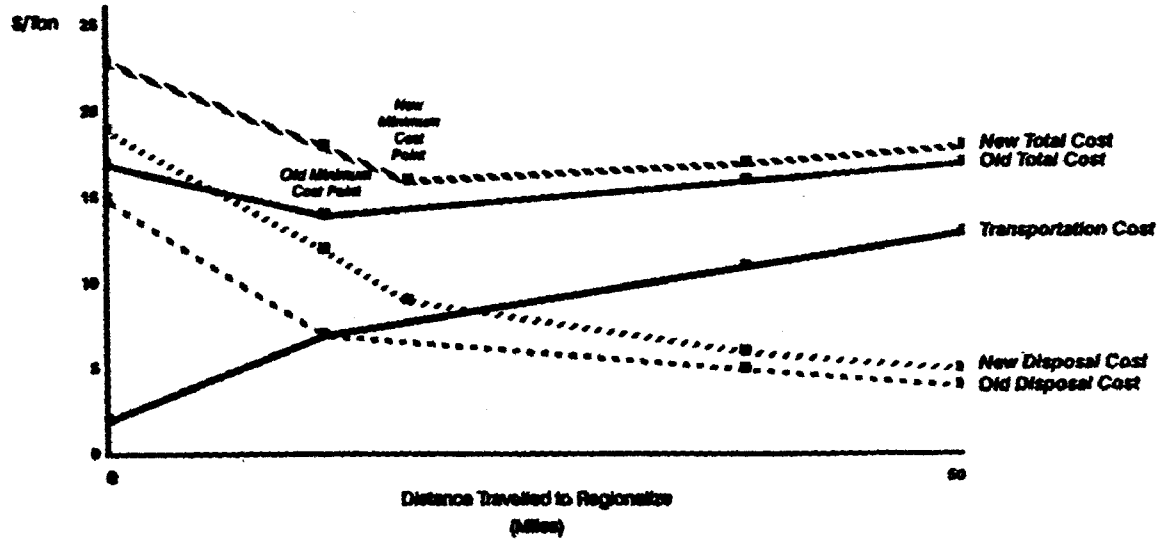
The shaded line in the figure represents the total cost of waste management (the vertical summation of the transportation and disposal costs) across distance. A community would ideally locate its disposal facility to minimize these total costs (i.e., at the minimum point on this curve). Shorter distances imply higher costs because of high unit costs of disposal while longer distances imply that landfill scale economies are overwhelmed by increasing transportation costs.

If disposal costs increase (for the reasons described earlier), longer hauling distances and use of larger landfills can help offset the increase. In Figure 2, increased disposal costs shift the optimum point on the total cost curve to the right (suggesting that a longer hauling distance is appropriate). Because the cost increases also reflect positive returns to scale, the disposal cost curve shifts up further for small landfills and a reallocation between disposal and transportation costs reduces total outlays. The next step of the analysis is to model the cost and distance factors to demonstrate the strength of the incentives to shift to larger, regional landfills.

Figure 2

Economic Model for Regionalization

Increased Disposal Costs



Modeling Incentives to Regionalize

When a landfill approaches its capacity, the communities it serves must plan how they will manage municipal solid waste when the unit closes. We compiled data on a sample of landfills, transportation and disposal costs, and communities served by these landfills to model the decision rules that communities might use to decide whether to site a new facility of the same size in the same general area or to shift to a lower-cost, larger facility at higher transportation costs. We assumed that a community would face this decision only when the remaining life of its existing landfill was exhausted. The decision rule analysis assumes that when a landfill is going to close the communities determine whether the existing transportation arrangements and the landfill size are appropriate given the potential savings available from shifting to a larger landfill. The costs of the new landfill includes the full cost to construct, operate, and close the facility including compliance costs with applicable regulations plus the appropriate transportation costs.

Model Inputs

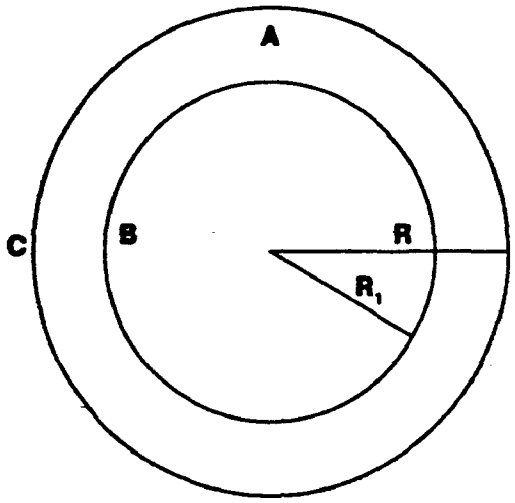
The model inputs include data on the area served by landfills, transportation costs, and disposal costs. We analyzed landfill size data to arrive at seven model sizes of landfills ranging from 10 tons per day (TPD) to 1,500 TPD.[7] We also categorized population density by compiling data on population density in jurisdictions across the country and computing five representative densities (the 10th, 30th, 50th, 70th, and 90th percentiles).[8] We conducted the decision rule analysis based on combined landfill size and population density scenarios that represent the range of cases found in the United States.

Areas Served by Landfills

The area served by a landfill is a function of the unit's size, the population surrounding it, and the cost to haul waste to that landfill. In order to estimate service areas, we assumed that landfills were located at the center of a circle and that the population served was distributed uniformly within this circular service area. Given a fixed and uniformly distributed population density, the only way to increase the amount of waste generated to support a given landfill size was to increase the area surrounding the landfill. The average distance traveled from the landfill to individual households within the circular area (for transportation costing) is defined mathematically. The average distance to the center of a circle equals the radius of an inner circle that circumscribes exactly one half the area of the entire circle (see Figure 3). This gives an average distance to the landfill of 0.707 times the radius of the entire circle.

Figure 3

Computing Average Distance Travelled in a Defined Area



Entire Area C = Area A + Area B

When Area A = Area B, R_1 = Average Distance Travelled

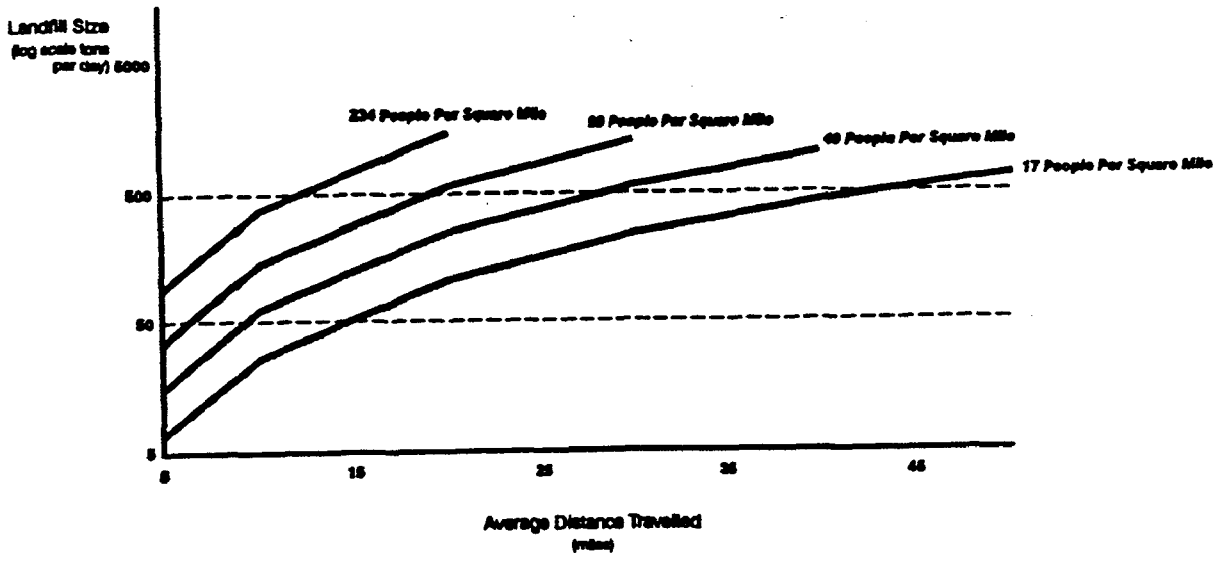
Area A = Area B When R_1 = .707 R

The next step was to combine landfill size, the area served, and the average distance traveled so we could define the size of an area large enough to support any landfill size as a function of population density. The area served by a landfill of a given size is a function of population density and the distance traveled. We can therefore express the size of landfills in terms of distance traveled (the average distance as defined above) and population density. Relatively short average hauling distances can be found at a wide range of landfill sizes depending on the population density in the landfills' service areas (see Figure 4). If population density is very high, landfill size increases very rapidly with distance. In rural settings, however, it is difficult to support a large landfill without long hauling distances. The result of this analysis was a table of average transportation distances associated with each model landfill size and each population density category.

Figure 4

Distance That Must Be Travelled to Reach Landfill

Sizes at Varying Population Densities



Once these distances were computed, we were able to calculate the increase in the average distance traveled if a community shifted up to a larger landfill to save on disposal costs. As the size of the hypothetical new landfill increases, transportation distances increase as well. We completed these calculations using the following formula:

Average distance traveled = [SQRT(TPD/DENS/0.002565/3.1415)] * 0.707

Where:

TPD	= Model landfill size for new facility
DENS	= Population density (people per square mile)
0.0026	= Average tons waste generated per person per day
3.1415	= Value of Pi
0.707	= Average distance factor calculated earlier

Finally, we subtracted the average distance to the current landfill from this new distance to compute the additional distance that waste would be hauled to reach a new, larger landfill.

Transportation Costing

We compiled transportation costs from several different sources. Hauling costs were estimated from a report prepared for presentation at the 1986 Annual Meeting of the Transportation Research Board (referred to here as the Arizona State study).[9] For both long and short haul transportation, the report estimated the costs to replace, maintain, and operate vehicles given standard assumptions about the size and operating parameters of both collection and long-haul vehicles. The study also estimated costs per mile for each type of truck.

We subsequently modified the short-haul estimates to reflect two operators per vehicle and waste density of 700 pounds/cubic yard in the truck. This cost per mile (in 1986 dollars) is approximately $4.40. Given a collection vehicle capacity of 35 cubic yards, we computed the cost per ton-mile as $0.36.[10] We derived transfer vehicle costs directly from the study at $2.00 per mile. Given a 72 cubic yard capacity for an open top trailer and a waste density of 1,000 pounds/cubic yard, the cost per ton-mile is $0.06.

Transfer station costs were estimated from two different sources. The Arizona State study reported costs for transfer stations of between 600 and 3,200 tons per day based on feasibility studies for cities in Arizona. We used the capital costs provided in the study and annualized them using a 3 percent real discount rate (to be consistent with the landfill cost estimates) and a 20-year operating life. Operating costs were taken directly from the report. The final step for these large transfer stations was to fit a curve to the point estimates and read off costs for the model sizes of landfills. We used a log-log transformation of the curve and used linear regression to fit a curve across a range of sizes. We used this equation to estimate costs per ton for the four largest landfill sizes; the 175 and 375 TPD facilities were based on extrapolations. The costs per ton are reported in Table 1.

For smaller transfer stations, we used estimates from SEA Consultants from December 1987.[11] This study reported engineering cost estimates (a low and a high estimate) for transfer stations of 5, 20, 65, and 150 TPD. To estimate consistent costs per ton (in 1986 dollars), we amortized equipment over 20 years at a 3 percent rate,

averaged the low and high estimates, and interpolated between the data points. The results are shown below.

Table 1

Transfer Facility Costs

(Annualized Costs per Ton)

TPD	$/Ton	Source
10	$27.01	SEA Consultants (note 7)
25	21.62	"
75	10.63	"
175	7.59	Regression from Arizona State (note 5)
375	5.67	"
750	4.36	"
1500	3.35	"

For comparison, recent estimates validate these estimates fairly well. Costs for a 600-TPD transfer station have been estimated to be $4.48/ton.[12] Also, estimates for a range of sizes showed $16/ton for a 50-TPD facility, $9/ton for a 200-TPD facility, and $8/ton for a 400-TPD facility.[13]

Disposal Costs

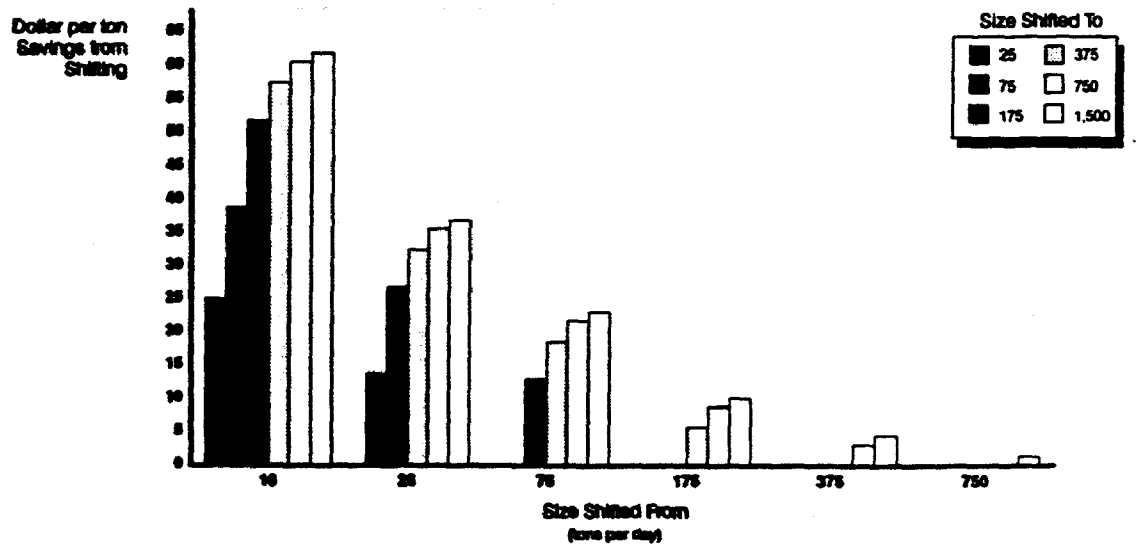
We computed the cost of disposal for each model landfill size using a cost model devised for EPA by DPRA, Inc. (Subtitle D Municipal Solid Waste Landfill Cost Model) and used as the basis for the Draft Regulatory Impact Analysis of the revised Subtitle D Municipal Solid Waste Landfill Criteria.[14] The model computes the full cost of designing and operating landfills including the cost of land; designing and planning (including permitting); site preparation; capital expenditures for equipment, buildings, monitoring equipment, containment systems, leachate collection, and closure; operating costs for monitoring, fuel, labor; and appropriate engineering, contingency, quality control, and profit fees. All capital costs are amortized over 20 years using a 3 percent discount rate.

The total costs reflect the full cost of building a new landfill once the new federal criteria are in place. The costs of compliance with proposed federal criteria were taken from the Draft Regulatory Impact Analysis cited above and averaged for each model size. Total costs used here are approximations of actual costs facilities will incur in the future. Individual landfills may experience costs well below or well above these averages once the criteria are promulgated, and costs associated with the promulgated criteria may differ from the 1988 proposed rule.

The final step was to compute the incremental disposal cost savings available when shifting from the existing landfill size up to a larger one. Figure 5 portrays the incremental cost savings available for shifts to larger size landfills. By far the largest savings are available for small landfills that can become part of a much larger, regional landfill: disposal savings of over $60 per ton could result.

Figure 5

Total Costs: Incremental Dollar Per Ton Savings from Shifts to Larger Landfills



Model Operation

As an existing landfill reaches its closure date, the owner/operator faces a build-or-shift decision that is tied to the full cost of rebuilding a new landfill of the same size, or shifting to a lower cost, larger landfill and paying additional transportation costs. We used the additional average distances associated with shifts to larger landfills to calculate an incremental cost per ton transportation (net of current distance traveled) both with and without the use of a transfer station. Because transfer stations allow

jurisdictions to employ more cost-effective long-haul transportation, they are often attractive options if the cost of the transfer station can be covered by the cost savings. Because we could not determine *a priori* whether transfer stations would be economical or not, we modeled transportation costs both ways.

To include transfer station costs, we computed its size midway between the starting size of the old landfill and the size of the new landfill. This calculation addresses cases in which several small landfills close, combine to support a single transfer station close by, and use a larger regional landfill.[15]

The model scenarios were computed on a spreadsheet and an excerpt of the model is reproduced as Exhibit 1. The first column shows the size of the current landfill while the third column shows the larger sizes available. The incremental savings available in disposal costs are shown in the fourth column. Since these savings are only dependent on size, they are the same for any population density scenario.

The population density column reports the assumed density category modeled. For the <17 category, the midpoint density of 8.5 is used to compute the current average distance traveled to the landfill (8.54 miles). Column five (MILES) calculates the additional average distance required to encompass a large enough population to serve each larger landfill size. For example, the average hauling distance to serve a 175-TPD landfill if the current landfill is 10 TPD and density is 8.5 people per square mile is 35.74 miles (8.54 currently plus an additional 27.20). We computed the hauling costs without transfer from the average cost per ton mile for short-haul transportation and the incremental distance. For hauling with transfer, the cost is the sum of the cost of the transfer station and the cost of long-haul transportation to the landfill.

Exhibit 1

Sample Output

LFSIZE	POPULATION DENSITY	NEWSIZE	TOTAL INCREMENTAL $/TON (LF SAVINGS)	MILES	W/O TRANSFER	TOTAL	TRANSFER FACTOR (.50) W/ TRANSFER	TOTAL
10	< 17	25	$25.03	4.97	$3.58	($21.45)	$24.91	($0.12)
10	8.5	75	38.84	14.86	10.70	(28.14)	$20.60	(18.24)
10	10	175	51.76	27.20	19.58	(32.18)	$20.56	(31.20)
10	8.54	375	57.37	43.78	31.52	(25.85)	$21.59	(35.78)
10		750	60.48	65.46	47.13	(13.35)	$23.54	(36.94)
10		1500	61.73	96.11	69.20	7.47	$26.71	(35.02)
10	17 - 40	25	25.03	2.71	1.95	(23.08)	$24.64	(0.39)
10	28.5	75	38.84	8.11	5.84	(33.00)	$19.79	(19.05)
10	10	175	51.76	14.85	10.70	(41.06)	$19.08	(32.68)
10	4.67	375	57.37	23.91	17.21	(40.16)	$19.21	(38.16)
10		750	60.48	35.75	25.74	(34.74)	$19.97	(40.51)
10		1500	61.73	52.49	37.79	(23.94)	$21.48	(40.25)

The TOTAL columns compute the savings by subtracting disposal savings from incremental transportation costs. The first total column shows savings if no transfer station is used and the second total column assumes use of transfer facilities. Positive values in the total columns indicate that no savings would result from a particular shift. Negative values in the total columns indicate a cost savings by shifting and the greatest savings are highlighted to represent the best decision within a specific landfill size and population density category. In the two size and density scenarios in Exhibit 1, landfills that close will always shift to larger landfills. In the first case, the most economical choice is to shift to a 750-TPD landfill and to use a transfer facility. In the second example, the greatest savings results from a shift to a 175-TPD landfill and no transfer station.

Resulting Shifts in Landfill Size

Aggregating results across all the landfill size and population density scenarios, we projected shifts for all landfills smaller than 125 TPD and for most landfills smaller than 275 TPD. The optimal shift for each scenario is shown in Table 2. A 10-TPD landfill will shift to between a 175-TPD landfill and a 750-TPD landfill

Table 2

Projected Shifts to Regional Landfills

	POPULATION DENSITY (People per Square Mile)				
Landfill Size (TPD)	**< 17**	**17 - 40**	**40 - 90**	**90 - 235**	**> 235**
10	750 T	175	375	375	750
25	750 T	750 T	375	375	750
75	750 T	750 T	1,500 T	375	750
175		750 T	1,500 T	375	750
375					750
750					
1,500					

T = Transfer station

depending on population density and will only use transfer stations in areas that are sparsely populated. A 25-TPD facility with a population density less than 40 persons per square mile will utilize transfer stations and will shift to 750-TPD facilities. Other 25-TPD facilities will shift to 375- and 750-TPD facilities, without using transfer stations. The largest landfills affected will be 375 TPD, but only in urban areas. Larger landfills are not projected to regionalize further. This is because the unit cost of disposal (economy of scale) flattens out considerably for larger landfills. If all landfills

shifted according to the decision rules, the smallest landfill, once all existing small landfills closed, would be 175 TPD.

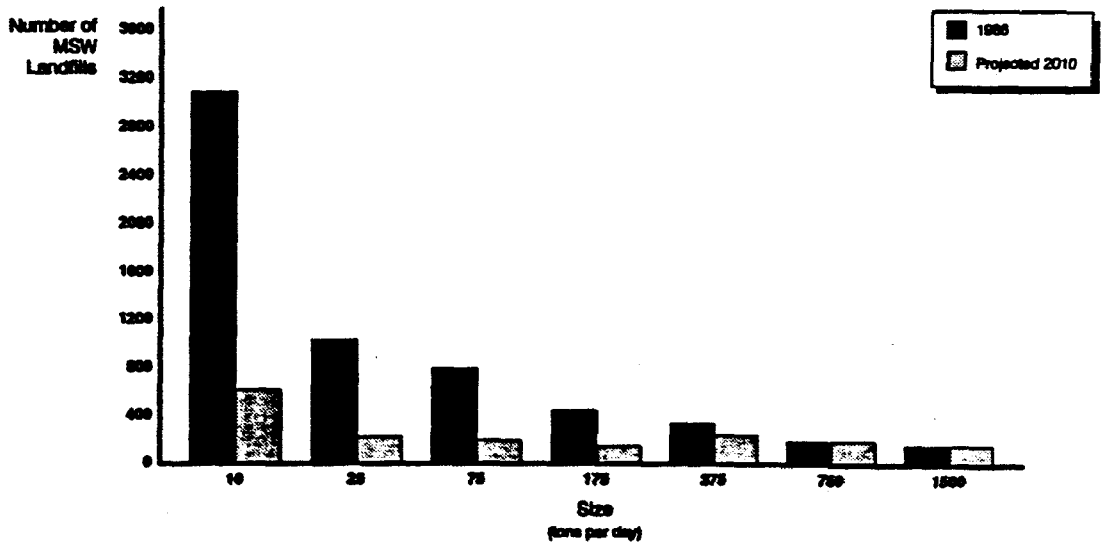
In order to translate the model results into effects on actual landfills, we combined the decision rules resulting from the model with data on the expected closure date of landfills in the EPA survey database. If a landfill projected a closing date prior to 2010, we "replaced" that closed landfill with a larger one according to the decision rules. If no shift was projected, we assumed that the closing landfill was replaced with another unit of the same size. While this approach oversimplifies the problems associated with siting (i.e., it minimizes the effect of noneconomic factors that may dominate siting concerns), this analysis emphasizes the economic tradeoffs and incentives available given the siting costs incorporated into the disposal cost estimates already.

We project a dramatic drop in the number of landfills, especially in the smaller size categories. Figure 6 compares the number of landfills in each of the seven size categories as of 1986 and projected for 2010. The number of landfills in the smallest size category drops 80 percent. The percentage decline decreases to only 28 percent for 375 TPD landfills and no change is projected for larger units.

Given these projected declines, the total number of landfills by 2010 would be 1,755, a 71 percent drop compared with 1986. The effect on total landfill capacity is not nearly as significant, however, because the small landfills account for such a small share of the total waste handled. In fact, based on projections of MSW disposal in

Figure 6

Current and Projected MSW Landfill Size Distribution



2010 (see note 5), the new population of landfills will have more than sufficient capacity to handle MSW after recovery of materials and combustion are taken into account.

These shifts assume that economic factors are the only ones driving the siting decisions. In fact, political factors profoundly affect the ability to site any waste management facility, regardless of the economic arguments for the facility. Our projections are based solely on the economic incentives that would encourage continued regionalization of landfills in the future.

Conclusion

The trend toward fewer and larger landfills is likely to continue for the next 20 years as existing landfills reach capacity and new waste disposal arrangements are developed. Higher costs of disposal at all landfills create an incentive to increase the size of landfills, which will save on disposal costs per ton (because of economies of scale) but will increase transportation costs. In the case of most small landfills (smaller than 275 TPD), the comparative costs of transportation and disposal provide an economic incentive to shift to larger landfills farther from the individual communities served by the landfill. The analysis we conducted indicated that the 6,034 landfills that operated in 1986 might be reduced to 1,755 units by 2010 with only a limited impact on overall capacity.

While siting costs are built into the disposal cost estimates (e.g., costs of preparing and defending a permit application), local siting complications would affect the projected profile of future landfills. Because of opposition to facility siting and other non-economic considerations, the economic factors we have identified may play an inconsequential role in determining where replacement landfills are ultimately sited. Instead, logistical and political factors may control siting decisions. Logistical factors could include a desire to site landfills in areas with naturally impermeable soils or easy transportation access. Political concerns stemming from NIMBY may force landfills to locate in remote areas or in jurisdictions willing to accept compensation for agreeing to host the facility. Nevertheless, the incentives for regionalization that result from potential savings in total disposal costs are already in place and will be increased by upcoming federal landfill criteria revisions.

Disclaimer

The information contained in this paper does not necessarily reflect the views and policies of the U.S. Environmental Protection Agency.

Endnotes

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9. A.E. Radwan and K.D. Pijawka, "The Economics of Transporting Solid Wastes," Arizona State University, unpublished.
10. Costs of $0.21 per ton mile were estimated in "Transfer Trends," *Waste Age*, February 1980, but the costs assumed a smaller truck (25 yds vs. 35 yds) and lower wages ($9 versus $12).
11. Anthony Quena, SEA Consultants, *Waste Age*, December 1987.
12. R. Peluso and E. Ruckert III, "How Much Will Transfer Cost?", *Waste Age*, May 1989.
13. I. Gordon, "How to Think About Waste Transfer," *Waste Age*, February 1988.

14. "Draft Regulatory Impact Analysis of Proposed Revisions to Subtitle D Criteria for Municipal Solid Waste Landfills;" prepared for Economic Analysis Staff, Office of Solid Waste, U.S.EPA; prepared by Temple, Barker & Sloane, Inc., August 5, 1988.

15. Assuming that the transfer station was the same size as the current landfill or the same size as the new, larger landfill would have understated the benefits associated with a longer haul to the regional landfill when transfer stations serving other communities were available. In addition to analyzing costs of transfer stations half way between the current landfill and the larger one, we also analyzed costs of transfer stations 25 percent and 75 percent of the way between the two. The 0.25 factor resulted in little change in the resulting costs while 0.75 caused most facilities to shift to very large landfills via transfer stations.

Summary of

ESTIMATES OF THE VOLUME OF MUNICIPAL SOLID WASTE DISCARDS

By

William E. Franklin
and
Robert G. Hunt

Franklin Associates, Ltd.

Presented at the

First U.S. Conference on Municipal Solid Waste Management

June 13-16, 1990

While characterizations of municipal solid waste by weight have been available for some time, reliable estimates of the volume of MSW have been lacking, although there have been many "guesses." There is a strong demand for this information, however, because wastes are collected and landfilled on a volume basis. This paper presents the findings of the first comprehensive, systematic study relating volume and weight of the components of MSW. The research, sponsored by the Council for Solid Waste Solutions, was performed by Franklin Associates, Ltd. and The Garbage Project at the University of Arizona.

Estimates of MSW components by weight were based on the EPA characterization report prepared by Franklin Associates. Samples of materials and products in MSW were obtained by The Garbage Project and were subjected to pressure in a machine designed for the purpose. Weight-to-volume density measurements thus obtained were used to calculate the volumes of materials and products in MSW, using the categories as published in the EPA report. Density factors were calculated for materials in the trash can (uncompacted) and compacted in a landfill. Landfill densities were determined for 22 different common waste components; the relationship of weight percent to volume percent was also determined.

Copies of the full report on this subject are available free of charge upon request in writing to Franklin Associates, Ltd., 4121 West 83rd Street, Suite 108, Prairie Village, KS 66208.

EVALUATION OF NEW YORK STATE'S RETURNABLE CONTAINER ACT

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Willkie Farr & Gallagher

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Presented at the

First U.S. Conference on Municipal Solid Waste Management

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EVALUATION OF NEW YORK STATE'S RETURNABLE CONTAINER ACT

Robert S. Amdursky

I. Introduction

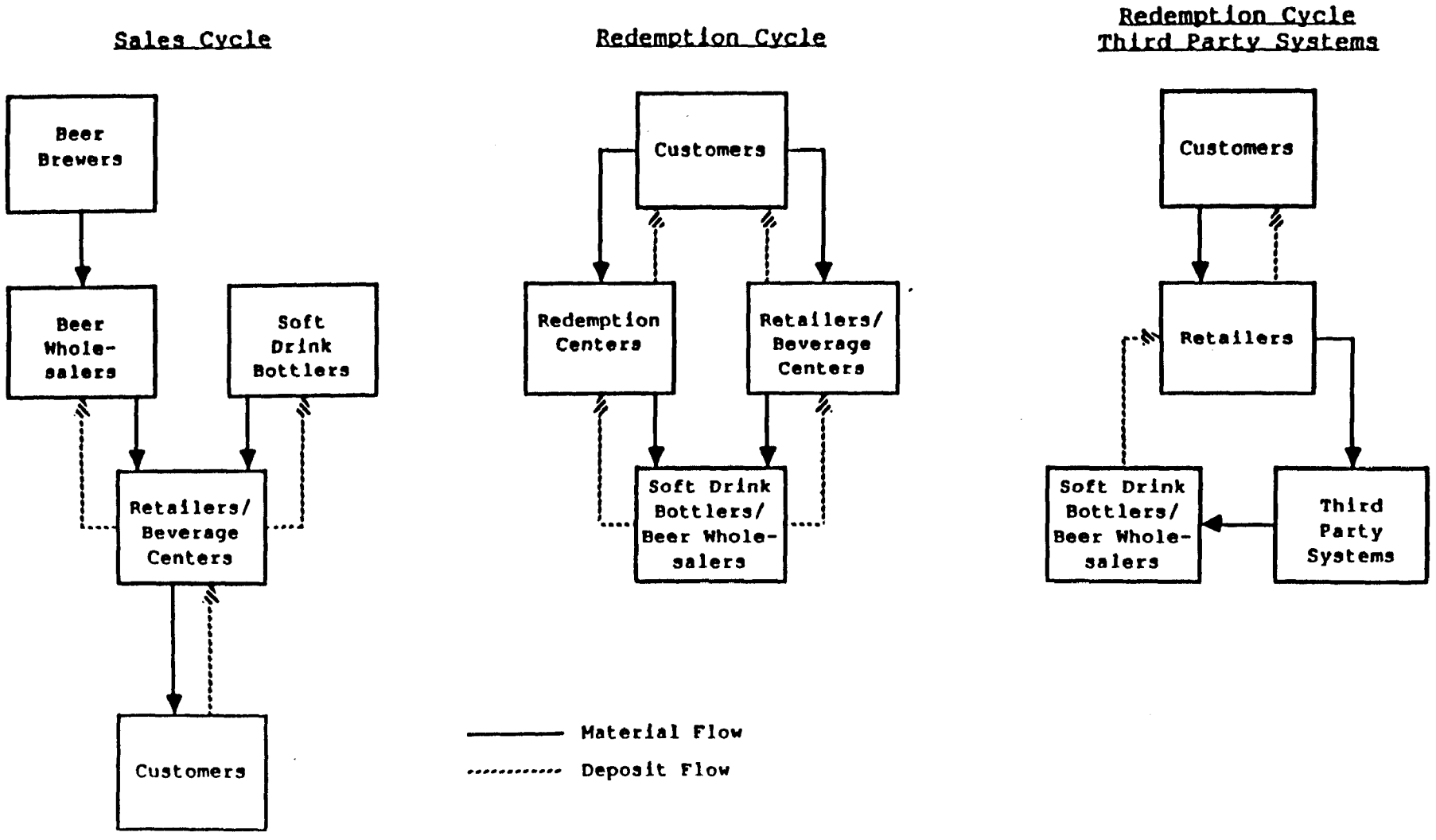
New York's Returnable Container Act (McKinney's Environ. Conser. L., Article 27, Title 10) (Act) took effect on September 12, 1983. Its purposes are to reduce litter, ease the burden on solid waste disposal facilities, and encourage recycling activities.

To accomplish these goals, the Act imposes a mandatory deposit value of 5 cents on virtually all beer and soft drink containers sold in New York State (State). Specifically, distributors (generally, beer wholesalers and soft drink bottlers) charge retailers the deposit value of returnable containers -- in addition to the market price of the beer or soft drink -- when the retailers purchase the containers from the distributors. Upon resale to consumers, retailers collect the deposit value from the consumers.

Consumers return the "empties" to retailers, who repay the deposit value to the consumers. Retailers, in turn, are reimbursed for the deposit value, plus a statutorily mandated handling fee of 1.5 cents per container. If a consumer fails to redeem a returnable container, the distributor is permitted under present law to keep the unclaimed deposit. *See Figure 1.*

Figure 1

Material and Deposit Flow



(Peat Marwick Management Study)

The Act, to a large extent, has achieved its purposes. Since its inception, litter in the State has been reduced by about 72 percent and solid waste by about 5 percent by weight and 8 percent by volume. It has success- fully encouraged the redemption of beverage containers: for 1988-89, the State Department of Environmental Conservation (DEC) reported a statewide redemption rate for all containers of 71.8 percent; upstate that rate was 90 percent.

Redemption rates, however, are declining. The 71.8 percent statewide redemption rate reflects an 8 percentage point decline from the 80.1 percent redemption rate reported in 1984-85.

II. Background

A. The Moreland Act Commission

On September 14, 1989, Governor Mario M. Cuomo issued an executive order creating a Moreland Act Commission to Investigate the Returnable Container Act (Commission).

The executive order charged the Commission with investigating and determining (1) the extent to which the Act is not working effectively and fairly, (2) methods to improve the efficiency of the Act, and (3) the adequacy of State enforcement. The Commission also was charged with making recommendations for improving the effective, fair, and orderly implementation, operation, and enforcement of the Act, including statutory and regulatory changes.

The Governor appointed as members of the Commission: a trustee of the Natural Resources Defense Council; the executive director of Consumers Union of United States, Inc.; an elected County Executive; the president of a national food processor that sells to retailers; and, as chairman, a partner in a major New York City-based law firm.

B. Commission's Methodology

The Commission began its investigation by holding public hearings in the State's five most populous areas. These hearings were designed to allow all interested parties to present their perspectives on the operation and effectiveness of the Act. In addition, the members of the Commission undertook a series of site visits in order to gather firsthand knowledge of the operations of the various industry groups affected by the Act.

The operation of Bottle Laws in other states was analyzed. Comparisons were made of the comprehensiveness and the effectiveness of other states' programs and of the relative merits of their various administrative structures.

Finally, the Commission retained KPMG Peat Marwick (Peat Marwick) to undertake a management study. The study involved an analysis of (1) the efficiency of the Act; (2) the reasons for the lower than expected statewide rate of redemption, i.e., 72 percent; (3) the existence and types, if any, of disincentives to redemption by distributors or retailers or both; and (4) options to improve the effectiveness of the Act and its enforcement, with

arguments in favor and against each option.

The Management Study consisted of three phases. The first involved one-on-one interviews with a representative cross-section of each affected segment of the beer and soda industries, and the food retailers, as well as third-party recyclers, redemption centers, consumers, and environmentalists. Representatives of DEC also were interviewed. The individual interviews were followed by a group session in which all those who had participated in a one-to-one interview were invited to analyze, as a group, the reaction of each affected industry to proposed changes in the Act and its enforcement. Finally, a representative sample of 2400 consumers was surveyed by telephone to ascertain their buying and redemption patterns, their views on the Act, and recommendations on how it might be improved.

III. Commission Findings and Recommendations

Based on the public hearings, site visits, the telephone survey and the Peat Marwick Management Study, the Commission made the following findings and offered the following recommendations to the Governor.

A. Subsidize Redemption Centers and Third-Party Recyclers

In large measure, convenience -- or more properly stated, inconvenience -- appears to account for the low redemption rate in the New York City area. Factors such as lack of storage space, difficulties in transporting empty containers

to retailers, and the reluctance of many retailers to redeem containers have created a climate that discourages consumer redemption.

Therefore the Commission recommended that the State provide subsidies for redemption centers and third-party recyclers. The Commission was convinced that the Act cannot work effectively in large metropolitan areas -- and particularly in New York City -- without a network of redemption centers and third-party recyclers.

Redemption centers would provide an additional site for large-volume redeemers -- those who seek to raise money by redeeming containers, including the City's scavaging poor. The economics of establishing and operating such centers in metropolitan areas -- the lack and high cost of space, labor and transportation, etc. -- have precluded redemption centers from realizing enough income to attract private capital for investment.

Third-party recyclers collect returned containers from retailers and redemption centers and transport them to storage and recycling facilities. In addition, they monitor returns and provide billing services between retailers and distributors. Upstate, third-party systems have been quite successful. But in the New York City area, given such problems as picking up from a multitude of small retailers, there are only a few successful operations.

B. Do NOT Increase the Amount of the Deposit

Perhaps the proposal most frequently made to the Commission for improving redemption rates was to increase the deposit value of containers. The assumption underlying this proposal is that an increase in the deposit would motivate consumers to alter their behavioral patterns and return their empty containers.

The Consumer Survey demonstrated that the consumers' failure to redeem is best explained by lack of storage space, difficulties in transporting empty containers to retailers, and inconvenience at the retailer in effecting redemption. There was little evidence to suggest that increasing the deposit value to $.10 or even $.25 would change redemption patterns in any meaningful way.

Furthermore, the Commission determined that unintended, adverse consequences were likely to occur if the deposit value was increased in the State. A difference between the deposit value in New York and that in neighboring deposit states in all probability would increase the number of containers crossing the border into the State for redemption; New York distributors would be forced to bear the burden of paying an increased dollar amount in redemptions without having collected the supporting deposits.

IV. Creating Industry Incentives

A. Retailers

The Commission recommended that the handling fee paid

to retailers be increased from 1.5 cents to 2 cents per container.

At the public hearings, retailers repeatedly made the claim that their costs substantially exceeded the 1.5 cents handling fee mandated by the Act. The Commission requested that Peat Marwick investigate this claim, and they confirmed that the actual handling cost appears to range from 1.95 cents per container (for the most efficient) to a high of 5.97 cents per container. In all cases, retailers are paid the statutorily mandated 1.5 cents per container handling fee which reduces their net cost of compliance under existing law to a range of .45 cents to 4.47 cents per container handled.

B. Beer Distributors

The Commission recommended that the process of deposit initiation should be transferred from the distributor to the brewer.

New York State has a distinctive four-tier distribution system that includes brewer, franchise wholesaler, nonfranchised distributor/beverage center, and retailer. While this system provides distinctive benefits to the consumer -- traditionally, beer prices in New York have been comparatively low -- it has also created a disincentive to comply with the Act. That disincentive is transshipment.

Transshipping is a legal and competitive tool by which nonfranchised distributors purchase beer in one market and ship

it to another market for sale to retailers. Partially because of transshipment, metropolitan New York has one of the lowest beer prices in the country.

However, transshipment can create significant disincentives for redemption. A prime example is one-way beer. In this case, a transshipper purchases beer in one market (typically upstate or out-of-state) and ships it to metropolitan New York where it is sold at below-market prices. The prices are set with the understanding that the empty containers will not be returned to the originating (upstate) distributor. Rather, these containers are returned to local distributors (i.e., those located in metropolitan New York). Because these local distributors did not originate the deposit on these containers, they must assume what the Commission determined to be an unwarranted burden. They must overredeem, i.e., redeem a greater number of containers than they originated.

By moving the origination process from the distributor to the brewer, the brewer, rather than the distributor, initiates and holds the deposits until the containers are redeemed. No distributor will be penalized by overredemption because the brewer would pay each distributor the deposit value of every container it returns to the brewer.

V. Educational Programs

The Commission concluded that if the Act is to work more effectively — and if the residents of New York State are

to understand the importance of recycling — a much greater educational effort is needed.

A. Public Sector

1. The Department of Environmental Conservation

DEC is mandated by the Act to provide information to the public on the various aspects of the Act. In fact, however, DEC has done little to educate the public. The Commission recommended that DEC should do more, including for example integrating facts about the Act in its educational efforts surrounding mandatory source separation and throughout its publications.

2. State Consumer Protection Board

The Commission also recommended that the State Consumer Protection Board become actively involved in promoting recycling. In keeping with its mandate to protect the consumer, it should promote a state-wide Consumer Bill of Rights. Equally important, it should take a leading role in educating the consumer about the importance of waste reduction, reuse, and recycling — and the public's role in each.

3. State Department of Education

In order to promote understanding of the importance of recycling, the Commission recommended that the State Department of Education include information about the Act and recycling in its environmental syllabus.

VI. Enforcement of the Act

Everything the Commission heard -- at the public hearings, interviews and the Management Study -- indicated that DEC has failed to vigorously, or even adequately, enforce the Act. The major reasons for this failure appear to be two-fold: lack of resources and inadequate penalties.

A. Redistribution of Enforcement Response

Given the inadequacy of DEC resources, the Commission recommended that DEC be relieved of its enforcement responsibilities, and the responsibilities for enforcement be redistributed.

1. Department of Sanitation

The Commission recommended that enforcement responsibility in New York City be given to the New York City Department of Sanitation.

The Department of Sanitation already has existing staff patrolling and enforcing related regulations in the same areas where the bulk of enforcement work on the Act is needed. Moreover, the Department of Sanitation has offered to provide approximately 50 sanitation enforcement officers whose primary duty would be to enforce the Act.

2. Department of Agriculture and Markets

The Commission recommended that enforcement responsibility in the remainder of the State be given to the Department of Agriculture and Markets.

The Commission recognized that the Department of Agriculture and Markets also suffers from inadequate manpower and financial resources. Nevertheless, its broad mandate -- to protect the health and safety of the State's food supply -- takes its inspectors, on a regular basis, into retail food stores. In addition, because the administrative arm of the Department of Agriculture and Markets is each county's Consumer Affairs Department or Sealer of Weights and Measures, the Commission determined that Agriculture and Markets would have an acceptable number of enforcement officials in the appropriate locations.

B. Penalties

A shift in the enforcement system alone, the Commission recognized, will not solve the enforcement problems plaguing the Act. It was the judgment of the Commission that the current penalties for violations of the Act send the message that the State does not consider these violations serious. As a result, **the Commission recommended that penalties for violations of the Act be significantly increased as follows:**

1. Increase the maximum fine for each violation from $500 to $10,000, per day;
2. Create a private cause of action against defaulting retailers, distributors, and bottlers -- so that any citizen who has met with noncompliance of the Act can initiate action; and

3. Make it a violation to sell a returnable container without a proper deposit marking or without collecting a deposit.

VII. Development of End-Use Markets for Recycled Materials

The Commission recognized that the success of the Act, as well as all recycling programs, depends upon the availability of markets for the raw materials generated by recycling.

Therefore, the Commission recommended that the State Department of Economic Development be directed to aggressively foster and promote the expansion of markets for recycled materials.

VIII. The Act and Solid Waste Management

The Act is widely regarded to be the cornerstone of the State's recycling program and a critical part of its strategy for solid waste management. Nevertheless, the Commission considered the argument that on September 1, 1992, with the advent of mandatory state-wide source separation including the recycling of all containers (McKinney's Gen. Mun. L. § 120aa), the Act may become redundant. However, mandatory curbside source separation will not be fully in place until 1992, and its effectiveness will not be established for some years after that.

As a result, the Commission recommended that the status of the Act should be reviewed in 1995 — three years after state-wide source separation becomes mandatory — to see whether the Act should be further amended or repealed.

FULL COST ACCOUNTING IN SOLID WASTE MANAGEMENT

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First U.S. Conference on Municipal Solid Waste Management

June 13 - 16, 1990

Full Cost Accounting In Solid Waste Management

Solid waste programs have historically been funded and operated in the same manner as their other governmental social service programs: as a function of direct expenditures. Time and circumstances have progressed to place solid waste management under an increasing regulatory responsibility with the ultimate impact being higher costs. In this time of economic pressures, managerial science is being called on to transition these governmental programs to a basis where their operating budgets can be used to uniformly analyze program productivity and cost effectiveness.

In the State of Florida, this is being accomplished through statutory mandate. The 1988 Florida Legislature passed Chapter 88-130, which has become known as the Florida Solid Waste Management Act of 1988. In addition to broadening and enhancing the powers of the Florida Department of Environmental Regulation, the Act requires that all Florida governments providing solid waste management services annually compute and report the "Full Cost" of these services to both the State and the service users. Thus, the challenge has been placed on local governments to know and report the costs of their services exactly as though they were businesses. While this is sure to cause governmental managers concern at first, natural selection will, as it always does, allow the quick and knowledgeable to use this information to improve the planning and management of their operations.

What follows is a short discussion of the history and application of Full Cost Accounting as well as the State of Florida's requirements. The reader will, hopefully, be able to come away with an understanding of the principles which are broadly presented and apply them to their own operations.

What is "Full Cost Accounting"?

Full Costing is an accounting buzzterm which, because of manager's needs to differentiate from traditional accounting, has become an accepted term. The differences between traditional accounting and cost accounting are clear when their goals are seen. Traditional accounting's principal goals are to accurately track expenditures by an organized and consistent method which allows management to determine total expenses, units produced/received/shipped, etc. for comparison against total revenues or units sold/delivered and other benchmark data. Cost accounting's goal is to take the information generated by traditional accounting and create management tools for performance measurement.

Phoenician and Arab traders of biblical times employed "clerks." These were the first accountants. Merchants often kept clerks at both the beginning and end points of trade routes to determine if there was any loss enroute. Treasure hunter Mel Fisher used the records of Spanish clerks to identify the wreck location and even the treasure which made him famous.

History progressed into the industrial age and organizations began to accept that the benefits of specialization of labor extended to those parts of the organization which supported the production function. The industrialists began

the development of pricing theory, which included the assignment of the costs of these support functions to their products proportional with their use. This functional application gave birth to "Full Cost Accounting."

Full Cost Accounting, then, is the inclusion of all costs of producing a product or service. To accomplish this objective in solid waste, all inputs to the services must be identified and charged to their production.

As we will see throughout this discussion, the Rules for Florida Statute 403.7049 generally follow the principles of full cost accounting and, in some ways, makes the computation of full cost easier than it might have been.

Rule 17-708 of the Florida Administrative Code (F.A.C.) requires the inclusion of all costs and their allocation between the collection, disposal and recycling functions of the government. This process, however, does avoid requiring the iteration of central services and other costs received by central service departments downward to receiving programs.

The Florida Full Cost Reporting Rules

17-708 F.A.C. has been constructed to include in full cost all major components of service provision. Throughout the construction of the Rule, the Florida Department of Environmental Regulation (FDER) and its advisors were very open to input from those about to be regulated and the professional community. The Rules, while being loosely written, should accomplish the objectives while allowing local governments to decide what information is most pertinent in their service area.

Rule 17-708 requires, at the minimum, that the full cost reported must include rates for service charged to end users plus:

A. Any direct and indirect costs required by the service, regardless of its inclusion in the service budget.
B. All costs billed directly to end users by an outside contractor.
C. Tipping fees where not included in any other billing.

These cost must be categorized into residential and non-residential and reported separately for collection, disposal and recycling. All workpapers and source documents must be kept on file and treated as public information for three years. Governments must annually inform all users of their share of the cost, on an average basis, which may be expressed in an appropriate measure or on an individual basis. Costs provided through an interlocal agreement must be included in the receiving government's annual report. Where a countywide assessment for service is used, the providing government reports the costs of the service provided; the receiving government does not. Full cost must be reported for residential and non-residential categories of collection, disposal and recycling.

Public Disclosure requirements can be fulfilled through either direct mail or publishing a display ad in a newspaper of general circulation. A copy of the public disclosure must be sent to FDER on governmental letterhead.

17-708 F.A.C. does not require that an audit be performed of solid waste programs to determine full cost. As any CPA will tell you, the cost of certifying the computations required for the "Disclosure" would be significant. As well, an accurate computation of full cost is more dependent upon a thorough organizational analysis and use of an appropriate allocation base than any

differences which might be found between the annual Comprehensive Annual Financial Report audit required by Florida Law and a special audit. As was noted earlier, the Rule does require that the documentation and workpapers be maintained for three years and be made available to both the public and FDER.

Relating to audits, 17-708 F.A.C. does not require that contractors or franchisees be audited to determine the costs of the services they provide. The contractual costs of their services are accepted as being the full cost.

Further, 17-708 F.A.C. does not require any specific allocation base be used for the Disclosure's computations. Due to the critical nature of this aspect of full costing, this in itself is likely to raise more questions concerning accuracy than lack of a special audit.

Where Does "Full Cost" Vary From "Budgeted Cost"?

To accomplish the Full Costing of solid waste services all costs of operation, whether provided directly by the solid waste division or some other organizational division, must be accounted for. Generally, such costs may be classed as Direct Costs, Incoming Costs and Indirect Cost

The costs of all services and materials used specifically in providing solid waste services are termed "Direct Costs." To differentiate between costs which are directly controlled by solid waste division managers and costs which may not be, we term the cost of services used in production but coming from an organizational unit outside the solid waste program "Incoming Costs." As an example of the differences between Direct and Incoming costs; the wages of a compactor operator at the landfill are generally considered a Direct Cost

whereas the cost of wages paid to an engineer in the road maintenance division for services performed for the landfill would generally be considered an Incoming Cost. The controlling factor is that the engineer's salary is not found in the solid waste division's budget but the service performed is directly related to production of the service.

An appropriate allowance for the support services utilized by solid waste services must also be charged. These support services are not related to the actual production of service but are as essential to operation as the compactor operator's services. Examples of support services are finance/accounting, personnel, and legal services. Organizational analysis is used to identify these support services. The proportion used by the solid waste services must then be allocated to the respective services.

Thus, Full Cost, is equal to the budgeted direct costs of service production plus the unbudgeted incoming costs of service production plus the unbudgeted costs of support services.

Full Costing in a Fund Accounting Environment

Fund Accounting, the system which most local governments use, is a system designed to more readily track direct operating expenses. Within the Fund Accounting System, three basic operating cash sources are found:

General Fund Accounts: where costs of operation are underwritten by the tax base revenues collected by the local government.

Enterprise or Revenue Fund Accounts: where costs of operation are underwritten by revenues received from charges for services.

Internal Service Fund Accounts: where costs of operation are underwritten by intra-organizational transfers from other fund accounts for a service provided.

Solid waste operations in Florida have traditionally been funded through the General Fund of local governments. While the budgeting policy may vary from organization to organization, my experience has been that GF solid waste operations rarely contain all direct and incoming costs of operation, much less the indirect costs.

Enterprise/Revenue Funds have, in many cases been organized around services which have been leveraged for start-up capital purchases or the provision of service under an interlocal agreement. Thus, more of the direct and indirect expenses are likely to be found charged to the budgets of these activities.

While solid waste operations may use services provided by an internal service fund department, ISF's are not usually formed to accommodated solid waste operations. Some examples of services this type of fund is created around are fleet management, data processing and building maintenance. Where an internal service fund is found, it is generally because costs of services are being charged back to the user departments.

17-708 F.A.C. specifically defines an Enterprise Fund as meaning ".... a fund used to account for operations that are financed and operated in a manner so that all direct and indirect costs .... are primarily financed by revenue(s) received...." As discussed earlier, budget policy may vary between organizations but generally even enterprise funds will fall short of being a fully costed funding environment. This is mainly due to local government's not

applying a managerial analysis to their entire operation. Thus, Enterprise Fund accounts should also be reviewed to identify the completeness of the charges for direct, incoming and indirect expenses. Where they're found to be incomplete, the same conversion process as for general fund operations is required.

1. A review of the solid waste program's organizational asset usage must be accomplished to identify all inputs into service production.

2. A comparison of the budgeted activities must be made with the results of the review.

3. Unbudgeted services and assets used in service production must be appropriately allocated and program budgets adjusted for these amounts.

Some governments annually prepare a full cost allocation plan for all of their operating divisions. In such cases, the allocation to the solid waste services should be reviewed to determine if the allocated amounts were appropriate and then the plan's allocation must be distributed among the respective categories of solid waste services identified by 17-708 F.A.C.

Cost Allocation for Fund Accounts: An Example

In presenting a simplified and brief example of full cost, the key point of the exercise, organizational analysis, must be taken as a given. Thus, when referring to **Exhibit I**, the example which follows, we have already determined that the only operating service provided to the "Myth County Landfill" program from an unbudgeted source is engineering services. As well, **Exhibit I** shows that the number and type of central services provided are limited to Administration, Finance, Personnel, and Purchasing. In practice, it is unlikely that this limited a number of Incoming and Indirect costs would be found.

Once the sources of inputs to services are determined, the value of services must be determined. Operating budgets must be adjusted to remove the influence of uncharacteristic costs. This can be accomplished through adjustments such as removal of budgeted costs for capital purchases or the corresponding addition of an allowance for capital asset depreciation. Another addition to the cost of services provided can also be the allocation of the indirect and incoming costs which these programs receive. When the cost adjustment process is completed, allocation to the landfill program can begin.

An appropriate allocation base must be selected for each input source. The allocation base used must reflect an equitable measure for the service provided. In support of this, it is obvious that while a value can be placed on the services received from the Personnel Department by assigning a value equal to the respective proportion of Landfill personnel to total personnel, the same measure cannot be used to determine the value of services received by the Landfill from the Finance Department.

Other cost adjustments must also be accomplished to the Landfill's budget. Current year capital purchases must be removed and an allowance added back for capital asset depreciation; as they were in the valuation of inputs to the Landfill program. Costs of debt amortization and escrow requirements for site closure and long - term maintenance are cost factors which are often contained in budgets or accounts apart form landfill operating budgets. These too must be adjusted into the full cost equation.

The Summary of Costs shown on the final page of **Exhibit I** graphically **depicts the 27.2% Increase over the operating cost** which is caused by

adjustments which bring the Landfill program to full cost. As a final note to the exercise, the size of the net increase does not reflect a typical outcome. Generally, in an operating program the size of the example, the indirect cost factors would be much higher. As was noted earlier, the number of central services applied to the example were extremely limited.

EXHIBIT I: Cost Allocation With Fund Accounts

Keys to Identifying Full Cost of Service:

A. Organizational analysis to identify source of inputs to service provision.
B. Determine the total cost of inputs.
C. Selection of allocation base.
D. Allocation of inputs to Solid Waste services.
E. Determination of Full Cost.

Location: Myth County, FL **Operating Budget: $985,000**

Central Svc Depts.	Adjusted Budget	Amt Allocated Landfill	Amt Allocated Other
Administration	$250,000	$16,217	$233,783
Finance	$600,000	$17,397	$582,603
Personnel	$185,000	$12,007	$172,993
Purchasing	$85,000	$1,666	$83,334
Subtotal:	$1,120,000	$47,287	$1,072,713
Incoming Services			
Engineering	$218,000	$13,026	$204,974
Grand Total:	$1,338,000	$60,313	$1,277,687

Allocation of Administration:Myth County, FL

Allocation Basis: Number of Personnel
Total BCC Personnel: 185
Total Landfill Personnel: 12
Amount to Allocate: $250,000

12/185=6.49%
6.49%*$250,000=$16,217

Allocation of Finance: Myth County, FL

Allocation Basis: Number of Financial Transactions
Total Transactions: 1,422,944
Landfill Transactions: 41,257
Amount to Allocate: $600,000

41,257/1,422,944=2.90%
2.90%*$600,000=$17,397

Allocation of Personnel: Myth County, FL

Allocation Basis: Number of Personnel
Total BCC Personnel: 185
Total Landfill Personnel: 12
Amount to Allocate: $185,000

6.49%*$185,000=$12,007

Allocation of Purchasing: Myth County, FL

Allocation Basis: Number of Purchase Orders
Total Myth Co. P/O's: 11,122
Total Landfill P/O's: 218
Amount to Allocate: $85,000

218/11,122=1.96%
1.96%*$85,000=$1,666

Allocation of Engineering: Myth County, FL

Allocation Basis: Billable Hours
Total Billable Hours: 4368
Total Hours of Landfill Engineering: 261
Amount to Allocate: $218,000

261/4368=5.98%
5.98%*$218,000=$13,026

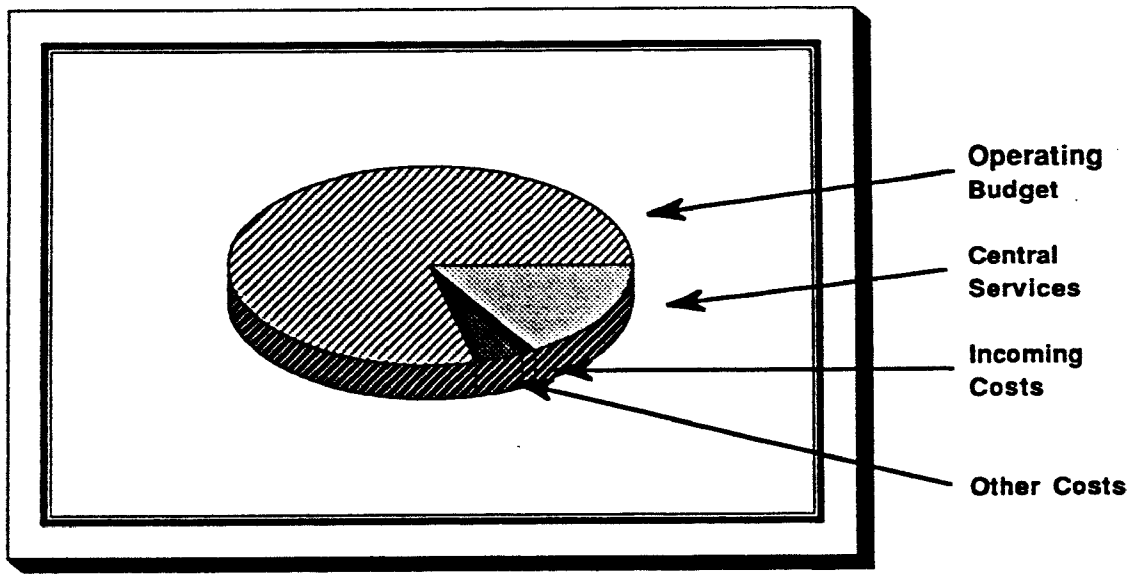
Other Landfill Costs: Myth County, FL

Capital Purchases:*	$39,300
Bond Retirement:	$119,000
Reserve for Closure:	$48,500
Total Other Costs:	$206,800

*Amortized Value

Summary of Landfill Costs: Myth County, FL

Operating Budget:	$985,000
Central Svc. Allocations:	$47,287
Incoming Costs:	$13,026
Other Costs:	$206,800
Full Cost Total:	$1,252,113
Tons Disposed:	36,145
Operating Cost/Ton:	$27.25
Full Cost/Ton:	$34.64



GEORGIA COMPREHENSIVE SOLID WASTE MANAGEMENT ACT OF 1990

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Presented at the

First U.S. Conference on Municipal Solid Waste Management

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GEORGIA COMPREHENSIVE SOLID WASTE MANAGEMENT ACT OF 1990

Georgia's principal solid waste management statute was enacted in 1972.[1] As with other states, the focus of this law was to phase out open dumps in favor of "sanitary landfills." During the 18 years since its passage, the situation in Georgia has changed dramatically, while the law has remained virtually unchanged. The result is a significant increase in the amount of municipal solid waste generated and an increase in opposition to siting facilities that can effectively manage that waste. The state and its local governments were thus faced with addressing the solid waste problems of the 1990s with the waste management law of the 1970s.

Ground Work

Although Georgia has problems with municipal solid waste, they are not generally as severe as the problems faced by a number of other states. Consequently, Georgia has had the luxury to learn from the efforts of these states and to adopt solutions that, though effective in Georgia, might prove ineffective where pressures are even more intense.

As concern over solid waste management mounted, four factors contributed to the effective development and enactment of Georgia's solid waste management legislation. First, a number of pieces of legislation designed to address specific,

generally siting, concerns were introduced in the Georgia General Assembly in 1988 and 1989. These bills did not address the overall policy problems related to municipal solid waste but, rather, served to demonstrate what a contentious public policy arena solid waste management could be. Second, a waste round table was created through the Southeast Negotiation Network at the Georgia Institute of Technology. This round table allowed for open membership and served as a forum to share ideas and to meet others involved in the solid waste field. Participants included representatives from environmental organizations, business and industry, state and local governments, and academia. Meetings generally entailed a report or presentation and an open discussion on that topic as well as others of concern. The round table, in hindsight, accomplished two things: it provided an opportunity for the development of rapport among individuals with different perspectives on solid waste management and it spawned a realization that there was general consensus on what needed to be done and focused discussion on how to effectively reach those goals.

A third factor contributing to the development of Georgia's solid waste policies was the creation of a joint task force by the Association County Commissioners of Georgia and the Georgia Municipal Association. This task force allowed local governments to participate throughout the

process and it enabled cities and counties to present unified support for legislative efforts.

A fourth factor was a 1989 policy study of the solid waste management situation in Georgia which identified a number of issues that would need to be addressed if municipal solid waste was to be effectively managed.[2] This study focused attention on those issues the state was in a position to address and made specific recommendations for resolving municipal solid waste problems in Georgia.

Legislative Action

As these efforts collectively produced an understanding of the policy problems and built support for addressing them, legislative action was called for. In 1989, the Georgia General Assembly passed Senate Resolution 103 which created the Joint Study Committee on Solid Waste Management. The 15 member study committee composed of three Senators, three Representatives, three agency heads, and six individuals appointed by Governor Harris from environmental interests, industry, local governments, and academia[a] labored during the 1989 interim to draft SB 533, the Georgia Comprehensive Solid Waste Management Act.[3]

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[a] The author of this article was appointed to the study committee as the representative from academia.

The study committee divided into five subcommittees: waste reduction and education, recycling, incineration, landfilling, and legislation. The first four subcommittees explored the substantive issues related to their areas of interest and the legislative subcommittee considered the existing law and how that might be revised. The subcommittees met on numerous occasions to determine the nature of the problems and the alternatives for resolving them.[b] The process was open in order to address the concerns of the affected interests before the legislation was introduced.

In December, 1989, the study committee released its report[4] and a draft piece of legislation. Based on comments received, the legislation was perfected prior to the beginning of the legislative session and incorporated into the Governor's legislative package. The bill was introduced as an administration bill in both the Senate and House in identical form, SB 533 and HB 1364, respectively.[c] A joint hearing before the Senate Natural Resources Committee and the House Environment and Natural Resources Committee on January 25, 1990, resulted in support for the legislation being voiced by

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[b] In fact, some fifty meetings were held between June, 1989 and January, 1990 by members of the study committee to perfect their recommendations and legislation and to share ideas and obtain input from interest groups.

[c] Since the bill was considered first by the Senate, it was SB 533 that was acted upon.

every person that made a statement. The changes in SB 533 recommended by those testifying tended to be minor in nature. The legitimate concerns raised at that hearing were incorporated into an amendment adopted by the study committee on February 1 and adopted as a committee substitute by the Senate Natural Resources Committee on February 5. The bill was then unanimously passed by both the Senate and the House and signed by Governor Harris on March 30, 1990.

The result of the study committee's efforts is a well thought out, comprehensive bill that received the endorsement of all affected parties, an accomplishment that is unique for an issue as controversial as solid waste management.

Major Components of the Bill

The Georgia Comprehensive Solid Waste Management Act is responding to the two major thrusts apparent in solid waste management today. First, due to environmental concerns, federal and state standards for disposal facilities are being increased. These new standards will result in greater assurance that environmental quality will be protected but also in higher costs associated with solid waste management--in some cases three to five times greater than current levels. Second, because of these higher costs and the difficulty of siting new facilities, there is considerable interest in reducing the amount of waste entering disposal facilities.

Solid Waste Education

If municipal solid waste is to be effectively managed, it is essential that the public support and participate in the effort. Consequently, solid waste management education is an integral part of the comprehensive bill. Senate Bill 533 calls for the expansion of the Georgia Clean and Beautiful Program, a statewide affiliate of Keep America Beautiful, to increase and coordinate public education efforts on solid waste. The bill creates a thirty member advisory committee to serve as a forum on solid waste management education and an interagency council to coordinate state solid waste management activities.[5]

Paying for the Service

One of the most effective ways of educating people about the need to reduce the solid waste they generate is to let them know how much it is costing them individually to dispose of that waste. The bill requires the development of full cost accounting procedures by local governments and the notification of the public annually of these costs.[6]

Along with full cost accounting, the study committee felt it was important to attach a fee mechanism to the disposal of waste and to earmark this money for solid waste management purposes. Although from an education standpoint the optimum fee would be for the full cost of the service provided,

instituting a tipping fee at disposal facilities that reflects the full cost of solid waste management would result in "Sticker Shock." To go from what many in Georgia perceive as a free service to paying $20.00 to $50.00 per ton would be politically difficult and potentially counterproductive. The bill requires, however, that a minimum fee of $1.00 per ton be charged at the disposal facility and that these funds be paid into a local restricted account.[7] This money is to be used for solid waste management purposes, including education. Although this is a modest beginning in connecting the full cost to the service, it is an important step toward effective solid waste management in Georgia.

Solid Waste Reduction and Recycling

Senate Bill 533 establishes the state goal of reducing on a statewide per capita basis the amount of solid waste received at disposal facilities in FY 1992 by 25 percent by 1996.[8] The study committee believes this to be a realistic, reachable goal. The goal itself, however, is only important in forcing a change in behavior. Once our mind set is altered from that of a "throw-away society" to one that consciously attempts to reduce and recycle waste, the goal will likely be surpassed. One concern, however, is the date of 1996; why not sooner? The problem the study committee faced was in not knowing how much waste is currently being generated. To

determine this, scales must be installed at disposal facilities or alternative mechanisms for weighing the waste must be instituted in order to quantify the amount of waste received. The earliest that scales could be required is FY 1992. Thus, that year would serve as the baseline year for measuring waste and 1996 would be the target date for reaching the 25 percent reduction goal.

The Georgia law does not attempt to mandate recycling since it is not possible to do so. State and local governments can mandate the separation and collection of certain items in the waste but if there are no markets for those items, they will not be recycled. The separated materials may then be taken to the landfill at additional cost. Until those recovered materials are turned into useful products and reused, recycling is not complete. Senate Bill 533 recognizes, however, that recycling is an important mechanism for reducing waste and puts in place mechanisms to facilitate and encourage recycling without requiring it.

To encourage markets for recyclables, SB 533 creates the Recycling Market Development Council to study the market situation and to make recommendations to the Governor and General Assembly on what the state can do to expand these markets.[9] One important step the state can take to expand markets for recycled materials is for state agencies to purchase these materials. Senate Bill 533 requires the

Commissioner of the Department of Administrative Services to analyze the current state procurement requirements and to report to the Governor and the General Assembly on what the state can do to increase the amount of recycled materials purchased.[10]

The study committee felt that it was important for the state to assume a leadership role in recycling. Senate Bill 533 requires that the General Assembly and state agencies establish collection programs for recovered materials generated as a result of agency operations, including aluminum, high-grade office paper and corrugated paper.[11]

Solid Waste Management Planning

If solid waste is to be effectively managed, planning is essential. The state of Georgia, however, has lagged far behind most states in growth related planning and coordination. Rapid growth in the state and the difficulties faced by local governments in effectively managing this growth spurred Governor Harris in 1987 to create a blue ribbon Growth Strategies Commission. Legislation resulting from the commission's work was enacted in 1989 that established a comprehensive planning process and mechanisms for coordinating state, regional and local efforts.[12]

Solid waste planning is a component of comprehensive planning and thus must be integrated with the process

established by the growth strategies legislation. Senate Bill 533 creates a solid waste planning requirement that each local government, independently or in cooperation with other local governments, develop or be included in a solid waste management plan.[13] The plan must stipulate, among other things, how the local government intends to reduce its solid waste consistent with the state reduction goal. Thus, the law provides flexibility for local governments to plan what options would work best for them to reduce the waste they generate.

Under the growth strategies legislation, the Department of Community Affairs (DCA) is the lead state agency for overseeing the comprehensive planning process. DCA establishes the criteria for local plans and provides technical assistance to local governments through the 18 regional development centers (RDCs). The RDCs review and confirm that local plans are consistent with the state plan.[14]

Criteria to be met by local government solid waste plans are established in the state solid waste management plan which is to be jointly developed by DCA and the Department of Natural Resources (DNR) in cooperation with the Georgia Environmental Facilities Authority and local governments.[15] Once the state plan is completed and the criteria established for local plans, local governments are to develop their solid waste management plans in conjunction with their comprehensive

planning effort. Those local governments who are facing urgent solid waste problems will be fast-tracked through the comprehensive planning process.

Active participation by local governments in reducing their solid waste is accomplished through tying the planning process and the permit, grant and loan processes together. After July 1, 1992, no permit, grant or loan for solid waste facilities will be issued that is not consistent with the local or regional solid waste management plan.[16] In determining if a permit should be issued for a facility, DNR must determine if: (1) the facility for which a permit is being sought complies with local land use and zoning requirements; (2) the facility meets the ten-year capacity needs identified in the local or regional solid waste management plan; and (3) the jurisdiction is actively involved in, and has a strategy for, meeting the statewide goal for reducing solid waste disposal.[17] This process allows local governments the flexibility to determine what options would work best for them to meet the state goal and ties the issuance of permits, grants and loans to the existence and active implementation of the reduction strategy.

Monitoring progress by state and local governments is accomplished through the reporting requirements included in the law. Local governments must report annually to DCA on, among other things, their progress in reducing solid waste.[18]

In turn, DCA must compile the local government data and report annually to the Governor and General Assembly on progress toward meeting the state goal.[19]

Protecting Environmental Quality

New federal standards for disposal facilities are currently being developed. Under the existing state law and incorporated into SB 533 is the directive for the Board of Natural Resources to promulgate rules and regulations that are consistent with the federal requirements.[20] Consequently, these criteria are not included in the law. In conjunction with the new standards, the study committee recommended that operators of solid waste disposal facilities be provided training and certified that they can carry out their responsibilities.[21]

Mechanisms for addressing certain troublesome items such as tires[22] and lead acid batteries[23] are included in the legislation. The legislation also prevents the siting of a regional landfill in significant ground water recharge areas.[24]

Conflict Resolution

Two mechanisms for resolving conflicts are incorporated in Georgia's solid waste legislation. First, conflict may arise among local jurisdictions with attempts to site regional facilities. These multijurisdictional conflicts are to be

resolved through the mediation process included in the growth strategies legislation.[25]

The second mechanism for resolving conflict relates to the concerns of local residents and land owners whenever a specific site for a facility is identified. People are concerned about solid waste facilities partly because of potential environmental impacts and partly because of their effect on property values and the creation of nuisance factors such as noise and truck traffic. Environmental concerns are addressed through the standards incorporated into the permitting process for solid waste facilities administered by DNR. Until now, however, there has not been a mechanism in Georgia to address the nonenvironmental concerns associated with solid waste management facilities. Senate Bill 533 creates a facility issues negotiation process through which local residents and land owners can negotiate with the permit applicant to resolve issues.[26] Concessions agreed upon are adopted by the local government in the form of a resolution. There is no arbitration mechanism for issues that can not be resolved through the negotiation process nor does nonagreement on any or all issues prevent the facility from being sited. Consequently, this process reduces but does not preclude the need for litigation.

Regional Solid Waste Management

As previously mentioned, the new regulatory requirements for solid waste disposal facilities will have two results: (1) greater assurance that environmental quality will be protected and (2) the costs associated with waste management will increase. Some local governments will find that they can no longer afford to be in the solid waste management business and will look for alternatives for providing the service. One option may be privatization. The decision to privatize solid waste services is a local government decision, not a state policy issue. Consequently, SB 533 is silent on privatization.

Regionalization is another alternative. Due to the economies of scale, local governments may find that collectively they can offer a service that individually they can not afford. Under Georgia law, local governments have the authority to enter into contracts with each other to provide services and a few local governments have used this authority to manage solid waste on a regional basis, generally two or three counties.

For larger regional efforts, it is important to provide local governments with a structure for creating regional authorities to manage solid waste. Language is included in SB 533 that authorizes local governments to voluntarily create regional solid waste management authorities.[27]

Conclusions

SB 533 is a comprehensive piece of legislation. It was developed through a process that produced consensus before the legislation was introduced in the General Assembly. It assures that solid waste disposal facilities will be designed to stringent standards; that they will be operated by certified individuals; that state and local governments will plan and coordinate their solid waste management efforts; and that public participation will occur throughout the process. It does not resolve all the issues related to municipal solid waste in Georgia but it does create the foundation upon which these issues will be addressed in the future.

ENDNOTES

1. O.C.G.A. 12-8-20.
2. James E. Kundell. Municipal Solid Waste Management in Georgia: Policy Alternatives, Carl Vinson Institute of Government, University of Georgia, Athens, Ga., 1989.
3. Georgia Acts of 1989, Act No. 1106.
4. "Report of the Solid Waste Management Study Committee," Georgia General Assembly, Atlanta, Ga., December, 1989.
5. O.C.G.A. 50-8-7.3.
6. O.C.G.A. 12-8-39.2.
7. O.C.G.A. 12-8-39.
8. O.C.G.A. 12-8-21 (c).
9. O.C.G.A. 12-8-33.

10. O.C.G.A. 12-8-35.

11. O.C.G.A. 12-8-36.

12. Georgia Acts of 1989, Act No. 634.

13. O.C.G.A. 12-8-31.1.

14. O.C.G.A. 12-8-31.1 (c).

15. O.C.G.A. 12-8-31.

16. O.C.G.A. 12-8-31.1 (e).

17. O.C.G.A. 12-8-31.1 (e).

18. O.C.G.A. 12-8-31.1 (d).

19. O.C.G.A. 12-8-31 (d).

20. O.C.G.A. 12-8-23.

21. O.C.G.A. 12-8-24.1.

22. O.C.G.A. 12-8-40.1.

23. O.C.G.A. 12-8-28.

24. O.C.G.A. 12-8-25.3.

25. O.C.G.A. 12-8-32.

26. O.C.G.A. 12-8-32.

27. O.C.G.A. 12-8-50-59.1.

A HAULER'S PERSPECTIVE OF PROBLEMS AND PROCEDURES IN CONNECTION WITH INTERSTATE TRANSPORTATION AND DISPOSAL OF SOLID WASTE

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(1)

IMPACT OF FEDERAL AND STATE WEIGHT LIMITATIONS ON THE TRANSPORTATION OF SOLID WASTE

A lack of uniformity exists in the standards established for federal and state highway vehicle weight limitations. In states such as New Jersey, for instance, gross vehicle weight is the standard used for weight limitation on state highways. However, under federal law, the applicable restrictive standard for federal highways is the "bridge formula", which utilizes the criteria of rear axle weight. Unfortunately, certain vehicles commonly employed in solid waste collection and transportation are manufactured so that their weight is disproportionately centered in the rear of the vehicle. This has resulted in the situation arising where the waste hauler can be in compliance with state law requirements and travel state roads, yet on the same trip carrying the same size load he is nevertheless unable to meet the divergent requirements of federal law and is thus unable to use federal highways or state highways in adjoining states.

In addition to the normal transportation concerns, as expressed above, solid waste vehicular traffic has become the subject of concern of solid waste regulators, local officials and the affected public. Thus, in some states, solid waste regulators and local officials are imposing permitting requirements that address the routing of solid waste vehicles in the utilization of solid waste disposal facilities.

An actual case history will be reviewed, illustrating the effect of these variant weight limitations upon the solid waste hauler's operation when juxtaposed against both the need for efficient utilization of such vehicles and compliance with mandatory routing requirements for the utilization of solid waste disposal facilities.

(2)
EFFECT OF VARYING STATE-TO-STATE WASTE CLASSIFICATION PROCEDURES AND REQUIREMENTS

A lack of uniformity also exists in the classification from state to state of various types of waste thus affecting interstate disposal practices. The same waste that would be classified a certain way in one state may receive a different classification in another state. The ramifications extend beyond mere definitional confusion, however. The procedural requirements for disposal of the same waste will often vary from state to state. A waste whose disposal would be unrestricted in one state may require special approval in another state. A case in point is medical or infectious wastes, which have varying permitting (and in some instances tracking) requirements from one state to the next. Other prevalent waste types subject to differing degrees of restriction (or prohibition) include, for example, asbestos, sludges, fly ash, incinerated ash and contaminated soils. These types of issues affect the solid waste hauler's activities relative to the generators served. Various concerns are presented relative to potential liability for environmental damage or regulatory liability under applicable state and/or federal laws (CERCLA).

(3)
IMPACT OF U.S. DOT REGULATIONS ON SOLID WASTE COLLECTION FLEETS

Because waste haulers are deemed to fall within the scope of authority of the Federal Motor Carrier Safety Act, 49 U.S.C. 2501 et seq. as for-hire carriers operating in interstate commerce, they are subject to a panoply of federal regulations promulgated by the Department of Transportation (DOT). (See Federal Motor Carrier Safety Regulations, 49 C.F.R. 385 et seq.) These regulations mostly pertain to reporting and recordkeeping requirements in regard to traffic violations, accidents, licensing, vehicle maintenance and inspection, driver testing and insurance coverage. The hauler's entire trucking fleet and corps of drivers are subject to these regulations regardless of whether the particular vehicle or driver is actually deployed in transport across state boundaries. The Federal Highway Administration conducts spot compliance inspections and has authority to bring enforcement proceedings to compel compliance and seek civil penalties. Violators may be subject to civil penalties of $500 per violation and an additional $500 for each day the violation continues up to a maximum of $2,500 per violation.

(4)

BACKHAULING PRACTICES: POTENTIAL IMPACTS OF FEDERAL AND STATE REGULATORY CONTROLS

Congress is currently in the process of enacting legislation (HR 3386 and S 2393) aimed at prohibiting the practice of "backhauling" waste. The legislation generally seeks to eliminate the practice in which raw food or produce carriers, rather than returning home empty upon delivery of their food product, haul waste, sometimes hazardous in nature, to a disposal facility. After minimal cleanout of the trailer, the same vehicle will then once again carry food products to a destination. Essentially, the pending legislation prohibits food products from being carried in any vehicle that has previously carried unacceptable, non-food products unless such vehicle has been decontaminated. Not surprisingly, waste materials are included within the definitional scope of "unacceptable, non-food products." The legislation also requires the Secretary of Transportation to promulgate standards for proper and sufficient decontamination.

This legislation could have a spiralling effect upon the transportation of solid waste, particularly in those areas of the country where longhaul transportation is utilized, such as the Northeast. Additionally, waste haulers may feel the impact of the legislation principally in the area of leasing and resale of trailers that have been dedicated to hauling waste and would necessarily be restricted in any future use outside of waste hauling. The increase in leasing costs and decrease in resale value of owned trailers will ultimately result in these costs being passed on to the customer.

INTEGRATED SOLID WASTE MANAGEMENT: INCENTIVES FOR REDUCED WASTE GENERATION, INCREASED RECYCLING AND EXTENSION OF LANDFILL LIFE

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Introduction: Economic Causes of the Solid Waste Crisis

As the U.S. EPA turns its attention again to the problem of residential solid waste management after eight years of neglect during the Reagan administration, it has adopted a useful set of objectives to guide policy making in the area. It has proposed a hierarchy of policies and solid waste management practices to make the handling of the flow of solid wastes more efficient from a social point of view: waste reduction, recycling, energy recovery and landfill. In this appropriately named "integrated solid waste management" system, communities should first seek to reduce the amount of material entering the waste stream, to recycle that portion which is not reduced, to incinerate with some form of energy recovery for that portion which cannot be recycled and to landfill the incineration residuals. In contrast, the current practice in most communities is to incinerate or landfill virtually everything, practices that are leading to much conflict in many communities.

Because a substantial number of communities in large metropolitan areas around the country are facing rapidly diminishing landfill capacity for a number of reasons, and because it has become increasingly difficult to site new landfills and incineration facilities, the NIMBY ("not in my backyard") syndrome, many have started recycling programs in the last two or three years. Unfortunately , there are some disquieting signs that the recycling programs may not be as successful as planned because the secondary materials markets have not been able to accept large increases in supplies, particularly paper, without a large decline in the prices paid for recycled materials. For those communities facing very high tipping fees at the landfills, the costs avoided

by not landfilling still justify running recycling programs at a loss. Nonetheless, for most communities, the reduced prices for secondary materials will likely mean that they will opt instead for landfill until the associated tipping fees at the landfills become intolerable. In virtually all communities, the first step in EPA's policy hierarchy, waste reduction, receives only lip service, as local communities do not believe they have much ability to influence it.

Waste Reduction Ignored. The position taken in this paper is that the solid waste crisis is the result of a solid waste management failure, or of a crisis in solid waste management. Inadequate conceptions of the problem and how to deal with it have caused management and research responses to be focused on engineering (or supply side) solutions to the near total neglect of the incentive mechanisms (demand side--waste reduction) that are required for the engineering responses to be properly supported. This failure of understanding and implementation is the true source of the solid waste crisis and until it is rectified, solutions that the public will be willing to pay for will elude solid waste managers. As a result, solid waste management will remained unintegrated until the economic context which governs materials flows through the economy is explicitly included in solid waste management practices.

An economist's view of the solid waste problem could be summarized as follows: if all scarce resources dedicated to managing the nation's solid wastes, including landfill capacity, were properly priced in competitive markets, then EPA's suggested hierarchy (waste reduction, recycling,

incineration and landfilll) would be more effectively implemented in all sectors of the economy. This would be so because in general the hierarchy would become broadly consistent with the least cost method of solid waste management in whatever form it may take. However, under conditions present today in most communities, a case cannot be made that the solid waste "market" is well functioning; rather it is heavily biased against waste reduction. That bias is created principally and precisely by local solid waste management policies which ignore how the marketplace for newly produced materials and products functions with respect to materials and packaging choices.

A logical consequence of these policies is that the household and commercial sectors are given incentives to present too much waste for recycling, incineration and landfilling. This situation unnecessarily aggravates the price declines in the secondary materials markets, in turn leading to too many efforts to site incinerators, causing unnecessary community conflict and reduced landfill life. This form of "market failure" as economists refer to it results from the fact that the price system is being prevented from working properly. In this case, this is due not so much due to governmental interference in the price mechanism as local governmental choices of solid waste management policies that operate outside of the marketplace by attempting to use inappropriate methods to "close" the materials cycle. These methods are incineration and landfill and their "inappropriateness" lies in exclusive reliance upon them. The same can be said for those communities that pin all of their expectations on recycling as the way to reduce the landfill crisis they face.

As a result, current recycling efforts underway around the nation are destined for failure at worst or ineffectiveness and high cost at best.

Communities across the nation are embracing recycling only, generally ignoring waste reduction, even while the structure of prices in the marketplace stimulate the manufacturing sector of the economy to gear its operations principally to the use of virgin materials and once-through materials flows, thereby increasing waste generation. Packaging designers and manufacturers still do not design or choose packaging materials with final disposal in mind, mainly because they receive no signals from the price and market mechanisms to indicate that traditional methods of solid waste management are increasingly expensive and inappropriate and should be substituted by other methods. This situation is beginning to change as some communities, notably Seattle, move aggressively against some specific consumer products.

This situation results from a classic problem in economic analysis: the market mechanism fails to perform properly precisely because some resources necessary to complete the materials use cycle in a socially acceptable manner remain either totally unpriced or underpriced: in the case of solid waste management, the unpriced resources are those dedicated to collection and disposal, landfill capacity and the air to receive incineration emissions. Note that we indicate that these resources are unpriced in the market, not that they are unpaid for or not financed (although the external costs they generate represent uncompensated costs). The principal solid waste management problem, as we shall develop more fully in this article, stems precisely from the fact that the nexus between pricing and finance is broken by local solid waste management practices. (Parenthetically, Seattle does close the price system properly through an appropriate choice of management methods, as discussed below.)

The fundamental cause then of the solid waste problem in the U.S is governmentally instigated "market failure". Governmental production of goods and services nearly always politicizes the delivery of the service, usually resulting in the substitution of equity considerations for efficiency (maximun net benefit to the community) in policy and management decsions. Local solid waste management has been no exception to this rule. This is of course exactly the cause of the economic chaos in the Soviet Union and other communist countries: government seeks to allocate resources without the use of the marketplace and as a consequence usually creates economic and social problems.

Alternative Measures to Rationalize Solid Waste Management Practices

In the 1970's at the height of intellectual ferment over the environment there were numerous proposals to correct the bias of the economy toward virgin materials versus recycled materials. These proposals among others included removing tax advantages for virgin materials (e.g. depletion allowances), altering railroad freight rates biased against secondary raw materials, bottle legislation (deposits), and most comprehensively, fees levied at the national level on materials contributing in a major way to the solid waste problem (such as packaging), to be distributed to local communities to help defray solid waste management costs. There have been some adjustments to freight rates and some bottle bills have been adopted around the nation. The waste content fee, however, not only presents an easy target for industry lobbyists, but would be exceedingly cumbersome to administer, if not impossible. This proposal died in Congress in the 1970's. The ultimate obstacle to federal correction of distorted markets for materials, however, is that the U.S.

Congress is inappropriately structured to deal with environmental fees, as too many confused members of Congress have insisted on calling them taxes. Of course, the climate in Congress for new taxes is never hospitable.

Economic Incentives for Solid Waste Management. Integrated solid waste management is a set of policies to be implemented by local governments. It is a fair question to ask what incentive mechanisms are available to local governments to reduce the magnitude of their waste problems. Neglected in both past and current discussions and analyses of the problem is the possibility of closing the price system at the end of the materials flow, i.e. at the consumer level or at the local level. This would occur simply by explicitly charging, as is already done in a few communities, a fee based on volume and/or weight for collecting and disposing of the residential solid wastes. After all, it is principally consumer waste that is the cause of the solid waste crises confronting many communities. In virtually in any normally functioning market, if there is an increased scarcity of a resource essential to the production and use of a product, the price of the scarce will rise and an incentive created to economize on its use. We have virtually no such mechanism operating in the solid waste arena, and it should come as no surprise that there is a solid waste "crisis". It is the textbook case of "excess demand" when markets are forced to operate at disequilibrium prices. In fact, under the tax financed and flat rate charge systems (a monthly charge not related to the amount of waste presented for collection), consumers have no reason to choose waste reduction and recycling activities and equally as important, neither does the manufacturing sector, as it receives virtually no market signals that there exists any scarce resource for which they are already not paying (labor, materials, etc.). We argue here that the failure

of local government to ensure that solid waste management is appropriately priced is the cause of the solid waste crisis that afflicts many communities.

The potential advantages of local user charges for solid waste management are many: solid waste management institutions are already in place virtually everywhere and no particular industry will have its product specifically singled out by the federal government for special measures, avoiding that political obstacle. In fact, one could argue that the problem of perverse incentives in this area can be best resolved at the local level, not the national or even state levels, precisely because the extent of the problem varies considerably from community to community, especially as between rural and urban areas, as well as from state to state. It may make little sense to subject Idaho and Montana to the same federal incentives designed to solve the problems on Long Island, e.g. Flexibility and the ability to tailor the policy to local conditions indeed is the principal reason markets do a better job of allocating resources than does central control.

Lest we appear too optimistic about the potential for these user charges, it is important to note that by no means do we have enough information on the behavioral effects of the charges on all of the dimensions of the problem. What evidence there exists is quite suggestive of the potential for user charges, but because the U.S. EPA has not studied the problem very much, we are still without all the information required to make confident predictions. Presented next is a brief discussion of what is known and of the expected effects.

Expected Effects of Volume Based User Charges

There are a number of favorable effects that can be expected to flow from the institution of user charges for solid waste management. These are: 1) stimulation of a long term interest in households in waste reduction and recycling, including composting, thereby lengthening landfill life; 2) a reduction in the cost of solid waste management; and 3) resolution of the NIMBY problem by the creation of a self-contained mechanism for compensating those near landfills and incinerators. Included with 1) would be a stimulus to local and state governments to be entrepreneurial in waste reduction efforts, effectively creating a national but not federal solution to a problem local to each community but national in scope. We also will argue that the introduction of user charges will ameliorate the contentious problem of the export of solid wastes across state boundaries to be landfilled in other states. We discuss each of these in turn.

Waste Reduction. There is accumulating evidence of a definite waste reduction response to user charges, specifically to the variation in the charges. Econometric evidence (drawn from the author's research and various small studies over the last 15 years) suggests that a 10% increase in volume based charge, in the absence any organized waste reduction or recycling effort, will lead to a reduction of waste presented of about 2%, or in other words, a 100% increase in the charge would lead to a 20% reduction in waste. Economists refer to this as the price elasticity being equal to 0.2. The author's evidence is drawn from the experiences of Tacoma, Washington, and is consistent with the fragmentary evidence presented over the years in professional economic journals.

Just how does waste reduction occur as currently practiced and how might it proceed if it were an explicit community objective? First it needs to be emphasized that not enough is yet known about the totality of the effects of different financing mechanisms to be able to predict the effects confidently in new or "changeover" situations. For example, Tacoma has had a user charge system for over 50 years, so any measured response today to variations in the charges will understate by an unknown amount the household waste reduction response. Also, since the residents are charged on the basis of the number of cans, as well as the distance to the curb and the number of flights of stairs to be traversed, some of the "waste reduction" probably is not actually less physical waste, but increased stuffing of the cans. This has been observed in Seattle and dubbed the "Seattle Stomp". Thus the volume but not the weight is reduced. Now, volume reduction is cost reducing in that it saves labor time and motion in the collection phase, but it probably contributes little if anything to increased landfill life.

What is important about this finding is that there is an household response. What may appear to be a modest and commonsensical finding (at least to economists) is nevertheless a fundamental finding, because there have been many who believe that there will be a zero response to variations in price for collection and disposal, despite all that we know about demand responses or behavior in private markets. This waste reduction effect should be viewed as continuous and not simply the result of a community campaign to heighten awareness. The effects of information campaigns can be expected to be only temporary in duration if the effort to change attitudes is not backed up with appropriate incentives to reinforce changed behavior. The effect would be more pronounced in the presence of local entrepreneurship to households

continuously aware of waste reduction possibilities.

Organized Waste Reduction. These observations naturally raise the question of what magnitude of the waste reduction response would be if local communities were to promote it. Unfortunately, there is not yet any information available on this aspect of the problem. For those communities facing severe landfill capacity problems, the customary first response to the need to reduce the flow of solid waste to the landfill is to institute a recycling program rather than to experiment with incentives and programs for waste reduction; as we have seen, these recycling efforts have run directly into inadequate demand and capacity in the secondary materials markets. The important point to note here is that user charges for solid waste are a necessary part of the waste reduction and recycling effort, and that campaigns to raise consciousness are not a substitute for them--user charges, recycling and education campaigns are complementary. This has been exactly the experience in Seattle.

The typical local solid waste manager is a sanitary engineer with seemingly little to no appreciation of the possibilities of organizing or stimulating a local waste reduction "market"; such duties never have been part of the job description. Furthermore, it is clear that the typically small local solid waste management district can have little impact on the quantity of waste generation flow from the commercial and household sectors such as packaging waste, for example. The same is not true for the very large districts, however, as in the case of Seattle which recently banned the use of foam containers in the fast food sector within the municipality. These

observations have implications for administrative staffing in solid waste management offices.

Furthermore, from a national perspective, if the adoption of waste reducing incentives such as the user charge and other measures were widespread such that a significant proportion of the national commercial and household sector were affected, then a de facto national waste reduction policy would be in effect and it could have very significant impacts on important parts of the waste stream. For example, it is abundantly clear that the design and manufacture of packaging is driven nearly wholly by product protection and marketing considerations, with virtually no concern for the disposal problem. If a significant percentage of the national supermarket industry found itself pressured by consumers, state and local governments to reduce packaging waste,it is reasonable to expect that changes in packaging configurations would be relatively quickly adopted by the grocery products industry. This industry receives virtually no to weak effective signals today on the impacts of packaging on solid waste management, and furthermore is able to mobilize itself effectively against federal and state actions that single out particular products and/or packaging, as in the case of deposit legislation for non-returnable drink containers.

The point is then that fuller use could be made of the market mechanism for reducing the waste content and changing waste generation practices in the retail sector of the economy, and this would likely be much more effective than the command and control approaches being imposed at the federal and state levels. As an example, the state of Pennsylvania in conjunction with the Pennsylvania Resources Council and the Pennsylvania Food Merchant's Association have begun a "environmental shopping" campaign by which consumers

are given information on the waste content of various packages in an effort to get supermarkets involved in waste reduction. This very laudable step in the right direction is destined to be ineffective in the long run if consumers and producers do not find continuous reinforcement in the marketplace for changed shopping behavior--that reinforcement has to be economic in part. Volume based user charges would provide that incentive.

Education and information campaigns are necessary but not sufficient to rationalize waste generation practices. There are relatively recent parallels in other sectors of the economy from which to derive useful lessons. Witness the roller coaster demand for small and large automobiles over the last 15 years. The seeming consumer fickleness for small cars was exactly a function of the rise and fall of the real price of gasoline over the period. All retailers know that consumers are fickle. What this means specifically is that consumer behavior is variable, leading to uncertainty. Producers and retailers will be adverse to making the necessary investments in their operations unless they can be reasonably sure that they will recover their costs, including a normal profit. Any campaign that appeals solely to non-economic motives such as the environmental ethic is destined to lose its momentum in the long run. What is required is to make institutional changes so that the marketplace continuously reinforces and supports that ethic. It is in fact easier to change people's economic behavior than it is their preferences or attitudes, although many doubt it.

What specifically might a local solid waste management authority do to stimulate the local waste reduction market? First we note that the temptation

will always be great to act legally against particular constitutent of the waste stream as the first attack on the problem, such as did Seattle against foamed containers. And while legal proscriptions may occasionally be warranted, it is usually best from an efficiency standpoint (maximum net social benefit or least social cost) to let the market find those segments of the waste stream most susceptible to change, i.e., where lower waste substitutes can be more easily and economically found.

The process can be envisioned to work along these lines: a local community institutes a volume based user charge system and with the information gained from a prior survey, informs households in general that the packaging waste content of their solid waste is X% and that the percentage can be reduced by pressuring the grocery chains to make available lower waste alternatives. With the local price structure of waste management now changed by the presence of the user charge, consumers (waste generators) will now find that waste reduction is in their long term economic interest, causing retailers and producers in turn to realize that it is also in their long term economic interest to adjust to the new situation. Therefore they will be more likely to make both manufacturing and retailing changes that facilitate waste reduction. This is because consumers would now have a mechanism in place that continuously reinforces waste reduction purchasing behavior and the uncertainty that producers face concerning consumer behavior will be reduced. This increases the likelihood that the producers can recover their investments in waste reduction plus a normal return. Continuous information flows are a necessary part of the waste reduction process.

As an example, many of the chains already make available bulk purchase items--these could be expanded. Pouch packaging for both liquid and dry foods

could be extended. In countries where paperboard packaging is expensive, such as in Mexico, wide use is made of pouch packaging--virtually all powdered laundry detergent is so packaged there. The development of such information on alternative packaging configurations and its dissemination to local solid waste management districts would be a proper function for the Office of Solid Wastes of the U. S. Environmental Protection Agency. The districts would in turn prepare flyers to the wate generating public to be distributed with the bills. The Pennsylvania experiment already contains several of these elements, although not the user charges.

Cost Reduction. We think that the scope for waste reduction is substantially greater than is current appreciated. Nonetheless, it is critical for public decision making on this issue to note that it is not so much the quantity or volume of the waste reduction response but the cost dimension of the problem that is relevant to the discussion. That is, a 20% reduction in waste generation that might be expected from a 100% increased in user fees can be very significant in those communities that confront disappearing landfill capacity and strong public resistance to site additional landfills or incinerators. This means that there is a potential to reduce local solid waste management costs significantly. If the marginal or incremental costs of landfill are rising rapidly, the cost reduction effect will be greater than 20%. Much more is involved than simply changing the type of financial mechanism from taxes to user charges, since with the user charge waste generators have an incentive to engage in waste and cost reducing practices, whereas systems that simply finance collection and disposal do nothing to motivate waste generators to economize on resources dedicated to

solid waste management.

We do not yet have available firm information on the cost savings obtainable in user charge based solid waste management systems versus systems with tax or flat rate finance, although the Seattle experiment will provide some.

Recycling. In my community, as in many facing landfill capacity problems, a comprehensive recycling program was initiated during the summer of 1989. In a matter of just a few weeks, the price paid by secondary paper brokers plummeted and now the recyclers will not accept newsprint--it instead goes to the landfill. This situation is commonplace, but it still makes good economic sense in those communities confronting acute landfill capacity shortages to pay waste paper brokers to accept the newsprint. This situation raises two important questions: 1) how much should be paid to secondary materials brokers and 2) out of what funds is the subsidy to be paid?

The answer to the first question is simple: a community is better off if it has to pay anything less than the cost of the next best alternative, typically landfilling. This is the avoided cost concept. The answer to the second question, out of what funds should the subsidy be paid, is more complex. In a community with special solid waste taxing districts, the question has to be put to the voters. In flat rate communities, the average charge for solid waste management would have to by raised to all, but again if the cost of paying the subsidy is less than the landfill alternative, the community is better off. Administrative feasibility is not a problem, but both tax and flat rate finance create questionable cross subsidies in the community, in particular from low income groups and the low waste generating

elderly, for example, to higher income and waste generating classes and families, a situation not generally viewed as equitable.

A more fundamental problem with financing the subsidy out of these traditional financial mechanisms is that they do nothing to stimulate waste reduction activities by the waste generators since they do not perceive any direct reward for doing so. That is the critical distinction between user charges on one hand and tax or flat rate finance on the other.

With a user charge system in place the larger waste generator would pay more of the required subsidy (generally referred to as a tipping fee) to secondary materials brokers. Therefore both the problem of financing the subsidy and the equity problem would be resolved. Furthermore, the larger waste generator would have a correspondingly greater incentive to seek out and employ waste reduction measures such as composting and pressuring supermarkets directly (and indirectly through government) to offer more goods with reduced packaging content. The larger household waste generators tend to be the more educated and politically aware and thus most likely to follow though on waste reduction efforts.

The NIMBY Problem. "Not in My Backyard" is the bane of all solid waste managers, making it nearly impossible to site additional landfill capacity and/or recycling technologies such as energy recovering incinerators. Much of the resistance is well founded, based on the unfortunate history of poorly managed landfills that contribute to water pollution. Further, most people object to the increased traffic of heavy trucks required to transport the

waste, all without being compensated for suffering the increased disamenity.

The NIMBY problem can be reduced substantially in two ways through the adoption of a user charge mechanism, both in the short run and the long term. In the short run, the user charge system provides a logical source of finance to indemnify those who would live near such facilities and the increased traffic. Indemnification could take the form of reductions in or exemptions of property taxes, for example, sufficient to offset any reduction in property value occasioned by the waste related activity. The finance for tax abatements would come totally from within the user charge mechanism and not include funds raised through taxes, it would be considered as fair and equitable because those causing the waste would be paying the indemnification and those who generate little waste would pay little. This fact should make it easy to stave off attempts to use the public fisc as a mechanism to finance other publicly caused disamenities, such as traffic noise and air pollution. Of course, implementation of such a mechanism may well require state enabling legislation.

In the long run, the NIMBY problem would be reduced due to the waste reduction stimulated by the incentive to economize on traditional waste disposal practices, i.e., landfilling and incineration. This means that landfill capacity will be longer lived and the need to site new facilities will be correspondingly reduced.

Interstate Transport of Solid Waste. Several states, principally on the east and west coasts, have been transporting solid waste beyond their borders for landfilling as their own landfill capacity rapidly diminishes and as they

find it nearly impossible to site new facilities within their own communities. Receiving states frequently are less than enthralled with this situation, but the courts have been interpreting attempts to restrict the inflow of wastes as a restraint of interstate commerce. The question facing the recipient states is how to reduce this problem legally. The following comments do not represent legal advice, but perhaps the economic rationale presented here can serve as a firmer conceptual basis on which to predicate restrictive legislation that can withstand a legal challenge.

We argue that states can diminish the flow of out-of-state wastes in two ways:

1. Sending or exporting states should be charging their own citizens for solid waste management services using the mechanisms outlined in these pages. If they do not, and most do not, then it can be easily argued that the exporting jurisdictions are in fact encouraging their citizens to be wasteful of scarce landfill capacity at home and elsewhere. That is, they are causing citizens in other (receiving) states to incur costs on the waste generator's behalf; in other words, they cause receiving states to subsidize the public services in the generating states. This follows because if exporting jurisdictions do not price properly, they encourage overuse of landfilling as measured by the disparity between the incremental costs and incremental benefits of solid waste management. Recall that tax finance is not pricing; furthermore, flat rate prices (i.e. fixed monthly charges, independent of waste quantity) in increasing landfill cost jurisdictions also lead to overuse and to out-of-state subsidies for solid waste management in another. This means that the exporting state is generating too much waste, recycling too

little, incinerating too little, prematurely exhausting its scarce landfill capacity and not siting enough additional disposal capacity within its own borders.

2. Receiving states should also be pricing solid waste management services to their own citizens, so that no case can be made by an exporting state that the receiving state is using pricing to discriminate against it and thus violate the interstate commerce clause.

Level of User Charges. These points raise the question of at what level should the charges to receive out-of-state wastes be set. There are two arguments possible here.

a. Importing states should set the level of charges to reflect all current and future costs. Future costs would include remediation of leaking landfills that lead to ground water contamination. The future costs are actually expected costs, i.e., probabilistic, and while these can be estimated, they are necessarily uncertain in magnitude. This uncertainty may be an unavoidable issue of legal contention. That there will be future costs is a virtual certainty given the imperfect state of the art for landfill construction--it is the magnitude and the timing of the costs that is uncertain.

If the citizens of both the importing as well as exporting states have to pay these costs through the pricing mechanism, then it should be more difficult to argue a violation of the interstate commerce clause.

b. Being forced to accept unwanted wastes means that a receiving

state's scarce resource (landfill capacity) is being depleted by outsiders. This in turn means that future citizens of the importing state will incur future costs that the current exporting state citizens do not pay. It can be argued that they should have to pay. That is, the future costs, certain to occur, will have to be borne by the citizens of the receiving state. Therefore, charging a higher price now to other states than to the citizens of the receiving state could be viewed as proper and fair.

Barriers to the Adoption and Implementation of User Charges

The tenor of the arguments presented here is that the promise of user charges in rationalizing the solid waste management problem is high, at least high enough to warrant serious consideration and experimentation. There are, nonetheless, barriers that need to be surmounted before user charges can be offered as an important tool in managing the nation's wastes and before there will be wide enough acceptance at the local level for it to become a national solution to the solid waste management problem.

The barriers are essentially two: 1) insufficient knowledge of household waste generation and reduction behavior and of the cost relationships (supply factors) to be able to make reasonably accurate predictions about waste reduction and costs, efficiency and effectiveness of incentive based solid waste management systems; and 2) insufficient understanding at the local governmental of the economic principles involved, complicating the "selling" of an integrated program to local voters--this is a problem of communication and persuasion.

With respect to the first barrier, it has to be readily admitted that the knowledge base on which to predicate fully confident and reasonably certain predictions of the effects of user charges on waste generation, recycling, etc. is extremely limited. There is a serious need to develop this information. The U.S. EPA should have funded this work over the last ten years and it should do so now. Especially needed are measures of consumer response in a "change-over" situation--going from tax and flat rate methods of finance to user charges. Also needed are measures of the costs and benefits of making such a change-over; local communities need to know how much money can be saved under one management systems vs another.

Given the very large statistical difficulties that exist in extracting the requisite information from existing data, the greatest promise in obtaining the needed information in the least amount of time and with the least number of methodological difficulties is to do so within an experimental context. That is, a community which is contemplating a major change in its approach to solid waste management could be selected as an "experiment". This proposal is much less revolutionary that it sounds, as most communities undertake these experiments all the time, frequently with little proper preparation and understanding--exactly this is occurring with the great recycling "experiment" underway across the nation. Proper experimentation requires careful measurement of the baseline situation, and a planned introduction of changes so that the responses can be properly and carefully measured. A properly conceived program would take about four years to initiate and complete.

Local governments typically do not have the human resources to undertake

such programs by themselves and neither are they to be found in the typical engineering or management consulting firms that serve local governments. This research should be undertaken by the Office of Research and Development of the U.S. EPA, perhaps in conjunction with the National Science Foundation.

A second problem, for which there are no readily implementable solutions, is perhaps more fundamental. Years of involvement in the solid waste area have convinced this observer that a fundamental impediment to implementation of the basic economic principles lies in the simple lack of appreciation of these principles by a significant number of the professionals working on solid waste problems at all levels of government. In the first instance, this means that looking for violations of basic economic principles referred to here in local governmental management is not the first instinct of these professionals. It surely is not by accident or coincidence that engineering solutions to the solid waste problem are always the first to be chosen by the civil and other engineers who constitute the majority of technical professionals in all levels of government.

Additionally, this generalized lack of understanding and appreciation of economic (vs. engineering) efficiency in government means that local officials are usually poorly equipped to "sell" such programs to the voters. Proposing an engineering "solution" often seems much more palatable politically. Perhaps now that advice is changing, given the generalized opposition to more incinerators and landfills. Part of this opposition is fueled by the NIMBY syndrome, but much of the opposition comes from a reasoned position that engineering solutions only are inappropriate.

A properly conducted experiment will do much to fill in the information lacunae that exist in this area--it is the thesis of this article that it will show that user charges have an important and necessary role in modern solid waste management.

Conclusions

While much information on the effect of user charges is lacking due to little governmental attention to developing the needed information and knowledge base, the conceptual analysis of the role of user charges in local solid waste management indicates that such charges are a necessary component of a successful and efficient integrated solid waste management system. Engineering systems will of course always play a critical role in solid waste management, but it is clear today that they are destined to fail if pursued as the only approach to waste management. Waste reduction and recycling programs will always be problematical without the continuing incentive that the user charge mechanism provides.

The available empirical information is not firm enough to be able to provide clear guidance on the appropriate structure of a local incentive mechanism for solid waste management. A major research program is in order. Identification of and assistance to a community desiring to change over to a user charge system, providing all of the necessary evaluation and technical advice, will provide the most expeditious way in which to develop the needed information on waste generation relationships and the associated costs. This approach is preferable to attempting to uncover the relationships with historical studies on incomplete and fragmented data.

Volume based prices for solid waste collection and disposal alone will not automatically lead to a resolution of the solid waste crisis. It is the set of behaviors that are subsequently and consequently stimulated that will lead to long run community willingness to participate actively in waste reduction and recycling programs and provide the financial wherewithal to ensure their success. User charges will provide the proper signals, now lacking, to local solid waste managers and engineers to guide them in making correct decisions about the type and size of the technologies needed to handle the waste flows, avoiding the current tendency to overdesign these facilities. It carries the potential to provide a truly national solution to the solid waste crisis.

INTEGRATED SOLID WASTE PLANNING FOR A REGIONAL AREA

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INTEGRATED SOLID WASTE PLANNING FOR A REGIONAL AREA

INTRODUCTION

Municipal solid waste management planning today must address a number of waste management alternatives. It is no longer enough to just find another landfill site. Suitable sites are not that easy to find, strong public resistance accompanies virtually any siting attempt, and landfill regulations and costs are increasing. Additionally, there is increasing recognition that valuable resources are lost with a landfill-only approach.

Public officials are now looking toward an integrated solid waste management approach to solve their community's solid waste problems. Waste reduction, recycling (including composting) and incineration (with or without waste-to-energy) are all being considered as alternatives to reduce landfilling.

Many counties and communities, particularly those in less than major metropolitan areas, are joining together in a

regional solid waste management planning effort. These regional approaches are being taken for the following reasons:

- To better manage the complexities of choosing, implementing, and operating an integrated system
- To achieve "economies of scale" with larger waste management facilities
- To share risk
- To reduce facility siting needs.

This paper includes a discussion of social and political, technical, economic, and implementation issues attendant to planning integrated solid waste management for a regional area. Many of these issues are important in waste management planning in any area. Some, however, are particularly important or specific to regional planning.

SOCIAL/POLITICAL ISSUES

Needs and Goals of Communities

The needs and goals of the communities included in the planning process must be determined at the outset. Often, the planning process begins only after a disposal crisis appears imminent. Where several counties or communities are planning jointly, there will likely be different degrees of immediate

need and different goals. For example, one community may be facing a near-term landfill closing, whereas others have the luxury of more time. Some may wish to consider waste-to-energy alternatives, whereas others may strongly oppose any consideration of incineration.

Obviously, the more communities included in the planning process, the greater the challenge of finding mutually satisfactory solutions. It is vitally important for public officials and their consultants charged with finding these solutions to understand the different needs and desires of the participant communities.

Public Input Process

An often underestimated part of developing an acceptable solid waste management plan is the public input process. Perhaps the surest road to failure is to leave the public out of the planning process. Even if a viable solid waste management plan has been developed, the public may well be suspicious if they have not been involved.

EPA's new Decision-makers Guide to Solid Waste Management urges involvement of the public early in the planning

process (1). This is mutually beneficial in that the public becomes better educated as to the problems and realities of managing their wastes and decision-makers become better attuned to the public's concerns and desires. This will lead to a better planning process with the best potential of arriving at mutually satisfactory solutions with the needed public support for implementation.

The larger the geographical area included in solid waste planning, the greater the difficulty in obtaining representative public input. Public involvement in a region that includes several counties may be assisted through establishing groups of citizen representatives. These citizen groups can be responsible for acting as liaison between those planning solid waste management solutions and the remaining citizenry. The citizen representatives must be carefully selected to represent the wide range of public interests. In addition, public meetings and hearings should still be made available to the general public to obtain added public input.

Obviously, the public input process can be important in determining the needs and goals of the participant communities. Public input is usually critical to obtaining the support to implement a solid waste management plan.

Intergovernmental Cooperation

Establishing and operating a planned regional solid waste management system may require substantial intergovernmental cooperation. For example, financing capital-intensive waste management facilities for joint use by numerous communities will require assurances of waste delivery to the facilities.

Intergovernmental agreements may be used to empower local governments to act as a single (regional) entity in planning and implementing the collection, transportation, recovery, and disposal of solid waste (2). Such agreements have been enacted in some areas designated for regional solid waste management planning.

Need for Regional AGency

Formation of a regional agency with authority to provide for regional solid waste management implementation may be necessary and can be accomplished through an intergovernmental agreement. The necessary powers of the agency, as provided by the agreement, might include the following:

- To operate or cause to be operated solid waste management services and facilities
- To enter into contracts
- To levy fees for payment of services
- To borrow money and issue evidence of indebtedness for the purpose of financing regional services and facilities
- To regulate the flow of solid waste to regional facilities.

Clearly, such powers must be exercised prudently and care should be taken in structuring the regional agency. It may be advisable to assign the agency one priority task initially, and conduct reviews of the agency's success and needs to accomplish succeeding tasks. For example, a first priority in some regions could be the development of a landfill. The regional authority could be assigned this effort prior to undertaking others. A drawback to this approach is the potential delay of other needed elements in the solid waste management plan.

TECHNICAL ISSUES

The following are among technical issues that should be considered in choosing between waste management alternatives:

- Mutual comparability
- Environmental impacts
- Reliability/longevity
- Land use requirements/resource conservation
- Facility siting
- Regulatory compliance
- Implementation timing.

In an integrated system it is important that waste management alternatives be chosen and designed to complement one another (3). For instance, mixed waste processing or waste-to-energy should be sized and designed to account for the degree to which source separation of materials for recycling will occur. Recycling (including composting) and waste-to-energy are compatible if they are not designed to process the same wastes. In fact, it has been shown that municipal solid waste (MSW) remaining after recovery of recyclables can have a higher per ton heat energy value than MSW before recovery (4)(5).

Environmental impacts with modern waste disposition alternatives, including incineration and landfilling, are expected to be minimal. However, waste reduction and recycling are still judged as preferable to disposal alternatives in avoiding environmental harm. In addition, waste reduction and recycling conserve energy, materials, and land. Waste-to-energy is also an energy conservation measure that helps reduce the use of fossil fuels and landfill space.

Reliability and lifetime factors need to be considered in planning an integrated system. The more complex the system, the greater the potential for problems. A landfill-only system of waste disposition has the greatest reliability. Recycling and waste-to-energy facilities will sometimes have mechanical failures that may necessitate by-passing processible wastes to a backup component in the system. Decisions will need to be made as to the degree of redundancy to design into each component of the system to prepare for both component downtime and seasonality changes in waste quantities. The landfill will always be the element of last resort and may need to be designed for considerably greater waste quantity fluctuations than in a landfill-only system.

Land use requirements are highest with a landfill-only system. The lack of available land for new or expanded landfills is one of the driving forces behind today's greater emphasis on integrated solid waste management. Diverting wastes from landfilling is maximized when waste reduction, recycling, and incineration are all used in a solid waste management system. Although of varying local interest, conservation of other natural resources may also be maximized by using these waste management alternatives.

While siting new landfills is usually very difficult, siting any facility that processes MSW can meet with varying degrees of public resistance (6). The regional system approach can be an advantage in dealing with this issue since fewer facilities may be needed. However, a regional system may allow the use of certain options not otherwise affordable in smaller communities. For example, a materials recovery facility (MRF) may not be economically viable in a community of 10,000, but such a facility serving several such communities will be far more cost effective. Thus, more types of facilities may require siting with a regional approach. The number of facility sitings may still be fewer if different facilities can be located together.

Regulatory compliance increases in complexity with increasing use of waste management alternatives and facilities. Obtaining necessary permits for a solid waste management system that includes a MRF, waste-to-energy facility, and landfill will require considerable effort and time.

Since, at least, some solid waste from an integrated solid waste management system will ultimately be landfilled, this may have a bearing on implementation scheduling. Assuring the availability of a landfill meeting regulatory requirements is of first priority. It may be advisable to proceed next with system components that can be effective in the near term—e.g., yard waste composting is of comparatively low technical complexity and can potentially be implemented quickly.

ECONOMIC ISSUES

System Costs

Choosing between waste management alternatives almost certainly involves cost considerations. In some instances, costs are the only criteria used in making these choices. Both capital costs (i.e., long-term investment costs) and on-going operating and maintenance costs must be considered.

Capital investment for waste management facilities can vary substantially depending upon the size and type of facility. At one end of the spectrum, waste-to-energy facilities may require an initial investment of $100,000 per ton of daily capacity or more (7). At the other end, landfills require a much smaller initial investment. Although capital investment costs can often be financed through borrowing, financial risk increases directly with the amount of investment and the period required to retire the investment. Thus, the risk attendant to high capital costs can impact choices of waste management alternatives that appear cost effective.

Adding annualized capital investment costs to annual operating and maintenance costs provides total annual costs for a waste management alternative. Subtracting any revenues from the sale of recovered materials or energy results in a net cost for the facility. The net cost may be converted into a cost per ton of waste processed at the facility for comparison purposes.

Factors Impacting Costs

It is important in assessing the costs of various waste management alternatives to account for their impact on the entire solid waste management system. For example, a recycling program that includes separate collection of recyclables has an impact on the collection, transportation and disposition of wastes. Thus, in determining the cost effectiveness of materials recovery for recycling, the costs of separate collection and processing of recyclables must be compared with resulting avoided waste collection and disposal costs. Unfortunately, the avoided collection and disposal costs, in most cases, are not linearly proportional to the reduction in waste quantity.

A cost advantage with regional solid waste management is the potential to achieve cost savings through the use of larger waste management facilities. Most such facilities, from materials recovery facilities (MRFs) for processing recyclables to waste-to-energy facilities and landfills, offer "economies of scale" that result in savings with larger sizes (7). Of course, the savings with larger facilities must be weighed against increased transportation costs.

Markets for recovered materials and energy are vitally important to the feasibility of resource recovery (including recycling). The net costs of recycling programs and waste-to-energy are highly dependent upon the revenues from recovered products. Since the prices for materials and energy can vary markedly over time, as well as geographically, care must be taken in planning resource recovery facilities. It is important to negotiate price commitments for recovered products to the extent that they can be obtained. Larger quantities of potentially recoverable materials and energy from regional facilities may result in more favorable market opportunities.

Methods used to finance waste management facilities can impact costs significantly where large capital expenditures are required. With current financing options, municipal bonds may be the least cost (8); interest on municipal government bonds are tax exempt, which results in lower interest rates. Using municipal (i.e., public) financing requires public ownership of the financed facilities. With privately owned facilities, tax-exempt financing can sometimes be secured through the use of private activity bonds (PABs). However, limits (or caps) on the use of PABs for financing privately

owned facilities often prevents their use for financing waste management facilities.

Implementation decisions with respect to ownership, procurement, and operation can also impact system costs. In addition to affecting financing options, implementation decisions will have cost implications with respect to operation efficiencies, allowances for profits, etc.

IMPLEMENTATION ISSUES

If waste management facilities are to be established, choices must be made relative to facility ownership, procurement, and operation. A general description of the choices and interrelationships between these implementation factors and their potential impacts follows.

Ownership

Waste management facility ownership may be either public or private. Public ownership normally means that a municipal governmental unit, authority, or agency owns the facility. Private ownership may be through a private corporation, partnership, or sole proprietorship.

Public versus private ownership dictates available options for procurement, operation, and financing, and may impact facility control as well. Private ownership of capital-intensive waste management facilities (e.g., waste-to-energy) has sometimes been chosen to avoid public agency involvement and risk in an unfamiliar area. Also, the tax benefits of private ownership were substantial prior to the Federal Tax Reform Act of 1986 and were often judged to result in a lower cost operation.

Currently, public ownership of capital-intensive waste management facilities is often recommended as the most cost-effective and practical approach. Public ownership projects are reported to require less time to finance and implement and may involve little if any additional public risk. The financing of such privately owned projects usually requires risk sharing such that ownership, per se, may have little impact on risk allocation.

Procurement and Operation

Waste-to-energy and other waste management facility procurement options include the following:

- Architectural/Engineering (A/E)
- Turnkey
- Full service.

The A/E procurement method is the standard method that governmental bodies use to build most public facilities. A consulting engineer is retained by the governmental entity to prepare the facility design. a contractor is hired through a bidding process to build the facility, which is publicly owned and usually publicly operated.

With a turnkey arrangement, a contractor will be responsible for both designing and building the facility. Turnkey procurements, typically, involve public ownership. The completed facility may be operated either publicly or privately. Private operation may be by the turnkey contractor since he is intimately familiar with the facility design and construction.

A full service procurement involves one private entity accepting responsibility for design, construction, and operation of the facility. This form of procurement is normally considered mandatory for private ownership of a

waste-to-energy facility, but may be used with public ownership as well.

Most waste management facility procurements follow one of the three basic options described above or close variations thereof. Either of these options may be used with public facility ownership while full service would usually be the only acceptable procurement for private ownership. Also, it seems doubtful that a public owner would wish to use an A/E or turnkey procurement if private operation were desired; a private operator would be more inclined to accept risk if he were thoroughly familiar with the facility by virtue of having designed and constructed it.

The accompanying table is used to summarize solid waste management facility procurement and operation options available with public and private ownership. Financing options, comparative public risk, and implementation time with each form of ownership is shown as well.

SUMMARY

Many factors that may be assessed in integrated MSW management planning are important to any planning area.

Technical and economic comparisons of solid waste alternatives will always be considered in the planning process. Determining and responding to community needs and goals, and decisions on how and when to implement needed waste management alternatives will be important also.

Table

FEATURES OF PUBLIC VERSUS PRIVATE OWNERSHIP OF SOLID WASTE MANAGEMENT FACILITIES

	Public Ownership	Private Ownership
Procurement options	A/E Turnkey Full service	Full service
Financing options	G.O. bonds Municipal revenue bonds Federal/state grants Public funds	Private activity bonds (PABs) Taxable bonds Private party loans Equity from vendor/ third party
Operation	Public (typically) with A/E or turnkey Private with full service	Private
Public risk	Similar 1/	Similar 1/
Implementation time	Less than with private ownership	Greater than with public ownership

1/ Applies primarily to waste-to-energy facilities financed with large bond issues.

Source: Franklin Associates, Ltd.

Regional planning introduces a few additional considerations. More communities will mean different degrees of needs and goals to address. Intergovernmental cooperation will be necessary to implement a regional solid waste management system; a regional authority with specific powers may be needed. In addition, planning a solid waste management system for a large geographical area will increase the complexity of comparing system costs. More waste management options may be feasible with greater waste quantities, but the "economies of scale" with larger facilities must be balanced against increased transportation costs.

Despite the difficulties that may be encountered in planning and implementing regional solid waste management systems, they can be beneficial in many areas. The trend toward regional solid waste management in these areas is expected to continue.

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INTERNATIONAL EXPERIENCES WITH ECONOMIC INCENTIVES FOR SOLID WASTE MANAGEMENT

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Presented at the

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June 13-15, 1990

INTERNATIONAL EXPERIENCES WITH ECONOMIC INCENTIVES FOR SOLID WASTE MANAGEMENT

I. Introduction
- A. The value of economic incentives for solid waste management
- B. The state of national and international information about economic incentives for solid waste management

II. The Advantages and Disadvantages of Using Economic Incentives
- A. Costs and benefits with respect to household waste behavior
- B. Impacts on the disposal solid waste management system
  1. Financial costs arising from the variability of the waste stream
  2. Transaction costs for administering the programs

III. Case Studies of Communities Employing Quantity-based User Fees
- A. European experiences: Germany, Switzerland and Sweden
- B. Japanese experiences

IV. Program Comparisons
- A. Differences in program design
- B. Program effectiveness
  1. Impact on waste stream
  2. Financial consequences

V. Conclusion
- A. Maximizing effectiveness of economic incentives
- B. Topics needing further investigation
- C. Implications for U.S. policy

THE MAJOR ECONOMIC ISSUES OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY'S PROPOSED MATERIALS SEPARATION REQUIREMENT FOR MUNICIPAL WASTE COMBUSTORS

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The Major Economic Issues of the
U. S. Environmental Protection Agency's
Proposed Materials Separation Requirement
for Municipal Waste Combustors

Introduction

Description of separation requirement

Goals of study:

- Estimate national diversion by material
- Estimate national cost of separation requirement
- Capture range of behavioral and market responses

Household Response

Determinants of household participation in recycling program

Determinants of household capture rates

Estimating cost to household of its recycling activity

Municipal Response

Potential separation programs

- No household separation
- One-stream
- Two-stream
- Multiple separation

Determinants of program choice

- Demographic characteristics of municipalities
- Compliance requirements

Costs

Environmental concerns

Modeled communities and modeled programs

Materials separated

Costs

National aggregation issues

Choice of program by community

Scaling up from modeled communities and programs to nation

Secondary Market Response

Materials separated

Supply shift

Price response (and impact on community's net costs)

Partial equilibrium multi-market model of newspaper

A MODEL FOR CALCULATING THE COSTS OF DISPOSAL

Steve Greenwood
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Presented at the

First U.S. Conference on Municipal Solid Waste Management

June 13-16, 1990

A MODEL FOR CALCULATING THE COSTS OF DISPOSAL

The Need for Cost Information

As public officials examine important policy questions on solid waste management options for the 1990s, a key factor will be cost. In evaluating landfills and other waste management options, the comparative cost of these options will be important.

The Oregon Department of Environmental Quality (DEQ) has developed an easy-to-use microcomputer model of the "true cost" of solid waste landfilling, which is also useful in estimating the "avoided costs of disposal" when comparing landfilling to various waste reduction options. The model attempts to measure the "true social costs" of landfilling, with the assumption that historic "tipping fees" at the local landfill may not provide an accurate or fair comparison to the costs of recycling.

The Oregon Opportunity to Recycle Act, passed in 1983, provides that all communities in Oregon with a population of more than 4,000 people shall be provided with curbside collection of recyclable materials. The list of "recyclable materials" is based primarily on an economic test, which compares the cost of recycling (including the revenue received) to the avoided costs of pick-up and disposal. In the absence of the other data, the comparison is based upon current tipping fees at the present landfill, which do not reflect the potential environmental risk posed by

historical methods of landfilling, nor the cost of the next landfill with increased environmental protection features.

The 1985 Oregon Legislature took action to formulate a comprehensive solid waste program for the Portland metropolitan area, which contains half of the state's population. This program was to be based on an aggressive waste reduction program that went beyond the requirements of the Opportunity to Recycle Act. Policy options included recycling, material recovery, and the use of alternative technologies such as composting and incineration. Once again, the Oregon Legislature brought costs into the analysis by stating that waste reduction measures must be "economically feasible." One way to determine economic feasibility is to compare the costs of waste reduction to costs of land disposal.

The easiest, and most obvious, measure of disposal costs is to take the existing "tipping fee" at the landfill. Indeed, this is how most of the disposal costs have been estimated in performing the economic test for recyclable materials under the Oregon Opportunity to Recycle Act. Many recyclers and environmentalists, however, are quick to point out that these tipping fees do not always reflect the true "societal" costs of landfilling. What about the "external costs" of environmental risk or damage that are not accounted for in the tipping fee? Many of our present landfills will soon be full. What about the costs of the next landfill, which will require a much higher level of environmental controls? Are we under-valuing the cost of landfilling by not looking at the replacement cost of the landfill space we're using up today?

Developing the "True Cost" Model

In 1986 the Oregon Department of Environmental Quality (DEQ) hired ECO Northwest, economic consultants, to develop a model for estimating the true social cost of landfilling solid waste. Working with ECO Northwest were Brown and Caldwell, consulting engineers, who supplied technical cost data. ECO Northwest developed a micro-computer model of landfill costs using Lotus 1-2-3, requiring an IBM-PC compatible computer with enough capacity to run Lotus 1-2-3. Other hardware requirements include a compatible printer. The model is expressly designed to be used by planning and engineering professionals who are familiar with solid waste management, and who have a basic understanding of micro-computers and Lotus 1-2-3. It is very easy to use, and does not require expertise in either computer programming or micro-economics.

The model incorporates data that is entered into a Lotus spreadsheet under the following categories:

Baseline Data: Characteristics about an existing or proposed landfill site, such as size, depth of fill, number of tons per year, etc.

Pre-Development Costs: Costs of siting, environmental impact studies.

One-Time Capital Costs: Costs of initial construction and related facilities such as roads, property acquisition, leachate treatment facilities, etc.

Periodic Capital Costs: Divided into heavy equipment purchases, and cell preparation and closure.

Annual Operation and Maintenance Costs: Operating costs such as personnel, daily cover, insurance, etc.

Closure Costs: Primarily legal costs, since the landfill is assumed to close on a cell-by-cell basis.

Annual Post-Closure Costs: Calculated for a 30-year post-closure period, includes costs of monitoring and leachate treatment.

Other Environmental Costs: This optional category was included for potential impacts to property values. However, it was not utilized (see discussion below).

Transportation Costs: An optional section, can calculate either direct haul costs, or transport from transfer stations.

In each category, a number of cost factors are listed. After entering the appropriate data, the model provides a total cost for each factor, then for each category. Finally, the model summarizes the totals

for each category and provides a cost-per-ton figure for each category and for the total landfill.

The following example will help illustrate how the model works:

Pictured below is some of the baseline data from the model's spreadsheet, for a landfill with an annual capacity of 650,000 tons:

1. BASELINE DATA p 1

CATEGORY (UNIT)	ENTRIES			
1. LIFE OF LANDFILL	MONTH	YEAR	YRS.	MOS.
1.1 Today's Date	4	1986	NA	NA
1.2 Pre-development Beginning Date	4	1986	3	0
1.3 Construction Phase Beginning Date	4	1989	0	9
1.4 Fill Operations Beginning Date	1	1990	47	0
1.5 Closure Phase Beginning Date	1	2037	1	0
1.6 Post-Closure Care Beginning Date	1	2038	30	0
1.7 End-of-Care Date	1	2068	NA	NA
TOTAL PROJECT LIFE (YRS, MOS)	NA	NA	81	9
2. SITE SIZE/CAPACITY				
2.1 Annual Waste (000 Tons/Year)	947			
2.2 Depth of Fill (Feet)	136			
2.3 Buffer (Feet From Edge of Fill)	865			
2.4 Tons/Cubic Yard, Compacted	0.60			
3. DATA DERIVED FROM ABOVE ENTRIES:	DERIVED TOTALS			
3.1 Lifetime Capacity (000 Tons)	44540			
3.2 Operating Area (Acres)	340			
3.3 Buffer Area (Acres)	374			
3.4 Total Site Area (Acres)	714			

Later in the spreadsheet, under one-time capital costs (see below), the user enters data for the cost of land acquisition. Notice that the spreadsheet user has the option of using a unit price (multiplied by number of units) or a lump sum ("L.S.") figure for each cost factor.

A. ONE-TIME COSTS

CATEGORY (UNIT)	$/UNIT	#UNITS	L.S.	TOTAL $
1. LAND COST				
1.1 Off-Site ROW Land ($/Acre)	5000	50		250
1.2 Other Land ($/Acre)	2000	43	2086	2086
1.3 On-Site Land Cost ($/Acre)	5000	714		3569
SUBTOTAL (Or Enter Lump Sum)	NA	807		5905

Finally, cost totals for each category, and an overall cost are summarized at the end of the spreadsheet (see below). The left-hand column provides the total amount (in thousands of dollars), and the right-hand column provides a cost per ton. The lifetime capacity is also listed in thousands of tons.

TOTAL SITE ACREAGE	714
REAL DISCOUNT RATE	3.0%
LIFETIME CAPACITY (000 Tons)	44540

	1986 DOLLARS IN THE FIRST YEAR OF OPERATION	
	1990 $(000)	1990 $/TON
PREDEVELOPMENT COSTS	4010	$0.09
CAPITAL COSTS		
Land	6038	$0.14
1-Time Construction & Equipment	27975	$0.63
Periodic Equipment	8492	$0.74
Periodic Cell Development	49852	$4.35
Periodic Cell Closure	4488	$0.39
TOTAL CAPITAL COSTS	96844	$6.24
OPERATION & MAINTENANCE COSTS	73146	$6.38
FINAL CLOSURE COSTS	37	$0.00
POST-CLOSURE COSTS	6168	$0.14
OTHER ENVIRONMENTAL IMPACTS	0	$0.00
TRANSPORTATION COSTS	93261	$8.14
TOTAL COSTS	273465	$20.99
LESS BASE-CASE TOTAL COSTS	71465	$7.32

Society's Cost Versus the "Tipping Fee": What are the "True" Costs?

The landfill cost model developed by ECO Northwest provides a structured format for easily entering data, which the model then uses to calculate total and per-ton cost estimates. However, because of the Department's belief that there may be costs to society not captured in a tipping fee, the model had to be more than a standard accounting of costs directly experienced by the landfill operator.

In constructing this economist's view of the cost of landfilling solid waste, a number of important questions were addressed:

1) How do you account for costs occurring over time - and what about inflation?

In calculating the "true" cost to society, we first put all costs in terms of present (1986) dollars. In order to do this, we first assumed that all goods and services would, over time, experience a similar inflation rate. We, therefore, assumed away inflation in our analysis and put everything in what economists call "constant" dollars.

Secondly, because people have a preference for consumption now, rather than later, a "real" annual discount rate of 3% was used to devalue costs occurring in future years. This discounting of future costs is commonly used by economists and financial

analysts to make costs (or benefits) that occur in different years comparable. A 3% discount rate, for example, assumes that a person would just as soon have 97 cents today as a dollar next year. While the 3% discount rate was recommended, this rate can be easily changed.

It is important to note that by assuming away inflation, the model also does not incorporate financing costs (i.e., interest) but rather assumes the total cost of an item when it is experienced or purchased. Once again, this differs from the accountant's view of landfill costs.

2) How do you account for the potential (or real) environmental damage caused by landfilling?

The "true" social costs of landfilling are assumed to be the sum of costs reflected in the tipping fee ("internal" costs in the economist's jargon) and the "external" costs of environmental damage or degradation not incorporated into the tipping fee. The question is, how do you calculate the cost of environmental damage? Considerable attention was given to this most critical issue in developing the "true cost" model. Several alternatives were considered.

The principal environmental risks from landfilling include: a) groundwater contamination from leachate, b) risk of methane

gas migration to nearby structures, and c) air quality problems from particulates and air emissions from the landfill. One way of calculating the costs is to conduct a direct estimate of the value of the damage, or potential damage. This method was not considered feasible because of the tremendous effort involved, and the potential for inaccuracy.

A better approach, and the one utilized in the model, is to calculate the costs of preventing the environmental damage. In effect, determine the measures that will effectively reduce the risk of environmental damage to a negligible level (close to zero). This approach has two advantages. First, it is a figure that is much easier to accurately calculate. Second, when comparing future policy options, it is more important to consider future actions and expenses, rather than previous experience.

It should be noted, however, that this technique can be used to evaluate the cost of existing landfill facilities as well as proposed facilities. For example, an existing landfill may have limited design features for groundwater protection. To estimate the environmental cost of that landfill, one would calculate the cost of liner systems and leachate collection that would effectively prevent any groundwater contamination.

Interestingly, some of the assumptions made about "tipping fees" versus "social" costs when the model was developed in 1986 may now, in some cases, be reversed. Requirements for environmental controls, nuisance abatement, host community fees, buffering, and (most importantly) the cost of cleaning up environmental problems at older disposal sites, are causing what were previously external environmental costs to be internalized in the costs of siting, constructing, operating, and closing a sanitary landfill. In some communities now, the tipping fee at the landfill is actually higher than the true societal cost of current disposal.

3) How do you account for nuisance effects of landfilling?

There are a number of less tangible environmental costs, "nuisance costs," associated with landfills, that are impacts to the quality of life for nearby communities. These impacts include litter, noise, odor, and visual impacts of a landfill. It is those "environmental disamenities" that prompt a large portion of the public's resistance to the siting of landfills.

If these disamenities carry an associated social "cost," economists would argue that these costs should be reflected in property values, particularly for nearby residential property. Substantial research has been conducted on property value impacts of landfills, with most of the research indicating that

impacts are generally negligible or non-existent, beyond distances of 1,000 feet from the landfill. One study indicated that the size of a landfill influences these impacts, and that large sites may have an effect.

Once again, however, the method chosen for measuring these nuisance costs is by measuring the cost of design and operation measures which effectively eliminate these impacts: a buffer area for visual and noise screening, daily cover of the waste, litter patrols, gas collection systems, etc. In a well-buffered, well-designed and operated landfill, these formerly "external" costs (difficult though they were to measure) are now internalized into the cost of new landfill facilities. Where facilities do not incorporate these features, the cost model allows the user to calculate the costs as if it did.

4) <u>How do you account for the loss of valuable materials buried through landfilling?</u>

Many recyclers believe that an additional cost of landfilling is the loss of materials (glass, metals, etc.) buried in the ground. This is certainly true, although the "loss" is reduced by the cost required to retrieve, separate, market, and process these materials.

When comparing the cost of landfilling to waste reduction strategies, however, including the loss of recyclable materials in the cost of landfilling is to count the value of these materials twice. Their value is already incorporated (as a positive benefit) into the cost of recycling. To engage in this double-counting is to distort the analysis.

A similar argument is often made with respect to the value of the land used to dispose of garbage. "What about the future value of that land?" many ask. The economists (and real estate professionals) will tell us that the potential future value of land is a factor incorporated into today's market valuation of that land, which is already incorporated into the cost model. Therefore, to separately calculate the future value of land resources would be another example of double-counting.

Limitations of the Model

The biggest problem in using the model to compare the costs of landfilling to waste reduction options, is that the cost of those other options is often calculated with different assumptions. For example, the cost of financing and inflation are often included in recycling or waste-to-energy analyses. One therefore was the risk of making apples-to-oranges comparisons which may unfavorably distort the analysis of waste reduction options. A recent financial analysis of a proposed landfill in

Oregon added in the costs of inflation and financing to the cost model, which resulted in cost figures that were nearly 100% higher by the fifth year of analysis.

Second, we have found in Oregon that when using this model to compare solid waste landfills, that the comparisons need to be made over a comparable period. Or, if that is not possible, the differences in facility-life should be accounted for in the comparison. This is true primarily because of the reduced value of a dollar over time. Without accounting for these time differences, the analysis will be distorted in favor of the option which has been discounted over a longer period of time.

A third limitation of the model is that it does require accurate estimates of costs for each item, and therefore requires review by persons knowledgeable in landfill design and operational cost. As the saying goes, "garbage-in, garbage-out."

A fourth and related limitation is that environmental risks and other design requirements will differ from site to site and between geographic areas. There are always some unique features to each landfill site. Therefore, it is important that these site specific features be included into the analysis when comparing sites, rather than relying on the generic model.

Conclusion

The model developed by ECO Northwest and the Oregon Department of Environmental Quality represents an attempt to include both private costs and "external" environmental costs associated with landfilling. With some limitations, this kind of model can be useful for policy-makers faced with difficult choices on how to deal with solid waste.

SW\SK2774 (5/90)

Public Participation in Facility Siting

A Decision Technique

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ABSTRACT

Local governments, utilities, and private industry often confront chaos when implementing plans for new solid waste disposal facilities. In the face of this chaos, Rogers, Golden and Halpern has developed a method to successfully site facilities by incorporating meaningful public involvement in the decision-making process.

Each facility siting effort is tailored to the unique attributes of the particular area, but includes two basic elements: a regional screening process to identify candidate sites, and a structured decision-making methodology with an advisory committee to rank the sites in order of preference for development.

The methodology, known as the Nominal Group Technique (NGT), is favored over less structured practices because it incorporates diverse viewpoints of the advisory committee members, thus fostering problem solving. In and of itself, the committee provides broad geographic and interest-group representation, which enhances the unbiased, repeated value-setting and participant discussion and interaction that are hallmarks of the Technique.

Members participate in a series of meetings and tours to learn about facility design, construction, and operation. During the course of the meetings, they transform their concerns about waste management facilities into actual criteria by which the candidate sites will be ranked.

The NGT includes a series of "weighting" exercises wherein concensus is reached about the relative importance of these criteria. The values are then applied to the actual sites and arithmetically scored, and then the sites are ranked. The locations of the sites are kept confidential until the final ranking is complete, enabling participants to make siting decisions based on objective, quantified data rather than on arbitrary opinion or conjecture.

This process has been used successfully by RGH for major solid waste facility projects in New Jersey, Pennsylvania, Maryland, Indiana, and Virginia.

Local governments, utilities, and private industry often confront chaos when implementing plans for new solid waste disposal facilities. In the face of this chaos, Rogers, Golden and Halpern has developed a method to successfully site facilities by incorporating meaningful public involvement in the decision making process. This method combines regional screening for candidate sites with a public decision making technique to rank the candidate sites in order of preference for development.

Many of us who have been involved in facility siting are familiar with this scenario: The project manager has met with the client and has thoughtfully performed a detailed scope of work, all of the data collection tasks are performed in a thorough manner, the technical investigations are completed, thousands of dollars have been spent to determine the best site location and a well-intentioned announcement is made to the public. Instead of informed, rational debate something else happens - all hell breaks loose.

Experience has shown that public opposition to proposed locations of the entire range of solid waste facilities can scuttle otherwise technical suitable sites. For this reason, solid waste planners sometimes refer to the 80/20 rule. This rule of thumb equation says that facility acceptance is only about 20 percent technical merit, and really 80 percent socio-political consideration.

Solid waste planners, facility developers and municipal officials must realize that solid waste facility siting is really a balancing act. This balancing act must obviously address technical considerations very carefully and accurately, but must also bring into the decision process social, economic, and political considerations. We must also recognize that certain environmental and regulatory considerations may exist outside of the permitting process. With these considerations in mind, RGH tailors each facility siting effort to the specific attributes of the particular area and facility type. However, each study contains the following consistent elements:

- o regional screening using exclusionary criteria to identify candidate sites;
- o development of evaluative criteria;
- o structured public decision-making to rank candidate sites.

The regional screening process involves the identification of exclusionary or limiting criteria from federal state and local policy. These criteria may include such areas as protected farmland, public recreation areas, airport restrictions, wetlands, unique natural features and developed land. Once the criteria are determined the appropriate data is collected and overlay maps are developed to identify candidate areas. Several mapping scales may be used to move from the candidate areas to the identification of specific candidate sites.

As far as the regulatory process is concerned, a particular study area's candidate sites may all be equal, as far as the public is concerned, they may not be. It is important to acknowledge and discuss with the public the fact that there is no perfect site. The selection process will involve a series of tradeoffs and a decision method must be used which can account for these tradeoffs. Two hypothetical examples can illustrate the concept of tradeoffs: a large buffer for a candidate site may be desirable, but the conditions of a study area may necessitate the use of a haul route which produces an unacceptable level of truck traffic in a particular area; or minimal disturbance to farmland or forest may be desirable, but this consideration may place sites unacceptably close to high density residential areas.

Because these tradeoffs reflect value judgements, RGH uses public advisory committees to develop a seperate set of evaluative criteria to reflect their concerns about the facility being sited. The criteria developed by these advisory committees generally fall into three categories: environmental, social or economic.

To develop the criteria, the committee members first participate in a series of educational workshops where they learn detailed information about facility siting, design, operation, end use and other concerns such as geology and risk assessment. Committee members also participate in a Saturday field trip to existing facilities to gain a first hand understanding of facility operations and their potential impacts to adjacent communities.

The specific evaluative criterion begin as concerns raised during a committee meeting. The concerns may address such things as surface water protection, single source aquifers, truck traffic or facility end use. Through a series of meetings, these concerns are refined into measurable criteria which can distinguish between sites. The objective of each criterion is mutually agreed upon as well as the data sources and data collection methods. Data categories are developed for a range of conditions, with a uniform numerical scale used for consistency between criterion.

Once the criteria have been developed, agreed to by the Advisory Committee and the appropriate data collected, a structured decision process is needed to objectively rank the candidate sites. The process that RGH has used successfully to establish the relative importance (weights) of different environmental, socioeconomic and engineering cost criteria is called the Nominal Group Technique. This decision making technique has several advantages:

- o incorporation of variety of viewpoints;
- o unbiased value setting;
- o ample discussion and interaction among participants;
- o highly defensible.

The objective of this process is to arrive at a group statement on the relative importance of various issues related to the construction and operation of a solid waste facility. To maintain the objectivity of the advisory committee members, to focus their attention solely on the criteria - the locations of the candidate sites are kept confidential.

The advisory committee participates in an all day Saturday workshop in which they individually assign weights to the criteria based on each criterion's relative importance. Several rounds of discussion and weighting take place until the committee is satisfied that they have thoroughly discussed each criterion. (see figure one)

To rank the candidate sites in order of preference for development, the weights given to each criteria must be multiplied by the site's data category rating. Scores for the criterion are then summed to give each site a total site score. We use a computer to calculate the results and rank the sites from best to worst, or highest to lowest score. (see figure two)

A sensitivity analysis is performed for the criteria to help participants understand how the criteria influenced the ranking. For example, does the ranking of the candidate sites change if only the environmental criteria are used? Which criteria influenced the ranking process most heavily? How does the site ranking appear if only the top ten ranked criteria are used? This type of analysis builds further understanding of the decision process and greater confidence in its results.

Site confirmation is the final step in the process. Because the data used for the ranking process is based on available printed information only, field investigations are necessary to evaluate the sites for inconsistencies in published data. These inconsistencies, if they exist, are noted and the decision makers may decide to allow the information to re-rank the candidate sites.

To conclude, our experience has shown that public participation is only one element in successful facility siting. The first essential element in a successful effort is a clearly defined need for the project. This is followed by the need for a strong lead agency, or champion, to maintain project momentum and keep the efforts on track. Tested technologies are necessary which match technically suitable and appropriate candidate sites. A clearly defined decision process which incorporates public involvement must be combined with a willingness on the part of the decision-makers to listen and negotiate. Finally, the project must be accompanied by incentives which can be viewed as a method of sharing the benefits the facility will have on the larger society with the community that bears the perceived risks of hosting the facility.

Figure 1

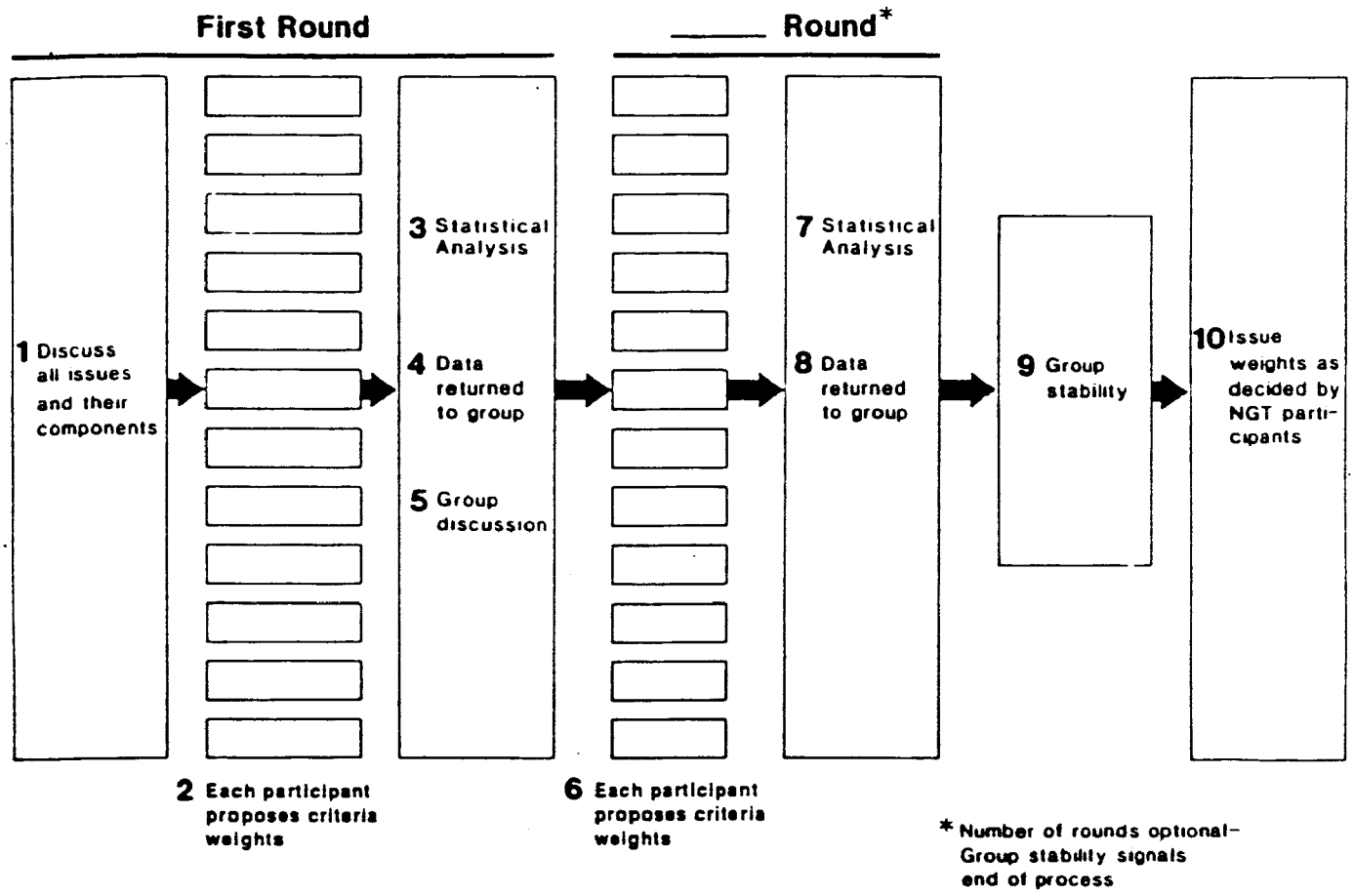
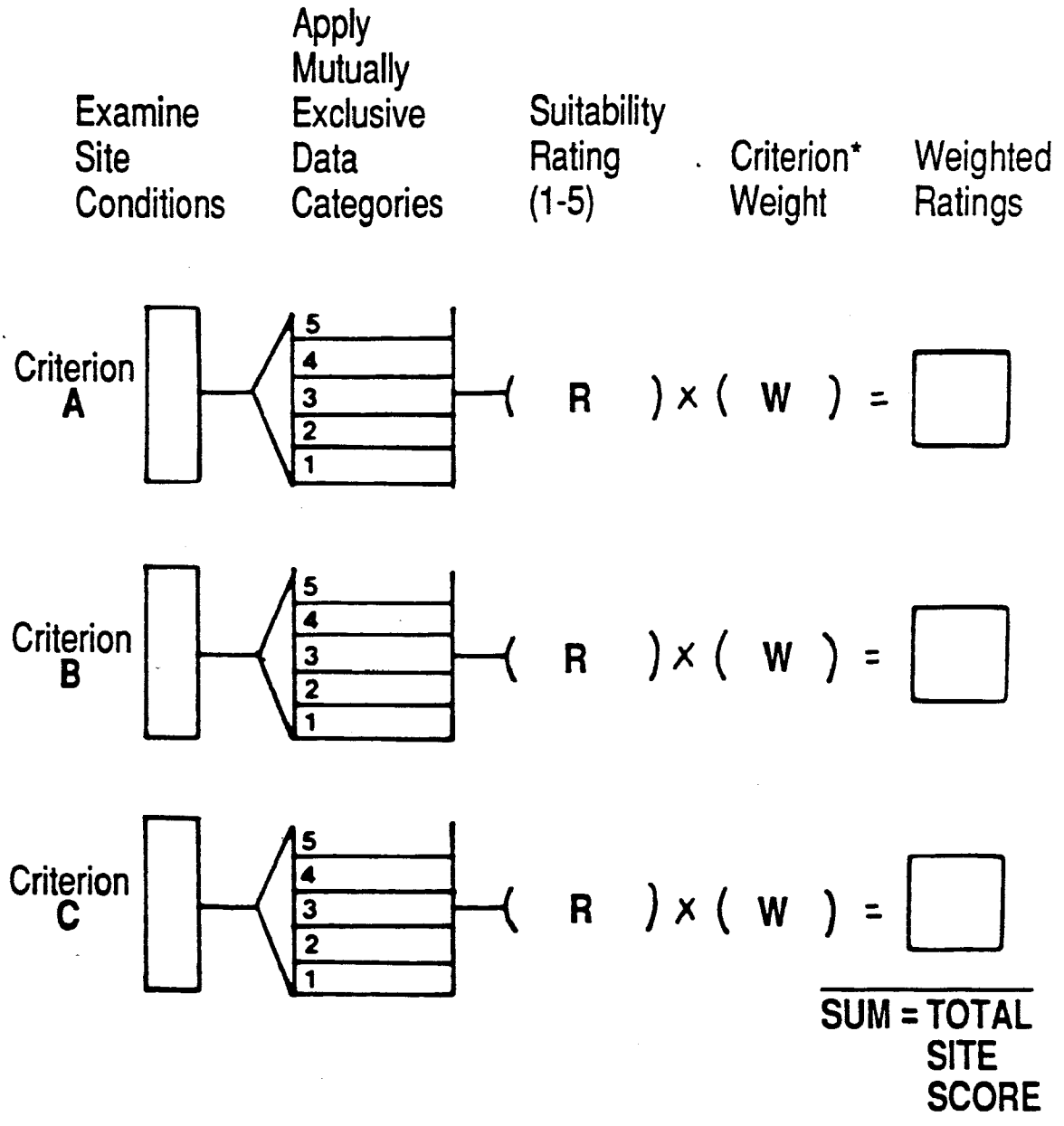

First Round
_____ Round*
1 Discuss all issues and their components
2 Each participant proposes criteria weights
3 Statistical Analysis
4 Data returned to group
5 Group discussion
6 Each participant proposes criteria weights
7 Statistical Analysis
8 Data returned to group
9 Group stability
10 Issue weights as decided by NGT participants
* Number of rounds optional– Group stability signals end of process

Figure 2



*Developed through the NGT process

RECYCLING IN RHODE ISLAND
A BLUEPRINT FOR SUCCESS

Victor Bell
Department of Environmental Management

Presented at the

First U.S. Conference on Municipal Solid Waste Management

June 13-16, 1990

RECYCLING IN RHODE ISLAND

A Blueprint for Success

Victor Bell
Chief, Rhode Island's Ocean State Cleanup and Recycling Program (OSCAR)

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FOREWORD

The nation is facing two powerful and converging forces. Waste generation is increasing while the supply of waste disposal facilities is declining. As the pressure to handle growing tonnages of garbage intensifies, traditional waste management methods—landfill and incineration—are becoming more costly. Environmental concerns make it almost impossible to site new facilities, even though one-half of the country's existing landfill capacity will be exhausted in ten years.

The solid waste disposal crisis is most acute in the populous northeastern states, where few major landfill facilities have been sited for a decade. But the problem is evident to some degree from coast to coast. Governments at all levels are facing pressure to adopt waste management solutions that are both cost-effective and environmentally benign.

In Rhode Island, with the passage of the 1986 Solid Waste Management Law, the first statewide mandatory recycling law in the country went into effect. Rhode Island's program is characterized by strong state leadership and a centralized structure for implementing recycling programs. This comprehensive approach has given the state the opportunity to develop and test programs, gather information, and measure results in a timely and systematic way.

With this in mind, the Council of State Governments, in cooperation with Rhode Island's Department of Environmental Management (DEM), and its Ocean State Cleanup and Recycling staff (OSCAR), is presenting this review of Rhode Island's program. We believe that Rhode Island's experience, and the lessons it has learned, will provide valuable insight for everyone concerned with developing workable options for solid waste management.

We wish to acknowledge the Rhode Island Solid Waste Management Corporation, Resource Integration Systems, Ltd., Coca-Cola USA, the Rhode Island League of Cities and Towns, and FitzGerald & Company, Inc. (Cranston, Rhode Island) for their assistance in producing this document.

Shelley Dresser-Gagnon
Director of Energy-Environment Programs
Council of State Governments

Victor Bell
Chief, Rhode Island's Ocean State Cleanup and Recycling Program

"I think that the most valuable insights that other jurisdictions might gain from a review of our program relates to our experiences to date. There are plenty of experiments in government today, which makes the ones that truly work that much more important and interesting. In Rhode Island, our experience is that recycling is working."

Brad Gorham, Minority House Leader, past chairman of special legislative committee on solid waste and current chairman of Rhode Island Source Reduction Task Force.

THE OVERVIEW

When Rhode Island lawmakers set out to solve the state's solid waste management problem, their goal was to maximize recovery of recyclable materials and reduce the amount of waste going to landfills.

In 1986, lawmakers passed a far reaching solid waste management bill. Its focus was mandatory recycling for every business and municipality in the state. The bill made it state policy to reduce the amount of waste going to landfills, re-use items that were once tossed out, and to incinerate non-recyclable waste and convert it to electricity.

Implementing the mandatory recycling bill was no small task. So, lawmakers chose an integrated and comprehensive approach.

1986 SOLID WASTE ACT AMENDMENTS
KEY POINTS

- Established statewide priorities: Reduction, Recycling, Energy Recovery,Landfilling.
- Set goal to recycle a minimum 15 percent of Solid Waste. (residential, commercial, government agency)
- Required construction of recycling facilities at or near all state disposal facilities.
- Required garbage to be separated into recyclable/non-recyclable components prior to disposal at solid waste facilities.
- Set subsidized fee for disposal of separated solid waste.
- Required municipal recyclables to be tipped at no charge.
- Required state to fund all reasonable additional costs for municipal recycling during first three years of the program.
- Required state to provide technical assistance for all waste generators.
- Required state to give preference in state bids and contracts to vendors of recycled paper.

THE APPROACH

Rhode Island's mandatory recycling program is operated by the state, and applies to everyone from homeowners to big businesses.

The Department of Environmental Management's Ocean State Cleanup and Recycling (OSCAR) program works in partnership with the Solid Waste Management Corporation, the Rhode Island Department of Administration, municipalities and businesses to reduce the amount of waste placed in state landfills.

This comprehensive and integrated statewide approach eliminates the problem of working with recycling programs that differ from town to town. Because the waste management program operates within one system, it is possible for the state to achieve management efficiency and economy of scale.

Through this cooperative statewide effort, Rhode Island has become the first state in the country to mandate collection of a broad range of recyclables. The state not only recycles the most common and marketable products, but also recycles such items as steel cans, plastic milk containers and plastic soft drink bottles.

WHY RECYCLE?

Until recently, recycling was viewed only as a way to make money, and was considered a failure if it didn't produce substantial revenue. Rhode Island has put recycling in a different context. The state treats recycling not as a way to make money, but as an economical and environmentally acceptable way to manage solid waste.

Recycling reduces the cost of waste disposal, and provides the cheapest option available for solid waste management. Each day, hundreds of tons of waste are diverted from Rhode Island landfills. Recycling has become a key component in a comprehensive and integrated strategy to conserve existing land space and reduce the amount of garbage entering the waste stream.

SOLID WASTE MANAGEMENT
LEGISLATIVE HISTORY

R.I. General Assembly creates Solid Waste Management Corporation (SWMC) to build and operate solid waste facilities.	1974
Litter Control and Recycling Act is adopted. Ocean State Cleanup and Recycling Program (OSCAR) established and funded through a broad-based litter tax.	1984
Brown University awarded grant from OSCAR to study role of recycling in solid waste management. In late 1985, study recommends strategies for implementing recycling programs.	1985
Waste-to-Energy and Flow Control legislation WITHOUT mandatory recycling is killed.	1985
Special House Commission studies Resource Recovery and Solid Waste Management.	1985
Comprehensive Solid Waste Management Bill, including mandatory recycling, passes.	1986
Rhode Island Source Reduction Task Force is established.	1986
Pilot recycling program begins. Includes more than 4,500 households.	1987
Municipal recycling program adds more than 112,000 households and 305,000 residents.	1988
January 1 — commercial recycling regulations go into effect. Rhode Island disposal facilities cannot accept wastes containing more than 30 percent recyclable materials by weight.	1989

"To some extent, recycling as a waste management option has been hampered in other jurisdictions because of its history as an activity people did to make money. Now, it's starting to be understood for its full value as an essential waste management tool."

Victor Bell, Chief, OSCAR program

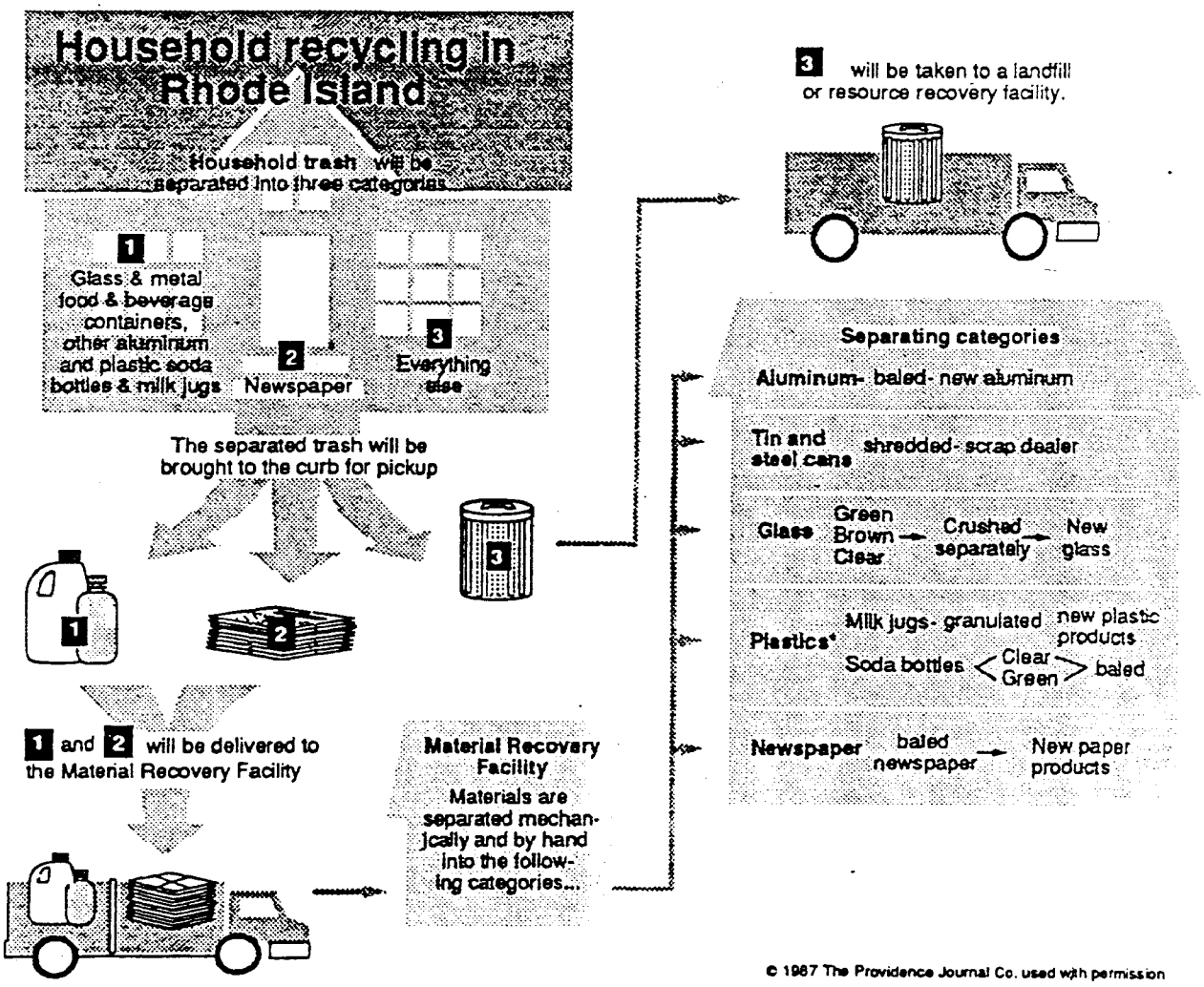
MUNICIPAL RECYCLING

The programs seek to maximize recovery of materials in order to divert the greatest amount of waste from the landfill and to keep collection costs under control.

How It Works:

Programs are designed in consultation with each community in order to be compatible with the existing solid waste collection and disposal system. As a class-one program*, all recyclables, with the exception of newspapers, are placed in one bin by the resident and set out for curbside collection on the same day each week as garbage pickup. Newspapers are bundled separately and placed next to the recyclables container. The containers are provided by the state, one to a household. The truck operator places the mixed materials in one compartment of the truck and newspapers in another, then transports the items to the Materials Recovery Facility (MRF) for further sorting and processing.

Recycling trucks are designed to promote collection efficiency and accommodate high-volume items such as plastic milk containers and soda bottles. Each large capacity vehicle has a dedicated closed body so no trailers are necessary. Flexible compartments can be moved around if the amounts or types of materials collected changes. Each truck has easy loading, automatic unloading, a low-entry cab, and can be operated by one driver.



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*A class-one program means that multi-materials are included in the recycling program and that collections in urban areas are made weekly at curbside on the same day as garbage pickups. Class one also means that special set-out containers are provided, one to a household. In rural areas, municipalities establish drop-off centers.

These features contribute to efficient and cost-effective collection.

The Department of Environmental Management's OSCAR program and the Solid Waste Management Corporation work together to help cities and towns prepare for recycling.

OSCAR is responsible for writing the regulations, preparing start-up schedules, defining the list of recyclables, administering state funds, and providing technical assistance to municipalities. Technical assistance is an important part of OSCAR's work because the success of recycling depends on cooperation and a clear understanding of how the program works. Services include helping local officials to develop planning studies, write ordinances, and train recycling coordinators. In general, the OSCAR staff acts as a resource wherever necessary.

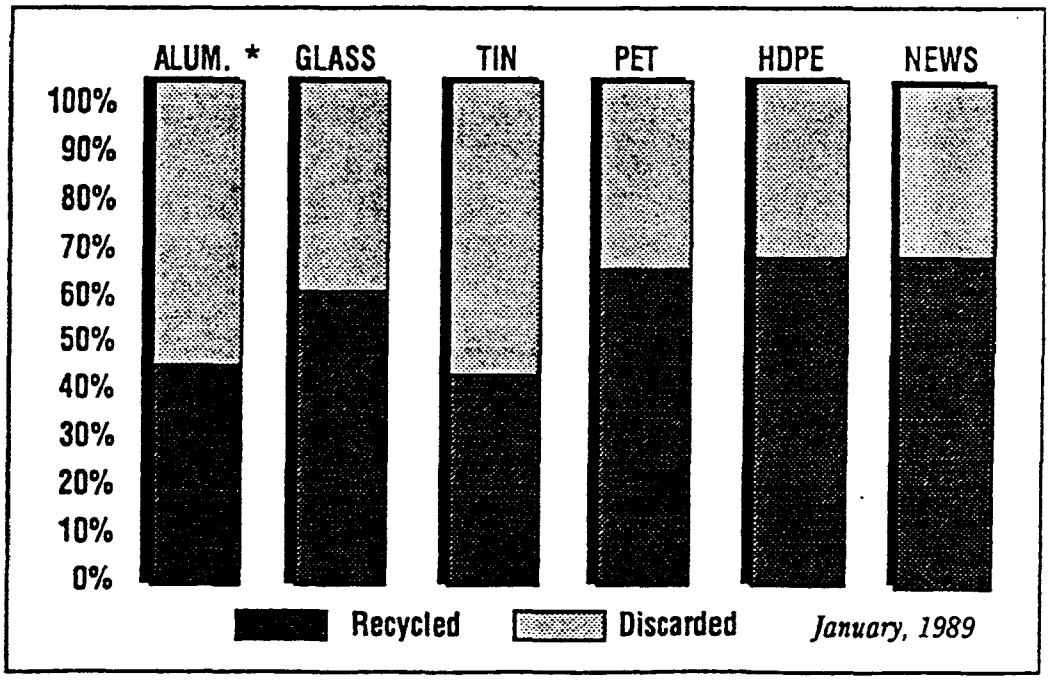
The Solid Waste Management Corporation funds all reasonable additional costs of recycling during the first three years of the program in each town and city. The Corporation provides a Materials Recovery Facility at or near each state solid waste disposal facility, where municipalities may deposit mixed recyclables free of charge.

Continued on page 7

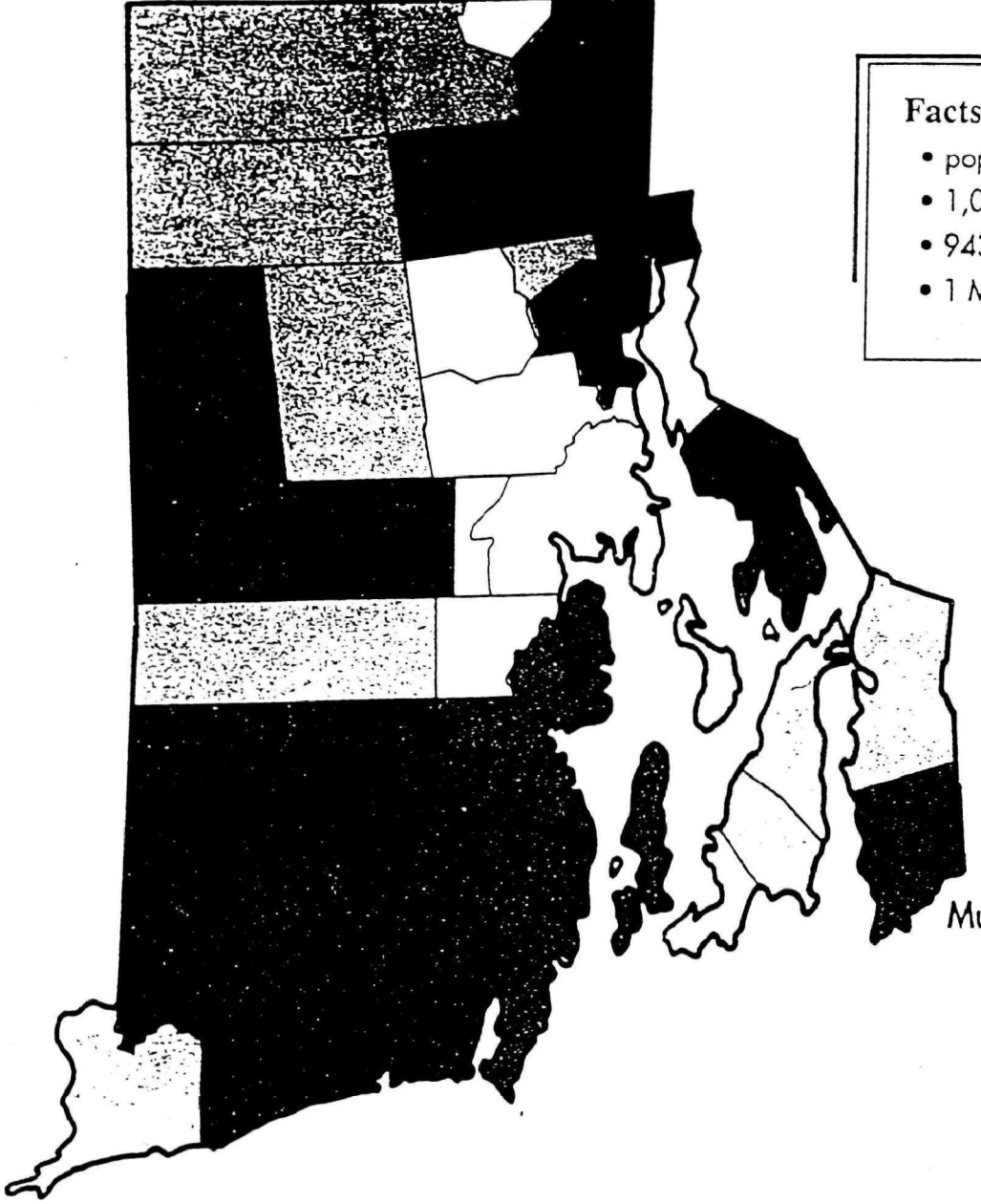
"Typically, state agencies have the capability and experience in providing centralized services, such as planning and program development or advertising, while municipalities have historically been involved with the provision of local services such as garbage collection. Therefore, the Rhode Island municipal recycling program works well because there is no requirement for any of the players to change the current nature of their operation. The state has also reduced risks for municipalities considerably by arranging to handle the final preparation, shipment and sale of materials to markets."

Ken Payne, Former Director of the
Rhode Island League of Cities and Towns

Capture Rates of Recyclable Materials (percentage by weight)



This capture rate for aluminum does not include the aluminum recovered through buy-back centers.



Facts about Rhode Island:

- population: 1 Million
- 1,049 square miles
- 943 persons/square mile
- 1 Million tons of solid waste created per year

Municipal Recycling Schedule

On line as of:

1988

1989

1990

Municipal Recyclables

- Newspaper
- Glass, food and beverage containers
- Tin-coated steel cans and steel cans
- Aluminum cans
- Plastic milk containers (HDPE)
- Plastic soft drink containers (PET)

Facts about Recycling:

- 112,000 households on line
- 305,000 people on line
- 85% participation rate
- 14% of all solid waste is diverted from the landfill

As of January, 1989

Continued from page 5

Cities and towns must separate solid waste into recyclables and non-recyclables before disposal in state-owned facilities. During the first three years of their programs, municipalities must meet the same percentage of separation achieved by similar communities in the mandatory recycling program.

Results

Today, more than 112,000 households (305,000 residents) are participating in recycling. Participation rates have averaged more than 85%, and over 14% of all residential waste is now diverted from landfills. The result has meant substantial savings in local solid waste management and hauling costs. Recyclables are accepted free of charge at Materials Recovery Facilities, so every ton tipped represents an $11 per ton savings to communities.

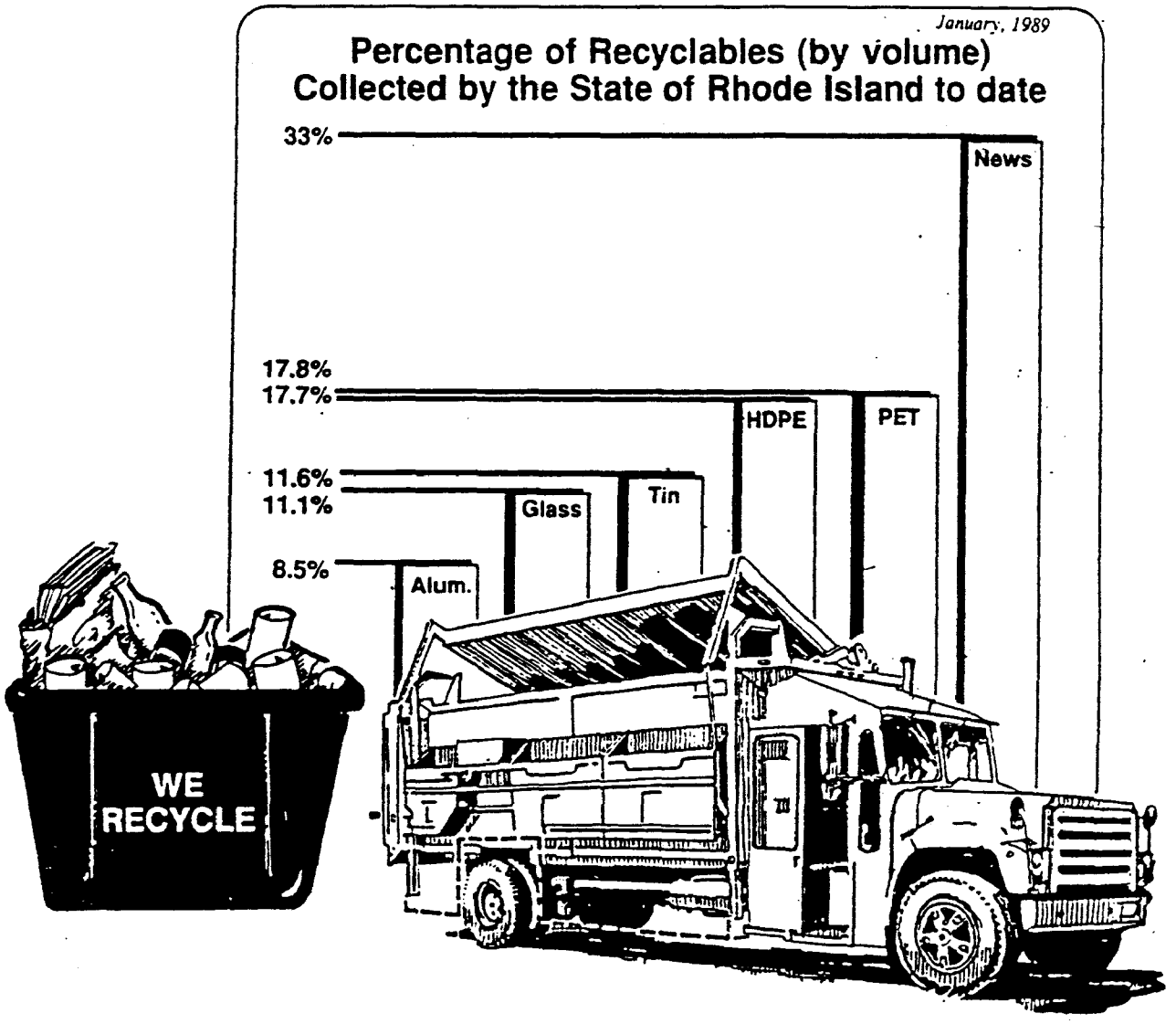
FUTURE MUNICIPAL RECYCLING PROJECTS

January, 1989 — On-truck densification study with NAPCOR.

Spring, 1989 — Pilot project for mixed rigid plastic collection and separation.

Spring, 1989 — Household battery separation and collection within the blue box pilot.

Early 1990 — Leaf and yard waste added to list of recyclables.

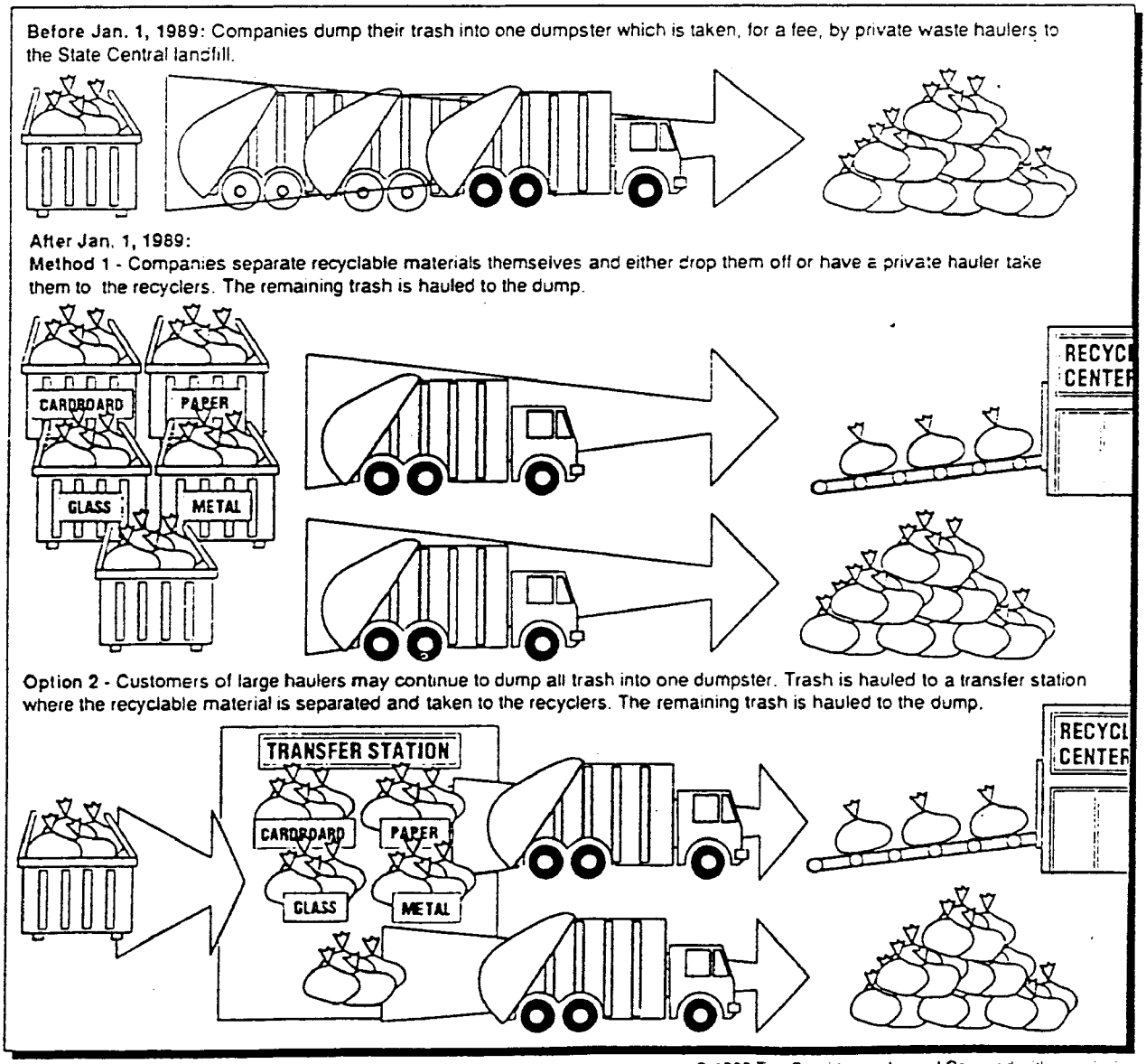


Automatically Loaded Closed Body Recycling Truck

COMMERCIAL RECYCLING

In studies of Rhode Island's commercial waste stream, the state found large amounts of recyclable materials were being disposed of in landfills at high tipping fees (currently $49 per ton), when these same materials could have been sold and recycled. The state has targeted marketable recyclables which can be collected in large quantities. Industry, commercial establishments and large apartment complexes must segregate recyclable materials from their solid waste before it is delivered to a solid waste disposal facility. (Apartment complexes must begin recycling no later than six months after the municipal recycling program begins in their community.) Starting January 1, 1989, Rhode Island disposal facilities cannot accept waste containing more than 30 percent of listed recyclable materials by weight. In 1990, waste must contain less than 20 percent listed recyclables to be accepted for disposal.

Rhode Island's plan for commercial recycling



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Commercial Recycling: How It Works

The first phase of the commercial recycling program requires businesses to recycle listed materials. These targeted materials are the easiest to identify, separate and market. The Department of Environmental Management provides a list of regional markets. Because prices in the private sector recycling market fluctuate, creating a climate of uncertainty for commercial generators, the Solid Waste Management Corporation has agreed to serve as a "market of last resort" for listed recyclable materials. Should no other market exist, the SWMC will accept any of the listed materials at the state's Materials Recovery Facility for a payment of 1/4 of the commercial tipping fee per ton.

At any time, a company may petition the state to add a commodity to the list of recyclables. The company must guarantee a market for the commodity and demonstrate an economical collection system. The state is currently reviewing several commodities for possible addition to the list of recyclables.

. The second phase of the commercial recycling program requires businesses, beginning with the largest employers in the state, to submit detailed waste reduction and recycling plans to the Department of Environmental Management. Every business with more than 500 employees must submit a plan for reduction and recycling of solid waste no later than June 30, 1989. Subsequently, employers of 251 to 500 people must submit plans before December 31, 1989, and businesses with 101 to 250 employees must submit plans before June 30, 1990. In preparing these plans, each business will be required to conduct a waste audit, prepare a detailed analysis of the solid waste streams, and propose methods for effectively reducing and recycling waste.

Roles

In addition to writing the regulations, defining recyclable materials, and keeping the list of recyclables updated, the Department of Environmental Management provides technical assistance to help businesses meet recycling requirements. DEM offers on-site consultations and provides copies of *The Handbook for Reduction and Recycling of Commercial Solid Waste,* and *A Guide for Preparing Commercial Solid Waste Reduction and Recycling Plans.* Other public information and education materials are being prepared.

The Solid Waste Management Corporation is responsible for enforcement of regulations at state-owned facilities. In addition, the SWMC provides information and technical assistance to solid waste haulers and generators.

Commercial Recyclables

- Newspaper
- Glass, food and beverage containers
- Tin-coated steel cans and steel cans
- Aluminum cans
- Plastic milk containers (HDPE)
- Plastic soft drink containers (PET)
- Corrugated cardboard
- Sorted, colored ledger paper and white office paper

FUNDING

Over a six-year period, the Solid Waste Management Corporation (SWMC) of Rhode Island is expected to provide approximately $30 million (roughly $5 per capital per year) to municipalities in the form of three-year grants. Under the SWMC funding program, municipalities will be reimbursed for a period of three years for reasonable additional costs which are incurred in operating their recycling programs. SWMC also provides the Department of Environmental Management's OSCAR program with funds to administer municipal recycling.

OSCAR operates on an annual budget of approximately $1.5 million which is funded through a broad-based litter and solid waste tax. OSCAR operates municipal and commercial recycling programs, as well as a variety of other programs in litter control, cleanup and hazardous waste.

Other OSCAR Programs

Youth Litter Corps Program

Litter Control Grants

Prisoner Highway Cleanup Program

Used Oil Program

Hazardous Waste Reduction Program

Educational Programs

Compost Grants

Vehicle Battery Recycling Law

Adopt-a-Spot

CONCLUSION

Rhode Island's mandatory recycling program has been in operation for almost two years. During that time, the state has had the opportunity to continually test and improve the program. Rhode Island's experiences with recycling have resulted in eight "lessons" which may be applicable to other states, countries or regions.

First, recycling is an effective waste management tool. Results from recycling have been predictable and reliable. In addition, recycling has had important benefits such as reduced environmental damage and preservation of landfill capacity.

Second, a broad-based statewide program which includes everyone, achieves economies of scale in design, in operations of the recycling system, and in the processing and marketing of recyclable materials.

Third, strong state or regional leadership is very important for achieving a comprehensive effort. For example, in the municipal recycling program, cities and towns have been able to follow a

clear and easy road map. The state prepared the basic program design, and provided a wide range of technical assistance. This has allowed municipalities to focus on operating their recycling collection programs.

Centralized leadership has also prevented costly and confusing duplication of efforts. By providing a consistent definition of recyclables, constructing a Materials Recovery Facility, and committing to market the recyclables if no one else does, the state has built a recycling system which is comprehensive and uncomplicated. This has minimized risk for participants and built confidence in the ability of the state to operate successful recycling programs. State leadership in providing capital and three-year operating funds to municipalities has also minimized initial uncertainty.

Fourth, programs must be flexible and adaptable to ensure success. The most important thing is to get started, then adapt. For example, pilot testing of the Rhode Island municipal recycling program was a critical step in convincing skeptics that recycling could work. Initial opposition from some municipalities was quickly resolved when public works personnel were given the opportunity to "kick the tires" of a real-life program. In commercial recycling, several large corporations began pilot programs before state regulations went into effect. Their solutions to common recycling problems have helped other businesses plan recycling programs.

Fifth, it is very important to evaluate all potentially recyclable material to allow for future expansion of recycling programs. Some recyclable materials cannot be retrofitted into an existing recycling program, but must be included in the initial program design. For example, plastic milk containers and soda bottles, which were included in Rhode Island's municipal pilot programs, influenced the size and design of recycling trucks.

Sixth, it is important to examine the waste stream and concentrate on eliminating materials which are major sources of solid waste. In Rhode Island, office paper and corrugated cardboard occupied an inordinately large part of the state's landfill. By recycling these materials, Rhode Island expects to divert significant amounts from the waste stream.

Seventh, recycling must be convenient for residents. Rhode Island has made recycling easy for residents by providing containers for recyclables, requiring only minimal separation of recyclables from solid waste, and by providing curbside pickup. Convenience has been a key to high recovery rates.

Eighth, extensive public information and education have resulted in high public awareness, understanding, and support for the programs.

Rhode Island has learned how to make recycling work as a solid waste management tool. Future plans are to continue to judiciously increase the list of recyclables as markets for these recyclables are identified and secured.

The Rhode Island program has come a long way in showing what can be done in recycling, source reduction and solid waste management. We are happy to share the lessons we have learned with other communities.

Please feel free to contact us at any time if you would like more specific information about our progress.

The Rhode Island experience has shown that recycling can work effectively as an integral part of a solid waste management system. We have been particularly pleased with our progress in establishing markets for recyclable materials such as plastic milk containers, soda bottles and newsprint. Currently, the Solid Waste Management Corporation is exporting paper at the rate of 60 tons per day to European markets. Needless to say, the results have been very gratifying.

Tom Wright, Director of the Solid Waste Management Corporation

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SEATTLE: A CASE STUDY IN INTEGRATED PLANNING

Diana H. Gale, Director

Seattle Solid Waste Utility

Presented at the

First U.S. Conference on Municipal Solid Waste Management

June 13-16, 1990

Seattle has experienced a renaissance in solid waste management. Three years ago, the City's Solid Waste Utility (SWU) was in chaos and economic crisis; today, it is leading the nation in recycling and a year ago initiated an entirely new collection and disposal system. The crisis and economic distress forced public attention to focus on garbage; the renaissance is the result of system planning and excellent staff work. Seattle's experience can be duplicated by other cities.

Seattle's system relies heavily on waste reduction and recycling, the most effective and cost-efficient forms of solid waste management today. Getting the public to reduce or recycle waste requires a behavior change; getting a behavior change requires getting people's attention. Both the sense of crisis and economic distress are factors necessary to force public and political attention on the problem. For decades garbage collection and disposal has been a "silent service." A citizen puts garbage out (usually in unlimited amounts) and it diappears during the day for little cost or free (i.e., garbage is often paid for in one's property tax). As long as a citizen receives low cost, silent service, there is no incentive to change behavior. Seattle's is a story of how garbage became one of the top four public issues in the Puget Sound region; first because it was a problem; then because recycling was such a success story.

BACKGROUND

The Seattle Solid Waste Utility (SWU) contracts out collection, manages two transfer stations, is closing two landfills, and uses the county landfill for disposal. Seattle has a population of 490,000 and a collection base of 150,000 customer units. Our transfer stations accept residential and commercial self-haul waste. In addition, the commercial haulers collect 225,000 tons per year of commercial tons which are taken to private transfer stations. These tonnages have been dropping dramatically as a result of the total set of solid waste programs. The SWU is a Division of the Engineering Department but has an enterprise fund, which means it is run like a small business where rates and revenues have to match expenditures. The annual budget of the Utility is between $45 and $50 million for operations with an additional $5-10 million a year for capital expenses depending on what aspect of the landfill is currently under construction.

In 1987 the SWU was in crisis. Rates had skyrocketed. They had gone up more than 82% over the previous two years. Both landfills were closed with no other disposal option other than the county landfill. As part of the contract governing use of its landfill, the county had given the city the opportunity to leave the county system if it had its own disposal option. The City was given a

total of six years to select a disposal system, get the system permitted and complete any construction necessary on the selected site. At the time the most likely disposal option was an incinerator.

PLANNING PROCESSES

In 1987, the SWU initiated four planning processes simultaneously. The first was a comprehensive planning process for future disposal options. This process had two pieces, one of which was called the Recycling Potential Assessment (RPA). The concept behind doing the RPA was that the City should be willing to pay as much for recycling as it would spend for an incinerator. The Council asked the question that if we were willing to spend that much, how much recycling could we achieve. The second part of the comprehensive plan was a Disposal Options Environmental Impact Statement (EIS). We first did a Programmatic EIS and then a site-specific EIS with four sites selected for potential incinerator projects. In the Disposal Options EIS, we considered landfill options, incinerator options and continuing in the County landfill.

The second piece of the planning process was to develop a curbside recycling program. We developed a Request for Proposals (RFP) which was performance-based in which we described the frequency of collection, the type of collection, and put the major responsibility for the design of the system on the private sector. We also expected in that Request for Proposals for the Contractor to do all processing and all marketing of materials.

The third part of the planning process was a redesign of our garbage collection system. Again, we used an RFP for getting a contractor to design a curbside system. Seattle residents had previously been using a backyard collection system. With the new collection contracts we moved the City from backyard to curbside service and we added a yard waste collection program. We asked for certain other services like "bulky item" (white goods, sofas, etc.) pickup.

The fourth piece of the planning process was to design a rate structure that would complement our recycling goals. We had in place a variable can rate, but we wanted the system to further encourage and support recycling and complement the new garbage collection system we were going to have in place. As part of the rate structure, we gave customers a choice of the level of service they wanted from a mini-can to three or four cans and then we charged them according to the size of can they selected. The rate structure was designed so that rates would go up steeply thereby encouraging customers to recycle more. Recycling programs were offered free and yard waste programs were at a very low price as

further incentive to divert waste from the garbage system.

As part of the comprehensive planning process, we developed what we call the RPA (Recycling Potential Analysis) model. This was a model that was to predict for us how much waste reduction we could achieve for various programs that we might put in place. The model was based on electric forecasting models from the electric utility. The model starts with a prediction of waste stream composition and estimates of growth rates in various elements of the waste stream. The model analyzes a range of different recycling programs, how fast they would come into operation, how much they would cost, and what components of the waste stream they would reduce. This information is then fed into a system cost analysis which can predict the impact selected recycling programs will have on collection, transfer, and disposal. Finally, the fourth step in the model is to determine how the system costs transfer into a rate structure. Once rates are established, they are iterated back into the original projections to see the impact they have on garbage production and generation. A second piece of the comprehensive plan analysis was to do comprehensive waste stream composition studies. We have spent about $100,000 each year for the last three years to test and measure what is in our waste stream. This year we are also doing composition studies on the recycling waste stream to see how well the data we get from our contractors matches what we find in the recycling stream.

GOALS

As a result of these planning processes, the City made a decision to establish a goal of 60% for recycling by 1998. In order to achieve this goal, there were specific goals for specific City programs. Curbside recycling was to achieve 7.8%; the self-haul dump-and-pick program a reduction of 4.8%; curbside yard waste, a reduction of 4.8%; apartment recycling program, a reduction of 2.4%; source reduction programs, a reduction of 1%; and backyard composting, a reduction of 2%. In addition, in order to achieve the 60% recycling, we had to hold on to the 24% private recycling which had been going on previous to the time we initiated curbside recycling and we would have to achieve an additional 10% of new commercial sector recycling.

In achieving a 60% recycling goal by 1998, we would still need to dispose of 40% of our waste. 50% of our waste would be about a thousand pounds a day. The City decided to select a landfill option instead of an incinerator option. We put our a Request for Proposals for landfill space in Eastern Washington or Eastern Oregon to get the benefits of the dry, arid climates which were thought to be environmentally benign for a landfill. Waste would be put into compacted containers at the transfer station, taken to

a railyard and loaded on rail cars and long-hauled to the selected site. The site chosen was a site in Gilliam County, Oregon, that is managed by Waste Management, Inc.

In addition to bringing all of these programs on line, the SWU has other recycling and disposal programs that constitute the Comprehensive Integrated Waste Management System. The City has had a history of strong private recycling efforts. The private recyclers have both drop-box and buy-back centers and then charitable organizations hold extensive drives. By 1986, the City was at 22% recycling through private efforts; when the curbside program started in 1988, private recycling was at about 24%. Currently, private recyclers still have buy-back centers and drop boxes, although the City's collection program has led to a reduction in the quantity of the materials they collect.

Another thrust of Seattle's system was to create a permanent household hazardous waste shed. One shed is sited at the South Transfer Station; a second shed is currently being sited in the north end of the City. In 1989, the shed collected 953 barrels of materials, of which 47% was latex paint. Of the materials collected at the shed, 63% are recycled. Some of them are solvents that are turned into different kinds of fuels at a chemical processing plant.

The Utility also maintains active recycling centers at the transfer stations. The transfer stations can collect all the items collected in curbside recycling programs, which include glass, tin, newspaper, plastic, aluminum and mixed wastepaper. In addition, they collect cardboard, bulky items such as refrigerators, stoves, waterheaters, motor oil, wood waste, and we have been experimenting with a mattress recycling program.

It has been important to Seattle to keep very current and accurate data on the markets. We make monthly projections of the markets for all the items we are collecting. In writing a contract with one of the curbside recyclers, we agreed to share market risk. Consequently, we have created an index of the historical market price for each product; and when price for the material goes either 10% above or below an index, we begin to share the revenue or loss for that particular product. Seattle still has reasonable markets for most of its materials. Aluminum, glass and tin all have strong collection points in the northwest. Plastic is being picked up through a local branch of a national plastics corporation. Newspapers are collected and deinked in the northwest. Most mixed paper is sent abroad to Asia. The mixed paper and newspaper prices have taken the largest dips. Otherwise, prices have remained relatively stable.

To support and back up all of these programs, Seattle has a variable can rate. The variable can rate may be the critical piece to all the programs because it gives a rate signal by allowing customers to have a choice over their level of service, but charges them for the amount of garbage they produce. A customer will select a size can and then pay by the volume. For a mini-can (20-gallon) a customer pays $10.70 per month for weekly pickup; 1 can (30-gallons) is $13.75 per month; 2 cans (60 gallons) are $22.75 a month; and 3 cans (90 gallons) are $31.75 a month. In addition, if a customer selects backyard service, s/he pays a 40% premium in addition to these can rates. Customers who are unable to get their cans to the curb because they are handicapped or elderly are given backyard service at curbside rates. Low income customers get special reduced rates. The City currently has 85% of its customers on one can or less. In 1981, the average number of cans was 3.5 per each household, so there has been a tremendous response to the variable can rate.

Overall, Seattle's programs have been highly successful. To date, each of the programs we have initiated is performing at expected levels or higher. The yard waste and curbside programs are exceeding projected estimates for the first few years of operation. Our overall tonnage disposed was 22% less in 1989 compared to 1988. The curbside garbage collection system also meant that the City's total cost for garbage collection was less than it had been under the backyard service system.

Although most of the elements of Seattle's programs could be adapted in one way or another to most communities, each community is going to have its unique characteristics which will affect how those programs take hold and what levels of participation customers will have in them. There are certain elements about Seattle which have made our success in recycling happen so quickly. First of all, there is a very strong concern about the environment. This means that for years citizens have been concerned about recycling. They started recycling in the '70s and there was a strong recycling business. When we began our program in 1988, we were already achieving 24% recycling. So we started with a very strong base of recycling before we began to initiate the SWU programs. A second characteristic of Seattle which helps in encouraging recycling is the large number of single family houses. It is easier to send a price signal to a family which pays a garbage bill. It is easier to communicate with single family households, especially when there is a strong sense of neighborhood and community. We expect that our multi-family programs will be much harder to initiate and much harder to achieve the levels of recycling we have achieved in single family houses. So the preponderance of single family structures has helped us achieve high recycling rates. A third aspect of our programs which we have felt were important in making

them successful is to make them convenient. For the recycling programs we gave all customers who signed up a bin; for the garbage collection system, again we gave all customers a wheeled bin. If you are asking customers to do so much additional work in separating managing their waste stream, then it is important to make the collection programs as convenient as possible. A fourth element of our program was a strong emphasis on publicity. We believe that it is essential to market and publicize your programs. We have spent a considerable amount of money on public information, market analysis, and market surveys to determine how to focus future programs. A final element of Seattle's programs which has helped achieve high recycling rates has been the rate structure. The variable can rate undoubtedly is important to affecting customer behavior. When customers have to pay by the amount of waste they produce, they become more conscious and attentive to the amount of waste they are producing. As a result, they will eagerly seek out and participate in alternatives such as recycling and yard waste which reduce waste from their garbage can. At the point that one puts a steep inverted rate structure into effect, however, it is also important to have decision alternatives available so that customers don't exhibit behavior such as illegal dumping.

In summary, what Seattle presents as a model of integrated waste management system is a goal toward which communities can aspire. However, it will take time for communities to get the infrastructure in place to make high levels of recycling achievable. We in Seattle believe our 60% goal is reasonable and achievable. We are currently exceeding projections on an annual basis. However, we started ahead because we had a strong private recycling system in place, and a well developed environmental ethic in the community.

SOLID WASTE MANAGEMENT PLANNING -- LESSONS FOR THE 90's

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INTRODUCTION

In the early 1970's, after the first Federal Clean Air Act went into effect, many municipalities throughout this nation were confronted with the choice of either closing their old incinerators or spending a great deal of money to bring them into compliance by adding the necessary pollution control equipment. In most cases, the age and condition of these facilities did not justify further investment and many were put out of operation. It was in this context that elected officials and others responsible for solid waste policy, particularly in densely populated urban areas, first began to make systematic determinations regarding short term and long term waste disposal.

The short term disposal option usually meant the local landfill. However, because of the rapid rate at which these landfills were reaching their capacity as a result of the additional waste being added to them and, in light of new environmental concerns being expressed over the operation of these older unlined landfills, the identification of new long term solutions became imperative. In many communities engineering consulting firms were called in to help. Sanitation people with hands on experience were often enlisted as well as government officials and planners with no real solid waste experience. Indeed, there were very few solid waste management professionals as we know them today. Most people were learning on the job, exploring a very limited number of disposal alternatives with limited operating experience. Vendors were selling experimental technologies and true recycling was on the

distant horizon. It was in this environment that solid waste management planning as we know it today, was born.

Lacking the more sophisticated tools now available for analyzing waste composition and measuring and projecting future waste and recyclable volumes, these early efforts resulted in plans which were often inadequate. They succeeded, however, in one area where modern waste management plans often fail. Reflecting the home grown, broad based community involvement which created them, these plans reflected the unique political, economic and demographic elements of the community. Although controversial, support for these early plans was garnered from the public more easily because the plans emanated from the community and its elected officials rather than being imposed upon a community.

As a result of these initial pioneering efforts and with the passage of nearly twenty years, our knowledge and skills have been significantly enhanced. We can now measure waste composition with more accuracy and project future waste and recyclables generation rates. We can examine the actual operating histories of systems and technologies and more reliably evaluate future performance. Our understanding of environmental impacts has progressed most dramatically and we have regulations and standards in law to act as guideposts. Consultants are more knowledgeable and informed and the science of solid waste management planning has been advanced in all respects.

With this progress has developed an interesting problem. Our solid waste management planning efforts are becoming rigid

and predictable. As solid waste management analytical tools and procedures have become more standardized within the industry, solid waste management plans are reflecting less and less a community's unique circumstances.

With the computers of solid waste advisors loaded with data and plans from other areas, a solid waste plan can emerge by merely retrieving the standard model and entering the predetermined variables. This modern planning effort is far more removed from public input than those of the past. We must seek to renew the primacy of each community's unique historic, political, demographic and geographic factors into solid waste management planning in order to assure that these plans will not just sit idle in city hall. We must once again develop plans that the majority within a community will embrace and wish to have implemented.

There is also a great tendency today to avoid innovative solid waste solutions because they are nontraditional and perceived to be difficult for regulators to accept. This attitude has caused consultants to dictate solutions to locally elected officials even though these elected officials know that the plans, as outlined, may not be practical for their communities.

The solid waste management planning process needs to be improved in a number of ways. There are two improvements which are most imperative. First, we need to be more willing to innovate in order to bring new solid waste management techniques into practice. Secondly, technologies and systems must reflect the unique circumstances of a particular community as opposed to

forcing a community to accept a plan that for political, demographic or environmental reasons is not and cannot be embraced by the people.

A solid waste management planning process which is targeted toward the creation of a plan which will be successfully implemented because it reflects the unique characteristics of the community requires three chronological steps: Community Specific Research; Conceptualization; and Detailed Planning.

COMMUNITY SPECIFIC RESEARCH

Many recent solid waste management planning efforts have focused their research and data gathering efforts either exclusively or predominantly on the community's historical and current waste disposal and recycling activities. This data is clearly a necessary building block of any plan.

Its primary value, however, is in assuring that the future systems and facilities recommended within the plan will fit mechanically into existing structures. The ability to implement the plan, however, will require a broader understanding of a community and an appreciation of certain specific factors that determine the peoples' response to the recommendations of a solid waste management plan.

Identifying the centers of power and leadership within a community is an important early step in the solid waste management planning process. In addition to the elected officials at the state, county and local level, key individuals within the press, regional and local environmental groups, business and neighborhood organizations and local political party organizations must be identified and their unique concerns and interests accounted for. Since the time necessary to research, plan and implement a solid waste solution almost always exceeds the term of office of some key elected officials, the likelihood and impact of a change in leadership during the process must be assessed. Too many municipalities have learned the hard way that it is essential to keep the solid waste management planning process out of the political elective process by approaching the issues on a bipartisan basis from the

start.

Once the relevant centers of community leadership have been identified, it is useful to review their recent history. Issues which have played a role in the evolution of the leadership structure have elements in common with those that will impact a solid waste management plan. Understanding how these issues have been resolved in the recent past will help identify the elements necessary to be able to implement a solid waste management plan.

Another valuable goal of the community specific research phase is to identify the "personality" of the community. The rural New England "Yankee" community, for example, sees itself as strongly independent. Newer, innovative solutions to solid waste problems are welcome whereas "cookie cutter" answers imported from other states or regions are often met with skepticism. In order to understand how a community looks at itself, what it feels about itself and where it thinks it wants to be in the future, one must examine its history from birth through various periods of growth and restructuring.

Of particular importance is a review of the history of major public work projects. Did they achieve what the public expected of them, or are they viewed as failures? How has the community historically viewed the ability of the public sector to deliver services effectively and what has been its experience with major private sector service providers?

Finally, the public's sensitivity toward perceived environmental and aesthetic impacts varies greatly from one community to the next. The important issue here is to what

extent is a community willing to incur higher service costs or other inconveniences in exchange for perceived environmental or aesthetic benefits? We are all aware of the dramatically heightened concern for environmental issues which is being experienced nationwide. Nevertheless, an examination of how local issues with significant environmental and aesthetic implications have been resolved recently in a specific community can provide clues as to which solid waste management options are apt to be found acceptable.

Another important aspect of the research phase is the identification of relevant zoning and land use planning guidelines. Conforming to land use and planning guidelines can be a more difficult task than it first appears. In addition to complying with technical zoning and planning constraints, other equally important issues regarding the appropriateness of a site for a solid waste management facility must be addressed. It is difficult, however, to address these issues other than in the context of a specific community because dramatic differences in siting appropriateness emerge depending, for example, upon whether the community is predominantly rural, agricultural, suburban or urban.

An important element in determining the appropriateness of a site is the impact upon traffic patterns and related transportation issues. Research in this area must go beyond road patterns and traffic surveys. The residents' views of their transportation system must also be identified. Perceived traffic congestion is highly subjective and dependent, again, upon the rural or urban nature of the community.

The extent and probable nature of citizen involvement in solid waste issues must also be considered during the research phase. The emergence in some communities of the Citizens Advisory Committee (CAC) as an important and regular player is simply the latest evidence of the important and growing role of citizen involvement in the solid waste planning process, nationwide. Citizen involvement will be generated from, among others, residents who live near potential facility sites and from local, regional and national environmental groups whose primary concern relates to the impact of solid waste facilities on the environment.

Even the most technically sound solid waste plan will fail in the implementation stage if the positions and activities of citizens groups have not been correctly anticipated.

In the research stage, an examination of how citizens have organized and reacted to previous issues and events may suggest what to expect regarding solid waste issues. During the research phase, efforts should be made to determine whether citizen involvement is apt to be on an ad hoc basis or whether identifiable entities, such as taxpayer organizations, neighborhood groups or specific environmental groups, will be involved. Specific individuals within the community who historically play important roles as interested citizens must be identified and their particular interests and concerns taken into account.

Finally, the community specific research phase of the planning process must identify the public's attitude toward solid waste and other environmental issues.

Numerous national and regional surveys have documented the public's deep concern for the environment and in some cases their willingness to incur higher prices and inconvenience for environmental benefits.

The public's support for various waste reduction and recycling programs such as reusable containers and curbside separation is one of many examples. However, within any particular community there may be important attitude differences that must be known and understood.

Leading private sector developers of solid waste systems and facilities are beginning to utilize community specific attitude surveys or polling in the project evaluation and development process. Public sector solid waste management planners should incorporate well designed, professionally executed local attitude surveys into the research phase of their solid waste planning efforts in order to reveal the public's attitude towards various solid waste issues and to identify how the public thinks their officials should be reacting to them. The results are often enlightening and at times surprising.

The public's attitude towards regionalization and intergovernmental cooperation should also be tested. Creating an efficiently scaled region for solid waste management planning can render significant benefits by capturing certain economies of scale and allowing for more advantageous siting choices.

CONCEPTUALIZATION

Armed with a thorough and clear view of the specific community at hand, planners can now begin to conceptualize an appropriate solid waste management plan.

Perhaps the most important aspect of this phase of the planning process is to build as broad a consensus as possible among the public, various interest groups, elected community leaders and planners regarding the objectives to be met by the solid waste management system.

To fully identify these objectives, numerous distinct issues must be addressed. One is the extent to which the community wishes to devise a solid waste management system which relies totally or largely upon facilities within its jurisdiction as opposed to a system which relies, to some degree, upon out-of-region facilities. More and more states, counties and cities are imposing restrictions or prohibitions upon the importation of waste. As a result, some communities may make waste management self sufficiency an important solid waste management objective. Others may be willing to rely upon some out-of- region facilities.

The ability to achieve solid waste management self sufficiency can be greatly increased through the regionalization of the planning process. Many attempts to develop regional plans have failed, however, because they have not achieved a broad based consensus regarding system objectives before addressing the more potentially divisive issues of site and technology. By approaching the solid waste planning process on a regional basis, more community resources can be brought to

bear in a cooperative manner to solve difficult solid waste management problems.

During the delineation of the solid waste system objectives it is also important to establish which portions of the waste stream are to be addressed by the plan. Attention may be focused primarily upon that portion of the residential and commercial waste stream that is currently being landfilled or incinerated or upon the community's entire waste stream including tires, white goods, commercial, industrial and household hazardous waste.

Closely related to this issue is the community's objectives regarding recycling. Rapid advances have been achieved in the area of recycling planning and implementation and many communities are well on their way to achieving aggressive recycling target rates of 25% - 50%. Given the rapid rate of technological innovation occurring in this field, and the strong support for recycling efforts among residential waste generators, an ever growing portion of the residential and commercial waste stream may be recycled. Since some of the disposal technologies to be examined in the detailed planning phase of the waste planning effort can accommodate the uncertainty of future recycling better than others, it is important in the conceptualization phase to define recycling objectives as clearly as possible. A recycling objective may be to simply meet recycling requirements set by the regulatory agencies, or it may be to minimize total solid waste management costs by avoiding high disposal fees, or it can be to recycle to the maximum extent possible, regardless of cost.

Another important issue which must be addressed during the conceptualization phase is how the community views tradeoffs between expected waste management costs, perceived and actual environmental impacts and the nature and magnitude of the various system risks which must be borne by the community. For example, if a newer, non burn disposal or recycling technology avoids some of the undesirable environmental impacts of older, more proven technologies, is the community willing to accept the incremental higher system performance risks or potentially higher total system costs? The issue of waste importation can also be addressed in this context. Will the community consider importing waste for processing and disposal if this additional volume will allow it to mitigate the potential for higher future disposal costs that may result from greater levels of recycling activity or lower rates of generation?

Finally, without referencing specific potential facility sites or technologies, does the community generally recognize the appropriateness of host benefits to be provided from the revenues of the solid waste system to localities which are selected as sites for transfer stations, recycling or disposal facilities?

A number of important results should emerge from the conceptualization phase before specific sites or technologies are considered.

First, a broad understanding must emerge that the community is facing or may soon face a serious crisis if the tough solid waste management choices are not addressed in a timely manner and an appropriate solid waste management plan identified and

agreed upon. Second, it should recognize that certain difficult tradeoffs must be made within the plan to balance the potentially competing concerns regarding cost of service, environmental and aesthetic impact, system performance risk allocation and future flexibility. A well designed and executed solid waste public education and information program should begin by communicating these concepts clearly to the public.

In addition, a consensus must emerge regarding the specific criteria to be applied in evaluating and selecting specific sites and technologies. The relative importance of these evaluation criteria must be established in order to reconcile potential conflicting solid waste plan implications.

For example, many communities have recently begun examining commercial scale mixed waste composting systems as an alternative to burn based technologies. While the composting of organic waste is by no means a new idea or practice, the consideration of a compost based system for the long term management of a community's mixed municipal solid waste stream is. The sudden emergence of MSW composting as an important technology option has resulted to some extent from the widespread resistance by community groups to the siting of burn facilities. In addition, the recent development of this technology by system vendors who possess sufficient financial and technical strength to offer project development support and system performance guarantees equivalent to those offered by the older and larger vendors of burn technologies, has greatly enhanced the appeal of these alternatives. Nevertheless, the limited operating experience of such systems in the U.S. may

place greater system performance risks upon a community which chooses this technology.

If the planners involved in selecting between these two technology options have, during the conceptualization phase of its planning process, developed a consensus regarding how to handle the tradeoff between the benefits of utilizing a non burn technology and the potentially higher performance risks of a less well proven system, then this technology choice may proceed more easily.

One effective way some communities have addressed the tradeoffs involved in technology selection before digging into the specifics of systems and vendors is by establishing a list of evaluation criteria and assigning a numerical ranking to each. This numerical ranking reflects a consensus agreement regarding the relative importance of the criteria.

Finally, a thorough conceptualization phase should identify a methodology to be utilized in the detailed planning phase. A properly detailed procedure for the selection of a facility site(s) is a particularly important preliminary step to this most controversial aspect of a solid waste plan. Based upon the knowledged gleaned from the community specific research, a methodology which involves a broad spectrum of public representatives in the formulation of site selection criteria should be defined.

At this point in the planning process a number of important goals will have been achieved. In addition, public confidence in the solid waste decision making process will be strengthened through an appreciation for the thoroughness and logical

sequence of steps taken up to this point. By addressing technology and site selection only after completing the community specific research effort and after detailing relevant management issues such as technology evaluation criteria, site selection methodology and consensus building, the solid waste planning process will be management driven. This will help avoid the pitfalls of plans which are created through a technology or site driven process.

Only upon achieving the objectives in the conceptualization phase can planners expect to succeed in the detailed planning phase and subsequent implementation of the plan.

DETAILED PLANNING

In the detailed planning phase of the process, extensive technical and financial data is assembled. Each alternative waste collection, processing, marketing and residue disposal technology or system under consideration must be thoroughly detailed.

For each of the solid waste management options under consideration, three important elements; life cycle costs, environmental impact, and risk allocation must be clearly identified in order for community specific objectives and criteria to be applied.

Comparing the life cycle costs of each alternative involves a full projection of all capital costs, operating and maintenance costs, residual disposal costs, tip fee revenues and product or energy sales revenues.

Within this life cycle cost analysis, different levels of capital costs will be reflected through differing debt service schedules. Care must be taken to utilize consistent and reasonable assumptions regarding interest rates, debt to equity ratios (if a facility is to be privately owned) and debt maturity and structure.

The time value of money is reflected within the cost analysis either by calculating an average system cost over a specified period of time or by calculating the total net present value of costs utilizing a reasonable and consistent discount rate.

Through this process a clear and objective comparison can be made regarding the total system costs of each alternative.

Similarly, a thorough comparative evaluation of the environmental and aesthetic impacts of alternative solid waste management options must be undertaken. Some aspects of this process, such as comparing the air emission standards of, say, two different mass burn technologies, will lend itself to clear quantification. Others will require subjective judgements. The environmental and aesthetic impact of each alternative must be as fully identified as possible.

Other issues must also be detailed in this phase of the planning process. An evaluation of alternative financing options including public vs private ownership, taxable vs tax-exempt debt and variable vs fixed interest rates must be undertaken. Additionally, alternative procurement methods must be evaluated. In some cases, local or state law may require a public RFP or bidding process. If the planning entity faces a choice of procurement methods, the time, cost and other aspects of each alternative must be identified and evaluated.

The purpose for this detailed identification and quantification of community specific objectives and selection criteria is to finally select the correct detailed elements of the plan.

It is not uncommon for those involved in the planning process to revisit the decisions made earlier regarding objectives and criteria once the technology specific implications of these choices start to become clear.

In fact, at this point in the planning process, the defining and redefining of system objectives and evaluation criteria and the development of an ever greater level of

financial and technical detail regarding the options under consideration should become a dynamic, ongoing process.

Under the guidance of an individual or firm with a broad knowledge of all aspects of solid waste management and who maintains senior responsibility for the overall development of the plan, the highly specialized expertise of consulting engineers, financial advisors and the legal community must be drawn upon. The consulting engineers must assure that each step of the solid waste chain (generation, collection, processing, product marketing, and residual disposal) is mechanically integrated within the detailed plan being developed. The attorneys must assist in the procurement, negotiation and contracting with private sector vendors and system users, and, of course, in the permitting process. Financial advisors must participate to assure that the revenues necessary to support the costs of the system are structured in a manner that will guarantee access to the capital markets for financing.

The role of engineering, legal and financial experts should not be to identify the "best" solution, but rather to properly identify the strengths and weaknesses of the alternatives in light of the objectives and selection criteria unique to that community.

Finally, the most difficult aspect of the detailed planning effort must be addressed...facility siting.

The potential divisiveness of this issue will have already been significantly lessened if the solid waste planners have achieved the objectives of the research and conceptualization phases of the process. Notwithstanding the participation of a

broad spectrum of community representatives in the siting process, however, and the development of a consensus regarding site selection criteria and methodology, the actual selection of a facility site must be the decision of the elected officials. Since even the most ideal of solid waste facility sites will encounter some level of community opposition, elected officials must impose upon themselves the obligation to move forward in a timely manner even in face of some site opposition.

The correct structuring of a host community benefit program can play an important role in determining the success of the siting procedure. All too often planners assume that monetary benefits alone will adequately address the concerns of the host community. The fact is that many communities may prefer to pay not to have a facility.

By correctly researching and understanding the most pressing needs of the host community and structuring a host community package accordingly, planners and elected leaders can bring a valuable element of creativity to the siting process.

Host community benefits may take the form of up-front and annual cash payments or the provision of recreation, law enforcement, educational or other facilities and programs which the community needs. Since neighborhood leaders from within the host community most clearly understand their own unique needs, creating a process by which they help specify the elements of a host benefits package can be most effective.

CONCLUSION

The science of solid waste management planning has made several important advances in the past decade. This progress has, however, been accompanied by a standardization of solid waste solutions which increasingly fail to reflect important unique aspects of the communities they are meant to serve. By preceding the examination of alternative technologies and sites and other elements of the detailed planning process with a thorough program of community specific research and solid waste plan conceptualization, detailed plans will emerge which more fully integrate important unique aspects of the community.

As a result more of the plan's elements will achieve timely implementation and greater progress can be made in meeting America's solid waste management challenges in the '90's.

SOLID WASTE WARS:
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INTRODUCTION

Wright County, Minnesota's Solid Waste Task Force concluded a four-year planning phase by completing and adopting a comprehensive Solid Waste Management Plan in July, 1987. The Plan indicated that the County was to initiate yard waste composting, recycling, waste reduction, and public education programs. In addition to those low technology programs, the County is also actively planning for a state-of-the-art secondary material/solid waste composting facility which will manage the vast majority of its solid waste.

The Solid Waste Task Force recommended to the Board of Commissioners that a Project Management Team (PMT) be established to plan and guide the implementation of the composting project. The PMT consists of five members from the Task Force; two members are County Commissioners and represent the Board, while the others are County residents. Technical and Financial advisors assist the PMT.

The first and most difficult task which the PMT addressed was selecting a location for the proposed 165-TPD processing facility. The PMT has been working on this task since October, 1987.

SITE SELECTION PROCESS

The first step in the siting process involved compiling, selecting, and prioritizing a set of siting criteria which are presented in Table 1. PMT members assigned environmental issues to the lowest priority because they could be mitigated or controlled through careful planning and proper engineering. The PMT decided to assign the criteria of feasibility and haul distance the highest priority; cost and population density the second highest priority; odor control and water quality/hydrology/geology the third highest priority; and visual, agriculture, noise, zoning, planning, fish and wildlife, recreation, and historical/archaeological the fourth highest priority.

The next major step involved assigning definitions to four siting criteria: haul distance, cost, population density, and zoning. A preliminary search encompassing area approximately 160 square miles was established by using the definition for haul distance. The definition was used to demarcate (identify) the preliminary search area because it placed the proposed facility close to the County's population center (minimizing future collection costs) and to the largest sanitary landfill operating within the County (minimizing transportation costs provided the landfill received facility rejects; and some compost distribution costs.) In addition to haul distance, the PMT also considered population density which is directly related to municipal waste generation and cost, limiting the search to a 7-, 9-, or 10-ton road.

TABLE 1
Siting Criteria

SITING CRITERIA	PRIORITY# 1
- preferred sites have a minimum of ten to twelve acres for facility development and a potential for expansion	Feasibility
- preferred sites minimize haul distance from major sources of waste generation to the facility and from residuals to the landfill	Haul Distance
	PRIORITY #2
- preferred sites minimize operational costs	Cost
- preferred sites minimize cost of constructing water, sanitary services, and other utilities	
- preferred sites minimize construction or upgrading of roads for safe access to a 9- or 10-ton road	
- preferred sites are located in areas of lower population density	Population Density
	PRIORITY #3
- preferred sites allow for adequate air flow for odor dispersion	Odor Control
- preferred sites minimize impacts on surface and underground water quality	Water Quality/ Hydrology/ Geology
- preferred construction sites are not located in a floodplain	
- preferred sites minimize drainage or run-off to water courses and channel modification	

TABLE 1 (continued)
Siting Criteria

SITING CRITERIA	PRIORITY#4
- preferred sites are not located in geologically unstable areas (e.g., sink holes, peat soils)	
- preferred sites minimize negative visual impacts on residences	Visual
- preferred sites minimize consumption of prime agricultural land	Agriculture
- preferred sites do not significantly increase noise in residential areas (once construction is completed)	Noise
- preferred sites minimize impacts on local zoning	Zoning
- preferred sites minimize impacts on known historical and archaeological resources	Historical/ Archaeological
- preferred sites minimize impacts on rare, endangered and threatened plant and animal species	Fish and Wildlife
- preferred sites minimize impacts on federal, state, county or local recreation	Recreation

After establishing the preliminary search area which encompassed approximately 160 square miles, the PMT needed to narrow the area down to a manageable size. To do this, the PMT used definitions for cost, population density, and zoning and established seven search corridors along State and County roads encompassing an area about 14 1/2 square miles.

Each search corridor was inspected by PMT members, County staff, and its technical advisor. The goal was to eliminate unsuitable portions within the search corridors or possibly eliminate a search corridor itself; and establish an inventory of working areas which would subsequently be evaluated for potential sites. All of the search corridors were evaluated using individual or combinations of siting criteria presented below. PMT members formulated questions such as the following when they assessed the search corridors.

- Feasibility/Water Quality/Hydrology/Geology - Does the working area contain at least one usable ten to twelve acre site which, if designated, would not pose any adverse affect on the environment (e.g., wetlands, or floodplains)?
- Haul distance - Which working areas are closer to the landfill?
- Cost- How much will it cost to provide safe access to a 9- or 10-ton road at each working area relative to the others?
- Population Density/Visual/Noise - Relative to other working areas, will more residential dwellings and homeowners be affected?

During the search corridor evaluation, the PMT identified 13 working areas; two of the working areas were County owned parcels, while the remainder were privately owned. The PMT compared each working area to one another in relation to the previously established siting criteria. To complete the assessment, existing information

such as U.S. Geological Service topographic maps, soil maps, residential well logs, HUD Flood Plain Maps, DNR wetland maps, aerial photographs, and field inspection notes were used to describe and characterize each working area. Existing land use and proposed residential or commercial development within and surrounding each working area was also taken into consideration. Topographic features such as wetlands, drainage ditches, lakes, ponds, and wooded areas were also noted.

A detailed list of advantages and disadvantages was compiled for each working area. Advantages included items such as: immediate access to a 9- or 10- ton road, a relatively flat area, no residential dwellings located within the working area, low population density in the surrounding area, no surface water or wetlands on or adjacent to the working area, and some potential for visual screening. Disadvantages included items such as: increased site development costs due to terrain, the need for right or left turning lanes, homes located within working areas, 15 or more property owners within 1,000 feet of a working area, wetlands or ponds located within a working area, lakes located one-quarter mile or less from a working area, an open field with little or no naturally occurring vegetation, and private property.

PMT members thoroughly debated the advantages and disadvantages of each working area. They objectively and critically assessed the merits, and discussed existing or potential problems associated with each working area. The PMT also developed a methodology which was used to objectively compare and rank the working areas to one

another. Following extensive discussion, the PMT decided that the four highest scoring working areas had the greatest prospect of containing a potential site.

The next step involved selecting potential sites within the working areas. After careful and thoughtful consideration of many factors, such as a 20 acre parcel with a minimum width of 660 feet, proximity to residences, surrounding land use, potential for visual screening, access to a 9-ton road, and distance to utilities; the PMT selected five potential facility sites within four working areas.

After each site was selected, the PMT decided to proceed with a two phase site evaluation process. The Phase I work effort consisted of three tasks. The first task involved preparing a detailed description for each site. To complete this task, each site was jointly inspected by Wright County staff and a geologist from the County's technical advisor. During each site visit, observations were made concerning the following items: topography, drainage, vegetation, screening potential, electrical utility line location, surrounding land use, and sight lines from public roads and residences. Other sources of readily available information were also reviewed for the site descriptions. For example, to assess subsurface conditions six groundwater studies were reviewed. In addition to local geology and hydrogeology studies, real estate abstracts were reviewed for evidence of past land uses which could have resulted in contamination of soil or groundwater. Second, a preliminary cost analysis was conducted for the sites. The analysis included estimating and comparing site development costs (i.e., land acquisition,

public road upgrade, utility installation, site access road, and grading and dozing) and two operating expenses (transporting facility rejects and groundwater monitoring) for each site. Finally, subsurface conditions (geology and hydrogeology) at the sites were assessed based on readily available and reliable information.

The PMT reviewed and assessed the information presented in the Phase I report. After considerable discussion and debate, PMT members decided on the following actions. First, they decided to eliminate one of the potential sites from further active consideration: and second, to proceed with the siting work effort by continuing the investigation at the remaining four sites.

The Phase II evaluation consisted of visually inspecting and completing soil borings at each site to characterize the soils for construction suitability. Soil borings were completed using a hollow-stem auger. A standard penetration test (which is commonly used to estimate the bearing capacity of a soil), and split-spoon sampling procedures were completed for each boring from 0 to 5 feet in depth, and then at 5-foot intervals until termination of the borings. One or two borings were taken at each site.

In addition to the truck-mounted borings, one or two hand auger borings were completed at each site in low areas or swales peripheral to the assumed construction

site. The purpose of these borings was to determine shallow soil characteristics, and correlate these characteristics with those noted as a result of the truck-mounted auger borings.

Upon completion of the Phase II evaluation, the PMT had sufficient information to make an informed decision regarding the selection of a preferred site. The members reviewed previously drafted reports and memoranda, and selected one of the four parcels as the primary site and another to serve as an alternate facility site.

SOURCE SEPARATION vs. CENTRALIZED PROCESSING

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SOURCE SEPARATION vs. CENTRALIZED PROCESSING

1. Introduction & Summary

As waste management systems evolve toward reliance on reduction and recycling instead of disposal for handling municipal solid waste, communities will need to make choices among a wide variety of possible methods for achieving their waste diversion goals. One central issue will be the extent to which a community emphasizes source separation versus processing unseparated waste, or both, as the central strategy for its recycling plan. Source separation is attractive as a way to minimize both contamination and the amount of handling required to prepare recyclable materials to meet market specifications. On the other hand, source separation may be less convenient for waste generators than having unseparated waste sorted at a centralized mixed waste processing facility.

Although economic cost is not the only criteria used in developing a recycling strategy and choosing a specific recycling plan, it is certainly a major factor. This paper describes an economic optimization model called *CurbConserve* (developed by Dr. Morris) that uses waste management system cost minimization as the criteria for selecting among source separation and unseparated mixed waste recycling methods, as well as for determining what amount of waste should simply be sent to disposal.

Because *CurbConserve* is an optimization model, in addition to being an interactive spreadsheet model, it can evaluate relative costs for various waste management methods and determine the cost-minimizing integrated combination for a particular community. Full account is taken of avoided disposal costs, additional collection costs that may be associated with curbside recycling, and waste stream composition impacts as waste materials filter through various waste management methods from generator source to their final disposition. *CurbConserve* automatically searches among the multitude of possible combinations of specific management methods to find that particular integrated combination that minimizes systemwide costs for managing a community's solid waste.

Results are reported in this paper that demonstrate *CurbConserve's* application for single-family residential waste from urban, small town and rural communities in Washington state. An extensive analysis of avoided costs for the urban type community is given as the last section of this paper and precise formulas for computing net avoided costs are developed in the Appendix to this paper. These formulas illustrate some of the complexities involved in actually calculating recycling's avoided costs.

The menu of specific waste management methods considered by the *CurbConserve* model for inclusion in the integrated system for Washington state residential waste stream applications was:

- Existing privately operated buy-back and drop-site recycling systems.

- Weekly curbside collection of recyclables separated into three 11-gallon containers that are distributed to participating households.
- Biweekly collection of yard waste set out in containers that are provided by households.
- Weekly collection of food waste set out in 5-gallon tightly lidded containers that are distributed to participants.
- Weekly collection of refuse set out in 60-gallon containers that are provided to all households.
- Self-hauling of refuse by households.
- Mixed waste processing at a centralized, capital-intensive facility to recover recyclables and compostables.
- Labor-intensive, mostly hand-pick centralized processing to recover only recyclables.

For the three Washington state residential community types, analysis of the cost-effective integrated combinations of waste management and recycling methods yielded a number of interesting conclusions. For multi-family residential or for commercial waste streams, for collection systems using either different containers or pick-up frequencies, or for method menus that include other waste management and recycling programs, one would expect *CurbConserve* to yield optimal results that perhaps differ. For the Washington state single-family residential waste examples the generalizations about optimal systems are:

- In the presence of existing buy-back and drop-site recycling that recovers about 10 percent of waste, curbside collection of recyclables and lawn and garden waste can divert from disposal an additional 40 percent of single-family residential household waste—about half from source separated recyclables and half from source separated lawn and garden waste.
- Where recyclable materials prices are strong, or disposal costs are high, source separation and processing of unseparated mixed waste are complementary, not competitive, recycling methods. However, if a community expects both materials prices and disposal costs to be low in the long run, then a choice between source-separated and unseparated waste recycling methods may be required.
- Curbside methods for collection of single-family residential recyclables and yard waste are most economical in urban areas near major recyclable materials markets. Curbside collection on a weekly basis for recyclables and biweekly for yard waste is less economical in smaller urban communities and rural areas, but may still be optimal given high disposal costs.
- Lower cost-effectiveness of curbside collection in smaller towns and rural areas is primarily a function of waste quantity. However, cost-effectiveness of curbside methods also depends on materials prices, processing costs for recyclables versus mixed waste, the portion of refuse self-hauled, and waste composition. Housing density is not critical.
- Regional programs for collecting and processing source separated recyclables and for processing unseparated mixed waste are most cost-effective.
- To be most cost-effective, curbside collection programs that use separate trucks should maximize the total quantity being collected at each curbside stop, including low-value materials such as mixed waste paper. Diversifying types of materials also reduces price risks.
- The cost-effectiveness of both yard waste collection and mixed waste processing is dependent upon avoided disposal costs. Also markets must exist for compost products.

Besides computing the most cost-efficient integrated combination of methods for managing solid waste, the *CurbConserve* model also

allows the decisionmaker to vary input parameters (such as disposal costs, materials prices or participation rates) for determining whether the combination of cost-effective methods changes as an input parameter varies. For example, as reported later in this paper, market price variations during the past decade are used to measure the risk that "market gluts" could result in some source separation recycling methods becoming too costly relative to processing or disposing unseparated waste. These price variations also illustrate how revenues from materials sales fluctuate less when more materials are targeted by a community's recycling programs.

It should be noted that *CurbConserve* yields steady-state projections for long-run waste management costs using properly sized facilities, as compared with the twenty-year time period longitudinal costs that are often used for solid waste planning. The steady-state projection is believed preferable for two reasons:

1) It minimizes confusion about start-up costs for new programs and wind-down costs for old or oversized methods. The projected steady-state allows for straightforward comparisons of long-run cost for different integrated waste management systems, as well as comparisons of disposition of the different waste materials under each system.

2) While issues about public versus private ownership of facilities, life of existing facilities, impacts on existing landfill capacity, and financing methods often require the twenty-year longitudinal analysis, decisions about overall waste management strategy and comparisons of system alternatives are more effectively focused by examining the steady-state, long-run economic implications.

Finally, it is important to emphasize that the projected costs yielded by *CurbConserve* do not account for expenses associated with modifying existing waste management systems and starting up new recycling or composting programs. Rather, *CurbConserve* is used to project costs once the new integrated system is in place and fully operational.

2. Model Description

CurbConserve is a linear programming optimization model that uses as inputs: 1) a menu of specific waste management methods, 2) operational assumptions and 3) financial parameters and costs, including amortization for capital facilities needed by each particular waste recycling or disposal method. Basically, the linear programming technique is a systematic method of searching for "that one" integrated combination of given waste management methods (among the many possible combinations from the selection menu) and "that one" combination of materials to collect (for source separation recycling methods) in minimizing the net cost of managing a community's solid waste. Here, net cost is defined to include revenues (both positive and negative) from materials sales.

The *CurbConserve* model is built on a Lotus 1-2-3® spreadsheet. The general program for linear optimization is What's Best!® developed by General Optimization, Inc. to run in conjunction with Lotus 1-2-3® spreadsheets. Numerous input parameters (or assumptions) and a menu of waste management methods provide the information used by *CurbConserve* to find the least-cost integrated waste management system. Input parameters for the example of a larger urban area in Washington state are listed on Tables 1 and 2. The menu of specific waste management and recycling methods for this example was described above in the introduction and, as well, is defined by the heading on Table 1, some of the input parameters on Table 2 and the column headings on Table 3.

Table 1 lists residential single-family subwaste stream composition data and existing privately operated buy-back/drop-site recycling rates for the Puget Sound waste generation area (WGA) in Washington state in 1987. The table also lists projected separation efficiencies for materials source separated by households for collection at the curb. These efficiencies repre-

CURBCONSERVE MODEL VERSION: Weekly Recyclables, Food and Refuse Collection; Biweekly Yard Waste Collection
125,000 Single Family Urban Residences(1-4 Families Per Building) in the Puget Sound WGA

TABLE 1

Waste Stream Composition and Quantity Data, Separation Parameters, and Material Price Parameters

Waste Component	1987 Residential Drop Off & Buy Back Rcycing Rate	Recyclables Separation Efficiency: Home Srtng for Crbside Collection	Mixed Waste Process(MWP) Sorting	Hand Pick Only Sorting	Compost Process Capture Rate During MWP Sorting	1987 PgtSnd Residential Sngle Family Waste Comp*	Collection Truck Waste Density(#/cu yd): Rcycl Trck	Refuse Truck	Source Separated Materials Mkt Price Per Ton	Materials Sorted from Mixed Waste Mkt Price Per Ton	MWP Composted Materials Mkt Price Per Ton
Newsprint	64%	85%	15%	15%	70%	11.6%	500	900	$45	$23	$0
Crgtd Cardboard	29%	85%	50%	50%	35%	5.2%	150	600	$65	$33	$0
High Grade Paper	0%	85%	15%	0%	70%	0.3%	500	900	$100	$50	$0
Mixed Waste Paper	0%	85%	15%	0%	70%	10.4%	150	700	$25	$13	$0
Rfible Glass Cntnrs	65%	50%	60%	60%	0%	0.7%	400	1000	$116	$12	$0
Othr Rcyclble Glass	15%	50%	60%	60%	0%	5.9%	400	1000	$40	$12	$0
Alum Bevrge Cntnrs	26%	85%	60%	60%	0%	0.8%	75	150	$1,000	$750	$0
Tin Food/Bevrge Cns	2%	40%	80%	0%	0%	1.9%	150	300	$49	$37	$0
Ferrous Metals	54%	0%	80%	40%	0%	1.5%	650	750	$65	$49	$0
Non Ferrous Metals	29%	0%	40%	40%	0%	0.4%	400	500	$800	$400	$0
White Goods	89%	0%	85%	85%	0%	1.7%	400	400	$20	$10	$0
PET Bottles	0%	50%	25%	25%	0%	0.3%	40	300	$160	$48	$0
HDPE Bottles	0%	50%	25%	25%	0%	0.4%	24	300	$200	$60	$0
Plstc Pkgng/Film	0%	35%	0%	0%	15%	4.4%	50	300	$160	$48	$0
Other Plastics	0%	0%	0%	0%	15%	0.9%	50	300	$0	$0	$0
Tires	0%	0%	75%	75%	5%	0.4%	500	500	$0	$0	$0
Oth Rubber Products	0%	0%	0%	0%	20%	0.2%	400	600	$0	$0	$0
Food	0%	90%	0%	0%	95%	8.2%	750	1000	$0	$0	$0
Lawn & Garden Waste	0%	90%	0%	0%	90%	26.9%	415	415	$5	$0	$0
Wood Waste	0%	75%	25%	25%	65%	1.6%	300	600	$5	$0	$0
Cnst/Demo(Excl Wd)	0%	0%	25%	25%	10%	0.7%	800	1000	$0	$0	$0
Other Organic Waste	0%	0%	0%	0%	90%	9.2%	600	900	$0	$0	$0
Oth Inorganic Wst	0%	0%	0%	0%	30%	6.2%	600	750	$0	$0	$0
						100.0%			$38		

* Includes 11.7% of Self Hauled Waste.

Source for sorting efficiencies and waste densities: Washington State Department of Ecology Best Waste Management Practices Analysis for Solid Waste, Volume III, January 1989

TABLE 2

Truck Route and Collection Cost Parameters; Processing and Disposal Cost Parameters

Daily Waste Volume(Tons/Working Day)	500		
Housing Density(Num/Rd Mi)	125		
Waste Per Household(#'s/wk)	40		
Participation- Refuse	95%		
- Recyclables	75%	Weekly Set Out Rate:	
- Self Haul	5%	50%	
- Food Waste	90%		
- Yard Waste	90%		
Container Costs(10 Yr Life)		Amortization @ 4%	
-60 Gal Refuse	$50	$6.16	
-3 @ 11 Gal Recycling	$18	$2.22	
-5 Gal Food Waste	$10	$1.23	
- Yard Waste	$0	$0.00	
Processing Costs Per Input Ton			
-Recyclables	$22		
-Mixed Waste	$40		
-Food Waste	$40		
-Hand Pick	$20		
-Yard Waste	$23		
Disposal Costs Per Ton	$50		

Truck Data	
Speed(MPH) -Between Stops	10
-To/From Route or Tippng	30
Capacity(Cubic Yards)	
Yard Waste	32
Recycling	20
Refuse	20
Food Waste	2
Collection Stop Time(Hours)	
Recycling	0.008
Refuse	0.006
Yard Waste	0.006
Food Waste	0.006
Average Distances(Miles)	
Base to Route	10
Route to Recycling Center	15
Rte to Processng or Disposal Site	15
Center or Site to Base	15
Tipping Time(Hours)	
Recyclables	0.500
Refuse	0.500
Food Waste	0.167
Yard Waste	0.333

Daily Collection Information				
	Recycling	Food Waste	Yard Waste	Refuse
Potential Set Outs	12500	25000	12500	25000
Participant Set Outs	9375	22500	11250	23750
Collectd/Hshld(Lbs.)	21	0	19	20
Avg Density(#/cu yd)	255	750	415	736
Stops to Fill Truck	247	0	685	745
Hours to Fill Truck	2.85	0.00	5.02	4.77
Unload Time(Rnd Trp)	1.50	0.00	1.33	1.50
Start/End Rte Hours	1.83	0.00	1.67	1.83
Loads Per Day	1.4	0.0	1.0	1.0
Daily Drivebys	922	0	761	784
Required Trucks	27	0	16	32
Wrkng Hrs Per Truck	7.32	0.00	6.69	6.60
Truck Costs				
-Purchase Price	$50,000	$30,000	$85,000	$100,000
-Amrt(4% & 7yrs)	$8,330	$4,998	$14,162	$16,661
-Daily(260/Yr)	$32	$19	$54	$64
-Daily O & M	$45	$45	$65	$65
-Daily Labor	$160	$160	$200	$200
-Administration	$59	$56	$80	$82
Truck Cost/Ton	$83	$0	$60	$56

Note: CurbConserve rejects separate collection of food waste for this model version due to unacceptably high relative collection costs.

sent the percentage of material from each waste stream category that a curbside collection participant will keep separate from mixed household waste to set out for recycling collections.

The projected recyclables separation efficiencies for mixed waste processing (MWP) and hand-pick sorting indicate the portion of each waste material that will be pulled out of mixed household waste by, respectively, a capital intensive, mixed waste processing facility (using both mechanical and manual sorting) or a labor intensive, mostly hand-pick processing facility.

The compost process capture rate (or compostables separation efficiency) is that portion of each waste material that will be separated out for composting by a capital intensive, mixed waste processing facility. The total amount of a particular waste material that will be diverted from disposal by a capital intensive facility designed for sorting and composting unseparated residential solid waste depends on the sum of the mixed waste processing recyclables separation efficiency and the compostables separation efficiency. In the case of newsprint, for example, the equation from Table 1 is: 15% + 70% = 85%, indicating that 85 percent of newsprint in unseparated waste will be diverted.

Finally, Table 1 lists *CurbConserve* parameters for waste materials densities when loaded on a recycling or refuse truck, in addition to the market price parameters for recovered materials. These price parameters are based on 1988 Puget Sound WGA market prices and reflect deductions for costs involving transportation from processing facilities to resale markets.

Table 2 lists the following collection system parameters:

- Waste stream quantity in tons per working day.
- Residential household solid waste generation rate in pounds per week.
- Efficiency of the collection system including housing density (measured as number of single-family residences per road mile) and cubic yard capacity of collection vehicles.
- Participation rates for all collection methods and set-out rate for weekly recyclables collection.
- Collection stop times and truck unloading (tipping) times.
- Average truck speeds and distances between truck base, truck routes, and processing or transfer/disposal sites.

Table 2 also lists the real interest rate used to compute constant-dollar collection container and truck amortizations, processing and disposal costs per ton, collection container and truck costs, truck operation and maintenance costs, and truck labor and administrative costs, as well as a summary of daily collection information for the optimal integrated combination of waste management and recycling methods. These latter data are discussed in Section 3. Except for the optimal system truck requirements, all other data on Tables 1 and 2 provide the basic information used together with the menu of recycling, composting and disposal method alternatives by *CurbConserve* to determine the cost-minimizing integrated combination of waste management and recycling methods.

3. Results for a Large Urban Area with Ready Access to Markets

Table 3 lists 23 waste categories and *CurbConserve's* recommended integrated combination of methods to manage each of them economically in a large urban area in the Puget Sound WGA which has ready access to recyclables markets. Existing, privately operated buy-back or drop-site recyclers are projected to continue to handle about 47 tons, or 9 percent, of the 500-tons-per-working-day waste stream. This is a decrease from the 59 tons that existing recyclers handled in the absence of curbside recycling. The 12-ton decrease in drop-site recycling is caused by a projected diversion of recyclables from drop sites into curbside recycling due to curbside's greater convenience. The *CurbConserve* model specifies an operational hierarchy for diversion programs that gives buy-back programs first opportunity to divert waste, followed by curbside recycling programs, then drop-site programs and finally mixed waste sorting methods.

About 41 percent of newsprint, or 24 tons, and 25 percent of aluminum cans, about one ton, are recycled through buy-back operations. A total of about 22 tons of newsprint, corrugated cardboard, refillable and other recyclable glass containers, ferrous and non-ferrous metals and white goods are recycled through drop sites.

Curbside recyclables amounting to almost 97 tons, or 19 percent of daily single-family residential waste, are collected by the weekly three-container collection system. *CurbConserve's* optimization procedure chooses the materials to include in curbside recyclables collection as well as whether or not to use this source separation method. Materials included in the large urban Puget Sound WGA area program are all types of recyclable paper; glass, metal and plastic food and beverage containers; and plastic packaging and films.

Biweekly yard waste collection is also cost-effective. This program diverts about 109 tons, or 22 percent of daily waste.

The only source separation program that is not cost-effective is separate collection of food wastes. The amount of food waste available at each household is too small to warrant a truck and weekly route for its separate collection. In fact, as shown on Table 2, recycling, yard waste and refuse trucks collect an average of 19 to 21 pounds at each household. Only a little over 3 pounds of food waste are in each household's weekly waste stream—too little to justify a separate collection. On the other hand, applying *CurbConserve* to a commercial waste stream has suggested that separate collection of food waste from restaurants is cost-justified, given enough restaurants in a service area to warrant a separate route.[1]

The most intriguing result from the large urban area example is *CurbConserve's* finding that mixed waste processing to recover recyclables and compostables is economical even when about 50 percent of the single-family residential waste stream has been previously removed by source separation methods—i.e., by buy-back and drop-site recyclers, by weekly home collection of recyclables, and by bi-weekly home collection of lawn and garden waste. Processing the remaining unseparated waste that is collected or self-hauled as refuse diverts an additional 177 tons, or 35 percent, of residential waste from disposal.

Recovering compostables is critical to this result. Hand-pick sorting without compostables recovery is not economical because the recovery rate for just recyclables from mixed residential waste is too low downstream from extensive source separation recycling to justify the expense of going through every ton of mixed refuse, even at the relatively low unit cost for hand picking. Thus a market for mixed solid waste compost products is essential for mixed waste processing methods. In Washington state residential waste applications, it was assumed that mixed waste compost would generate no revenue, but that it could all be diverted to productive uses if sold at a zero revenue price.

1. See *Technical Memorandum to Work on Waste, U.S.A.: Avoided Cost Analysis for St. Lawrence County, New York, Using Source Separation of Recyclable Material & Mixed Waste Processing*, Sound Resource Management Group, Inc., June 1989.

TABLE 3

Summary of Optimized System Waste Allocations, Costs and Revenues

Waste Component	Daily Tons Managed Through Indicated Method							
	Buy Back	Crbsd Rcyc	Crbsd Yrd/Fd	Drop Site	MWP	Hand Pick	Disposal	Total Tons
Newsprint	24	22		3	8	0	1	58
Crgtd Cardboard	0	17		3	6	0	1	26
High Grade Paper	0	1		0	0	0	0	2
Mixed Waste Paper	0	33		0	16	0	3	52
Rflble Glass Cntnrs	0	1		1	0	0	0	3
Othr Rcyclble Glass	0	11		3	9	0	6	30
Alum Bevrge Cntnrs	1	2		0	1	0	0	4
Tin Food/Bevrge Cns	0	3		0	5	0	1	9
Ferrous Metals	0	0		4	3	0	1	7
Non Ferrous Metals	0	0		1	1	0	1	2
White Goods	0	0		8	1	0	0	9
PET Bottles	0	1		0	0	0	1	1
HDPE Bottles	0	1		0	0	0	1	2
Plstc Pkgng/Film	0	6		0	2	0	14	22
Other Plastics	0	0		0	1	0	4	5
Tires	0	0		0	2	0	0	2
Oth Rubber Products	0	0		0	0	0	1	1
Food	0		0	0	39	0	2	41
Lawn & Garden Waste	0		109	0	23	0	3	135
Wood Waste	0	0		0	7	0	1	8
Cnst/Demo(Excl Wd)	0	0		0	1	0	2	4
Other Organic Waste	0	0		0	42	0	5	46
Oth Inorganic Wst	0	0		0	9	0	22	31
Total Daily Tons	25	97	109	22	177	0	70	500
Costs and Revenues Per Ton								
Collection(Including Container Costs)		$91	$60		$65	$0	$65	$63
Processing		$22	$23		$56	$0		$29
Disposal		$0	$0				$50	$7
Less:Revenue		$70	$5		$8	$0		$17
Net Cost	$0	$43	$78	$0	$113	$0	$115	$82
Memo:Total Daily Cost	$0	$4,151	$8,518	$0	$20,051	$0	$8,048	$40,768
Memo:Annual Cost Per Household	$0	$9	$18	$0	$42	$0	$17	$85

This leaves only about 70 tons, or 14 percent, of the residential waste stream that requires disposal. In a large residential urban area with ready access to markets for all recyclable paper, glass, metal, plastics and organics, a residential recycling rate of 86 percent is achieved through a combination of source separation and mixed waste processing methods. The annual integrated system cost per household for this high recovery rate is indicated on Table 3 to be a projected $85 per household and $82 per ton.

In this example, the existing private buy-back and drop-site system is specified to have no cost. The same assumption was made for collection costs for self-hauled refuse. Of course, households pay directly in terms of transportation and tipping costs for hauling recyclables to private recyclers and waste to disposal sites. However, the objective in this application of *CurbConserve* was to minimize public sector costs of managing residential solid waste. Here the public sector included all waste management and recycling collection, processing and disposal methods, except for the self-hauling of refuse to public disposal sites, the self-hauling of recyclables to private buy-back and drop-site recyclers, and the private buy-back and drop-site operations themselves. In other applications, these methods could be given non-zero costs and judged for inclusion in the optimal waste management system on that basis.

For comparison, Table 4 lists volumes and costs when the waste management system does not use curbside collection of recyclables or yard waste. In this case private recyclers divert about 59 tons, or 12 percent, of residential waste from disposal. Mixed waste processing diverts an additional 339 tons, or 68 percent, for an overall system recovery rate of about 80 percent. Annual cost per household is $94, or about 11 percent more than for the more complete source separation plus centralized mixed waste processing system.

However, collection costs are about 21 percent less without the extra collection routes for recyclables and yard waste. Without these source separated materials home collection routes, 46 refuse trucks are needed to pick up an average 35 pounds of waste from each of the 118,750 households that choose to use weekly refuse service. This compares with the 32 refuse, 27 recyclables, and 16 yard waste collection trucks (a total of 75 vehicles) used for the source separation system.

As a final comparison, if mixed waste processing is also excluded, the cost per household rises another $4 per year to $98. The overall recovery rate from residential waste in this case falls dramatically to just 12 percent because only recovery by private sector recyclers remains as a disposal diversion method.

A few additional observations may be made about the collection system necessary to accomplish collection of both recyclable materials and yard waste, as well as unseparated refuse (see Table 2). First, a greater portion of each day is spent actually collecting yard waste than collecting recyclables due to the larger trucks used to collect yard waste and the greater density of in-truck yard waste materials versus that for recyclables. About 75 percent of the working day is spent on the lawn and garden waste collection route; the remainder involving driving to and from facilities and unloading. This compares with about 55 percent route time for the recyclables truck, due to the necessity of making a midday trip to unload at the recyclables processing center. Second, the ability to compact refuse also yields a greater amount of actual route time for refuse collection, equalling about 72 percent. Finally, about 25 percent of the working time in each day on all route types is spent driving to and from the collection route, to and from the unloading site, and end-of-day emptying.

A. Sensitivity of Optimal System to Disposal Cost Variations

The disposal cost input parameter was varied and the *CurbConserve* model was used to check for any resultant changes in the cost-effective integrated combination of waste management methods. Disposal costs were set at $50 per ton for the initial results reported in the previous section, and then varied downward in $5 increments for this sensitivity analysis. Disposal costs are assumed to include transfer and transport of

TABLE 4

System Waste Allocations, Costs and Revenues Without Curbside Recycling Methods

Waste Component	Daily Tons Managed Through Indicated Method							
	Buy Back	Crbsd Rcyc	Crbsd Yrd/Fd	Drop Site	MWP	Hand Pick	Disposal	Total Tons
Newsprint	24	0		8	23	0	4	58
Crgtd Cardboard	0	0		8	16	0	3	26
High Grade Paper	0	0		0	1	0	0	2
Mixed Waste Paper	0	0		0	44	0	8	52
Rflble Glass Cntnrs	0	0		2	1	0	0	3
Othr Rcyclble Glass	0	0		4	15	0	10	30
Alum Bevrge Cntnrs	1	0		0	2	0	1	4
Tin Food/Bevrge Cns	0	0		0	7	0	2	9
Ferrous Metals	0	0		4	3	0	1	7
Non Ferrous Metals	0	0		1	1	0	1	2
White Goods	0	0		8	1	0	0	9
PET Bottles	0	0		0	0	0	1	1
HDPE Bottles	0	0		0	0	0	1	2
Plstc Pkgng/Film	0	0		0	3	0	19	22
Other Plastics	0	0		0	1	0	4	5
Tires	0	0		0	2	0	0	2
Oth Rubber Products	0	0		0	0	0	1	1
Food	0		0	0	39	0	2	41
Lawn & Garden Waste	0		0	0	121	0	13	135
Wood Waste	0	0		0	7	0	1	8
Cnst/Demo(Excl Wd)	0	0		0	1	0	2	4
Other Organic Waste	0	0		0	42	0	5	46
Oth Inorganic Wst	0	0		0	9	0	22	31
Total Daily Tons	25	0	0	34	339	0	101	500
Costs and Revenues Per Ton								
Collection(Including Container Costs)		$0	$0		$57	$0	$57	$50
Processing		$0	$0		$52	$0		$35
Disposal		$0	$0				$50	$10
Less:Revenue		$0	$0		$8	$0		$5
Net Cost	$0	$0	$0	$0	$101	$0	$107	$90
Memo:Total Daily Cost	$0	$0	$0	$0	$34,238	$0	$10,833	$45,071
Memo:Annual Cost Per Household	$0	$0	$0	$0	$71	$0	$23	$94

Figure 1: Effect of Disposal Cost on Recovery Methods & Total Recovery Rate

125,000 Urban Residential Single-Family Households

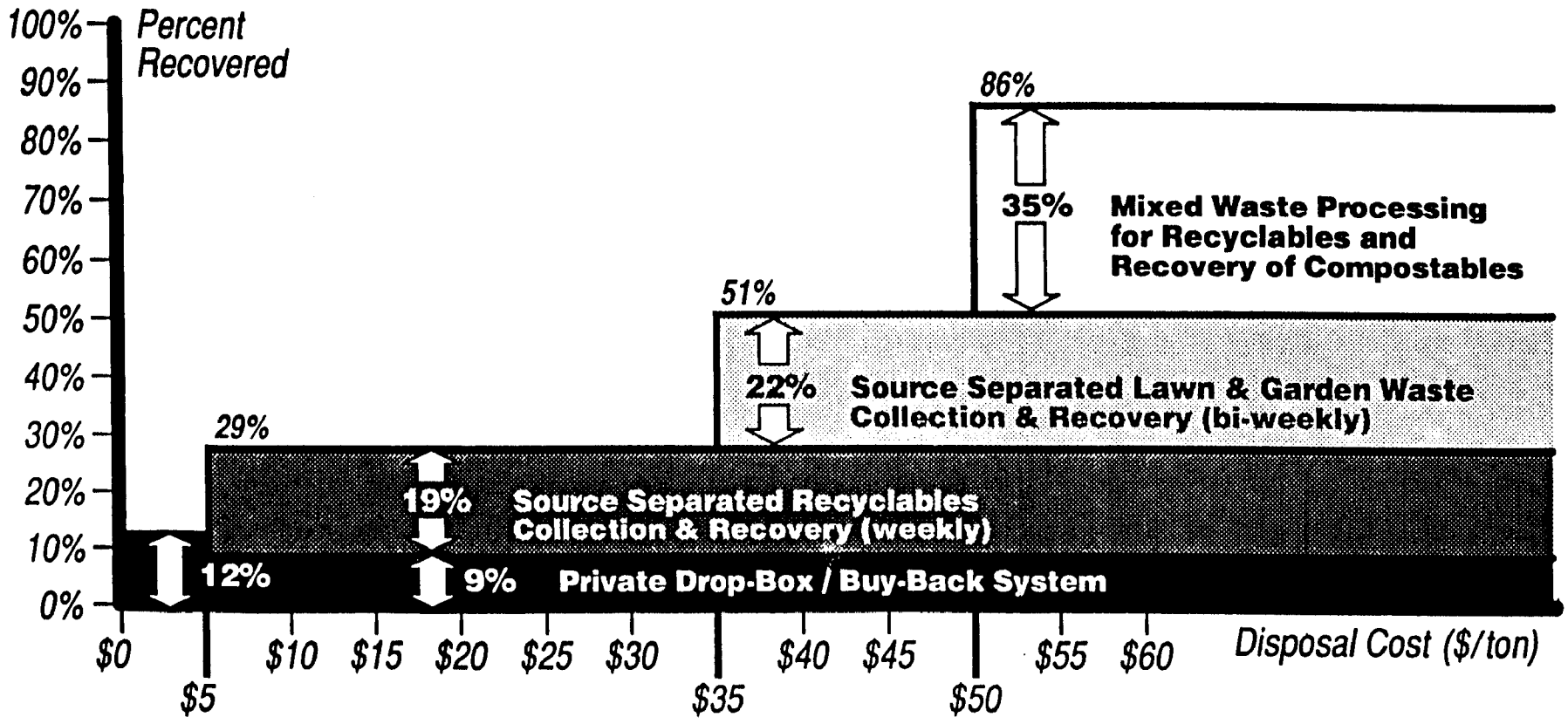

FIGURE 1

refuse to the disposal site whenever that site is further than 15 miles on average from collection routes (see Table 2). Increases in disposal costs above $50 would not change *CurbConserve's* optimal combination. However, increases in disposal costs would offset the effects of reduced materials prices. A sensitivity analysis for materials prices is discussed in the next subsection.

The effect of varying disposal cost is shown graphically on Figure 1. The first recovery method to become uneconomical when disposal costs fall below $50 is mixed waste processing. Table 3 showed that processing unseparated refuse cost $56 per ton of recovered recyclables or compostables. This is because mixed waste processing costs $40 per ton of refuse handled, yet it can recover only about 72 percent of waste processed. The remaining 28 percent requires disposal.

Average revenue for materials recovered is $8 per ton, for a net mixed waste processing cost, excluding collection, of $48 per ton. Thus when disposal costs drop to $45, mixed waste processing is no longer economical.

When disposal cost drops to $30, home collection and centralized composting of lawn and garden waste ceases to be cost-optimal. At a disposal cost of $30 or less per ton, the savings realized by collecting yard waste with refuse (rather than separately) are no longer offset by avoided disposal costs.

Finally, at 1988 prices for curbside collected recyclable materials, disposal costs must drop to near zero before home collection of source separated recyclables is not optimal. At a disposal cost of at least $5 per ton, avoided refuse collection and disposal costs plus the net revenue from selling recyclables are greater than the expenses of providing household recycling containers, operating a recycling truck and preparing recyclables for market.

To summarize the results of the disposal cost sensitivity analysis for a large urban area in the Puget Sound WGA:

- At 1988 Puget Sound WGA materials prices, curbside collection of recyclables is cost-effective even at near-zero disposal costs.
- Curbside collection of lawn and garden waste is economical at disposal costs above $30.
- Mixed waste processing is cost-effective as a supplement to source separation methods at disposal costs above $45 per ton.
- Annual savings from public sector recycling programs depend on disposal cost. At disposal costs of $5 to $30 per ton, savings of $1 to $5 per household per year are realized from weekly curbside collection of source separated recyclables. At disposal costs of $35 to $45 per ton, savings from home collection of both recyclables and yard waste are $6 to $10 per household per year. At disposal costs of $50 and up mixed waste processing can be combined with both source separation methods to increase annual savings to $13 or more per household.

B. Sensitivity of Optimal System to Market Price Variations

Sensitivity of *CurbConserve* results for a large urban single-family residential area in the Puget Sound WGA to change in market prices was also investigated. Prices shown on Table 1 above were varied in 5-percentage-point increments for all materials. Variation of prices for just a few materials would have less impact than the same relative increase or decrease of all prices. In fact, as discussed below, prices are unlikely to all move simultaneously in the same direction at the same rate. A recycling program that diversifies and includes more materials thus reduces price risk. However, to simplify the price sensitivity analysis, it was assumed that all prices do change proportionately.

The 1988 Puget Sound WGA prices shown on Table 1 yield an average value of $38 per ton for waste having the composition of waste generated by residential single-family households in 1987 (also shown on Table 1). Home collection of recyclables and yard waste, as well as processing of mixed refuse remaining after source separated materials are removed, are all cost-

effective recovery methods at these 1988 price levels. Given the efficiency parameters listed on Table 1 and the participation rates listed on Table 2, the *CurbConserve* model shows these three public sector sponsored programs recovering about 77 percent of the 500-ton-per-working-day single-family residential waste stream.

Mixed waste processing is most sensitive to lower material prices. If prices drop just 25 percent below their 1988 level to an average per-ton value of about $28, mixed waste processing becomes uneconomical. This result is depicted in Figure 2. It is also computable from Table 3 which shows that a reduction of the revenue yielded by mixed waste processing from $8 to $6 per ton leaves that method's net cost, excluding collection costs, equivalent to the $50 cost of disposal.

Public sector recovery drops from about 77 to 41 percent when mixed waste processing is removed as a diversion method. The recovery figures given on Figure 2 exclude private recyclers' recovery which accounts for about 9 percent diversion whenever home recyclables collection is offered as a public sector recovery method, and about 12 percent when curbside collection is not offered. Adding the appropriate private recycling rate to the public sector rates on Figure 2 will yield total recovery rates consistent with those shown on Figure 1.

An interesting result of the price sensitivity analysis is that removing materials from curbside collection as prices fall is not practical. Removal of any material present in the recyclables containers in significant quantity reduces the pounds collected per stop to an average that makes recyclables collection too expensive relative to refuse collection. This result is consistent with the implication already mentioned that to be most cost-effective a weekly curbside program using a separate collection truck needs to target low-priced but high-waste-quantity materials such as mixed waste paper, in addition to the usual newsprint and container glass and metals.

At about 50 percent of 1988 prices curbside recycling becomes inefficient relative to mixed waste processing, as depicted on Figure 2. At prices 40 to 50 percent of 1988 levels, the recyclables that come back into the unseparated refuse stream when curbside recycling is not available add enough value to the mixed waste to make processing it for recyclables and compostables recovery again economical, even when it would not be cost-effective to do so downstream from home collection of source separated recyclables.

At lower materials prices this tradeoff between source separation and mixed waste processing recovery methods is not surprising. At $50-per-ton disposal costs and strong materials price levels such as those experienced in 1988, the methods are complementary rather than competitive. But when materials prices are half their 1988 level, *CurbConserve's* optimization calculation suggests that the methods do become competitive. This means that expected future materials prices might be a critical factor in choosing source separation or mixed waste processing for a community's main recovery strategy.

Materials prices in 1988 averaged about 20 percent above their average level over the past ten years, according to U.S. Department of Labor Bureau of Labor Statistics Producer Price Indices for three wastepaper types—newspaper, corrugated cardboard and mixed papers; steel scrap; nonferrous scrap; and for aluminum used beverage can scrap. However, by the end of 1988 these materials prices for the most part had fallen to their ten-year average level. In addition, materials prices fell below 50 percent of their 1988 average level less than 10 percent of the time over the past ten years. Based on historical experience, then, one would not expect to encounter low materials prices in the long run that would make a community choose between source separated and unseparated waste recycling methods. Rather, rising disposal costs will dictate a phased approach to bringing first source separated and then unseparated waste recycling methods both on line.

Finally, Figure 2 shows that home collection of lawn and garden waste is cost-optimal even when compost products yield no revenue net of transportation-to-market costs. This recovery method is driven solely by disposal cost-avoidance and is essentially independent of market revenues.

FIGURE 2

Figure 2: Effect of Material Prices on Public Sector Waste Recovery

125,000 Urban Residential Single-Family Households

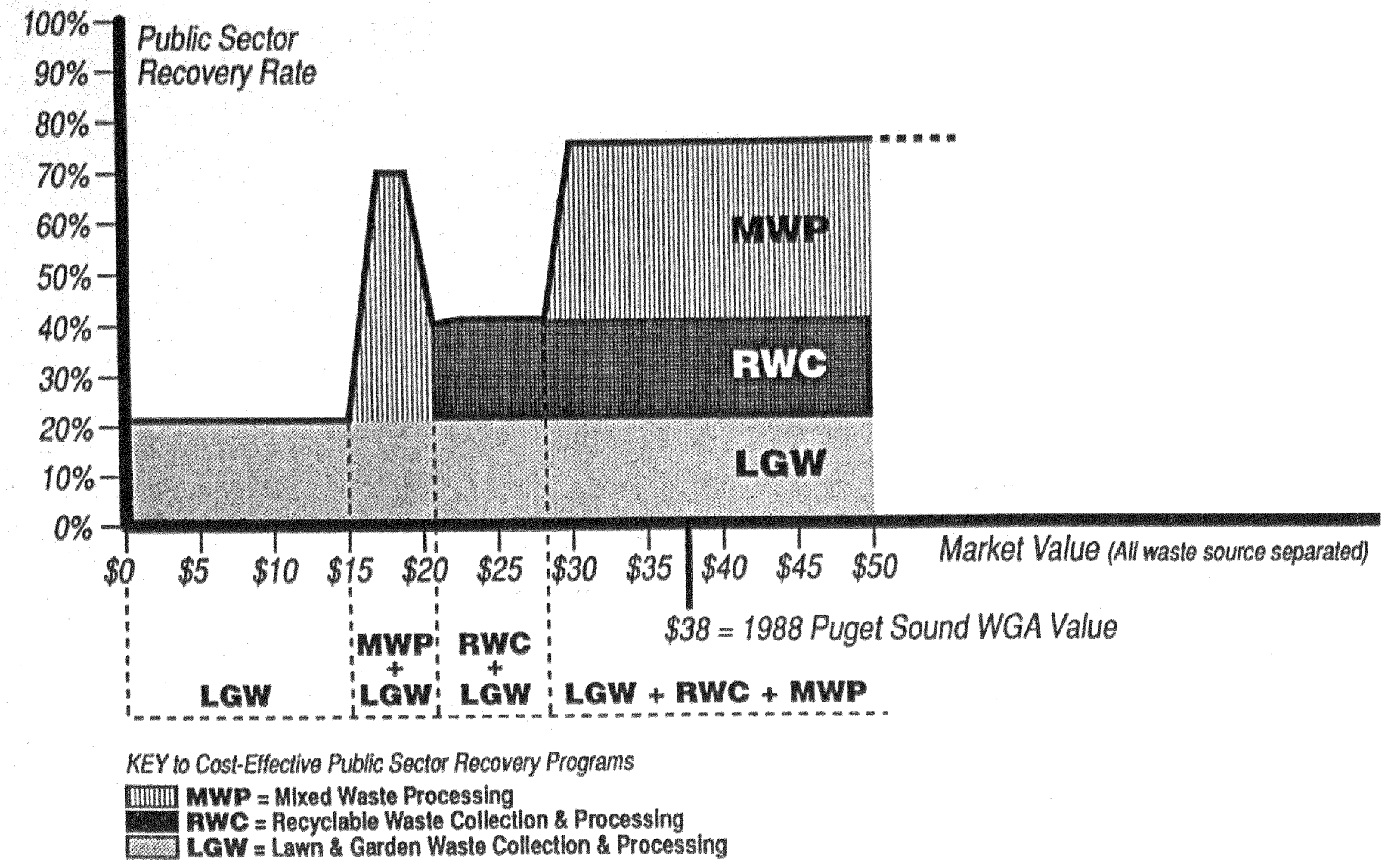

Figure 3: Comparative Price Indices for Recycled Materials

January 1980 to April 1989 (December 1986 = 100)

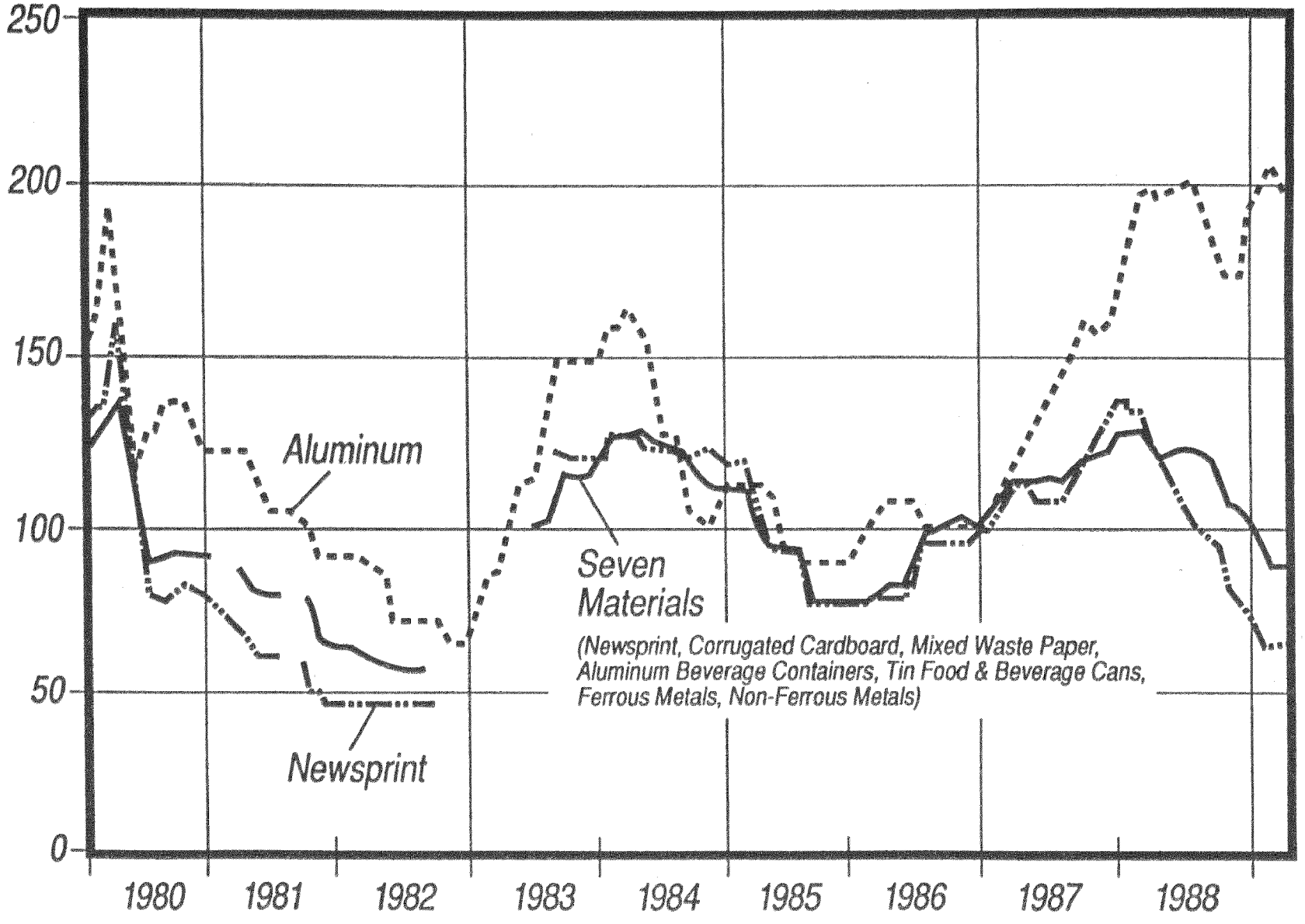

FIGURE 3

4. Diversifying Materials Collected to Reduce Price Risk

Figure 3 shows monthly price indices for recycled newspapers and recycled aluminum beverage cans for the period January 1980 through April 1989. These are Bureau of Labor Statistics Producer Price Indices with their reference month computed to be December 1986 equals 100.

Figure 3 also shows a price index for seven recyclable materials—newsprint, corrugated cardboard, mixed waste paper, aluminum beverage containers, tin food and beverage cans, ferrous metals, and non-ferrous metals. This combined index is based on a weighted average of the BLS indices for recycled news, recycled corrugated, recycled mixed papers, carbon steel scrap, nonferrous scrap, and aluminum used beverage can scrap. The weights are calculated from the relative tonnages recycled shown on Table 3.

What the price indices on Figure 3 show quite clearly is that revenue fluctuations for a recycling program can be reduced by targeting more materials for diversion. The markets for different recyclable materials are not all driven by the same economic forces at the same time, so that prices for different recyclables move in different directions and magnitudes at any given point in time. This diversity allows a community to reduce the revenue risk in its recycling program by targeting a multiplicity of recyclables rather than just a few materials for its recycling systems.

Average revenues from materials sale will be reduced when lower value materials such as mixed waste paper are targeted by recycling programs. But the savings in cost due to efficiencies of scale in collection, the avoided refuse collection and disposal costs, and the reduction in revenue fluctuations over time will compensate a community for the reduction in average per-ton revenues received from its recycling programs.

5. The Impact of Lower Housing Density on Curbside Collection

The households-per-road-mile density parameter, listed on Table 2 at 125 houses per mile, was varied to test whether the integrated residential waste management system that is most cost-effective for an urban Puget Sound WGA area would change as a result. To conduct this analysis it was assumed that daily waste volume is 50 tons per working day and that collection truck speeds increase to some extent as household density decreases. All other parameter data listed on Tables 1 and 2 remained constant—except for number of collection trucks of various types, truck cost per ton collected, and other collection system characteristics determined by *CurbConserve's* optimization calculations.

Table 5 lists the various household density and associated truck speed assumptions used to determine the impact of housing density on the cost-effectiveness of source separation and home collection recovery methods. The table shows the results of the test of housing density on annual cost per household, both with and without home collection of source separated recyclables and yard waste as an adjunct to mixed waste processing.

Reducing household density from 125 households per mile, or about 85 front feet per lot, to 20 per mile, or 528 front feet per lot, does increase the annual cost of managing solid waste. Further, collection costs for home collection of only refuse go up by less than they do for the integrated system that includes home collection of recyclables and yard waste. But the increase in source separation collection costs is not great enough to completely offset the additional recyclables recovery revenue and disposal cost avoidance savings from home collection of recyclables and yard waste.

A density of 20 households per road mile could be associated with as few as 40 house-

TABLE 5

Effect of Varying Household Density

Households Per Road Mile	125	80	40	20
Truck Speed (MPH)				
Between Stops	10	10	15	20
To/From Routes & Tipping	30	30	45	50
Annual Cost Per Household				
With Source Separation	$88	$90	$90	$94
(% Recovered)	(86%)	(86%)	(86%)	(86%)
Without Source Separation	$94	$95	$95	$96
(% Recovered)	(80%)	(80%)	(80%)	(80%)

holds per square mile (16 acres per dwelling)—for example, a rural area that has roads spaced one mile apart. Thus the results exhibited in Table 5 suggest that household density is not the principal determinant for cost-effective collection of source separated materials. The next section of this paper explores this issue in greater depth.

6. Results for Suburbs, Small Towns, and Rural Areas

Up to this point, *CurbConserve* model parameters have reflected the waste composition, collection and processing characteristics of a larger urban area, as shown on Tables 1 and 2. Waste composition and materials prices for the Puget Sound WGA were used to specify these parameters for a large urban area. This paper now considers optimum integrated waste management methods for smaller urban areas, small towns, and rural areas. To do this the Washington State Northwest and North Central WGA 1987 single-family residential subwaste stream compositions and 1988 materials prices were used—the Northwest WGA to characterize smaller urban areas, suburbs and small towns; the North Central WGA to characterize rural areas.[2]

Tables 7 and 8 show waste composition, private recycling rates and prices for the Northwest and North Central WGA's. The most substantial difference from the Puget Sound WGA in waste composition is that newsprint comprises 6 to 7 percent of residential waste rather than 12 percent. Table 6 details major differences in private recycling rates and materials prices. Table 6 also lists other comparisons for 50-tons-per-working-day waste quantity service areas in the three residential community types.

TABLE 6

Comparison of Parameters & Optimum System Costs

WGA	Large Urban Puget Sound	Small Urban Northwest	Rural North Central
Waste Quantity (tons/working day)	50	50	50
Household Density (units/road mile)	125	80	40
Truck Speed (mph)			
Between Stops	10	10	10
To/From Route	30	45	45
Disposal Cost	$50	$50	$50
Average Materials Price	$38	$35	$23
Private Recycling Rate			
With Curbside	9%	4%	4%
Without Curbside	12%	5%	4%
Refuse Self-Haul Percent	5%	5%	20%
Processing Costs (assumes regional facilities)			
Mixed Waste	$40	$40	$40
Recyclables	22	33	$33
Yard Waste	23	30	$30
MWP Optimal	Yes	Yes	No
Source Separation			
Yard Waste Optimal	Yes	No	No
Recyclables Optimal	Yes	No	No
Recovery Rate			
With Source Separation	86%	84%	44%
Without Source Sep.	80%	78%	4%
Annual Household Cost			
With Source Separation	$88	$105	$105
Without Source Sep.	94	102	98
Number of Collection Trucks			
With Source Separation	8	9	8
Without Source Sep.	5	5	4

2. See Washington State Department of Ecology, *Best Management Practices Analysis for Solid Waste, Volume 1: 1987 Recycling and Waste Stream Survey*, January 1989, for all subwaste stream composition detail used in this paper.

CURRCONSERVE MODEL VERSION: Weekly Recyclables, Food and Refuse Collection; Biweekly Yard Waste Collection
12,500 Single Family Suburban or Small Town Residences(1-4 Families Per Building) in the Northwest WGA

TABLE 7

Waste Stream Composition and Quantity Data, Separation Parameters, and Material Price Parameters

Waste Component	1987 Residential Buy Back & Drop Off Recycling Rate	Recyclables Separation Efficiency: Home Sorting for Crbside Collection	Mixed Waste Process(MWP) Sorting	Hand Pick Only Sorting	Compost Process Capture Rate During MWP Sorting	1987 Northwest Residential Single Family Waste Comp*	Collection Truck Waste Density(#/cu yd): Recycl Trck	Refuse Truck	Source Separated Materials Mkt Price Per Ton	Materials Sorted from Mixed Waste Mkt Price Per Ton	MWP Composted Materials Mkt Price Per Ton
Newsprint	28%	85%	15%	15%	70%	6.8%	500	900	$40	$20	$0
Crgtd Cardboard	5%	85%	50%	50%	35%	4.4%	150	600	$61	$31	$0
High Grade Paper	0%	85%	15%	0%	70%	0.6%	500	900	$88	$44	$0
Mixed Waste Paper	0%	85%	15%	0%	70%	11.9%	150	700	$9	$5	$0
Rfible Glass Cntnrs	62%	50%	60%	60%	0%	0.7%	400	1000	$34	$9	$0
Othr Rcyclble Glass	5%	50%	60%	60%	0%	6.0%	400	1000	$29	$9	$0
Alum Bevrge Cntnrs	41%	85%	60%	60%	0%	1.2%	75	150	$986	$740	$0
Tin Food/Bevrge Cns	3%	40%	80%	0%	0%	2.2%	150	300	$42	$32	$0
Ferrous Metals	64%	0%	80%	40%	0%	2.0%	650	750	$51	$38	$0
Non Ferrous Metals	9%	0%	40%	40%	0%	0.3%	400	500	$786	$393	$0
White Goods	44%	0%	85%	85%	0%	0.3%	400	400	$6	$3	$0
PET Bottles	0%	50%	25%	25%	0%	0.3%	40	300	$115	$35	$0
HDPE Bottles	0%	50%	25%	25%	0%	0.4%	24	300	$155	$47	$0
Plstc Pkgng/Film	0%	35%	0%	0%	15%	5.0%	50	300	$138	$41	$0
Other Plastics	0%	0%	0%	0%	15%	1.1%	50	300	$0	$0	$0
Tires	0%	0%	75%	75%	5%	0.6%	500	500	$0	$0	$0
Oth Rubber Products	0%	0%	0%	0%	20%	0.3%	400	600	$0	$0	$0
Food	0%	90%	0%	0%	95%	9.3%	750	1000	$0	$0	$0
Lawn & Garden Waste	0%	90%	0%	0%	99%	27.0%	415	415	$5	$0	$0
Wood Waste	0%	75%	25%	25%	65%	1.8%	300	600	$5	$0	$0
Cnst/Demo(Excl Wd)	0%	0%	25%	25%	10%	0.8%	800	1000	$0	$0	$0
Other Organic Waste	0%	0%	0%	0%	90%	10.5%	600	900	$0	$0	$0
Oth Inorganic Wst	0%	0%	0%	0%	30%	7.0%	600	750	$0	$0	$0
						100.0%			$35		

* Includes 12.1% of Self Hauled Waste

CURBCONSERVE MODEL VERSION: Weekly Recyclables, Food and Refuse Collection; Biweekly Yard Waste Collection
12,500 Single Family Rural Residences(1-4 Families Per Building) in the North Central WGA

TABLE 8

Waste Stream Composition and Quantity Data, Separation Parameters, and Material Price Parameters

Waste Component	1987 Residential Buy Back & Drop Off Recycling Rate	Recyclables Separation Efficiency: Home Srting for Crbside Collection	Mixed Waste Process(MWP) Sorting	Hand Pick Only Sorting	Compost Process Capture Rate During MWP Sorting	1987 Nrthcnt Residential Sngle Family Waste Comp*	Collection Truck Waste Density(#/cu yd) Recycl Trck	Refuse Truck	Source Separated Materials Mkt Price Per Ton	Materials Sorted from Mixed Waste Mkt Price Per Ton	MWP Composted Materials Mkt Price Per Ton
Newsprint	29%	85%	15%	15%	70%	6.0%	500	900	$45	$23	$0
Crgtd Cardboard	6%	85%	50%	50%	35%	4.4%	150	600	$65	$33	$0
High Grade Paper	0%	85%	15%	0%	70%	0.4%	500	900	$100	$50	$0
Mixed Waste Paper	0%	85%	15%	0%	70%	10.6%	150	700	$7	$4	$0
Rfible Glass Cntnrs	80%	50%	60%	60%	0%	1.3%	400	1000	$76	$9	$0
Othr Rcyclble Glass	2%	50%	60%	60%	0%	5.3%	400	1000	$31	$9	$0
Alum Bevrge Cntnrs	42%	85%	60%	60%	0%	1.0%	75	150	$984	$738	$0
Tin Food/Bevrge Cns	0%	40%	80%	0%	0%	1.9%	150	300	$39	$29	$0
Ferrous Metals	39%	0%	80%	40%	0%	2.3%	650	750	$46	$35	$0
Non Ferrous Metals	8%	0%	40%	40%	0%	0.4%	400	500	$781	$391	$0
White Goods	0%	0%	85%	85%	0%	0.5%	400	400	$1	$1	$0
PET Bottles	0%	50%	25%	25%	0%	0.3%	40	300	($251)	($75)	$0
HDPE Bottles	0%	50%	25%	25%	0%	0.4%	24	300	($211)	($63)	$0
Plstc Pkgng/Film	0%	35%	0%	0%	15%	4.5%	50	300	($46)	($14)	$0
Other Plastics	0%	0%	0%	0%	15%	1.1%	50	300	$0	$0	$0
Tires	0%	0%	75%	75%	5%	0.5%	500	500	$0	$0	$0
Oth Rubber Products	0%	0%	0%	0%	20%	0.3%	400	600	$0	$0	$0
Food	0%	90%	0%	0%	95%	8.4%	750	1000	$0	$0	$0
Lawn & Garden Waste	0%	90%	0%	0%	90%	26.7%	415	415	$5	$0	$0
Wood Waste	0%	75%	25%	25%	65%	4.1%	300	600	$5	$0	$0
Cnst/Demo(Excl Wd)	0%	0%	25%	25%	10%	1.7%	800	1000	$0	$0	$0
Other Organic Waste	0%	0%	0%	0%	90%	10.0%	600	900	$0	$0	$0
Oth Inorganic Wst	0%	0%	0%	0%	30%	7.9%	600	750	$0	$0	$0
						100.0%			$23		

* Includes 12.0% of Self Hauled Waste.

A. Analysis of Cost-Effective Integrated Systems

As Table 6 shows, residential source separation is not strictly economical for small urban and rural areas with characteristics as specified by Tables 6, 7 and 8. When smaller communities and rural areas have lower material prices, more self-hauling of waste to disposal facilities, higher processing costs and reduced quantities of certain recyclables such as newsprint, as well as lower housing densities, then home collection methods for source separated recyclables and yard waste increase annual public sector waste management costs. These integrated system costs exceed regular collection and disposal costs by $3 to $7 per household. Of course other considerations, such as increased diversion from disposal, might still make source separation a desirable waste management practice.

Three further observations should be noted. First, the weekly curbside recycling system used in the *CurbConserve* model versions described in this paper is quite likely one of the more expensive methods for collecting source separated recyclables. By reducing collection frequency, alternating refuse and recyclables collection, combining refuse and recyclables collection on the same vehicle, or commingling recyclables in fewer than three containers, a small community might still find source separation a cost-effective waste management method.[3]

Second, the processing costs shown on Table 6 are based on the assumption that processing facilities are shared with other communities. The quantity of recyclables or yard waste that can be source separated from a 50-tons-per-working-day waste stream is too small to permit their being processed alone at a reasonable cost in new capital intensive facilities of the type assumed for processing large quantities from a 500-tons-per-working-day waste stream.[4]

Third, mixed waste processing is not optimal for the rural area, primarily because of low materials prices. In addition, processing costs would be higher than $40 per ton if a 50 tons per working day waste management system built its own facility. As with recyclables and yard waste processing costs, the $40 cost parameter assumes new regional facilities shared with other waste management service areas.

B. Impact of Waste Quantity

The results reported on Tables 5 and 6 suggest that quantity of waste managed is more significant in determining the economic viability of source separation methods than is household density. To examine this issue further *CurbConserve* was run for a community having small town characteristics as given in Table 7, but waste quantity was reduced to 8.3 tons per working day.

At 8.3 tons of waste, just one refuse truck is needed to collect waste when no home collection of source separated materials is offered. However, three trucks (one for each type of home collection) are necessary if both recyclables and yard waste are source separated and collected at the curb. This raises the annual cost per household from $108 to $120, or $12 per household.

In comparison, the 50-tons-per-working-day system needs 5 trucks for refuse only, versus 9 trucks (3 recycling, 2 yard waste, and 4 refuse) to manage source separated materials. In a system of this size, the extra home collections increase annual costs by only $3 per household.

The conclusion from this analysis and the analysis of household density effects seems to be that waste quantity is much more important than household density in determining whether source separation and home collection is economically viable. As is the case with processing costs and facility size, collection costs for source separation systems are also subject to some economies of scale. Expansion of service areas through cooperative agreements may thus make source separation economical in more remote areas or smaller communities where it would otherwise be too costly.

3. For example, see Bullock, Dave, and Burk, Debbie, "Commingled vs. Curbside Sort," *Biocycle*, June 1989, pp. 35-36.

4. See *Best Management Practices Analysis for Solid Waste*, Volume III, Section C, Figure C-3, for some data gathered by Jan Allen, P.E., Sound Resource Management Group, Inc.

7. Material-Specific Net Avoided Costs for Source Separated & Unseparated Waste Recycling Methods

"Avoided cost" is a concept that is increasingly being used to justify waste reduction and recycling programs. For example, in New York state it has been memorialized into a general statewide municipal law which requires communities by September 1, 1992 to adopt a law or ordinance requiring that waste left for collection or delivered by the generator to a solid waste management facility should be separated into recyclable, reusable or other components for which economic markets exist. Economic markets are defined by the law to exist whenever the full avoided costs of proper collection, transportation and disposal of source separated materials are at least as great as the cost of collection, transportation and sale of said material minus the amount received from the sale of the material.

Based on laws and regulations such as this New York state general municipal law, one can expect a good deal of inquiry into proper calculation of avoided costs for various recycling methods versus various disposal methods. Because *CurbConserve* is an optimality model, it implicitly uses avoided costs to determine the least-cost integrated waste management and recycling system that can be selected from the input menu of various specific waste management and recycling programs. Further, the linear programming technique used to find this cost-minimizing integrated combination has, as part of its explicit output, what are called "shadow prices." For recycling programs, these shadow prices for waste stream materials managed by that recycling program are intimately related to avoided costs. Each shadow price represents the effect on total system costs of being able to recycle one more ton of any given material by means of that recycling program, whether home collection of source separated materials or recovery through processing of unseparated refuse.

However, there are two differences between shadow prices and avoided costs. The first is that as indicated in the New York state law recycling's avoided cost refers to savings in refuse collection, transportation and disposal costs when a ton of some waste material is kept out of garbage cans and is instead recycled. To obtain these savings in handling refuse, a recycling program incurs its own collection, transportation and processing costs, as well as obtaining some revenue from the sale of recyclable materials.

On the other hand, the shadow price for the waste material in question would be the net of the avoided garbage costs, the recycling program's costs, and the market revenue. Because it is this net cost which determines whether recycling a waste material would reduce a community's waste management system costs, the term "net avoided cost" (NAC) will be defined here to mean this net sum of avoided refuse costs plus recycling revenues minus the recycling program's costs. (The Appendix to this paper contains precise formulas for net avoided costs for both curbside and mixed waste processing recycling methods.)

The second difference between shadow prices and avoided costs, as well as the difference between shadow prices and *net* avoided costs, is that for a recycling method such as mixed waste processing (which has both recovered materials and compost as its outputs), both avoided cost and net avoided cost would be stated in terms of a ton of the material (for example, newsprint) managed by (input into) the mixed waste processing method. Alternatively, the shadow price for mixed waste processing is the value in terms of reduced waste management costs of one more ton of material (for example, newsprint) actually recycled by (output from) the mixed waste processing method. The difference between the two measures of net value—shadow price and net avoided cost—is thus a multiplicative factor, given in the example of mixed waste processing by the recyclable material's separation efficiency in the mixed waste process sorting operation.

For other recycling methods, such as curbside collection of source separated recyclable materials, that do not convert input waste material into both recovered materials and compost, net avoided costs and shadow prices are the same. For all types of recovery methods, any difference between shadow prices and net avoided costs would involve a multiplicative factor. A multiplicative difference does not change the decision as to whether a particular material should be recycled, regardless of whether the criteria is based on its having a positive net avoided cost or a positive shadow price. The analysis in the remainder of this paper will be conducted using net avoided cost to provide comparability with use of the avoided cost concept in the literature on recycling.

Table 9 lists material-specific public sector net avoided costs for both source separated and unseparated waste recycling methods for the Puget Sound WGA urban single-family residential subwaste stream discussed earlier in this paper. The table also lists in the first two columns the public sector marginal cost for additional refuse. The first column gives additional cost for managing an extra ton of household garbage when that ton is not run through a mixed waste processing facility but is instead directly disposed. The second column lists the added system costs for an extra ton of waste when mixed waste processing is involved prior to disposal.

When an extra ton is taken straight from the garbage can to disposal, the added public sector cost is the same $103 for all waste stream materials. This $103 is related to the net cost for disposal of $115 per ton shown on Table 3 above in that the difference reflects the $12 per ton annual cost for the refuse container supplied to each family. In the examples reported in this paper, the *CurbConserve* model takes the household's refuse container costs as fixed. The additional costs of an extra ton of household refuse are, then, the $50 disposal cost (which includes any transfer and transportation expenses), plus the $56 per ton collection truck cost (shown on Table 2), which is reduced to $53 per average ton disposed by households because 5 percent of household refuse is self-hauled to the disposal facility.

When unseparated waste is run through a mixed waste processing facility, added cost for an additional ton of some material is a function of the material's recovery efficiency as a recyclable, the rate at which the unrecycled portion can be converted into compost and the market value of the recovered material. For a material such as cardboard which has a high rate of separation into recyclables and a high rate of conversion into compost for the remaining portion, or for a material such as aluminum which has a high rate of recyclables separation and a high price for those recovered materials, the reduction in cost by using mixed waste processing is substantial, as shown by the differences between the marginal costs in the first two columns on Table 9. In fact an extra ton of aluminum in household waste would actually reduce total public sector waste management system costs by $337 through its recovery in the mixed waste sorting facility.

The third column of Table 9 explicitly lists the net avoided costs for mixed waste processing that account for the differences between columns one and two. For a few materials which have low combined recyclables and compost separation efficiencies, or which have low prices for recovered recyclables, net avoided costs are negative. However, because mixed waste processing operates on the entire unseparated waste stream, the decision to use this recycling method is not made on a material by material basis. It is the weighted average net avoided cost that determines whether the method is cost-effective. This weighted average is in turn dependent on waste stream composition and the extent of source separation recycling, because the weights used are the tons of each material in unseparated refuse. For the material specific net avoided costs for mixed waste processing given on Table 9, weighted average net avoided cost is $2.

Table 3 showed that the net cost per ton for mixed waste processing was $113, with processing costs averaging $56 per ton diverted from disposal and revenue from the sale of materials averaging $8. The net of these two averages is $48, which makes mixed waste processing slightly preferable on a cost basis to disposal at $50 per ton. This cost savings of $2 per ton is the same as

Table 9

Material Specific Net Avoided Costs for Source Separation and Unseparated Waste Recycling Methods

	Marginal Benefit/(Cost) of Extra Ton Managed By Indicated Method						
	Curbside Refuse		Mixed Waste Processing (MWP)	Curbside Program		Added to Curbside	
Waste Component	Without MWP	With MWP		Without MWP	With MWP	Without MWP	With MWP
Newsprint	($103)	($97)	$6	$20	$16		
Crgtd Cardboard	($103)	($84)	$19	$33	$20		
High Grade Paper	($103)	($93)	$10	$98	$88		
Mixed Waste Paper	($103)	($99)	$4	$23	$19		
Rflble Glass Cntnrs	($103)	($106)	($3)	$47	$48		
Othr Rcyclble Glass	($103)	($106)	($3)	$23	$25		
Alum Bevrge Cntnrs	($103)	$337	$440	$997	$563		
Tin Food/Bevrge Cns	($103)	($74)	$29	$45	$16		
Ferrous Metals	($103)	($64)	$39			$8	($10)
Non Ferrous Metals	($103)	$37	$140			$768	$669
White Goods	($103)	($92)	$11				
PET Bottles	($103)	($119)	($16)	$158	$174		
HDPE Bottles	($103)	($116)	($13)	$198	$211		
Plstc Pkgng/Film	($103)	($135)	($32)	$158	$191		
Other Plastics	($103)	($136)	($32)				
Tires	($103)	($103)	$0				
Oth Rubber Products	($103)	($133)	($30)				
Food	($103)	($96)	$8				
Lawn & Garden Waste	($103)	($98)	$5	$25	$20		
Wood Waste	($103)	($98)	$5			$3	($2)
Cnst/Demo(Excl Wd)	($103)	($126)	($23)				
Other Organic Waste	($103)	($98)	$5				
Oth Inorganic Wst	($103)	($128)	($25)				
Weighted Average			$2				

the weighted average net avoided cost for mixed waste processing computed from the data on Table 9.

The last four columns on Table 9 give material-specific net avoided costs for home collection of source separated waste materials. The first of the four columns lists curbside recycling's net avoided costs versus disposal for items collected in the three recycling bins or in the bi-weekly yard waste pick-up. The second column gives net avoided costs versus processing the unseparated waste before it goes to disposal. The third and fourth columns show net avoided costs versus disposal and mixed waste processing, respectively, for materials that might be added to the home collection system, assuming no change would be needed in the containers provided to households already participating in the program.

The net avoided cost of curbside recycling for a specific waste stream material depends on: 1) the price received when a source separated material is processed and marketed; 2) its collection and processing costs; and 3) the refuse collection and disposal costs saved when the material is put into recycling bins rather than garbage cans. When there is drop-site recycling, the public sector cost credit to curbside recycling for avoided refuse collection and disposal is reduced by the percentage of drop-site recycling diverted into the curbside program. Similarly, when there is self-hauling of refuse, curbside's public sector cost credit for avoided refuse collection is reduced by the percentage of mixed waste that generators take to the disposal site in their private vehicles.

The difference between net avoided costs for curbside recycling with and without mixed waste processing reflects the effect that utilization of mixed waste processing has on both the avoided cost savings from curbside and the loss for that portion of drop-off recycling that is displaced by curbside recycling.

First, when unseparated mixed refuse is being processed for recyclables and compostables, the net avoided cost of an additional ton of some waste material being recycled at curbside is reduced for those materials having a positive net avoided cost for mixed waste processing. Those materials that have a negative mixed waste processing net avoided cost shown in the third column of Table 9 yield greater curbside net avoided costs.

For example, the value of an extra ton of corrugated being set out for curbside recycling pickup is not as great if there is a mixed waste processing system that acts as a safety net for cardboard that is mixed in the refuse container rather than being source separated. On the other hand, the value of an extra ton of PET bottles set out for curbside recycling is greater when a mixed waste processing program is also in place. The low recyclables and compostables separation rates for mixed waste processing of PET cause a synergistic cost savings for sorting mixed waste when a ton of PET is moved out of the refuse can and into the recycling containers.

Second, availability of mixed waste processing has an effect on the magnitude of increased public sector costs when curbside recycling supplants a portion of private drop-site recycling. This effect arises because the displacement of drop-site recycling is valued at the marginal cost of an extra ton of refuse as shown in one of the first two columns of Table 9. For example, when a ton of corrugated cardboard is added to curbside recycling, 29 percent of that ton is drawn from drop-site recycling. Thus, increased waste management system costs are 29 percent of $103 in the absence of mixed waste processing, versus 29 percent of $84 when a mixed refuse sorting facility is operational.

The 29 percent figure is an estimate for the Puget Sound WGA of the proportion of corrugated's drop-site recycling displaced by the curbside program. The 29 percent comes from the assumption that curbside would supplant drop-site recycling at the same percentage rate as drop-site's recycling rate before curbside recycling was available (see footnote 5). In another community the substitution rate would depend on the extent to which curbside and drop-site recycling compete for each given material in that community.

The materials included in the home collection of recyclables and lawn and garden waste all have positive net avoided costs. Except for non-ferrous metals, the waste categories excluded

from home collection cannot be added on a cost-effective basis when unseparated waste is being processed for recovery of recyclables. For example, the combined recyclables and compostables separation efficiencies for wood waste in mixed waste processing make it more cost-effective to leave wood in the refuse container (at least for residential wastes that have less wood than commercial wastes) rather than source separating it. In the case of non-ferrous metals, some restriction on size would probably be necessary to fit them into the three 11-gallon containers used in the specified weekly curbside collection system. They were excluded from curbside because they were assigned separation efficiencies of zero for home separation for curbside (see Table 1).

8. Appendix for Net Avoided-Cost Formulas

For the quantitatively oriented reader, this appendix lists the formulas used to produce the net avoided costs in Table 9.

The public sector waste management system marginal cost (MC) of an extra ton in the refuse can for disposal is given for each waste material by:

$$(1)\quad MC = (1 - h)\, T_d + MC_d$$

where the variable T is truck collection cost per ton; the variable MC is marginal cost; the variable h is the refuse self-haul rate; and the subscript d represents the disposal method for managing municipal solid waste. MC_d is thus the marginal cost of disposal, e.g., the disposal cost of $50 shown on Table 2.

For mixed waste processing, material specific net avoided costs (NAC) are given by:

$$(2)\quad NAC_{mwp} = S_m\, P_m + S_c\,(1 - e)\, P_c + (S_m + S_c)\, MC_d - MC_{mwp}$$

where P is market price; S is separation efficiency; e is the compost process mass reduction rate; the subscripts m, c and d refer respectively to mixed waste processing for recyclables, mixed waste processing for compostables, and disposal; and the subscript mwp on NAC and MC refers to the mixed waste processing method. For example, S_c is the compost process capture rate (or separation efficiency) given on Table 1 for a given waste stream material; P_m is the price given on Table 1 for a material sorted as a recyclable from mixed waste; and MC_{mwp} is the marginal cost or processing cost for mixed waste, e.g., the $40 per input ton shown on Table 2.

The marginal cost of an extra ton in the refuse can when mixed waste processing occurs prior to disposal is then given by:

$$(3)\quad MC(mwp) = MC - NAC_{mwp}$$

where (mwp) refers to the presence of mixed waste processing in the integrated waste management system.

For curbside recycling, material specific net avoided costs when mixed waste processing is not available as a safety net are given by:

$$(4)\quad NAC_r = P_r - T_r - MC_r + (1 - h)\, T_d + MC_d - S_{ds}\, MC$$

where the new subscripts are r for curbside recycling and ds for drop-site recycling programs.[5]

Substituting from equation (1) for MC gives:

$$(4')\quad NAC_r = P_r - T_r - MC_r + (1 - S_{ds})\, MC_d + (1 - h)\,(1 - S_{ds})\, T_d$$

The net avoided cost of curbside recycling for a specific waste stream material depends on

5. Drop-site recycling rates (or separation efficiencies) in the Washington state examples were assumed equal to the residential buy-back and drop-off recycling rates shown on Tables 1, 7 and 8, except for newsprint and aluminum beverage cans. For those two materials, buy-back recycling upstream of drop-site recycling was assumed to involve 65 percent and 95 percent, respectively, of total residential buy-back and drop-off recycling. Buy-back recycling was assumed not to occur for other recyclable materials.

three factors: 1) the market price for that material; 2) its collection and processing costs; and 3) the collection and disposal costs saved when the material is put into recycling bins rather than garbage cans, where the extent to which public sector refuse collection and disposal costs are saved depends on the drop-site recycling rate (S_{ds}) and the refuse self-haul rate (h).

For curbside recycling backed up by a safety net of mixed waste processing, curbside's net avoided costs are given by:

$$(5)\quad NAC_r(mwp) = NAC_r + S_{ds}\,[MC - MC\,(mwp)] - NAC_{mwp}$$

But $MC - MC(mwp) = NAC_{mwp}$ from equation (3) above, so that:

$$(5')\quad NAC_r(mwp) = NAC_r - (1 - S_{ds})\,NAC_{mwp}$$

That is, the net avoided cost for curbside recycling with mixed waste processing as a backup disposal diversion program is NAC_r reduced by mixed waste processing's net avoided cost for that portion of a ton that would not otherwise be recycled through a drop-site program. For materials that are very valuable to a mixed waste processing program, such as aluminum in absolute terms or wood waste in relative terms, the reduction in net avoided costs for curbside can be considerable when its value is measured relative to mixed waste processing rather than disposal. For example, wood waste has a positive $3-per-ton curbside net avoided cost when mixed waste processing is not a supplemental diversion possibility, versus a negative $2-per-ton curbside net avoided cost upstream of a mixed waste processing facility.

SUBTITLE D MUNICIPAL SOLID WASTE LANDFILL COST MODEL

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SUBTITLE D MUNICIPAL SOLID WASTE LANDFILL COST MODEL

An interactive computer cost model was developed for the U.S. Environmental Protection Agency's Office of Solid Waste/Economic Analysis staff which estimates the cost to design, construct, operate, close, and provide post-closure care for Subtitle D municipal solid waste landfills (MSWLFs) under a variety of regulatory and technical options. The model was used in the development of EPA's proposed revisions to the Subtitle D criteria for MSWLFs to analyze the costs of regulatory alternatives as presented in the draft Regulatory Impact Analysis. The model is not EPA-approved and its results have not been extensively peer reviewed. The cost model is currently being converted to an IBM-compatible PC version for use by outside parties. It is very flexible and easily modified to accommodate a wide variety of landfill design and operating configurations. The user specifies such input variables as waste throughput, operating life, type and depth of fill operation, number of phases of construction, containment and cover system options, waste density, environmental monitoring and control options, post-closure period, and a variety of unit costs and fees for construction and operation of the facility. Based on these input variables, the cost model calculates the active area required, capital costs, operating and maintenance costs, closure costs, and post-closure costs of the facility. In addition, the model assigns these costs to specific years during the operating life and post-closure period of the facility and conducts a present value analysis to compare costs of technical options. A user's guide also is being developed for the PC version of the cost model.

I. BACKGROUND

A. Basis for Model Development

- The municipal landfill cost model was developed to estimate baseline and incremental compliance costs at existing and new facilities under proposed Subtitle D rules and regulatory alternatives considered by the Agency

B. Model Capabilities

1. Presents detailed design, operating, and closure/post-closure parameters, output specifications, and cost results.

2. Interactive, flexible, easily modified and updated.

3. Provides present value analysis for comparison of different facility designs.

II. MODEL FEATURES, VARIABLES, AND RESULTS

A. Model Overview

1. Up to 20 different user-specified facility designs and capacities.

2. Use of default database or development of new input design parameters and unit costs.

3. Calculation and reporting of facility dimensions, areas, material volumes, operating features, and equipment requirements.

4. Presentation of direct and indirect capital, operating and maintenance, closure and post-closure, and annualized costs.

B. User-Specified Input Parameters

1. Waste characteristics: quantity (1-8000 tons/day), density, and operating life (1-50 years).

2. Operating features: landfill type, number of phases, depth, and slopes.

3. Containment and cover specifications: drainage systems, intermediate cover, final cover materials and thicknesses (up to 10 layers and 16 material types), containment system materials and thicknesses (up to 10 layers and 16 material types), leachate detection, collection, and treatment systems, and gas migration controls.

4. Monitoring options: landfill gas, ground water, and surface water.

5. Over 50 unit costs for construction, materials, operating, and closure variables.

6. Model "flags" user to prevent specifying parameters outside acceptable range.

C. Model-Defined Parameters

1. Landfill unit is square.

2. Operating equipment package, required buildings, and service roads.

3. Operating labor requirements.

D. Model Outputs

1. Detailed summary of facility design and operating configuration specified (Exhibit 1).

2. Listing of unit costs specified (Exhibit 2).

3. Summary of facility design and operating configuration results (Exhibit 3).

4. Itemized summary of cost results (Exhibit 4).

5. Summary of annual costs (Exhibit 5).

E. Model Limitations

1. Model is not EPA-approved. Model results have not been extensively peer reviewed or field validated.

2. Unit costs based on national averages--adjustments for regional or local differences may be necessary.

3. Costs may be overestimated for very small landfills (< 10 tons/day)

due to fixed expenses.

4. Certain permitting and site related activities such as EIS preparation, legal fees, and public involvement costs are excluded.

5. Facility costs, not prices (tipping fees) are estimated.

6. Simplifying assumptions versus site-specific conditions (e.g., square shape with identical slopes on each side).

7. Costs for corrective action are not estimated by the model but can be input by the user.

III. MODEL APPLICATIONS

State and local government officials and facility owner/operators may find the cost model a useful analytical tool for estimating total, incremental, or selected regulatory component costs of various design configurations

A. Regulatory Analysis and Development

1. Examination of facility compliance costs based on state or federal standards.

2. Isolation of regulatory component costs (e.g., environmental monitoring, containment system, cover configuration, leachate management, etc.).

3. Estimation of closure/post-closure costs to assess financial assurance.

C. Sensitivity Analyses of Facility Costs

1. Model effects of variations in environmental settings, design and operating characteristics, and unit costs.

2. Model changes in interest rate and operating life to analyze financing alternatives.

D. Input to Comparative Cost Analyses

1. Compare municipal solid waste landfill costs ($/ton basis) with cost estimates for MSW alternatives (e.g., composting, recycling, source separation, combustion) as part of integrated solid waste management planning.

2. Measure cost effects of reducing community landfill requirements resulting from implementation of MSW alternatives.

IV. MODEL ACCESS

A. Development of PC Version of Model

1. Conversion to IBM-compatible PC system software currently underway.

2. Availability anticipated by December 1990.

3. Updated unit costs (1990 $) and default database.

B. Model Validation and Documentation

1. Conducting comparison of model design/operating features, unit costs, and cost results with empirical cost data.

2. Preparing model documentation and user's guide for PC version of model.

EXHIBIT 1

EXAMPLE OF A DETAILED FACILITY SUMMARY

```
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                    FACILITY  1
                    10 TPD                                                B202
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

        OPERATION TYPE................ COMBINATION FILL                   B203
        WASTE CAPACITY................    10.00 TONS/DAY                  B204
        COMPACTED WASTE DENSITY.......   667.00 KG/CU M                   B205
        OPERATING LIFE................       20 YEARS                     B206
        NUMBER OF LANDFILL PHASES.....        1                           B207
        POST CLOSURE MONITORING PERIOD       30 YEARS                     B208
        DEPTH OF FILL BELOW GRADE.....     4.57 METERS                    B209
        PERCENT OF FILL BELOW GRADE...    82.00 PERCENT                   B210
        BELOW GRADE SIDE SLOPE(RUN:RISE)    1.00                          B211
        BERM TYPE.....................    NONE                            B212
        GAS MIGRATION CONTROL......... EXTRACTION WELLS                   B213
        WATER MONITORING SYSTEMS...... GROUNDWATER AND SURFACE WATER      B214
        FIRST YEAR OF WATER MONITORING        1                           B215
        WATER SAMPLING FREQUENCY......        2/YEAR                      B216
        GAS MONITORING IS USED                                            B217
        FIRST YEAR OF GAS MONITORING..        1                           B218
        COMPLIANCE WITH SUBTITLE D CLOSURE                                B219
        CLOSURE/POST-CLOSURE PLAN INCLUDED                                B220
        PRECONSTRUCTION PLANS ADJUSTMENT      0. DOLLARS                  B221

        CONTAINMENT SYSTEM
        ------------------
        LAYER  1 CONSISTS OF SLOPE & EARTH FILL                           C301
             DEPTH OF LAYER  1 ........   .3050 METERS                    C302
        LAYER  2 CONSISTS OF GEOTEXTILE FILTER FAB                        C301
        LAYER  3 CONSISTS OF SAND                                         C301
             DEPTH OF LAYER  3 ........   .3050 METERS                    C302
        LAYER  4 CONSISTS OF  30 MIL HDPE                                 C301
        LAYER  5 CONSISTS OF ON-SITE CLAY                                 C301
             DEPTH OF LAYER  5 ........   .6100 METERS                    C302
        LEACHATE COLLECTION SYSTEM IS USED                                C303
        LEACHATE VOLUME COLLECTED.....    3.00 IN/YEAR                    C304
        TRUCKED OFF-SITE LEACHATE TREATMENT IS USED                       C305
        LEACHATE DETECTION SYSTEM NOT USED                                C307

        INTERMEDIATE COVER
        ------------------
        INTERMEDIATE COVER CONSISTS OF SLOPE & EARTH FILL                 D401
        INTERMEDIATE COVER VOLUME.....    2.00 PERCENT OF LANDFILL        D402
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EXHBIT 1

EXAMPLE OF A DETAILED FACILITY SUMMARY (Continued)

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FINAL COVER
-----------
FINAL COVER LAYER  1 CONSISTS OF SLOPE & EARTH FILL                E501
     THICKNESS OF LAYER  1....     .3050 METERS                    E502
FINAL COVER LAYER  2 CONSISTS OF GEOTEXTILE SUPPORT FAB            E501
FINAL COVER LAYER  3 CONSISTS OF  30 MIL PVC                       E501
FINAL COVER LAYER  4 CONSISTS OF SAND                              E501
     THICKNESS OF LAYER  4....     .3050 METERS                    E502
FINAL COVER LAYER  5 CONSISTS OF GEOTEXTILE FILTER FAB             E501
FINAL COVER LAYER  6 CONSISTS OF TOP SOIL                          E501
     THICKNESS OF LAYER  6....     .1520 METERS                    E502
FINAL COVER SLOPE (RISE:RUN)..     .0350                           E503
TOE SLOPE(RUN:RISE).....           2.00                            E504
COVER DRAINAGE PIPE USED                                           E505
STORMWATER CONTROL SYSTEM IS USED                                  E506

POST CLOSURE OPERATION
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POST CLOSURE OPTIONS CHOSEN:
     ANNUAL INSPECTION & CONTINUED MONITORING                      F601
     CONTINUED LEACHATE COLLECTION                                 F602
     NUMBER OF YEARS OF LEACHATE TREAT.      5 YEARS               F603
     LANDSCAPE MAINTENANCE                                         F604
     SLOPE MAINTENANCE                                             F605

CORRECTIVE ACTION
-----------------
CORRECTIVE ACTION IS APPLIED
     INITIAL COST OF CORRECTIVE ACTION. $ 100000.00                G701
     FIRST YEAR OF CORRECTIVE ACTION...         28                 G702
     ANNUAL COST OF CORRECTIVE ACTION..    10000.00 $/YR           G703
     NO. OF YEARS OF CORRECTIVE ACTION.          10 YEARS          G704
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EXHIBIT 2

EXAMPLE OF A LISTING OF UNIT COST INFORMATION

LISTING OF UNIT COSTS

LABOR COSTS			
OPERATOR COST	30.50	$/HR	H801
MANAGER COST	35.00	$/HR	H802
CLERICAL COST	15.50	$/HR	H803
UNSKILLED LABOR COST	14.50	$/HR	H804
PROFESSIONAL LABOR COST	50.00	$/HR	H805
TECHNICIAN COST	25.00	$/HR	H806
CAPITAL COSTS			
LAND COST	5000.00	$/ACRE	H807
CLEARING AND GRUBBING COST	5495.00	$/ACRE	H808
HYDROGEOLOGIC STUDY COST	20000.00	$/ACRE	H809
PAVED ROAD COST	87.34	$/METER	H810
TEMPORARY ROAD COST	24.45	$/METER	H811
FENCING COST	33.14	$/METER	H812
PARKING COST	393.00	$/CAR	H813
BUILDING COSTS			H814
OFFICE BUILDING	807.00	$/SQ M	
MAINTENANCE BUILDING	603.00	$/SQ M	
STORAGE BUILDING	124.00	$/SQ M	
CITIZEN DISPOSAL BOX COST	13940.00	$/BOX	H815
EXCAVATION COST	4.45	$/CU M	H816
BERM CORE TRENCHING COST	6.05	$/CU M	H817
DIVERSION DITCH COST	6.82	$/METER	H818
CLAY COSTS			H819
ON-SITE CLAY	12.83	$/CU M	
OFF-SITE CLAY	27.27	$/CU M	
SOIL COSTS			H820
TOP SOIL	19.26	$/CU M	
SLOPE AND EARTH FILL	7.56	$/CU M	
SAND COST	16.70	$/CU M	H821
GRAVEL COST	14.94	$/CU M	H822
SYNTHETIC LINER COSTS			H823
20 MIL PVC	2.35	$/SQ M	
30 MIL PVC	3.00	$/SQ M	
30 MIL HDPE	3.75	$/SQ M	
40 MIL HDPE	4.50	$/SQ M	
60 MIL HDPE	6.45	$/SQ M	
80 MIL HDPE	7.85	$/SQ M	
100 MIL HDPE	9.15	$/SQ M	
GEOTEXTILE COSTS			H824
SUPPORT FABRIC	1.50	$/SQ M	
FILTER FABRIC	.80	$/SQ M	
SYNTHETIC DRAINAGE NET COST	2.35	$/SQ M	H825

EXHIBIT 2

EXAMPLE OF A LISTING OF UNIT COST INFORMATION (Continued)

INSTALLED PIPE COSTS			H826
LEACHATE BRANCH PIPE.....	13.61	$/METER	
LEACHATE HEADER PIPE.....	29.81	$/METER	
COVER DRAINAGE PIPE.....	10.47	$/METER	
MANHOLE COST.....	720.44	$/EACH	H827
MANHOLE EXTENSION COST.....	282.81	$/METER	H828
WET WELL AND SUMP.....	10700.00	$/EACH	H829
GAS MIGRATION TRENCH COST.....	157.06	$/METER	H830
GAS EXTRACTION WELL COST.....	6125.00	$/WELL	H831
EXTRACTION WELL EXTEN. COST...	205.00	$/METER	H832
BLOWING STATION COST.....	75000.00	$/EACH	H833
GROUNDWATER WELL CLUSTER COST.	9200.00	$/CLUS.	H834
GAS MONITORING PROBE COST.....	312.50	$/PROBE	H835
REVEGETATION COST.....	1375.98	$/ACRE	H836
TREE COST.....	52.00	$/TREE	H837
O AND M COSTS			
RODENT AND BIRD CONTROL COST..	200.00	$/YR	H838
LANDSCAPE MAINTENANCE COST....	6.88	$/ACRE	H839
TRUCKED OFFSITE TREATMENT COST	.0330	$/GAL	H840
SEWERED OFFSITE TREATMENT COST	.0040	$/GAL	H841
SEWER COST.....	111.55	$/METER	H842
MONITORING COSTS			H843
GROUNDWATER MONITORING...	60.00	$/SAMPLE	
SURFACE WATER MONITORING.	60.00	$/SAMPLE	
LICENSE COST.....	10000.00	$/YEAR	H844
ELECTRICITY COST.....	.0700	$/KWH	H845
PROPANE COST.....	4.550	$/MBTU	H846
FEES AND ESCALATORS			
ENGINEERING FEE.....	10.00	PERCENT	H847
INSPECTION & TESTING FEE.....	5.00	PERCENT	H848
CONTRACTORS FEE.....	10.00	PERCENT	H849
SPARE PARTS INVENTORY.....	1.00	PERCENT	H850
CONSTRUCTION & FIELD EXPENSES.	5.00	PERCENT	H851
CONTINGENCY FEE.....	10.00	PERCENT	H852
QUALITY ASSURANCE.....	15.00	PERCENT	H853
EQUIP. CAPITAL COST ESCALATOR.	.00	PERCENT	H854
EQUIP. O & M COST ESCALATOR...	.00	PERCENT	H855
LEACHATE TREATMENT EQUIP ESCAL	.00	PERCENT	H856
GENERAL ESCALATOR.....	.00	PERCENT	H857
DISCOUNT RATE.....	3.00	PERCENT	H858

EXHIBIT 3

EXAMPLE OF A SUMMARY OF THE DESIGN CONFIGURATION RESULTS

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EXHIBIT 3

EXAMPLE OF A SUMMARY OF THE DESIGN CONFIGURATION RESULTS (Continued)

SURFACE WATER CONTROL AND ENVIRONMENTAL MONITORING

DIVERSION DITCH LENGTH.....	559.84	METERS
SETTLING BASIN VOLUME.....	43450.	GAL
GROUNDWATER WELLS.....	15	
GAS MONITORING PROBES.....	26	
GAS EXTRACTION WELLS.....	17	

ANNUAL O & M

OPERATOR LABOR.....	544.86	HRS/YR
MANAGER LABOR.....	120.00	HRS/YR
CLERICAL LABOR.....	60.00	HRS/YR
UNSKILLED LABOR.....	30.00	HRS/YR
INTERMEDIATE COVER VOLUME.....	90.	CU M/YR
GROUNDWATER SAMPLES.....	30	NO./YR
GAS MONITORING SAMPLES.....	104	NO./YR
LEACHATE VOLUME.....	349315.3	GAL/YR
ELECTRICITY.....	600.	KWH/YR
PROPANE.....	65.	MBTU/YR

CLOSURE

COVER SYSTEM:

LAYER 1 CONSISTS OF SLOPE & EARTH FILL		
VOLUME OF LAYER 1.....	5364.	CU M
LAYER 2 CONSISTS OF GEOTEXTILE SUPPORT FAB		
SURFACE AREA OF LAYER 2.....	17793.	SQ M
LAYER 3 CONSISTS OF 30 MIL PVC		
SURFACE AREA OF LAYER 3.....	17793.	SQ M
LAYER 4 CONSISTS OF SAND		
VOLUME OF LAYER 4.....	5487.	CU M
LAYER 5 CONSISTS OF GEOTEXTILE FILTER FAB		
SURFACE AREA OF LAYER 5.....	18197.	SQ M
LAYER 6 CONSISTS OF TOP SOIL		
VOLUME OF LAYER 6.....	2780.	CU M
SURFACE AREA OF FINAL COVER.....	18395.	SQ M
LENGTH OF COVER DRAINAGE PIPE.....	525.57	METERS

EXHIBIT 4

EXAMPLE OF AN ITEMIZED SUMMARY OF THE COST RESULTS

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EXHIBIT 4

EXAMPLE OF AN ITEMIZED SUMMARY OF THE COST RESULTS

(Continued)

STORMWATER CONTROL SYSTEM COST....	$	4356.
EQUIPMENT COST.....	$	154619.
ENGINEERING FEE.....	$	131258.
INSPECTION, TESTING AND QA.....	$	115377.
OTHER INDIRECT CAPITAL COSTS.....	$	351570.
TOTAL CAPITAL COST.....	$	2021154.

O & M COSTS

MANAGERIAL COST.....	$	84000.
OPERATOR COST.....	$	332365.
CLERICAL COST.....	$	18600.
UNSKILLED LABOR COST.....	$	8700.
MAINTENANCE LABOR COST.....	$	36513.
EQUIPMENT COST.....	$	147935.
INTERMEDIATE COVER COST.....	$	13640.
UTILITIES COST.....	$	12755.
ENVIRONMENTAL MONITORING COST.....	$	103800.
LEACHATE COLLECTION & TREAT. COST.	$	118706.
LICENSES, FEES AND PERMITS COST...	$	200000.
RODENT AND BIRD CONTROL COST.....	$	4000.
TOTAL O & M COST.....	$	1081014.

CLOSURE COSTS

OTHER CLOSURE COMPLIANCE COSTS....	$	1130.
FINAL COVER SYSTEM:		
COST OF COVER LAYER 1		
SLOPE & EARTH FILL.....	$	40555.
COST OF COVER LAYER 2		
GEOTEXTILE SUPPORT FAB.....	$	26690.
COST OF COVER LAYER 3		
30 MIL PVC.....	$	53380.
COST OF COVER LAYER 4		
SAND.....	$	91629.
COST OF COVER LAYER 5		
GEOTEXTILE FILTER FAB.....	$	14557.
COST OF COVER LAYER 6		
TOP SOIL.....	$	53552.
TOTAL COVER SYSTEM COST.....	$	280362.

EXHIBIT 4

EXAMPLE OF AN ITEMIZED SUMMARY OF THE COST RESULTS
(Continued)

COVER DRAINAGE SYSTEM COST.....	$	5503.
REVEGATATION COST.....	$	6256.
ENGINEERING COST.....	$	29212.
INSPECTION, TESTING AND QA COST...	$	58424.
OTHER INDIRECT CLOSURE COSTS.....	$	92715.
TOTAL CLOSURE COSTS.....	$	473602.

POST-CLOSURE COSTS

ENVIRONMENTAL MONITORING COST.....	$	115200.
LEACHATE COLLECTION & TREATMENT CT	$	57637.
LANDSCAPE MAINTENANCE COST.....	$	1877.
SLOPE MAINTENANCE COST.....	$	3210.
ANNUAL INSPECTION COST.....	$	2352.
ADMINISTRATION COST.....	$	18028.
TOTAL POST-CLOSURE COSTS.....	$	198304.

CORRECTIVE ACTION COSTS

INITIAL CAPITAL COST.....	$	100000.
O & M COST.....	$	100000.
TOTAL CORRECTIVE ACTION COST.....	$	200000.

EXHIBIT 5

EXAMPLE OF A SUMMARY OF THE ANNUAL COSTS

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::::::::::::
FACILITY 1
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10 TPD

TYPE OF OPERATION: COMBINATION FILL
TOTAL WASTE DEPOSITED..... 2358.70 M TONS/YR
OPERATING LIFE..... 20 YEARS
NUMBER OF PHASES..... 1
OPERATING AREA..... 4.29 ACRES
CONTAINMENT SYSTEM IS 1.22 METERS THICK,
CONSISTING OF 5 LAYERS
COVER SYSTEM IS .76 METERS THICK,
CONSISTING OF 6 LAYERS
VOLUME OF LEACHATE COLLECTED..... 349315. GAL/YR
POST-CLOSURE PERIOD..... 30 YEARS

DISCOUNT RATE IS 3.00 PERCENT

	CAPITAL	O & M OR POST-CLOSURE	CLOSURE	ANNUAL TOTAL
PRESENT VALUE	1975280.	912676.	255103.	3143058.
YEAR				
0	1807082.	0.	0.	1807082.
1	0.	48115.	0.	48115.
2	0.	48903.	0.	48903.
3	0.	49509.	0.	49509.
4	0.	50116.	0.	50116.
5	0.	50723.	0.	50723.
6	12400.	51330.	0.	63730.
7	0.	51936.	0.	51936.
8	6000.	52543.	0.	58543.
9	0.	53150.	0.	53150.
10	0.	53756.	0.	53756.
11	12400.	54363.	0.	66763.
12	0.	54970.	0.	54970.
13	0.	55576.	0.	55576.
14	0.	56183.	0.	56183.
15	6000.	56790.	0.	62790.
16	12400.	57397.	0.	69797.
17	0.	58003.	0.	58003.
18	0.	58610.	0.	58610.
19	0.	59217.	0.	59217.
20	12748.	59823.	32133.	104705.

EXHIBIT 5

EXAMPLE OF A SUMMARY OF THE ANNUAL COSTS (Continued)

LAST YEAR OF FACILITY OPERATING LIFE IS YEAR 20

21	152124.	16216.	441469.	609809.
22	0.	16216.	0.	16216.
23	0.	16216.	0.	16216.
24	0.	16216.	0.	16216.
25	0.	16216.	0.	16216.
26	0.	4689.	0.	4689.
27	0.	4689.	0.	4689.
28	100000.	4689.	0.	104689.
29	0.	14689.	0.	14689.
30	0.	14689.	0.	14689.
31	0.	14689.	0.	14689.
32	0.	14689.	0.	14689.
33	0.	14689.	0.	14689.
34	0.	14689.	0.	14689.
35	0.	14689.	0.	14689.
36	0.	14689.	0.	14689.
37	0.	14689.	0.	14689.
38	0.	14689.	0.	14689.
39	0.	4689.	0.	4689.
40	0.	4689.	0.	4689.
41	0.	4689.	0.	4689.
42	0.	4689.	0.	4689.
43	0.	4689.	0.	4689.
44	0.	4689.	0.	4689.
45	0.	4689.	0.	4689.
46	0.	4689.	0.	4689.
47	0.	4689.	0.	4689.
48	0.	4689.	0.	4689.
49	0.	4689.	0.	4689.
50	0.	4689.	0.	4689.

USE OF SOLID WASTE QUANTIFICATION AND CHARACTERIZATION DATA TO PLAN AN INTEGRATED SYSTEM IN MERCER COUNTY, NEW JERSEY

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STV/Environmental, Pottstown, PA

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Mercer County Improvement Authority, Trenton, NJ

Presented at the

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Introduction

This paper discusses the approach used in developing and revising quantification and characterization data to plan an integrated solid waste management system in Mercer County, New Jersey. The county's integrated system will include recyclable material collection, processing, and marketing, resource recovery processing, and landfill disposal.

The same basic approach could be adapted for use by a municipal entity in planning its own integrated system.

Background

In Mercer County, the Mercer County Improvement Authority ("The Authority") is responsible for implementation of the county solid waste management plan. STV/Sanders & Thomas, the parent firm of STV/Environmental, was retained by The Authority in 1986 to perform a study to determine the quantity and character of the solid waste generated within Mercer County.

In order to prepare these estimates, STV/Environmental performed the following three tasks:

- Reviewed existing solid waste collection data.

  The major piece of information available was the total daily collection vehicle volume that disposed of residential waste at nearby GROWS Landfill around Morrisville, Pennsylvania, which is owned by Waste Management, Inc., for the previous three years. While only five of the 13 municipalities in Mercer County participated on a continuous basis during the previous three years, the five municipalities comprised nearly 75 percent of the county's population and were a suitable sampling for the entire county's waste disposal practices.

  This data also indicated the seasonal variation of waste collection vehicle volume during the year.

- Conducted a two-season, (summer and winter) two-week, six-day-per-week weighing program to establish the weight and collection vehicle volume of material going to GROWS Landfill.

Nearly all collection vehicles traveling to GROWS Landfill from Mercer County were weighed on a commercial scale prior to entering the landfill. Pertinent information such as collection vehicle volume, origin of waste collected, and types of waste constituting the load were recorded to establish a relationship between the total volume of the collection vehicles and typical total weight of solid waste, as well as daily total weights for each community and for the county, as a whole. For each vehicle not weighed on the scales, weights were estimated either by applying a bulk density to the vehicle volumes for the appropriate vehicle type or by using additional information provided by a hauler survey to complete the data base.

- Conducted two five-day sorting programs to establish the composition of the solid waste for Mercer County.

A single collection vehicle was selected each day from a different area of Mercer County to deposit material in an enclosed area where a group of people sorted two- to four-ton loads of waste into 16 categories of material.

Analyzing the five-day summer and winter data allowed the composition of the waste within Mercer County to be predicted for a typical year.

To project annual and seasonal quantities of waste within the county, two pieces of information developed during the study were analyzed:

- The collection vehicle volume of residential waste delivered to GROWS Landfill on a daily basis for three years; and

- The collection vehicle volume and weight of waste delivered to GROWS Landfill for two, two-week weighing periods.

If additional analysis would correlate these two pieces of information, it would be possible to predict how much waste could be collected for a given month.

The two additional pieces of information that allowed these two sets of data to be correlated were:

1. the in-vehicle solid waste bulk density developed during the weighing program; and

2. the volume of collection vehicles that entered GROWS Landfill during the two-week weighing period versus during the entire month.

By using these data, the total waste quantity collected in Mercer County was estimated.

Based on its projections of population growth, and the quantity and composition of solid waste which were generated by the county, STV/Environmental had prepared projections of the allocation of this waste quantity to the various proposed county solid waste management facilities and the resulting composition of that waste. The information had been derived from the "Mercer County Solid Waste Quantification and Characterization Study" dated March 1988 ("March 1988 Study"), which was been prepared by STV/Environmental and to which reference should be made for more complete information.

In February 1988, The Authority executed a long-term contract with Waste Management, Inc. to dispose of raw waste and resource recovery residue for 25 years at GROWS and Tullytown Landfills. On May 1, 1988, also the effective date for the landfill disposal agreement, The Authority established a data management and monitoring system, based on truck volume in cubic yards delivering Mercer County's waste to GROWS Landfill.

Transfer Station Scale Data

On November 10, 1988, a private operator under contract to the Authority initiated operation of the Mercer County (former City of Trenton-Ewing Township) Transfer Station. The Authority operates the scale and uses a data monitoring system based on net weight in tons of vehicles delivering solid waste.

In January 1990, STV/Environmental and The Authority evaluated the scale data from the Mercer County Transfer Station for calendar year 1989. The purpose of this evaluation was (1) to analyze the solid waste quantity projections considering the first 12 months of actual transfer station scale data rather than extrapolating the two-season, four-week weighing program in July 1986 and January 1987 and (2) to analyze the solid waste composition and higher heating value considering the recently approved Modified Mercer County Recycling Plan. In July 1989, the Mercer County Board of Freeholders adopted the Recycling Plan and passed an ordinance to enforce its requirements.

This evaluation indicated that in 1989, 390,279 tons or a daily average of 1,069 tons, were generated in the county and delivered to the transfer station. This does not include an estimated additional 14,612 tons of yard waste being composted at home and by municipalities at local facilities. The estimated annual and average daily quantities to be collected at the Mercer County Transfer Station for each category of waste are:

Type	Percent Total Weight (%)	Average[a] Daily (tons)	Annual (tons)	Per Capita[b] (pounds/day)
10 - Residential	50.3	537	196,038	3.17
10 - Commercial/ Institutional	31.7	339	123,852	2.00
13 - Bulky	16.5	177	64,423	1.04
23 - Vegetative	0.0	0	53	0.00
27 - Dry Industrial	1.5	16	5,913	0.10
TOTAL	100.0	1,069	390,279	6.30

Footnotes:

[a] Ton per day based on a 7-day week
[b] Based upon estimate 1989 Mercer County population of 339,300.

Since long-term populations by municipality were not available in 1986, STV/Environmental developed population projections for use in estimating solid waste generation in Mercer County. The per capita waste collection rate of 6.30 pounds per person per day was maintained throughout the projection period.

Table 1 presents the amount of solid waste by type delivered monthly to the Mercer County Transfer Station for the calendar year of 1989. Table 2 defines the New Jersey Department of Environmental Protection (NJDEP) solid waste types. The monthly scale data from the Mercer County Transfer Station during January through December 1989 was analyzed. During the 12-month period, the total amount of solid waste received was 390,279 tons.

During this 12-month period, the amounts of processible versus unprocessible waste received were estimated for Type 10, 13, 23, and 27 wastes using the results of the previous two-season weighing program from the March 1988 Study. Since the amount of Type 23 waste received at the Mercer County Transfer Station during 1989 was so minimal, it was combined with Type 13 waste. The following processible and unprocessible contents for the three waste types were applied to estimated annual tonnages:

NJDEP Waste Type	Processible Content (%)	Unprocessible Content (%)
10	95.6	4.4
13 and 23	26.8	73.2
27	52.1	47.9

Using the same assumptions from the March 1988 Study, small amounts of unprocessible waste (which is combustible but too large to feed into the combustor) in mixed loads would be reduced in size by the shear and burned at the mass burn resource recovery facility. This quantity represents approximately 20 percent of the unprocessible waste collected. This assumption reduces the portion of unprocessible waste collected to 13 percent.

In 1990, The Authority expects to expand their data monitoring at the Mercer County Transfer Station scale to identify the processibility of the solid waste received for use in future projection updates. Processible solid waste is defined as material that can be burned at a resource recovery facility as-received or with slight size reduction.

Solid Waste Recycling Projections

1991 is the first full year that Mercer County will be required to recycle 25 percent of its 1988 Type 10 solid waste quantity in accordance with the 1987 Statewide Mandatory Source Separation and Recycling Act. 1994 is expected to be the first full year of commercial operation for the Mercer County Resource Recovery Facility. Also, 1994 may be the first year that the materials separation requirements of the recently proposed USEPA New

Table 1

1989 MONTHLY SCALE DATA BY WASTE TYPE FOR MERCER COUNTY TRANSFER STATION (TONS)

MONTH	TYPE 10 (TONS)	TYPE 13 (TONS)	TYPE 23 (TONS)	TYPE 25 (TONS)	TYPE 27 (TONS)	TOTAL (TONS)
JANUARY	24403	1968	0	0	279	26649
FEBRUARY	23636	2120	0	0	263	26020
MARCH	27479	3397	1	0	398	31275
APRIL	25961	6453	1	0	200	32615
MAY	31722	6410	3	0	253	38387
JUNE	30817	8573	1	0	644	40036
JULY	27901	6461	2	0	170	34534
AUGUST	28563	8009	0	0	149	36721
SEPTEMBER	25989	5982	0	0	227	32198
OCTOBER	26436	6853	31	0	722	34631
NOVEMBER	25177	4702	24	0	1682	31585
DECEMBER	21807	3497	0	0	925	26229
ANNUAL TOTAL	319890	64423	66	0	5513	389879
	82.0%	16.5%	0.0%	0.0%	1.5%	100.0%

Table 2

NJDEP SOLID WASTE IDENTIFICATIONS AND DEFINITIONS

SOLID WASTE TYPES	DEFINITIONS
10 - MUNICIPAL (household, commercial, and institutional)	Waste originating in the community consisting of household waste from private residences, commercial waste which originates in wholesale, retail or service establishments, such as, restaurants, stores, markets, theatres, hotels, and warehouses, and institutional waste material originating in schools, hospitals, research institutions, and public buildings.
13 - BULKY WASTE	Large items of waste material, such as, appliances, furniture, whole trees, branches, tree trunks, and stumps. Also included are waste building materials and rubble resulting from construction, remodeling, repair, and demolition operations on houses, commercial buildings, pavements, and other structures. Discarded automobiles, trucks, and trailers and large vehicle parts, and tires are included under this category.
23 - VEGETATIVE WASTE	Waste materials from farms, plant nurseries, and greenhouses that are produced from the raising of plants. This waste includes such crop residues as plant stalks, hulls, leaves, and tree wastes processed through a wood chipper.
25 - ANIMAL AND FOOD PROCESSING WASTE	Processing waste materials generated in canneries, slaughterhouses, packing plants, or similar industries. Also included are dead animals.
27 - DRY INDUSTRIAL WASTE	Waste materials resulting from manufacturing, industrial and research and development process and operations, and which are not hazardous in accordance with the standards and procedures set forth at N.J.A.C. 7:26-8. Also included are non-hazardous oil spill cleanup waste, dry non-hazardous pesticides, (and) dry non-hazardous chemical waste, and asbestos and asbestos-containing waste managed in accordance with 40 CFR 61 and N.J.A.C. 7:26-2.6.

Source Performance Standards are in effect. This proposed regulation will require Mercer County to recycle 25 percent of processible waste collected and yard waste collected and composted. For these reasons, the following data analyses focus on the years 1991 and 1994. Since the recycling goal during 1989 was only effective from May 26th when the Mercer County Recycling Plan was approved and the residential curbside collection program began September 11th, capture of recyclable components was expected to be considerably lower in the partial year of 1989 than the subsequent full years. Also, participation in the recycling program is predicted to steadily increase after 1989 as experience is gained.

Table 3 presents the solid waste composition and component amounts without recycling for processible and unprocessible Type 10, Types 13 and 23, and Type 27 categories during the year 1991. Analyses similar to Table 3 were prepared for the years 1989, 1990, and 1994. The values for the Type 10 component distribution were derived from the solid waste characterization program results of the March 1988 Study. STV/Environmental reviewed the comments from the field records of the previous weighing program and estimated the processible composition of Types 13 and 23, and Type 27 wastes. Also, Table 3 presents the estimated amount of white goods collected, an unprocessible Type 10 residential waste component, that are recyclable.

Based on our experience with other more recent solid waste characterization programs in Delaware County and York County, Pennsylvania, we made the following assumptions:

1. Newsprint is 95 percent recyclable, which allows for inserts that are not recyclable and contaminated newsprint.

2. For the Type 10 residential sector, 15 percent of the other paper are magazines, which are recyclable.

3. For the Type 10 commercial/institutional sector, 30 percent of the other paper is high grade paper, which is recyclable.

4. 40 percent of rigid plastics are high density polyethylene (HDPE) containers which are recyclable and 90 percent of the polyethylene terepthalate (PET) plastic containers are recyclable.

5. Glass is 90 percent glass containers (bottles and and jars), which are recyclable.

6. Ferrous metals are 40 percent bimetal and tin-steel cans, which are recyclable.

7. Aluminum is 65 percent beverage and food cans, which are recyclable.

Table 3

1991 SOLID WASTE WITHOUT RECYCLING BY TYPE IN MERCER COUNTY

PROCESSIBLE	TYPE 10 COMPONENT (%)	TYPE 10 COMPONENT (TONS)	TYPES 13 & 23 COMPONENT (%)	TYPES 13 & 23 COMPONENT (TONS)	TYPE 27 COMPONENT (%)	TYPE 27 COMPONENT (TONS)	TOTAL COMPONENT (%)	TOTAL COMPONENT (TONS)
COMBUSTIBLE								
NEWSPRINT	9.4%	29726		0		0	8.5%	29726
CORRUGATED	6.7%	21188	10%	2794	30%	1132	7.2%	25114
OTHER PAPER	27.7%	87595	20%	5585	15%	566	26.9%	93752
TOT PAPER	43.8%	138512		8382		1698	42.7%	148592
FILM	3.5%	11066		0	15%	566	3.3%	11634
RIGID	2.5%	7906		0		0	2.3%	7906
PET	0.3%	949		0		0	0.3%	949
TOT PLASTICS	6.3%	19923		0		566	5.9%	20489
TEXTILE, RUBBER, & LEATHER	4.0%	12649		0	5%	189	3.7%	12838
FOOD WASTE	9.8%	30991		0		0	8.9%	30991
WOOD	4.5%	14231	60%	16764	30%	1132	9.2%	32127
YARD WASTE	10.3%	32572		0		0	9.4%	32572
SWEEPINGS	7.1%	22453		0		0	6.5%	22453
SUBTOTAL-COMBUSTIBLE	85.8%	271331		25146		3585	86.2%	300062
NON-COMBUSTIBLE								
GLASS	5.9%	18658		0		0	5.4%	18658
FERROUS	3.3%	10436	5%	1397	5%	189	3.5%	12021
ALUMINUM	1.4%	4427		0		0	1.3%	4427
MISC METAL	0.2%	632		0		0	0.2%	632
TOT NONFERROUS MTLS	1.6%	5060		0		0	1.5%	5060
BRICK, CERAMIC	3.4%	10752	5%	1397		0	3.5%	12149
SUBTOTAL-NON-COMBUSTIBLE	14.2%	44906		2794		189	13.8%	47886
TOTAL PROCESSIBLE	100.0%	316237		27940		3774	100.0%	347950
UNPROCESSIBLE								
WHITEGOODS	7.0%	803	0%	0	0%	0	1.5%	803
OTHER UNPROCESSIBLE	93.0%	10667	100%	38112	100%	2284	98.5%	51062
TOTAL UNPROCESSIBLE	100.0%	11470	100%	38112	100%	2284	100.0%	51865

An analysis of Type 10 residential solid waste recycling was performed considering source separation of newsprint, magazines, rigid plastic containers, PET plastic containers, glass containers, tin-steel and bimetal cans, and aluminum cans. Recycling of plastics from the residential sector was not initiated in the analysis until 1990. Magazines from the residential sector were added to the components designated in the Modified Mercer County Recycling Plan. An analysis of Type 10 commercial/institutional solid waste recycling was performed considering source separation of newsprint, corrugated paper, high grade paper, glass containers, tin-steel and bimetal cans, and aluminum cans. Rigid plastic containers, PET plastic containers, and tin-steel and bimetal cans from the commercial/institutional sector were added to the components designated in the Modified Mercer County Recycling Plan. The additions were necessary to meet the state-mandated 25 percent recycling goal.

Table 4 presents the total Type 10 solid waste composition, total component quantities, recyclable component percentages and amounts non-recyclable component quantities, recyclable component capture rates, total component capture rates, recycled component quantities, and component quantities landfilled or processed at a resource recovery facility, for the total Type 10 waste during the year 1991. Analyses similar to Table 4 were performed for the years 1989, 1990, and 1994. Table 4 reflects the analysis of recycling the combined residential and commercial/institutional sector components that are specified in the recently approved Modified Recycling Plan for Mercer County and the additional ones listed above.

The proposed solid waste component recycling program satisfies the Statewide Mandatory Source Separation Recycling Act of 1987 and the recently proposed United States Environment Protection Agency (USEPA) Emission Guidelines: Municipal Waste Combustors (New Source Performance Standards), dated December 20, 1989. The intent of the material separation requirements of the USEPA regulations is to reduce the processible waste including yard waste that is to be burned by 25 percent. In 1994, the amount of material recycled and yard waste composted are estimated to be 94,000 tons, which is about 27 percent of the processible waste generated, thus exceeding the USEPA requirements.

Solid Waste Quantity Projections

Table 5 presents the annual solid waste quantity projections by categories for Mercer County during years 1989 through 2013. Table 5 presents the annual tonnages for the following 22 categories:

1. Total Waste Generated - Amount of waste generated in the county which is the sum of total waste collected, and yard waste collected and composted.

Table 4

1991 TOTAL TYPE 10 SOLID WASTE RECYCLING IN MERCER COUNTY

TOTAL PROCESSIBLE	TOTAL COMPONENT (TONS)	RECYCLABLE COMPONENT (%)	RECYCLABLE COMPONENT (TONS)	NON-RECYCLABLE COMPONENT (TONS)	RECYCLABLE CAPTURE RATE (%)	TOTAL CAPTURE RATE (%)	RECYCLED COMPONENT (TONS)	LANDFILLED COMPONENT (TONS)
COMBUSTIBLE								
NEWSPRINT	29726	95%	28240	1486	90%	86%	25416	4310
CORRUGATED	21188	100%	21188	0	63%	63%	13348	7840
OTHER PAPER	87598	21%	18395	69202	90%	19%	16556	71042
TOT PAPER	138512	49%	67823	70688	82%	40%	55320	83191
FILM	11068	0%	0	11068	0%	0%	0	11068
RIGID	7906	40%	3162	4744	90%	36%	2846	5060
PET	949	90%	854	95	90%	81%	768	180
TOT PLASTICS	19923	20%	4016	15907	90%	18%	3615	16308
TEXTILE, RUBBER, & LEATHER	12649	0%	0	12649	0%		0	12649
FOOD WASTE	30991	0%	0	30991	0%		0	30991
WOOD	14231	0%	0	14231	0%		0	14231
YARD WASTE	32572	0%	0	32572	0%		0	32572
SHREDDED	22453	0%	0	22453	0%		0	22453
SUBTOTAL-COMBUSTIBLE	271331	26%	71840	199492	82%	22%	58935	212396
NON-COMBUSTIBLE								
GLASS	18658	90%	16792	1866	90%	81%	15113	3545
FERROUS	10436	40%	4174	6261	90%	36%	3757	6679
ALUMINUM	4427	65%	2878	1550	90%	58%	2590	1837
MISC METAL	632	0%	0	632	0%	0%	0	632
TOT NONFERROUS MTLS	5060	57%	2878	2182	90%	51%	2590	2470
BRICK, CERAMIC	10752	0%	0	10752	0%	0%	0	10752
SUBTOTAL-NON-COMBUSTIBLE	44906	53%	23844	21061	90%	48%	21460	23446
TOTAL PROCESSIBLE	316237	30%	95684	220553	84%	25%	80395	235842
UNPROCESSIBLE								
WHITEGOODS	803	100%	803	0	100%	100%	803	0
TOTAL UNPROCESSIBLE	803	100%	803	0	100%	100%	803	0
TOTAL	317040	30%	96487	220553	84%	26%	81198	235842

2. Yard Waste Collected and Composted - Amount of yard waste composted is the leaves that are delivered to the nine municipal composting centers throughout Mercer County. In 1988, the municipalities reported to The Authority that approximately 14,400 tons of leaves were composted. The 1988 annual quantity of yard waste composted in the county was escalated by county population growth for subsequent years.

3. Total Waste Collected - Amount of total waste collected is the sum of Type 10 residential/commercial/institutional waste collected, Type 13 and 23 bulky and vegetative wastes collected, and Type 27 dry industrial waste collected as measured at the Mercer County Transfer Station during the 12 months of 1989 as shown in Table 1.

4. Type 10 Residential/Commercial/Institutional Waste Collected - Amount of Type 10 solid waste including recyclables collected from the residential and commercial/institutional sectors. It was estimated to be 82 percent of the total waste collected as measured by the Mercer County Transfer Station scales during 1989 as shown in Table 1. The residential sector was estimated to be approximately 61 percent of the Type 10 waste collected, while the commercial/ institutional sector represented the balance of 39 percent as measured during the previous two-season weighing program.

5. Types 13 and 23 Bulky and Vegetative Wastes Collected - Amount of Type 13 and 23 solid wastes collected. It was estimated to be 16.5 percent of the total waste collected as measured by the Mercer County Transfer Station scales during 1989 as shown in Table 1.

6. Type 27 Dry Industrial Waste Collected - Amount of Type 27 solid waste collected from the industrial sector. It was estimated to be 1.5 percent of the total waste collected as measured by the Mercer County Transfer Station scales during 1989 as shown in Table 1.

7. Processible Waste Collected - Amount of processible waste collected is the fraction of total waste collected including recyclables that will be processed at the Mercer County Recycling Facility and Mercer County Resource Recovery Facility, or landfilled. After the unprocessible waste percentage of the total waste collected was determined, the processible waste percentage was calculated to be 87 percent by difference.

8. Unprocessible Waste Collected - Unprocessible waste collected is the fraction of total waste collected including recyclables that will be recycled or landfilled. The amount of unprocessible waste collected was determined by applying the unprocessible contents of the Type 10, 13 and 23, and 27 wastes as measured during the previous two-season weighing program to the quantities of these three waste types received at the Mercer County Transfer Station. It was estimated to be 13 percent of the total waste collected.

9. Unprocessible Waste Recycled - Unprocessible waste recycled is white goods, which are major household appliances such as refrigerators, ranges, dishwashers, freezers, and air conditioners, that are separated to be recycled from the Type 10 residential sector. Amount of white goods received was estimated based our experience for other similar projects. It was estimated to be about seven percent of the unprocessible Type 10 waste collected.

10. Unprocessible Waste to Landfill - Amount of unprocessible waste landfilled is the unprocessible waste collected less the unprocessible waste recycled.

11. NJDEP Recycled Materials Goal - In accordance with the Statewide Mandatory Source Separation and Recycling Act of 1987 and recent discussions by The Authority with the NJDEP Office of Recycling, the annual recycling goal shall be calculated using the 1988 Type 10 waste quantity as the basis. The 1988 Type 10 waste quantity of 316,000 tons was estimated by a ratio of the two annual county populations times the annual 1989 Type 10 waste quantity. The amount of 1988 Type 10 waste was estimated since scale data from the Mercer County Transfer Station were available only for the last two months of 1988. For the year 1989, the recycled material goal was 15 percent of the 1988 Type 10 waste from May 26th to the end of the year. For the year 1990, the recycled material goal is the sum of 15 percent of the 1988 Type 10 waste from January 1st to May 25th and 25 percent of the 1988 Type 10 waste from May 26th until December 31st. For the year 1991 and subsequent years, the recycled material goal is 25 percent of the 1988 Type 10 waste.

12. Projected Recycled Materials - Projected recycled materials are the results of total solid waste recycling analyses for the year 1991 in Table 4. Amount of projected recycled materials for each subsequent year was increased by county population growth.

13. Processible Waste Recycled - Amount of processible waste recycled is the projected recycled materials less the unprocessible waste recycled.

14. Commercial/Institutional Materials Recycled by Others - Commercial/ institutional materials recycled by others are the result of commercial/institutional solid waste recycling analyses that were performed for the years 1989 through 1991 and 1994. Amount of projected recycled materials for each subsequent year was increased by county population growth.

15. Residential Materials to Recycling Facility - Amount of residential materials to recycling facility is the processible waste recycled less the commercial/institutional materials recycled by others. During 1989 and 1990, the recyclable residential materials have been delivered to the Mercer County Transfer Station. After 1991, the residential recyclable materials will be delivered to the Mercer County Material Recovery Facility.

16. Recycling Process Residue to Landfill - From years 1991 through 2013, amount of recycling process residue landfilled due to contamination and glass breakage is estimated to be five percent of the processible waste recycled based on our experience for a mature recycling program and a well-operated recycling facility.

17. Processible Waste to Resource Recovery Facility - In July 1993 the Mercer County Resource Recovery Facility is expected to commence commercial operation in July 1993. During the year 1993, therefore one-half of the processible waste collected less the processible waste recycled will be processed at the facility. The remaining items are calculated using this assumption. From years 1994 through 2013, amount of processible waste delivered is the processible waste collected less the processible waste recycled.

18. Allowable Rejected Waste from Resource Recovery Facility - From July 1993 through the year 2013, maximum amount of allowable rejected waste is 1.5 percent of the processible waste delivered to Mercer County Resource Recovery Facility in accordance with the service agreement with Westinghouse Resource Energy Systems Division.

19. Waste Processed at Resource Recovery Facility - From July 1993 through the year 2013, amount of total waste processed is the processible waste delivered to the Mercer County Resource Recovery Facility minus the allowable rejected waste.

20. Ferrous Recovered at Resource Recovery Facility - From July 1993 through the year 2013, amount of ferrous recovered at the Mercer County Resource Recovery Facility is total waste processed times 3.09 percent, the percentage of ferrous remaining in the processed component (tons) in Table 5D, times 80 percent recovery efficiency, in accordance with the service agreement with Westinghouse Resource Energy Systems Division.

21. Resource Recovery Process Residue - From July 1993 through the year 2013, amount of process residue produced is total waste processed at the Mercer County Resource Recovery Facility times 22.63 percent, in accordance with the service agreement with Westinghouse Resource Energy Systems Division less ferrous recovered.

22. Residue and Waste to Landfill - From year 1989 through June 1993, amount of waste and residue landfilled is unprocessible waste to landfill plus processible waste collected less processible waste recycled plus recycling process residue to landfill. From July 1993 through the year 2013, amount of waste and residue landfilled is the sum of unprocessible waste to landfill, recycling process residue to landfill, allowable rejected waste from resource recovery facility, and resource recovery process residue. Since May 1, 1988, when the landfill disposal agreement began with Waste Management, it was assumed that 250,000 tons of capacity was consumed during the eight-month period. Landfill capacity consumed during the year 1988 is considered in the 25-year total.

Table 5

ANNUAL SOLID WASTE QUANTITY PROJECTIONS (TONS/YEAR) FOR MERCER COUNTY (YEARS 1989-2013)

YEAR	(1) TOTAL WASTE GENERATED (2+3)	(2) YARD WASTE COLLECTED AND COMPOSTED	(3) TOTAL WASTE COLLECTED	(4) TYPE 10 RESIDENTIAL/ COMMERCIAL/ INSTITUTIONAL WASTE COLLECTED	(5) TYPES 13 & 23 BULKY AND VEGETATIVE WASTES COLLECTED	(6) TYPE 27 DRY INDUSTRIAL WASTE COLLECTED	(7) PROCESSIBLE WASTE COLLECTED	(8) UNPROCESSIBLE WASTE COLLECTED	(9) UNPROCESSIBLE WASTE RECYCLED	(10) UNPROCESSIBLE WASTE TO LANDFILL (8-9)	(11) NJDEP RECYCLED MATERIAL GOAL
1989	404,889	14,610	390,279	319,890	64,476	5,913	339,851	50,828	313	50,315	28,568
1990	409,838	14,791	395,047	323,799	65,264	5,985	343,801	51,247	635	50,612	66,443
1991	414,783	14,968	399,815	327,707	66,051	6,057	347,950	51,865	803	51,062	78,996
1992	419,731	15,148	404,583	331,615	66,839	6,130	352,099	52,484	812	51,672	78,996
1993	424,681	15,330	409,351	335,523	67,627	6,202	356,249	53,102	822	52,280	78,996
1994	429,634	15,514	414,120	339,431	68,415	6,274	360,399	53,721	832	52,889	78,996
1995	434,588	15,700	418,888	343,339	69,202	6,346	364,549	54,339	841	53,498	78,996
1996	439,545	15,889	423,656	347,248	69,998	6,419	368,698	54,958	851	54,107	78,996
1997	444,503	16,079	428,424	351,156	70,778	6,491	372,848	55,576	860	54,716	78,996
1998	449,464	16,272	433,192	355,064	71,565	6,563	376,997	56,195	870	55,325	78,996
1999	454,428	16,467	437,960	358,972	72,353	6,635	381,147	56,813	879	55,934	78,996
2000	459,393	16,665	442,728	362,880	73,141	6,707	385,297	57,432	889	56,543	78,996
2001	464,361	16,865	447,496	366,788	73,929	6,780	389,446	58,050	899	57,151	78,996
2002	469,332	17,067	452,264	370,696	74,716	6,852	393,596	58,669	908	57,761	78,996
2003	474,305	17,272	457,032	374,604	75,504	6,924	397,745	59,287	918	58,370	78,996
2004	479,280	17,479	461,801	378,512	76,292	6,996	401,895	59,906	927	58,979	78,996
2005	484,258	17,689	466,569	382,420	77,079	7,069	406,044	60,524	937	59,588	78,996
2006	489,238	17,902	471,337	386,329	77,867	7,141	410,194	61,143	947	60,196	78,996
2007	494,220	18,116	476,104	390,236	78,655	7,213	414,342	61,761	956	60,805	78,996
2008	499,205	18,334	480,872	394,144	79,442	7,285	418,492	62,380	966	61,414	78,996
2009	504,193	18,554	485,640	398,052	80,230	7,358	422,641	62,998	975	62,023	78,996
2010	509,184	18,776	490,408	401,960	81,018	7,430	426,791	63,617	985	62,632	78,996
2011	514,177	19,002	495,176	405,868	81,805	7,502	430,940	64,235	994	63,241	78,996
2012	519,174	19,230	499,944	409,776	82,593	7,574	435,090	64,854	1,004	63,850	78,996
2013	524,218	19,460	504,758	413,722	83,388	7,647	439,279	65,478	1,014	64,465	78,996
TOTAL	11,618,625	423,161	11,187,444	9,169,731	1,848,221	169,493	9,736,181	1,451,264	21,835	1,429,429	1,911,919

Table 5 (Cont'd)

ANNUAL SOLID WASTE QUANTITY PROJECTIONS (TONS/YEAR) FOR MERCER COUNTY (YEARS 1989-2013)

YEAR	(12) PROJECTED RECYCLED MATERIALS	(13) PROCESSIBLE WASTE RECYCLED (12-9)	(14) COMMERCIAL\ INSTITUTIONAL MATERIALS RECYCLED BY OTHERS	(15) RESIDENTIAL MATERIALS TO RECYCLING FACILITY (13-14)	(16) RECYCLING PROCESS RESIDUE TO LANDFILL (13*5%)	(17) PROCESSIBLE WASTE TO RESOURCE RECOVERY FACILITY 1993 (7-13)*50% 1994-2013 (7-13)	(18) ALLOWABLE REJECTED WASTE FROM RESOURCE RECOVERY FACILITY (17*1.5%)	(19) WASTE PROCESSED AT RESOURCE RECOVERY FACILITY (17-18)	(20) FERROUS RECOVERED AT RESOURCE RECOVERY FACILITY (19*3.09%*80%)	(21) RESOURCE RECOVERY PROCESS RESIDUE (19*22.63%-20)	(22) RESIDUE+ WASTE TO LANDFILL 1989-1992 (7+10-13+16) 1993 (50%*(7-13)+10+16+18+21) 1994-2013 (10+16+18+21)
1989	29,719	29,406	13,316	16,089	0						360,560
1990	68,618	67,984	31,662	36,322	0						326,428
1991	81,198	80,395	37,987	42,407	4,020						322,637
1992	82,166	81,353	38,440	42,913	4,068						326,486
1993	83,134	82,312	38,893	43,419	4,116	136,968	2,055	134,914	3,334	27,197	222,616
1994	84,103	83,271	39,346	43,925	4,164	277,128	4,157	272,971	6,745	55,028	116,238
1995	85,071	84,230	39,799	44,430	4,212	280,319	4,205	276,114	6,823	55,662	117,576
1996	86,040	85,189	40,252	44,936	4,259	283,509	4,253	279,257	6,901	56,295	118,914
1997	87,008	86,148	40,705	45,443	4,307	286,700	4,301	282,400	6,978	56,929	120,253
1998	87,976	87,107	41,158	45,948	4,355	289,891	4,348	285,542	7,056	57,562	121,591
1999	88,945	88,065	41,611	46,454	4,403	293,082	4,396	288,685	7,134	58,196	122,929
2000	89,913	89,024	42,064	46,960	4,451	296,272	4,444	291,828	7,211	58,830	124,268
2001	90,881	89,982	42,517	47,465	4,499	299,464	4,492	294,972	7,289	59,463	125,606
2002	91,850	90,942	42,970	47,971	4,547	302,654	4,540	298,114	7,367	60,097	126,944
2003	92,818	91,900	43,423	48,477	4,595	305,845	4,588	301,257	7,444	60,730	128,283
2004	93,786	92,859	43,876	48,983	4,643	309,035	4,636	304,400	7,522	61,364	129,621
2005	94,755	93,818	44,329	49,489	4,691	312,226	4,683	307,543	7,600	61,997	130,959
2006	95,723	94,776	44,782	49,994	4,739	315,418	4,731	310,686	7,677	62,631	132,297
2007	96,691	95,735	45,235	50,500	4,787	318,607	4,779	313,828	7,755	63,264	133,636
2008	97,659	96,694	45,688	51,006	4,835	321,798	4,827	316,971	7,832	63,898	134,974
2009	98,628	97,653	46,141	51,511	4,883	324,989	4,875	320,114	7,910	64,532	136,312
2010	99,596	98,611	46,594	52,017	4,931	328,179	4,923	323,257	7,988	65,165	137,651
2011	100,564	99,570	47,047	52,523	4,979	331,370	4,971	326,400	8,065	65,799	138,989
2012	101,533	100,529	47,500	53,029	5,026	334,561	5,018	329,542	8,143	66,432	140,327
2013	102,511	101,497	47,958	53,539	5,075	337,782	5,067	332,716	8,222	67,072	141,679
TOTAL	2,210,887	2,189,051	1,033,296	1,155,751	104,583	6,285,797	94,287	6,191,510	152,995	1,248,144	* 4,387,775

* INCLUDES 250,000 TONS OF DISPOSAL CAPACITY USED BY MERCER COUNTY DURING 8 MONTHS OF 1988 IN ACCORDANCE TO THEIR LICENSING AGREEMENT WITH WASTE MANAGEMENT.

A table similar to Table 5 was prepared to present the average daily solid waste quantity projection on a seven-day-per-week basis for the same 22 categories for Mercer County during years 1989 through 2013.

Recyclable Materials Collection, Processing, and Marketing

Tables 6 presents the average daily on a six-day-per-week basis and annual amounts of the Type 10 recyclable materials that are source-separated from processible waste and collected by commingled (plastics, glass, ferrous, and aluminum) and paper (newsprint, corrugated, magazine, and high grade) components for processing and marketing during the years 1989 through 2013. For the year 1989, the average daily values are based on 186 days remaining in the year since May 26th, which is when the Mercer County Recycling Plan was approved by NJDEP, and 96 days remaining in the year since September 11th, which is when the residential recyclable materials curbside collection program began in the county.

Processible Waste Composition

Table 7 presents estimated processible solid waste component percentages and amounts by sector and type for use as a fuel in Mercer County during 1994.

The residential and commercial/institutional/bulky/industrial sector amounts from Table 7 were used to determine its percentage of the total as follows:

Sector	Percent Total Weight (%)
Residential	56.5
Commercial/Institutional/ Bulky/Industrial	43.5

These values were used to weight the sector proximate and ultimate analytical composite values in Table 8 to calculate the sector - weighted total values. In 1990, The Authority expects to expand its data monitoring at the Mercer County Transfer Station scale to identify the source of solid waste weighed by the two sectors for use in future updates.

Solid Waste Component Proximate and Ultimate Analyses

Proximate and ultimate analyses were performed on the individual combustible waste component samples for each sector (residential and commercial/institutional/bulky/industrial) from the sorting program. Proximate and ultimate analyses were performed on the composite combustible waste component samples for each sector from the sorting program. Since

Table 6

ANNUAL PROCESSIBLE TOTAL TYPE 10 RECYCLABLE MATERIALS COLLECTED (TONS) IN MERCER COUNTY (YEARS 1989-2013)

YEAR	AVERAGE DAILY (TONS/DAY)							ANNUAL (TONS/YEAR)						
	COMMINGLED	PAPER					TOTAL	COMMINGLED	PAPER					TOTAL
		NEWSPRINT	CORRUGATED	MAGAZINE	HIGH GRADE	TOTAL			NEWSPRINT	CORRUGATED	HIGH GRADE	MAGAZINE	TOTAL	
1989 (186 DAYS)	38	56	31	17	17	121	158	6983	10475	5791	3078	3078	22423	29406
(96 DAYS)	73	109	60	32	32	234	306							
1990	65	72	38	20	23	152	218	20435	22323	11724	7270	6232	47549	67984
1991	80	81	43	23	30	177	258	25074	25416	13348	9461	7095	55320	80395
1992	81	82	43	23	31	179	261	25373	25719	13508	9573	7180	55980	81353
1993	82	83	44	23	31	182	264	25672	26022	13667	9686	7265	56640	82312
1994	83	84	44	24	31	184	267	25972	26325	13826	9799	7349	57299	83271
1995	84	85	45	24	32	186	270	26271	26628	13985	9912	7434	57959	84230
1996	85	86	45	24	32	188	273	26570	26931	14144	10025	7518	58619	85188
1997	86	87	46	24	32	190	276	26869	27235	14303	10137	7603	59279	86147
1998	87	88	46	25	33	192	279	27168	27538	14463	10250	7688	59938	87106
1999	88	89	47	25	33	194	282	27467	27841	14622	10363	7772	60598	88065
2000	89	90	47	25	34	196	285	27766	28144	14781	10476	7857	61258	89023
2001	90	91	48	25	34	198	288	28065	28447	14940	10589	7942	61918	89982
2002	91	92	48	26	34	201	291	28364	28750	15099	10702	8026	62577	90941
2003	92	93	49	26	35	203	295	28663	29053	15259	10814	8111	63237	91900
2004	93	94	49	26	35	205	298	28962	29356	15418	10927	8195	63897	92859
2005	94	95	50	27	35	207	301	29261	29659	15577	11040	8280	64556	93817
2006	95	96	50	27	36	209	304	29560	29962	15736	11153	8365	65216	94776
2007	96	97	51	27	36	211	307	29859	30266	15895	11266	8449	65876	95735
2008	97	98	51	27	36	213	310	30158	30569	16055	11379	8534	66535	96693
2009	98	99	52	28	37	215	313	30457	30872	16214	11491	8618	67195	97652
2010	99	100	52	28	37	217	316	30756	31175	16373	11604	8703	67855	98611
2011	100	101	53	28	38	220	319	31055	31478	16532	11717	8788	68515	99570
2012	100	102	53	28	38	222	322	31354	31781	16691	11830	8872	69174	100528
2013	101	103	54	29	38	224	325	31656	32087	16852	11944	8958	69841	101496

NOTES:

1. MINIMUM AVERAGE DAILY AND ANNUAL RECYCLABLE MATERIALS COLLECTED FOR THE PARTIAL YEAR 1989 ARE BASED ON 96 OPERATING DAYS REMAINING IN THE YEAR SINCE SEPTEMBER 11.

2. RECYCLED MATERIAL QUANITIES DO NOT CONSIDER RESIDUE LOSSES IN COLUMN 16 OF TABLE 5.

Table 7

1994 PROCESSIBLE SOLID WASTE COMPOSITION BY SECTOR AND TYPE AS A FUEL IN MERCER COUNTY

SECTOR	RESIDENTIAL		COMMERCIAL/INSTITUTIONAL/BULKY/INDUSTRIAL						TOTAL			
WASTE TYPE	TYPE 10 RESIDENTIAL		TYPE 10 COMMERCIAL/INSTITUTIONAL		TYPES 13 & 23		TYPE 27		TOTAL			
	COMPONENT (%)	COMPONENT (TONS)	COMPONENT (%)	COMPONENT (TONS)	COMPONENT (%)	COMPONENT (TONS)	COMPONENT (%)	COMPONENT (TONS)	COMPONENT (%)	COMPONENT (TONS)	COMPONENT (%)	COMPONENT (TONS)
NEWSPRINT	2.3%	3572	1.0%	893				0	0.7%	893	1.6%	4465
CORRUGATED PAPER	4.2%	6584	1.8%	1536	10%	2894	30%	1173	4.5%	5603	4.4%	12187
OTHER PAPER	30.1%	47090	30.2%	26494	20%	5788	15%	586	27.3%	32868	28.3%	79958
TOT PAPER	36.6%	57245	33.0%	28923		8682		1759	32.7%	39364	34.9%	96609
FILM	5.1%	8025	3.9%	3439		0	15%	586	3.3%	4025	4.3%	12050
RIGID	1.8%	2882	2.7%	2358		0		0	2.0%	2358	1.9%	5240
PET	0.1%	131	0.1%	56		0		0	0.0%	56	0.1%	187
TOT PLASTICS	7.0%	11038	6.7%	5854		0		586	5.3%	6440	6.3%	17478
TEXTILE, RUBBER, & LEATHER	5.9%	9171	4.5%	3931		0	5%	195	3.4%	4126	4.8%	13297
FOOD WASTE	9.2%	14445	20.1%	17655		0		0	14.7%	17655	11.6%	32100
WOOD	4.7%	7370	8.4%	7370	60%	17364	30%	1173	21.5%	25907	12.0%	33277
YARD WASTE	19.4%	30364	3.8%	3374		0		0	2.8%	3374	12.2%	33738
SWEEPINGS	8.9%	13954	10.6%	9302		0		0	7.7%	9302	8.4%	23256
SUBTOTAL-COMBUSTIBLE	91.7%	143587	87.2%	76409		26046		3714	88.1%	106169	90.1%	243756
NON-COMBUSTIBLE												
GLASS	1.4%	2203	1.7%	1469		0		0	1.2%	1469	1.3%	3672
FERROUS	2.7%	4151	3.2%	2767	5%	1447	5%	195	3.7%	4489	3.1%	8560
ALUMINUM	0.7%	1142	0.9%	761		0		0	0.6%	761	0.7%	1903
MISC METAL	0.3%	524	0.1%	131		0		0	0.1%	131	0.2%	655
TOT NONFERROUS MTLS	1.1%	1666	1.0%	892		0		0	0.7%	892	0.9%	2558
BRICK, CERAMIC	3.2%	5012	7.0%	6125	5%	1447		0	6.3%	7572	4.5%	12584
SUBTOTAL-NON-COMBUSTIBLE	8.3%	13031	12.8%	11253		2894		195	11.9%	14342	9.9%	27373
TOTAL PROCESSIBLE	100.0%	156618	100.0%	87661	100%	28940		3909	100.0%	120510	100.0%	277128

surface moisture and combustible content of the non-combustible waste components are negligible, those waste components were not analyzed.

The proximate analysis serves to define the combustion parameters of solid waste as a fuel. A proximate analysis determines the level of moisture, volatile matter, fixed carbon, and ash and the higher heating value in Btu per pound of solid waste. Moisture content and higher heating value are required information in the design of a solid waste combustion-steam generation unit in a mass burn resource recovery facility and predicting its performance. The design parameters of the unit are sensitive to moisture content and the heat release or input of solid waste, which changes due to seasonal variations in the nature of the fuel. The fixed carbon and ash contents are used to estimate the amount of residue (bottom ash and fly ash) produced by the entire system.

An ultimate analysis serves to define the levels of carbon, hydrogen, oxygen, nitrogen, sulfur, and chlorine in solid waste. This elemental analysis is used to calculate the mass and volume of both combustion air needed and resulting combustion/flue gas in the solid waste combustion-steam generation unit and air pollution control device. Some of the elemental levels are used to estimate the concentration of certain pollutants in the flue gas prior to the air pollution control device. Nitrogen content is used to predict the concentration of nitrogen oxides in the flue gas. Sulfur and chlorine contents are used to estimate the levels of acid gases in the flue gas, such as sulfur oxides and hydrogen chlorides. In an effort to relate the chlorine derivatives that may be deleterious in a combustion-steam generation unit, it has been generally concluded that the chlorine atoms which are insoluble in water are those of particular concern. The theory is that at the temperatures usually encountered in the furnace section, the insoluble forms of chlorine will vaporize and, therefore, have the opportunity to readily combine with other elements and become chemically aggressive to components in the unit.

Proximate and ultimate analyses on an as-received basis from laboratory analyses from the March 1988 Study for the processible combustible waste components by residential and commercial/institutional/bulky/industrial sectors were used as the starting point to determine the composite sector and total proximate and ultimate analyses.

Composite Sector and Total Proximate and Ultimate Analyses

Table 8 presents the proximate and analyses by weight of the residential sector, commercial/institutional/bulky/industrial sector, and a sector-weighted total on as-received, dry, and moisture- and ash-free bases. The proximate and ultimate analyses of the individual components on an as-received basis for a particular sector were weighted by the sector processible waste composition in Table 10 to calculate the composite sector values in Table 8. The sector-weighted total was determined by weighting the composite sector value with the sector processible waste ratio that was calculated from Table 7.

Table 8

2/16/90

COMPOSITE PROXIMATE AND ULTIMATE ANALYSIS BY SECTOR FOR MERCER COUNTY

SECTOR	PROXIMATE ANALYSIS					ULTIMATE ANALYSIS							
	MOISTURE (%)	VOLATILE MATTER (%)	FIXED CARBON (%)	ASH (%)	HIGHER HEATING VALUE (BTU/LB)	MOISTURE (%)	CARBON (%)	HYDROGEN (%)	OXYGEN (%)	NITROGEN (%)	SULFUR (%)	CHLORINE (%)	ASH (%)
					AS-RECEIVED BASIS								
RESIDENTIAL	30.92	46.59	5.40	17.09	4814	30.92	26.64	3.55	21.00	0.54	0.11	0.15	17.09
COMMERCIAL/INSTITUTION BULKY/INDUSTRIAL	23.75	51.79	6.67	17.79	5575	23.75	31.64	3.97	22.02	0.52	0.07	0.24	17.79
TOTAL	27.80	48.85	5.95	17.40	5145	27.80	28.82	3.73	21.44	0.53	0.09	0.19	17.40
					DRY BASIS								
RESIDENTIAL		67.44	7.81	24.75	6969		38.57	5.13	30.40	0.78	0.16	0.21	24.75
COMMERCIAL/INSTITUTION BULKY/INDUSTRIAL		67.92	8.75	23.33	7311		41.50	5.20	28.88	0.68	0.09	0.32	23.33
TOTAL		67.65	8.22	24.13	7118		39.85	5.16	29.74	0.73	0.13	0.26	24.13
					MOISTURE-AND-ASH-FREE								
RESIDENTIAL		89.62	10.38		9261		51.26	6.82	40.39	1.03	0.21	0.28	
COMMERCIAL/INSTITUTION BULKY/INDUSTRIAL		88.59	11.41		9536		53.49	6.71	37.23	0.87	0.11	0.41	
TOTAL		89.17	10.83		9381		[illegible]23	6.77	39.82	0.96	0.17	0.34	

* THE TOTAL IS WEIGHTED 56.5% FOR RESIDENTIAL FRACTION AND 43.5% FOR COMMERCIAL/INSTITUTIONAL/BULKY/INDUSTRIAL WASTE TYPE QUANTITY DATA DURING 1989 FROM MERCER COUNTY TRANSFER STATION SCALES AND THE RESIDENTIAL AND COMMERCIAL/INSTITUTIONAL FRACTIONS OF TYPE 10 WASTE DETERMINED DURING THE PREVIOUS TWO WEEK WEIGHING PROGRAMS CONDUCTED DURING 1986-1987 BY THE JOINT VENTURE.

The value of remaining solid waste processed as a fuel with 25 percent recycling during 1994 is predicted to be approximately 5,150 Btu per pound on an as-received basis. This value is well within the design range of 4,200 to 6,000 Btu per pound as indicated in the service agreement with Westinghouse Resource Energy Systems Division.

The other proximate and ultimate analytical values seem to be reasonably close in comparison to other published reference data.

Waste Flow Control and Enforcement

Supply of solid waste to waste management facilities has historically been a concern to public officials and an issue raised by opponents. Without a secure solid waste flow, the revenues needed to financially support a solid waste management project become questionable.

Recognizing the importance of waste flow control, the The Authority decided to obtain a franchise for the solid waste generated within the county's borders to reinforce the existing waste flow directives. Since Mercer County direct hauls to an out-of-state landfill facility, the county was not eligible to apply for a franchise. To be eligible the county needed to develop and operate a solid waste facility. Since this planning effort was ultimately directed towards ensuring waste flow to Mercer's long-term waste management facilities, the county decided to plan and develop a transfer station. With an operational transfer facility, the county was able to secure a franchise and the additional enforcement abilities associated with it.

The Mercer County Transfer Station, franchise, and the NJDEP's waste as well as flow directives now provide the mechanism for controlling the waste flow an additional level of confidence for flow of solid waste to our long-term waste management facilities. To ensure proper implementation of the waste flow control mechanisms. The Authority established an enforcement department which monitors solid waste hauling activities in Mercer County.

The more rigorous enforcement of waste flow regulations since the start-up of the county transfer station and the rise of tipping fees at competing out-of-county disposal facilities have virtually eliminated the "leakage" of Mercer County's waste from the system.

Transfer Station

The development of the Mercer County Transfer Station was not for transfer to distant landfills, but rather as a mechanism for gaining control of the waste flow and to assist in the quantification of the waste stream for long-term planning efforts. The transfer facility has been in operation since November 1988 and only transfers residential solid waste. The facility acts as a control point for commercial waste accounts by weighing these vehicles and rerouting them directly to the landfill.

Resource Recovery Facility

In 1994, the anticipated first full year of operation for the Mercer County Resource Recovery Facility, it is expected that annual total solid waste collected before recycling in Mercer County would be about 414,100 tons per year 1,135 tons per day$_7$ (seven-day week). Of these figures, approximately 360,400 tons per year 987 tons per day$_7$ would be considered as processible waste without recycling. With recycling at the 25 percent minimum level of 1988 Type 10 waste amount under the State Recycling Act requirements, the amount of processible waste available to be burned would be reduced to about 277,100 tons per year or 759 tons per day$_7$.

Using the processible waste quantity projections in Table 5, an assumed minimum annual operating availability factor of 85 percent, and an expected 20-year operating life for the Mercer County Resource Recovery Facility, the minimum average daily and annual processing capacities were calculated for years 1993 through 2013 as presented in Table 9.

Based on this analysis, a rated processing capacity of 975 tons per day was selected for the Mercer County Resource Recovery Facility. Initially, three 325-ton-per-day combustor-boiler units will be installed, and the addition of a fourth unit will be needed in the year 2002.

In May 1988, The Authority entered into a service agreement with Westinghouse Resource Energy Systems Division, who is responsible to prepare part of the environmental permitting and approval applications, design, construction, start-up, acceptance testing, and long-term operation of the Mercer County Resource Recovery Facility. All environmental permits and approvals for the facility are expected to be obtained in late 1990. Then construction of the facility would begin in early 1991. Anticipated initial date of commercial operation for the facility is mid-1993.

Recycling and Material Recovery Facility

With the requirement of mandatory recycling in the State of New Jersey, The Authority used the solid waste quantification and characterization data to plan, design, and implement a county-wide recycling program for both the residential and commercial/institutional sectors. These data were also used to demonstrate compliance with the state's mandatory recycling goals and for the planning of a material recovery facility to be co-located at the site of the resource recovery facility.

The quantification data was used to project the amount of designated recyclables expected to be collected through the residential curbside collection contract. This data was provided to bidders to assist in determining equipment needs under the contract scope. This information was also used to design an interim recycling facility which was constructed to transfer the commingled material to a distant market. The interim recycling facility was constructed at the county transfer station site to take advantage of the existing scales and scale house. Mercer County's curbside program services approximately 91,000 units in 13 municipalities.

Table 9

MINIMUM AVERAGE DAILY AND ANNUAL WASTE PROCESSING CAPACITIES (TONS)
FOR THE MERCER COUNTY RESOURCE RECOVERY FACILITY (YEARS 1993-2013)

YEAR	AVERAGE DAILY (TONS/DAY)	ANNUAL (TONS)
1993	744	136,968
1994	759	277,128
1995	768	280,319
1996	777	283,509
1997	785	286,700
1998	794	289,891
1999	803	293,082
2000	812	296,272
2001	820	299,464
2002	829	302,654
2003	838	305,845
2004	847	309,035
2005	855	312,226
2006	864	315,418
2007	873	318,607
2008	882	321,798
2009	890	324,989
2010	899	328,179
2011	908	331,370
2012	917	334,561
2013	925	337,752

NOTES:

1. MINIMUM AVERAGE DAILY AND ANNUAL CAPACITIES ARE BASED ON AN 85 PERCENT ANNUAL OPERATING AVAILABILITY FACTOR WITH 7-DAY-PER-WEEK, 24-HOUR-PER-DAY OPERATION.

2. AVERAGE DAILY WASTE PROCESSING CAPACITY FOR THE PARTIAL YEAR 1993 ARE BASED ON 7-DAY-PER-WEEK OPERATION, 184 OPERATING DAYS REMAINING IN THE YEAR AFTER JULY 1.

Commercial and institutional establishments are required to corrugated and high grade paper in addition to the materials designated for the residential sector. The results of the solid waste quantification and characterization program revealed that in order for Mercer County to achieve compliance with the state's recycling goals, the commercial/institutional sector must recycle additional components. In absence of the waste quantification and characterization program, the county would have been unable to demonstrate compliance with the state-mandated recycling goals.

As with the planning with any solid waste recycling or processing facility, project participants must know the quantity and character of the material to be processed. With the quantity and character of the material known, The Authority is planning a 120-ton-per-day material recovery facility that will be operational in 1991. When completed, this facility will process commingled recyclables collected through the county's curbside residential program.

USING BASIC ECONOMIC DECISION MODELS FOR INTEGRATED SOLID WASTE MANAGEMENT PLANNING

Loch McCabe
Resource Recycling Systems

Presented at the

First U.S. Conference on Municipal Solid Waste Management

June 13-16, 1990

Using Basic Economic Decision Models for Integrated Solid Waste Management Planning

Community planners and decision makers are faced increasingly with the challenging task of developing an integrated solid waste management strategy that best meets the community's short- and long-term waste recovery and disposal needs. This task usually requires a balancing of different waste management approaches (i.e. recycling, composting, landfilling and incineration). Achieving this balance in a technically and economically optimal manner requires three steps:

1. Determine the Alternative Waste Management Strategies.
2. Maximize the Cost-effectiveness of Each Strategy.
3. Choose the Most Cost-Effective Strategy.

Upon completing this decision process, planners should have the information they need to build the type, size and number of waste recovery/disposal collection and processing systems which are most cost effective in the short- and long-run.

Step 1: Determine the Alternative Waste Management Strategies. Given a certain volume and composition of solid waste, select the alternative waste management strategies which may potentially meet the community's needs. Some of the most common options, and their components, include:

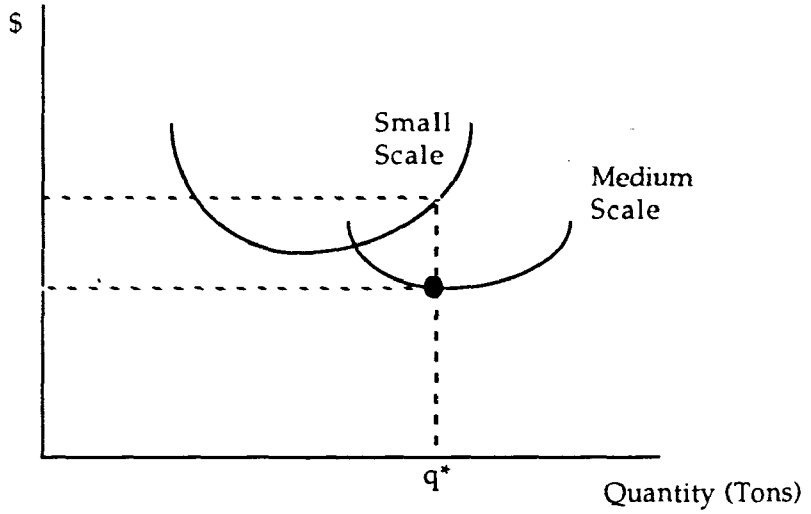
Sample Strategies	Strategy Components
Bury Only	Landfill all solid waste.
Burn All, Bury Ash	Burn all solid waste, then landfill ash.
Recycle Some, Burn Rest, Bury Ash	Recycle glass and metal, burn organic organic waste, then landfill ash.
Recycle Some, Bury Rest	Recycle paper, cardboard, plastic, metals, glass, then landfill residual waste.

Recycle/Compost Most, Bury Rest	Recycle paper, cardboard, plastic, metals, glass, compost yardwaste and remaining organics, then landfill residual waste.

The strategies which are selected will generally be chosen based on a variety of technical, political and fiscal criteria.

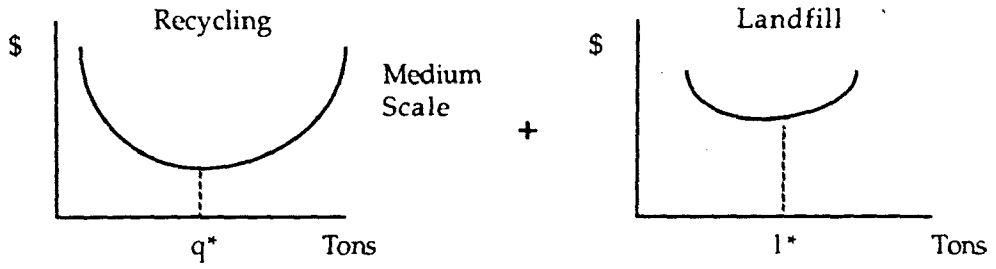
Step 2: Maximize the Cost-effectiveness of Each Strategy. Once an alternative strategy has been selected, determine how it might be implemented most cost-effectively. That is, identify the optimal *operating level* and *scale* for each component which minimizes the net costs of the approach.

For example, say the planner is developing a "Recycle Some, Bury Rest" strategy. First, determine the portion of the waste stream which would be recycled, or the operating level of the recycling system. Then evaluate the cost effectiveness of different scales (sizes) of recycling collection/processing systems to handle the desired volume of materials (q*). Avoid choosing a scale which is too small ("undersizing"), a scale of production which is too large ("White Elephant" syndrome). It is most desirable to choose an "optimal" scale, one that will produce the appropriate quantity at the lowest possible price.



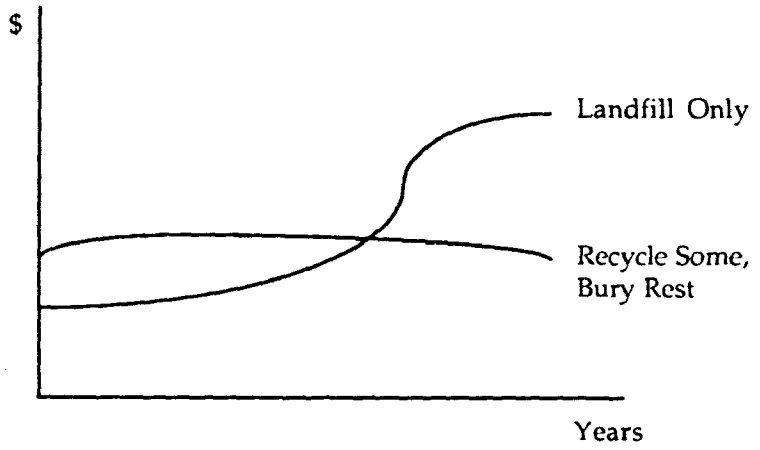
In the above case, a medium scale would be chosen. Then, use a similar process to determine the most cost-effectiveness scale for burying the residual waste.

Once the most cost-effective scale of recycling and the most cost-effective scale of residual landfilling (l*) have been identified, add these components together to determine an overall cost for the strategy.



Through this process, the planner will determine the right **mix** of components to ensure that the overall waste stream is managed in the most cost-effective manner given for the desired strategy. It is recommended that this be done for several different operating levels and scales of the components to ensure that most cost-effective combination of components is found.

Step 3: Choose the Most Cost Effective Strategy. Once the strategies have been identified in their most cost-effective form, evaluate their cost-effectiveness over time. To do this, first identify the nominal costs of implementing each strategy over a given time period.



In all likelihood, the relative costs of the strategies will change over time. If this is true (as shown above), it will then be necessary to determine the net present value (NPV) of each strategy over the time period. The present value for a cost in a particular year may be determined with this formula:

$$\text{Present Value} = \frac{\text{Future Nominal Value}}{(1 + d + r)^{t}}$$

where: d = discount rate, r = inflation rate, t = time (in years)

The net present value can then be calculated by adding the present value of the net costs over the time period.

$$NPV = \frac{C_0}{(1+d)^0} + \frac{C_1}{(1+d)^1} + \frac{C_2}{(1+d)^2} + \ldots + \frac{C_T}{(1+d)^T}$$

where C_t is the nominal cost of the strategy in Year t
$t = 0, 1, 2, \ldots T$ (end of project)

The planner would choose the strategy with the greatest net present value.

As community planners, managers, and politicians consider a range of interdependent waste management alternatives, using these standard economic models to determine the most cost-effective strategy may lend critical assistance to the solid waste management decision making process.

THE WATERLOO PILOT CURBSIDE PROJECT

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Presented at the

First U. S. Conference on Municipal Solid Waste Management

June 13 - 16, 1990

Good Morning Ladies and Gentlemen,

Before I begin, I would like to take this opportunity to tell you something about our company.

Advanced Recycling Systems is a manufacturing and marketing firm who targets municipalities and end-users of products used in recycling programs throughout the United States.

Although our roots are in Iowa, our product knowledge and expertise in curbside recycling reach national boundaries. I hope that each of us can benefit and learn from the experience's found in all the presentations at this exciting conference.

What you are about to see is a demonstration into the most efficient and effective pilot program ever recorded to date

The objective of this project was to:

1. Determine the educational effort that would be required to maximize the participation.

2. Compare equipment used in other programs and test the effects that each would have in the short term and long term plans in Waterloo, Iowa.

3. Implementation and documentation of productive levels for each system type and their effect on the overall collection process.

Using this criteria as a guide, The City of Waterloo, The Iowa Department of Natural Resources, Waste Management Authority, and Advanced Recycling Systems, entered into a cooperative agreement which would provide this specific data that would assist in the decision making process for future curbside recycling in Waterloo.

The Waterloo Pilot Recycling Project tested and compared two separate and distinct methods of separation.

(1) One unit tested was the single container system in three different sizes by three different manufacturers. The purpose was to co-mingle recyclable materials with final separation by collection crews at the curb.

(2) The second method was using the Residential Recycling Cart Kit by Advanced Recycling Systems in Waterloo. This system used the concept whereby each container was designated for each commodity that would be extracted from the waste stream using the waste generator as the labor force for separation at the point of generation.

The cart system containers were designated for paper, plastics, clear glass, brown glass, green glass, and metals. A severe disadvantage to the Waterloo Project would be that Iowa is a deposit can and bottle state, so the generation of beverage containers would be limited, or non-existent.

The Waterloo Pilot Project encompassed five different areas in five different geographical locations of the metro area. Each area was demographically chosen to include participants from low income through middle and upper middle income to high income. Truly, there was a wide cross section of participants involved.

Education played an important role and was a key element into the success of this program. Public meetings were held and "How To" books were distributed. A "Recycling Hotline" was established for those participants who required answers to specific questions.

The Waterloo Pilot Recycling Program was conducted over a 17 week period. The first five weeks was dedicated to weighing trash that was being generated by each home within the pilot areas. This would provide data on average weights generated prior to the pilot recycling program and act as a basis for comparison in a "before and after" case scenario. The City of Waterloo's special projects coordinator recorded all data to insure the accuracy of figures in the final reports to the Iowa Department of Natural Resources.

During this five week, pre-recycling study, a total of 81,740 pounds of material was placed out for collection. The average number of participants was 272 households out of a possible 322 in the pilot areas. The compilation of data indicates that each home placed an average of over 300 pounds of material out during the five week and that is equal to over 60 pounds per household per week.

The fifth week of the pilot project, recycling equipment was issued to all participants. This equipment included the residential recycling cart kit or the single container system and each participant was issued a bio-degradable 6% corn starch based landfill bag, and for those participants who placed compostable materials out to the curb, several 40 gallon bio/photo-degradable, 6% corn starch based compost bags were distributed.

The purpose for the issuance of one landfill bag was to test the effects by these large generators of refuse materials to recycle at a maximum effort and reduce the amount of non-recyclable materials that would be placed into the single 30 gallon landfill bag.

The single container system and the residential recycling cart kits were strategically placed across from each other with one side of a street receiving one system and the other side of the street receiving the other. The purpose of this alternate placement was to develop communications between neighboring families and share success stories or discuss problem areas with either of the systems. Subsequently, this information would be conveyed to the Waterloo Department of Public Works for action and final disposition.

It is important to note that because of locating these systems in the alternate placement configuration, 178 single containers were issued and 133 residential recycling cart kits for a total issuance of 311 total systems.

The following week, the recycling effort would begin.

Now, I would ask you to remember that this would be the first week of the pilot recycling project with participants who had never recycled prior to this program. People who had heard of recycling elsewhere in the country, but had never been involved in the process.

In the first week of the actual recycling project (or week 6), the single container system extracted over 38 percent (including compost materials) from the residential pilot areas. Without compost materials, the single container extracted over 30 percent. The participation rate for week 6 was in excess of 88 percent for single container users.

The same week, the residential recycling cart kit participants extracted nearly 60 percent (including compost materials) and the figure excluding compost was over 48 percent. Participation percentages for the residential recycling cart kit was nearly 84 percent. We feel that this lower rate was attributed to the higher capacity volume of the cart system, so the need to place the cart out for collection each week was not necessary.

Totally, for week 6, the combination of both systems extracted over 48 percent with compost materials and over 37 percent without the compost materials included. Average participation rates in week 6 was in excess of 86 percent.

The educational process was on-going. As the program progressed, less calls from those participating were received. The participants were beginning to feel comfortable with the recycling effort.

The percentages throughout the next 11 weeks were outstanding. The participants using the single container system during the entire program was over 53 percent (including compost materials) and nearly 37 percent excluding compost materials. Participation rates exceeded 86 percent with an average of 154 homes out of a possible 178 participating.

The participants using the residential recycling cart kit diverted 70 percent from the solid waste stream (including compost materials) and 59 percent excluding compost materials. Participation rates for the cart exceeded 90% and the average number of homes participating was 120 of a possible 133 carts issued.

I would like to add that the residential recycling cart kit, working with a 45 home disadvantage (178 single containers and 133 carts) extracted 10,500 pounds more material than the single container system.

Time studies throughout indicated that it took nearly four times longer to separate materials at the curb from the single container than it did to empty six containers from the cart system.

The final synopsis figures indicate that a total of 158,322

pounds of material was placed out for collection. The recycling percentage of both systems, overall, was over 61 percent with compost materials and nearly 48 percent without compost materials.

The participation percentage rate was 88 percent overall during the 12 week pilot recycling project.

These figures are very impressive by anyone's standards, but there is one thing that I haven't related to you yet. These high percentages of recyclable materials were done without the use of any ordinance or mandated legislation of any kind. It was a VOLUNTARY PROGRAM with areas chosen by Mr. John Meyer, Director of Public Works for the City of Waterloo.

The voluntary program was administered as if it were a mandated program with the exception of enforcement procedures. Originally, the decision was made that if recyclables were placed in a bag that had a landfill destination, the bag would not be collected. The mayor and city council received many negative responses to this policy and the procedure was soon abandoned.

Some participants wanted to recycle to their fullest capability, but some would not participate under any circumstance. We do feel that the numbers could have been several percentage points higher, had everyone been required to participate. As well, the recycling percentages been higher had this pilot program been conducted in a state that did not have the can and bottle deposit law in place.

IN CONCLUSION, The City of Waterloo, The Iowa Department of Natural Resources, Waste Management Authority in Des Moines and Advanced Recycling Systems compiled much data from this project. In fact, 1458 pages of documentation in the final report.

We learned that a 70% extraction was possible, even in a voluntary program and that a majority of the people are receptive to re-learning skills that will benefit their environment through a comprehensive recycling effort.

We learned that personal habits and lifestyles change. New habits in purchasing are developed, and the attitudes

became more positive toward waste reduction and recycling as the project continued.

We've learned that there are three distinct subjects that will motivate a recycling program. In order, they are:

1. Education, in direct or indirect methods and the willingness to learn about solid waste disposal and recovery.

2. Incentives that will conform and adjust to a volume related base rate whereas the large waste generators will pay more than those who generate less. And, finally,

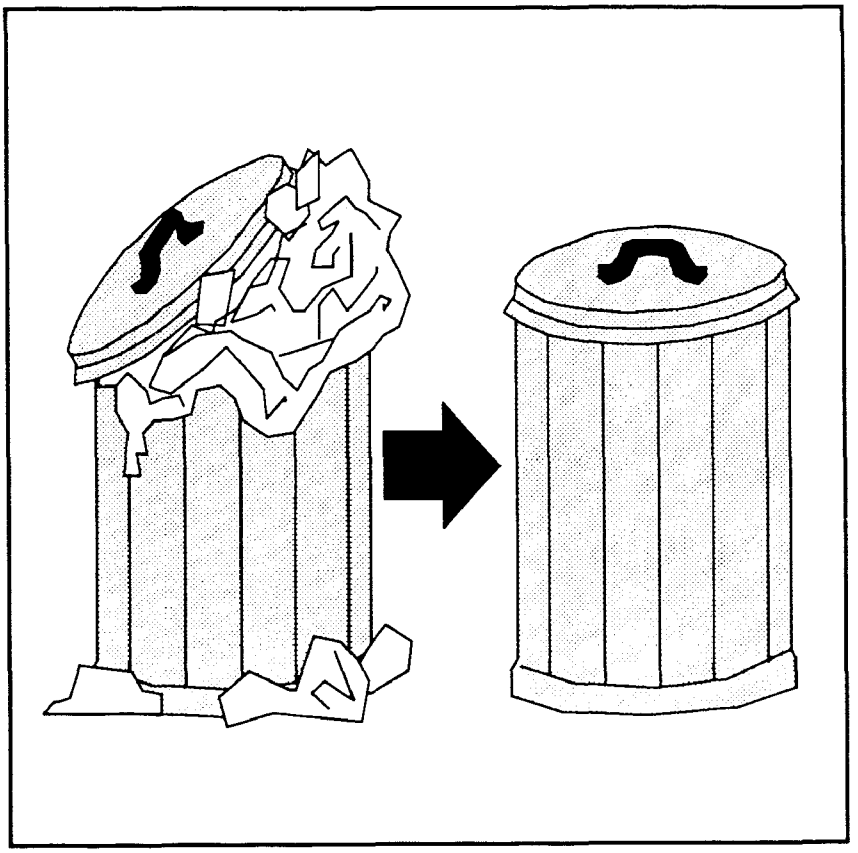
3. The proper equipment that will increase participation, thus, increasing the percentages extracted from the solid waste stream.

Education, Incentives and the proper equipment. These required subjects will insure the success of any program in nearly every instance, and in nearly every local.

A limited number of the executive summary's of the Waterloo Pilot Recycling Project are available. If you would leave me your card at the end of this session, I will see that it is given every consideration on being sent to you.

I would like thank you for your attentiveness and I hope to see you again.

Thank you.



SOURCE REDUCTION

CANADA'S NATIONAL PACKAGING PROTOCOL:

AN ACHIEVABLE PLAN FOR WASTE REDUCTION

D.J. Hay, A. Finkelstein, L. Losier
Environment Canada
Waste Management Branch

Presented at the
First U.S. Conference on Municipal Solid Waste Management
June 13-16, 1990

Background.

Waste management is an urgent and pressing problem in Canada. Each year Canadians generate 35 to 40 million tons of waste, of which about 16 million tons is from household and commercial sources. For the year 1989, on a per capita basis, Canada produced more waste than any other country in the world: 1.7 kilograms per person per day (figure 1). Overall, Canadians spend over $1.5 billion per year on waste management.

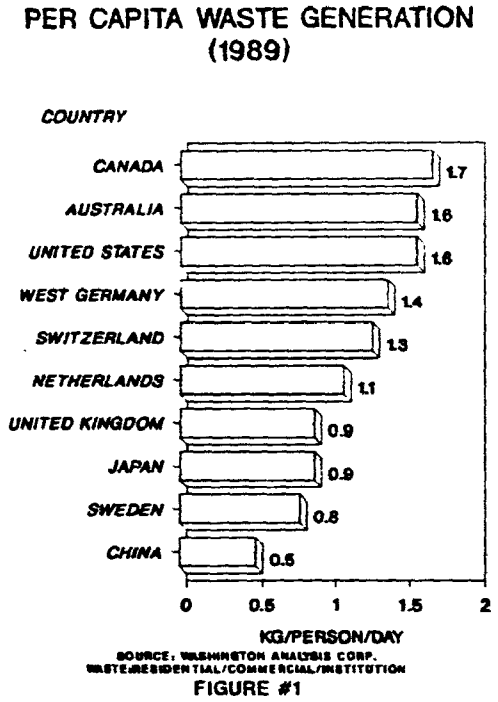


FIGURE #1

The contribution that packaging makes to Canada's waste management problems is substantial. The per capita consumption of packaging in Canada stands at an estimated one ton of packaging per family per year.

In total, packaging in Canada consumed 6.6 million tons of material in 1988, most of which is disposed of at a great environmental and economic price. Roughly 80 per cent of Canadian packaging is ultimately managed by disposal rather than by recycling or reuse (figure 2). Some 5.7 million tons of packaging material is landfilled or incinerated annually, at an estimated cost in excess of $100 million.

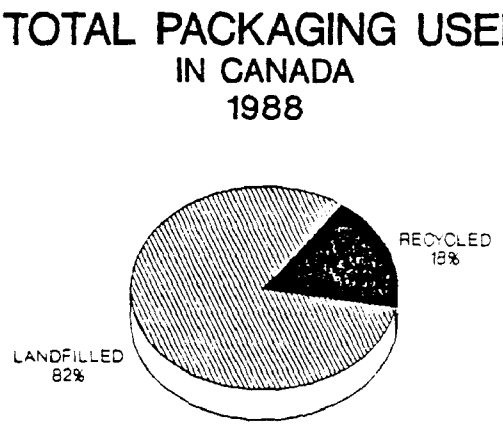
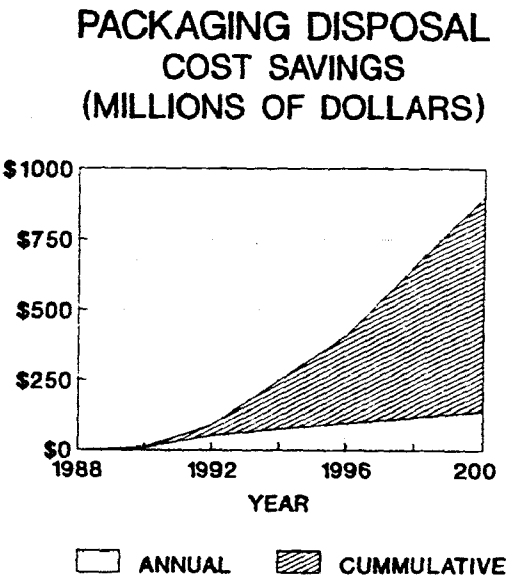


FIGURE #2

In order to come to grips with this problem, in May, 1989, the Canadian Council of Ministers of the Environment (CCME)--a body composed of Canada's federal, provincial and territorial ministers of the environment--commissioned a National Task Force on Packaging to develop national policies for the management of packaging. After preparing an extensive technical data base on packaging and conducting a Canada-wide consultation program, the Task Force produced the National Packaging Protocol.

The Protocol sets out six policy statements with supporting actions, establishes three packaging waste reduction milestone targets and puts forth two implimentation recommendations.

The 1992 target of a 20 per cent reduction from 1988 levels will reduce annual waste collection and disposal costs by $50 million. Further targets of a 35 per cent reduction by the end of 1996 and a 50 per cent reduction by the year 2000 will bring total savings to almost $1 billion (figure 3).



WASTE DISPOSAL AT $30 PER TONNE
FIGURE #3

The Canadian Packaging Industry.

Packaging is made to contain, transport, protect and market goods, and to provide product information. It is commonly composed of paper or paper products, plastics, wood, glass, steel and aluminum. These were the six most common groups of packaging materials used in Canada in 1988, and it is projected that these same materials will still dominate packaging in the year 2000 (figure 4).

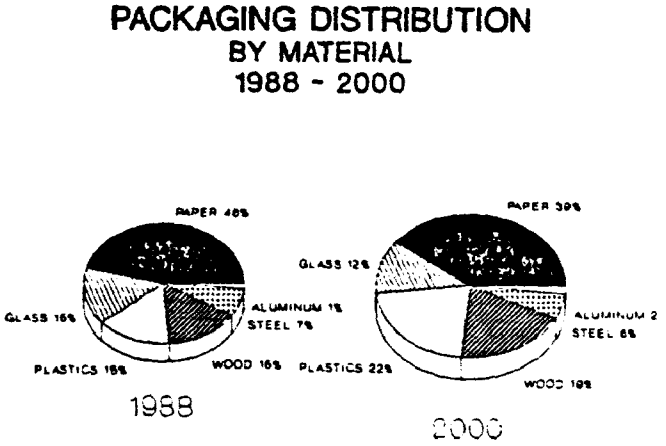
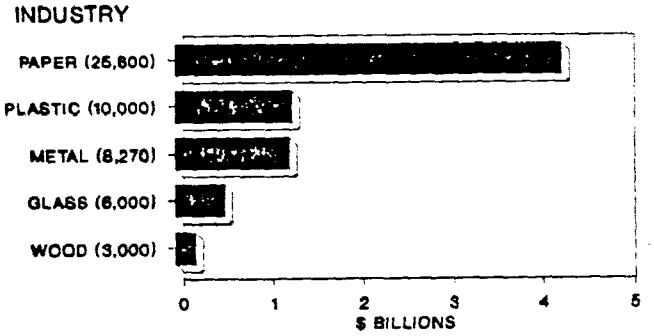


FIGURE #4

Packaging composites are composed of two or more types of materials, and are frequently used. Typical forms of packages include pallets, boxes, bottles, cans, jugs, drums, wrappers, etc.

The packaging industry is a major factor in the Canadian economy. More than 52,000 persons are employed by the Canadian packaging sector. The total value of packaging produced in Canada in 1988 was over $7 billion (figure 5), while the indirect value of packaging, the worth of the protection that packaging affords an almost infinite variety of products, is incalculable.

PACKAGING INDUSTRY
STATISTICS
(1986)



PEOPLE EMPLOYED IN PACKAGING ()
FIGURE #5

The Protocol Process.

Canada's National Task Force on Packaging was a broadly based "multi-stakeholder" group. Its members came from government, the manufacturing, shipping and retail sectors of industry, environmental and consumer organizations. It drew upon their experience and interest in packaging to obtain a broad basis of input for the development of the National Packaging Protocol. Six regional meetings were held in various geographical areas across Canada.

Task Force members were particularly prompted by public demand for packaging which is sensitive to the environment (i.e., which is compatible with waste reduction and with the wise use of energy, water and other resources). The Task Force was also aware of the fragmented approach to packaging in the United States, which has led to undesirable economic consequences for industry and, ultimately, for the consumer. In general, the work of the Task Force was governed by the need for a national approach to packaging waste minimization through reduction, reuse and recycling.

The Task Force agreed that the Protocol would concentrate on industrial, household and commercial packaging, and would be developed in consultation with key stakeholders from federal, provincial, territorial and municipal governments, and from industry, environmental and consumer groups. The Task Force focused on the management of packaging through source reduction, reuse and recycling. It did not consider disposal options such as incineration. Neither did it consider the effects that disposal techniques such as incineration and landfill have on package design. Concurrent with the development of the Protocol, the Task Force commissioned a wide variety of technical reports on all aspects of packaging. These included such topics as packaging design and manufacturing, consumer uses and attitudes, environmental and economic considerations, and legislative initiatives.

The National Packaging Protocol.

The National Packaging Protocol consists of six recommended packaging policies for Canada.

Policy Number 1. All packaging shall have minimum effects on the environment.

The environmental impact of packaging extends beyond the effect of its disposal; the quality of packaging waste is not the only issue. Resources and energy are consumed to produce and transport packaging. A consideration of broader environmental consequences should be included in an assessment of the impact of packaging.

The Protocol will address these broader consequences by encouraging the preparation of environmental profiles for each type of package. Where appropriate, this would be followed up by product and/or package design or redesign to minimize adverse environmental impacts. The Protocol will stimulate research and the development of new packaging products and technology which have minimal effects of the environment.

To attain these ends, government and industry will work together. The federal government, in consultation with a multi-stakeholder group, will develop methodologies and guidelines to be used in drawing up environmental profiles of packaging, and which will allow consumers to compare packaging choices. Industry will carry out packaging profiles in accordance with the federal guidelines, to identify the environmental impacts caused by the manufacture, use and post-use management of

packaging. Industry will then use this profile data to prepare action plans and schedules to minimize environmental impacts and manage packaging through source reduction, reuse and recycling.

Policy Number 2. Priority will be given to the management of packaging through source reduction, reuse and recycling.

The federal government, in consultation with industry and the multi-stakeholder group, will establish a "Code of Preferred Canadian Packaging Practices", to guide industry in the design of products and in the selection and design of packaging according to the following hierarchy of desirability:

1. No packaging
2. Minimal packaging
3. Reusable packaging
4. Recyclable packaging and packaging containing recyclable material.

Policy Number 3. A continuing campaign of information and education will be undertaken to make all Canadians aware of the function and environmental impacts of packaging.

Responsibility for the management of packaging is a shared responsibility. Achievement of the National Packaging Protocol targets requires the combined resources of government, industry, consumer and special interest groups. Education programs are necessary both to inform and motivate purchasers to make appropriate choices, and to support the development of a conserver society. A national program will

be developed to inform all Canadians of the functions and environmental impacts of packaging, and to encourage environmentally sound purchasing practices.

Policy Number 4. These policies will apply to all packaging used in Canada, including imports.

It is important that the National Packaging Protocol be applied to all packaging, both domestic and imported. Regardless of its country of origin, all packaging used in Canada has the potential to require management in Canada. Policy Number 4 will ensure a level playing field and prevent any packaging product from gaining a competitive advantage at the expense of the environment. Efforts must be undertaken to ensure effective monitoring of border markets against the entry of non-complying products.

Federal, provincial and municipal governments will, with sensitivity to the needs of local industries, establish standards and regulations to apply the National Packaging Protocol to all packaging used in Canada, including imports. The federal government will act as liaison with other countries to promote the policies of the National Packaging Protocol in the arena of international trade.

Policy Number 5. Regulations will be implemented as necessary to achieve compliance with these policies.

Monitoring the progress achieved through voluntary initiatives may indicate a need for regulatory measures to ensure that the effects of the National Packaging Protocol are felt equally, and that targets are met. Federal and provincial governments will, with the participation of the multi-stakeholder group, enact regulations which are compatible

across Canada. These will specify performance requirements, targets and deadlines for achievements consistent with the National Packaging Protocol.

Policy Number 6. All government policies and practices affecting packaging will be consistent with these national policies.

In the environmental and other public policy areas, existing and new government policies will be reviewed to ensure consistency with the National Packaging Protocol. Health, safety, technical and other factors will need to be assessed in order to identify conflicts or barriers to the achievement of the objectives of the National Packaging Protocol.

Government policies and practices which impede the objectives of the National Packaging Protocol will be identified and, where possible, removed or modified. Government policies and practices such as procurement will be developed and implemented to support the achievement of the objectives of the Protocol.

Implementation.

Canada's National Packaging Protocol will be implemented by a broad range of actions that will address the many facets of packaging issues. As has been indicated above, implementation actions will be closely linked to the six specific statements that make up the Protocol. The Protocol's implementation will be carried out through five main initiatives; these initiatives might frequently overlap into areas touched on by more than one of the six policy statements.

1. A Code of Preferred Canadian Packaging Practices will be developed with government and industry participation. This Code will guide industry in the design of products and in the selection and design of packaging. Standards will be established for packaging that will take into account health, safety, performance, consumer and regional requirements. Industry and governments will work together to develop infrastructures that will foster the recycling and reuse of packaging materials, and to develop markets for recycled packaging materials.
2. The Canadian Council of Ministers of the Environment have announced that they will proceed with the drafting of regulations that will ensure the achievement of the goals of the National Packaging Protocol. The Protocol is a voluntary and cooperative effort, which has set flexible targets; thus, industry is free to choose the most effective means to meet those targets. However, should the voluntary approach not work, or prove to be too slow, the CCME ministers have decided that it would be desirable to have an effective regulatory package ready for use if necessary. At the same time, the Task Force will be consulting with the packaging industry to analyze its needs and to determine the most effective incentives to which that industry will respond.
3. A Canada-wide coordinated data collection and monitoring network will be set up to provide needed data as the National Packaging Protocol is implemented. The data collection network will prove particularly helpful in monitoring progress towards the attainment of the Protocol's milestone targets. Indeed, the first target date, December 31, 1990, mandates the day by which all provinces must have in place a

nationally coordinated data collection program.

4. Long and short term communications plans will be developed by all parties participating in the Protocol. The short term plans will concentrate on explaining what the Protocol is and how it will benefit Canadians and their environment. Long term strategies will get concrete information out to individuals and businesses alike regarding practical things that can be done to reduce packaging waste. Communication plans will stress the concept of shared responsibility to all sectors of Canadian society -- governments, the private sector, consumers, environmental organizations, etc. Special efforts will be made to inform school children about what can be done to improve packaging behaviour.

5. A national reduction, recycling and reuse infrastructure will be put in place across Canada. In Canada, waste disposal is primarily a provincial and municipal responsibility, and at present a wide variety of waste disposal and recycling programs exist across the country. The National Packaging Protocol will build upon these already existing systems and help the main participants, the provincial and municipal governments, and industry, strengthen and improve their recycling and reuse practices.

Milestone Targets

The National Packaging Protocol has set a series of targets as cumulative national goals. These targets are designed to be flexible; in some provinces, initial targets may be higher than in others, in order to correspond to differing provincial waste management goals. As has been noted, regulatory frameworks will be developed so that they will be ready to be implemented quickly in the event that targets are not met.

The National Packaging Protocol has established a series of four milestone targets:

By December 31, 1990, all provinces must have in place a nationally coordinated data collection program to make possible the monitoring of the following targets.

By December 31, 1992, packaging sent for disposal in Canada shall be no more than 80 per cent of the amount sent in 1988.

By December 31, 1996, packaging sent for disposal in Canada shall be no more than 65 per cent of the amount sent in 1988.

By December 31, 2000, packaging sent for disposal in Canada shall be no more than 50 per cent of the amount sent in 1988.

The Protocol also dictates that 50 per cent of the decrease in packaging shall be achieved through new source reductions and new reuse initiatives. Recycling programs will make up the remainder of the decreases.

Specific targets will be established for various industry sectors, in order to achieve Protocol goals. It is incumbent on those industrial sectors unable to meet Protocol requirements to provide adequate supporting documentation and alternative targets, one year in advance of prescribed deadlines.

Since Protocol targets are to a certain extent adaptable it may be possible to exceed performance standards and deadlines; however, the possibility exists that some shortfalls may occur. Nonetheless, the Canadian Council of Environment Ministers firmly believes that the Protocol's targets and deadlines are realistic and attainable; every effort will be made to achieve them.

The Next Stage.

The work of drafting the National Packaging Protocol is over; the work of implementing the Protocol and actually reducing, recycling and reusing packaging is just beginning. Work has already started to make the Protocol's goals a reality.

The National Packaging Task Force and its multi-stakeholder group remain in existence, and have begun drafting the Code of Preferred Canadian Packaging Practices. Likewise, long

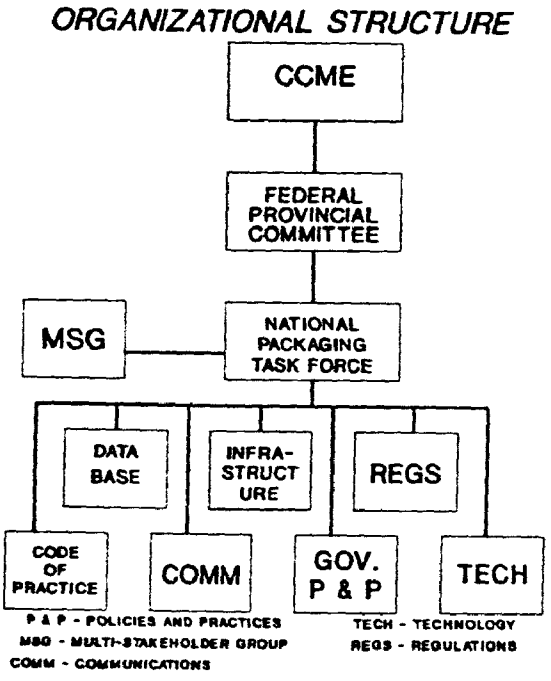


FIGURE #6

and short term communications plans are also being developed. Working groups have been or will be set up to implement Protocol policies regarding the creation of a data base, an infrastructure for reduction recycling and reuse, government policies and practices, the drafting of regulations and packaging technology (figure 6).

Most of these working groups will be established and operational by the fall of 1990. It is anticipated that the first milestone target, the creation of a Canada-wide data collection network by December 31, 1990, will be met.

The process that will lead to the attainment of the National Packaging Protocol's milestone targets in now under way. Canada's people and environment will be the big winners.

CLEANING UP THE WASTESTREAM

Michael Bender
Central Vermont Regional Planning Commission

Presented at the

First U.S. Conference on Municipal Solid Waste Management

June 13-16, 1990

For many, waste disposal is an "out of sight, out of mind" process. Common practice has long been to treat household toxics as normal trash. This can mean dumping hazardous waste down the drain, into the trash, or on to the ground. Until now, most Vermonters have not had environmentally sound alternatives.

So many household products contain potentially hazardous substances that the American shopping bag is a toxic waste dump in the making. Household hazardous waste (HHW) differs from other household wastes in that it exhibits characteristics that are either toxic, corrosive, caustic, flammable, reactive, or explosive. A Congressional study identified more than 100 types of hazardous chemicals in household products. Examples include such common products as paint and paint products, mothballs, insect and roach sprays, motor oils, antifreeze, wood preservatives, rust removers, metal polishes, batteries, weed killers, drain cleaners, pool acids, hobby products, bleaches, gasoline, kerosene, oven cleaners, nail polish remover, and car waxes.

The mismanagement of hazardous chemicals has turned into one of the environmental nightmares of the past decade. Although factories are consistently blamed for producing and inadequately disposing of hazardous wastes, unregulated hazardous wastes from both the home and the work place have steadily been adding to the problem. Only recently have we begun to understand the nature and extent of the unregulated

hazardous waste problem coming from small quantity generators.

Small quantity generators (SQGs) of hazardous waste are currently permitted to dispose of up to 220 pounds per month in Vermont's landfills. SQGs include auto repair shops, cleaning services, woodworking, service stations, printing and photography shops, construction operations, farms, schools, government entities and others. They produce such wastes as used oil, solvents, paints, pesticides, inks, and photo chemicals. A report recently completed by the Environmental Law Foundation for the Central Vermont Regional Planning Commission (CVRPC) estimated that Vermont's small businesses generate 5,000 tons of unregulated hazardous waste; more than twice recent State estimates in a report to the Legislature.[1]

When yearly households and SQGs waste amounts are combined together, the total is more than one-third of the hazardous waste generated in Vermont. CVRPC's study found that the majority of the SQGs dump their hazardous wastes into landfills or down drains. When rainwater drains through hazardous waste in landfill, it creates a toxic liquid called leachate that may contaminate groundwater and endanger human health. In addition, municipal sewage treatment plants receive unknown quantities of hazardous wastes. Much of the hazardous waste entering treatment plants remains hazardous after being discharged into a river or

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[1] "How Much Unregulated Hazardous Waste," Biocycle Magazine, April, 1990.

lake, because these plants are not designed to treat most hazardous chemicals (nor are homeowner's septic tanks).

A 1988 Texas A&M study found that at least 113 different toxics drain through municipal landfills, including 32 that cause cancer, 13 that cause birth defects and 22 that cause genetic damage. Compared to hazardous waste landfills (including the one in Love Canal, N.Y.), the runoff was just as toxic, the study concluded. New, state-of-the-art, lined landfills are designed to capture leachate, but are not foolproof. Flaws in design and construction, adverse weather conditions and chemical attack can all cause the liner to breech, according to the Environmental Protection Agency (EPA). Both the EPA and the landfill industry concede that lined landfills will eventually leak.

Although improper disposal of hazardous waste can have damaging consequences, it can be minimized or avoided. Small businesses generating similar kinds of waste can share information and ideas about ways to further reduce toxic use and properly manage residues. In the home, toxic use can be reduced and sometimes avoided by using alternatives that are often safer and cheaper. Ask your solid waste region or district or county health department for a list of non-hazardous alternatives. If consumers don't purchase hazardous chemicals, manufacturers won't make as much, and the leftover quantities needing disposal will decrease.

An excellent example of a safer alternative is to substitute latex paint in place of oil based paint. After waste oil, paints make up the largest quantities of liquids generated by households entering landfills. Compared to oil-based paints, (water based) latex has considerably less impact on the environment. There are only a few instances where latex is not a good substitute for oil based paint, and your paint retailers can provide the necessary information. Where there are no alternatives, buy only what you need, and use it up. Rather than throwing leftovers out, give what is left to a friend or neighbor, or save for proper disposal.

At present, there are few convenient ways to safely dispose of the majority of these wastes inexpensively. We realize that we can't say "don't do this" without presenting a reasonable alternative. However, there are opportunities to plan and develop programs for both the short and long term, but require public input to be successful.

Alternatives have been springing up all over the country. Beginning in 1979, a simple brochure entitled "Toxic Substances in Your Home" was credited with prompting citizens to start a toxic-cleanup movement in Seattle. With over 2,000 clean-up programs held over past ten years without any lawsuits being filed, unregulated hazardous waste management programs are seen by many as a responsibility that can be safely implemented.

Closer to home, Vermont's first Paint Drop and Swap was

held last September in Montpelier with over 500 Central Vermont residents bringing 1500 gallons of paint that was handled by over 50 volunteers. About half of the paint was useable (around 750 gallons), and was bulked by Sherwin-Williams for distribution to area schools, community organizations, and theatre groups. A number of HHW Collection Days, Paint Drop and Swaps, and educational awareness events are scheduled to occur in Vermont this spring. In addition, several communities are planning permanent acceptance centers for unregulated hazardous waste. One of the main objectives behind these programs is to get past people's basic anxieties and demonstrate that proper management of hazardous waste does not present a problem to the community; it's the mismangement of these wastes that presents the problem.

The bargain our modern society has struck in exchange for convenience and consumer comfort requires re-evaluation in light of new evidence presented by a number of studies. Over the past 40 years, we've substituted toxic products for non-toxic ones, but we have continued to use the old technology for disposal. New liner technology is a step in the right direction, but isn't a cure-all. Instead of continuing with the "out of sight, out of mind" phenomenon, we need long term comprehensive solutions. By cleaning up the wastestream, we can further minimize the risk of groundwater contamination and leave a cleaner environment for future generations.

HOW MUCH UNREGULATED HAZARDOUS WASTE?

THE NUMBER of small businesses in Vermont generating under 100 kg (220 lbs.) of hazardous waste may be more than double current estimates. A study done by the Environmental Law Foundation for the Central Vermont Regional Planning Commission (CVRPC) identified some 658 small quantity generators (SQG) in Central Vermont, compared with 151 such generators presently on file with the Vermont Agency of Natural Resources. Under current Federal and state guidelines, these businesses are exempt from many of the regulations governing disposal of larger amounts of hazardous waste. Although approximately half the small quantity generators in Vermont are believed to use acceptable methods of hazardous waste disposal, it is unknown how much of this waste actually enters local landfills.

"Disposal of hazardous wastes in unlined landfills presents a serious threat to human health and the environment by contaminating ground water, soil, and surface waters," according to the Central Vermont study. And even lined landfills may not be safe. A 1988 report, "Compatibility of Flexible Membrane Liners and Municipal Solid Waste Leachates" (EPA, 68-03-3413), notes that when small quantity generators and households use lined landfills for hazardous waste disposal, the integrity of liners becomes questionable over time.

The small businesses studied, ranging from auto dealers and machine shops to funeral parlors and photography labs, produce in excess of 725 tons of hazardous waste per year in the district. The survey did not include farms, schools or government entities. Byproducts generated include waste oils (393 tons per year), solvents and degreasers (199 tpy), antifreeze (70 tpy), paint thinner (50 tpy), and photographic chemicals (13 tpy). Data on paint residues, lead-acid batteries, corrosives, pesticides and printing ink wastes were not available and so were not taken into account. Extrapolated statewide, these figures indicate production of over 5,000 tons per year of hazardous waste from small quantity generators, compared to the 2,000 tons for SQG estimated in the state's recent report to the legislature.

A new Vermont study focusing on small quantity generators of wastes such as cleaning compounds, used oil, paint thinner, and antifreeze reveals larger amounts and a need for education.

"We think the study shows the scale of the unregulated hazardous waste problem," says Michael Bender, a Solid Waste Planner with CVRPC. "We hoped to alert the state to reexamine their own data and see if this study applies to the rest of Vermont as we think it does."

Another finding in the CVRPC study is lack of understanding on the part of many small businesses interviewed as to which substances they use are hazardous to the environment and why. "The major recommendations focus primarily on developing educational and management programs with area small businesses," says Bender. "We want to extend our hand and give the small business community the lead time that they'll need to help us keep volatile organics and other unregulated hazardous waste out of landfills."

On March 2, the Natural Resources and Energy Committee released a Bill in Vermont's House of Representatives dealing with a range of hazardous waste concerns. One section stipulates that regional and solid waste management districts include a component for the management of unregulated hazardous wastes in their plans by July, 1991. Funds also would be made available to survey small quantity generators in all regions or districts of the state. Before becoming law the Bill (H733) must pass votes in both the full House and the State Senate. D.R. ■

DEGRADABLE PLASTICS
AN ILLINOIS TOOL WORKS PERSPECTIVE

Fred A. Kish
ITW Technology Center

Presented at the

First U.S. Conference on Municipal Solid Waste Management

June 13-16, 1990

DEGRADABLE PLASTICS
AN ILLINOIS TOOL WORKS INC. PERSPECTIVE

The return of the errant barge, MOBRO, to Islip combined with the US EPA's premature closing of several hundred landfills and several other factors, seemed to have sparked a resurgence in the media's and, in turn, the public's interest in solid waste disposal and identifying it as a "crisis."

For two years now, the media, the Congress, multiple federal agencies, some 7,500 state legislators and innumerable state regulators have pursued several avenues for addressing this issue and inherent problems. A review of the plethora of legislation offered as solutions clearly places both the blame for this situation and the responsibility for its resolution on the shoulders of the private sector, particularly packaging manufacturers.

Industry has been prodded, pulled, and punched into taking actions that it might not otherwise have ever taken. In some cases, these actions have resulted in benefits. In others, the commitment and expenditure of resources has, in some cases, been wasted.

It is a common public perception that industry can simply push a button, alter feedstocks or spend a few dollars to affect change. Critics accuse us of being recalcitrant and myopic. However, as many in this room can probably attest, such changes require time, effort, and investment without any guarantee of return.

My presentation today is intended to provide you with a look at how a corporation responds to these accusations and challenges.

ITW has been asked to participate in this session to discuss our response to calls for the application of degradable enhancing technologies to our plastic packaging products. For purposes of this discussion today we will focus on four of these products: the Hi-Cone carrier, the Minigrip resealable bag Mima stretch film and Signode's Contrax strapping.

Illinois Tool Works Inc. is a Chicago-based international manufacturer of industrial components and packaging systems with 1989 sales of $2.2b. ITW is a very decentralized organization with some 70 operating divisions utilizing some 120 facilities in twenty-five states. The Company employs approximately 15,000 men and women in the United States and 30 countries. There is little you might buy in a store that bears our name; but there is little you come in contact with on a daily basis that has not been touched by ITW. Our history of responding to environmental challenges can be traced back some 20 years.

In the early 1960's ITW introduced a revolutionary means of multi-packaging beverage cans with a 20 mil sheet of polyethylene full of holes. This product, known today as "Hi-Cone Carrier" represented a significant decrease in the amount of material used to package these cans, as well as providing bottlers and consumers with a significant cost savings. Soon after the introduction of this product, ITW determined the carrier, along with its competition, was likely to be littered. In an effort to mitigate the effects of

improper disposal which, at than time, were limited to aesthetic degradation, ITW initiated a search to enhance the degradability of the polyethylene. By 1972, Hi-Cone introduced its ECO carrier, 5 years ahead of any state law requiring devices and materials used to multi-pack beverage cans to be degradable.

Of late, particularly in light of the data presented by the Center for Marine Conservation, Defenders of Wildlife and other responsible environmental advocacy organizations along with that proffered by NOAA, the National Marine Fisheries Service and the EPA, ITW has become increasingly sensitive to the possibility of its products being improperly disposed in the marine environment. Though none have been specifically identified, generic references to strapping, sandwich bags and film cause us concern.

In early 1988, the ITW Technology Center embarked on a program to identify products likely to be discarded or found in the marine environment and to determine the efficacy of applying any of the commercially available and developing plastic technologies intended to enhance the degradability of these products. Our goal was to develop products which would degrade in a fashion as to maintain integrity for the useful life of the product then degrade in the environment in a timely yet somewhat predictable manner.

In examining the environment where these products were likely to be found and pose a danger to wildlife, it became very clear to us that in order to address the issue of litter and animal entrapment, the solution to the problem lay in a photodegradable material. Currently all products which are

considered enhanced degradable and produced by ITW utilize proven photodegradable material.

At the outset, let me say all plastics degrade. Furthermore, everything degrades. However, the rate at which products degrade is the subject of this discussion. If we look at degradation rates, plastics, per se, are considered very stable elements of our material society. For a plastic to change its characteristics upon exposure to the environment, depending upon a variety of factors, lifetimes fall anywhere from 1 to 30 years. You have seen published comment or have heard that plastics take 400 years to degrade. Well, that's quite a supposition since plastics have only been around with us for some 80 or 90 years.

Today, when one talks about degradable plastics, one implies an accelerated rate of degradation, typically thought of in terms of months or years. This is an area which is fraught with difficulties where legislators, regulators, environmental advocates and even plastics engineers are trying to define "acceptable degradation." The school of thought you associate with, your industry, your product mix and/or the side of the fence you choose to sit on influences your definition of degradation.

Further complicating the issue of enhanced degradability and degradability mandates is the fact that there are multiple technologies and methods to achieve degradation. As was noted earlier, ITW has concentrated its efforts in applying enhanced photodegradable traits to selected products. For the record, however, there are other types of degradation of materials

which are talked about by various industry groups, namely chemical and biodegradation.

What is photodegradation? Photodegradation is the mechanism wherein a plastic material when exposed to sunlight disintegrates. Disintegrate per Webster, is "to break up, to crumble into pieces, to be resolved into elements, a gradual breaking up". That is in our case when exposed to the elements of sunlight.

Each and every polymeric system includes an antioxidant and/or stabilizer package for converting this material into a finished product. The antioxidant and stabilizer are, often times, unique to the polymeric system so that what works in one will not work in another. Also, that which is necessary in one grade to be utilized on a given piece of equipment will be different than that utilized in a very similar material but processed on a different kind of equipment.

If one accepts the premise that all plastics are, without antioxidants or stabilizers, naturally degradable, albeit very slow, enhancing their degradability requires the addition of an accelerator(s). These are materials which are being investigated to see if they can enhance the degradability of materials via various chemical reactions which are possible under a select set of circumstances.

For example, processing history affects the degradation rate of a given material and/or product. For example, if a material is processed at 100 lbs. per hour it requires a certain accelerator additive package as well as the product will have certain categories, certain characteristics

associated with it representing the slow speed at which this product has been formed. However, if a similar product is formed at 5,000 lbs. per hour, which is not uncommon, it will require different resin characteristics to take care of the increased processing speeds (which are usually carried out at a much higher temperature). Therefore, the product produced, while physically appearing the same, may have different chemical sensitivities.

Second, the degradation of a product in any environment is highly dependant upon the overall physical nature of the product. A thin product obviously will degrade at a much faster rate overall, than a thick product. This is because the surface to volume ratio of a thin product is much greater than any thick product. So the overall bulk changes in properties of the material are much greater given a equal percent degradation rate.

Third, there are other characteristics which are unique to a given set of processing parameters. How material is processed can effect the internal strains and stresses in a product which can have orders of magnitude effects upon how a product will ultimately degrade.

Aside from material characteristics, the other, though probably the most variable factor which effects degradation of a given material, is the environment to which it is exposed. There are two basic constituents of the environment which have an impact upon photodegradation. The first being time and the second, location.

When we consider time, we must ask, "At what time of year is the product being exposed to the environment?". For example, summers are hot and winters are cold, summers are sunny and winters are dreary, summer days are longer and shorter in the winter. We know from data produced from a variety of sources, the amount of ultra violet radiation available to affect photodegradation varies with the weather. Within the time component, we have to consider the duration of exposure. We have other factors to take into account: location (latitude and longitude), temperature, humidity and physical forces in the vicinity.

Overall ITW has internally established a criteria that we use to judge degradation -- performance. Performance of the product under a given set of circumstances where the product will stand up to the riggers of its useful life and then, if carelessly disposed, will not become a detriment to the environment.

In most cases we consider a product to be fully degraded when it has reached an absolute level of elongation where embrittlement occurs and the product no longer performs its intended purpose. Furthermore, as the product reaches ultimate elongation, a little mechanical action causes the product to break into smaller particles where it can no longer be considered litter nor possess enough strength such that it can endanger animal life through entrapment.

We have carried this philosophy through and applied photodegradation technologies to four different of products: the Hi-Cone's carrier, Signode's Contrax strapping, Minigrip's bags and Mima's stretch wrap film.

For the Hi-Cone ECO carrier we have developed proprietary resin system which is produced to our specifications by two major resin companies. This product has the inherent photodegradation mechanism built into the polymer chain. It is therefore very controllable, very reproducible and has been proven over the years to degrade within mandated parameters. It was developed in 1972, it has been produced on a commercial basis since approximately 1975. Currently, the majority of Hi-Cone's carriers are made with photodegradable ECO resin technology. It should be noted that Hi-Cone is not the only manufacturer of six-pack rings. However, the photodegradable carrier can be identified by the little diamond which is embossed on the carrier.

Attached for your information is a chart identifying those states that have enacted laws to require connecting devices and material to be degradable. Also, in 1988, the Congress enacted PL 100-556 which requires all manufacturers of plastic ring devices to use only degradable material in their production. The EPA is in the process of proposing rules to implement and enforce this statute. This statute, by the way, does not preempt more restrictive state laws.

Signode's photodegradable Contrax (polypropylene) strapping has only recently been made commercially available. Like the Hi-Cone ECO carrier, the additive system utilized in the manufacture of the degradable version of Contrax is proprietary. The reason for going this route was that we could not technologically incorporate, as we did with the ECO carrier, the photodegradable sensitive material directly into the polymer backbone. This product represents the

culmination of two years of rigorous and lengthy experiments and testing of the product, both internally and externally, to verify that we indeed had a product which would meet our criteria for degradation. Again, criteria for degradation is product performance. The target here was to develop a material which would degrade at rates comparative to those of the Hi-Cone ECO carrier after exposure to similar environmental conditions. Currently this material is available from Signode on an as needed basis.

ITW Minigrip has initiated a program to develop a degradable resealable bag. After nearly eighteen months of work and experimentation with a variety of resin formulations, we have concluded, for a variety of reasons, that a photodegradable bag provides us with the best properties both as a product and in its afterlife. It appears the ECO system, when applied to our manufacturing processes, will also meet our degradation criteria; that is, similar to that of the Hi-Cone carrier. As was noted earlier, the thickness of the product governs its degradation rate to a very large extent. The Hi-Cone carrier is anywhere from 4 to 16 times thicker than a typical Minigrip resealable bag. We therefore must still determine formulation consistency and characteristics so the product can routinely provide uniform degradation when exposed to environments similar to that as seen by the Hi-Cone carrier.

Mima stretch wrap film is a little different animal. First of all, it is a linear low density based material with the inherent characteristic, because of the thinness, of being photodegradable. Typical maximum thicknesses of this product is < 1 mil. However, in end use applications, prior to its application to a palletized load, it is stretched some 200%

thereby reducing its thickness even further. Our tests have shown, upon exposure to UV, under a variety of conditions, will completely photodegrade within 4 months, regardless of the time of the year.

In summary, ITW and "why degradables" - we got into them because of the likelihood of improper disposal, potential harm to the aesthetic and marine environment, animal entrapment and our experience with legislative backlash. Though we expect customers and downstream users of these products to be cognizant of the effects their improper disposal can have on the environment, we nonetheless, also expect some to find their way into parks and coastal waters. In an effort to mitigate the consequences of someone else's irresponsible actions and our fear of "shoot from the hip" governmental backlash, we chose to anticipate rather than wait.

Now, many here today are curious about the effect degradable plastics will have on the municipal solid waste stream. Well, I have given you a story as to why we offer our customers degradable enhanced products, and why we feel they are beneficial in limited markets. We do not, by any means, believe degradable plastics are the answer to the need to better manage our solid waste. ITW's position continues to be that there are appropriate, albeit limited, applications for proven degradable plastics. Over the years, there has been an ongoing effort to learn more about enhanced degradable plastics and to develop technologies that can be proven and where the testing can be replicated. ITW encourages this work and will continue to work with all who are involved in this process.

ITW's position on the question of proper solid waste management, though we are probably the worlds largest producer of proven degradable plastic products, is recycling.

Surely, everyone here has herd that degradable plastics contaminate the recycling process. While I cannot speak to so-call biodegradable or chemodegradable technologies, I can address the question as it relates to photodegradable plastics. The accusation is simply and clearly **false.** We will stand by our position that the ECO resin is recyclable.

To begin with, when we sell the Hi-Cone ECO carrier to a customer, we are, in a sense, selling holes. If you look at this product and remember that we are extruding it in sheet form, punching out the part that will not be used and then selling a skeleton, we have an awful lot of material which has to be in-plant recycled. Typically, 70% of the material that is extruded winds up getting reused within the plant. However, we do not consider this recycling in the sense that it has an effect upon municipal solid waste.

In order to demonstrate the recyclability of the ECO carrier, we have launched two demonstration projects. In one, several Coca Cola bottlers in New England and Wisconsin have begun returning carriers from their vending routes where they would otherwise be discarded. These carriers have been processed back into new carriers with no indication of integrity loss. In the other, the Naperville (IL)Area Recycling Center, which operates a voluntary curbside program for some 12,000 households, has included the carrier among the materials they will accept for collection. For this project, the ITW Technology Center is developing technology to separate, clean

and reprocess this material into a form that, when mixed with virgin ECO, can be used in the manufacture of new carriers.

Recycling is not new to ITW. Nearly 4 years ago, in an effort to cut costs, ITW Signode, the world's largest manufacturer of steel and plastic strapping and the attendant application systems, began to experiment with alternate feedstock for our polyester strapping lines.

Today, Signode is the nation's second largest user of post-consumer soda bottles. In light of the problems inherent in the supply side of this material, Signode is expanding its roll in the recycling of this material to include material sourcing, secondary processing and enhancement of the material for its own use.

Other ITW units such as Plastiglide, Extruded Products, High Performance Plastics, Mima, Minigrip and Buildex have all commenced research on using post-consumer material as feedstock, retrieving their own materials from the waste stream or identifying post-consumer markets for the material. However, as is the case for most everybody, a major stumbling block for these and other ITW units is the lack of expansive collection programs and secondary processing capability in the United States.

Finally, ITW, as the world's largest producer of products which have enhanced photodegradability in them, believe that there is a market to be served and a need for these products in the market place. However, we feel that this is a very limited market, and must be judged very carefully on its very specific needs prior to rushing whole heartedly into

degradable plastics. Secondly, the materials we are using, we believe and have demonstrated that the biggest volume product that we use is recyclable, and has no detrimental effect upon the current recycling stream.

Thirdly, as we further expand our recycling of our degradable materials, we will expand this to other degradable materials in our line, so as to provide for a continuous loop of these products and provide for a better environment. Lastly, we feel that recycling is the best way to go for a majority if not 99.9% of the plastics that are currently being used in this country to have their most beneficial effect upon the reduction of municipal solid waste and its disposal problems.

Thank you.

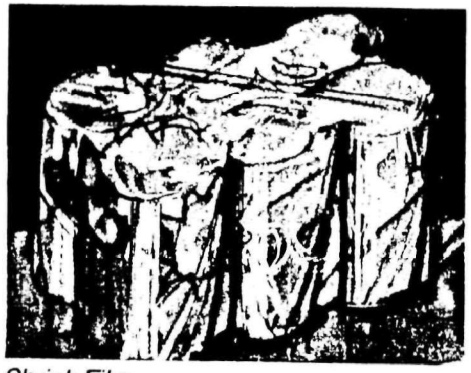
STATE LAWS REQUIRING DEGRADABLE CONNECTING DEVICES

Effective Date	State	* Type of Device	Coverage
1/1/77	Vermont	"plastic rings or similar devices"	All containers
1/1/78	Maine	"plastic rings or other plastic holding device"	All containers
9/1/78	Oregon	"plastic rings or other material"	Metal beverage containers
10/1/81	Alaska	"plastic rings or similar plastic devices"	Beverage containers
11/1/82	California	"plastic rings or similar plastic devices with holes more than 1 and ½ inches"	Beverage containers
1/15/83	Delaware	"plastic rings or similar devices"	All containers
1/17/83	Massachusetts	"plastic rings or any other device or material"	All containers
9/12/83	New York	"device constructed of plastic"	All containers
10/1/84	Connecticut	"device constructed of plastic rings or material"	Beverage containers
4/21/86	New Jersey	"device made of plastic"	Metal beverage containers
7/1/87	Rhode Island	"any device constructed of plastic"	Beverage containers
10/1/88	Pennsylvania	"plastic rings or similar plastic connectors"	Beverage containers
1/1/89	Minnesota	"polyethylene beverage rings or plastic material"	All containers
6/1/89	Michigan	"device constructed of plastic rings"	All containers
7/1/89	Florida	"device constructed of plastic rings or any other device"	All containers
7/1/89	Iowa	"device constructed of a material which is not biodegradable or photodegradable"	Beverage containers
7/1/89	North Dakota	"plastic rings"	All containers
1/1/90	Wisconsin	"device constructed of a material which does not decompose by photodegradation or biodegradation"	Beverage containers
1/1/90	Hawaii	"plastic connecting devices"	All containers
1/1/91	Missouri	"plastic rings or other plastic holding devices"	All containers
1/1/90	North Carolina	"yoke or ring-type holding device"	All containers
1/1/91	Nebraska	"device constructed of a material which is not biodegradable or photodegradable"	Beverage containers
1/1/91	Louisiana	"plastic rings"	All containers
1/1/91	South Dakota	"device constructed of material that is not biodegradable or photodegradable"	Beverage containers

Excerpted from state laws

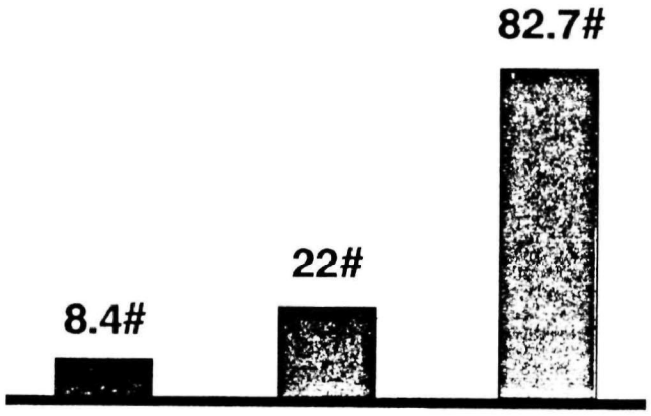
ITW Hi-Cone ECO® Carriers
Effective Solid Waste Management

Hi-Cone ECO Carrier



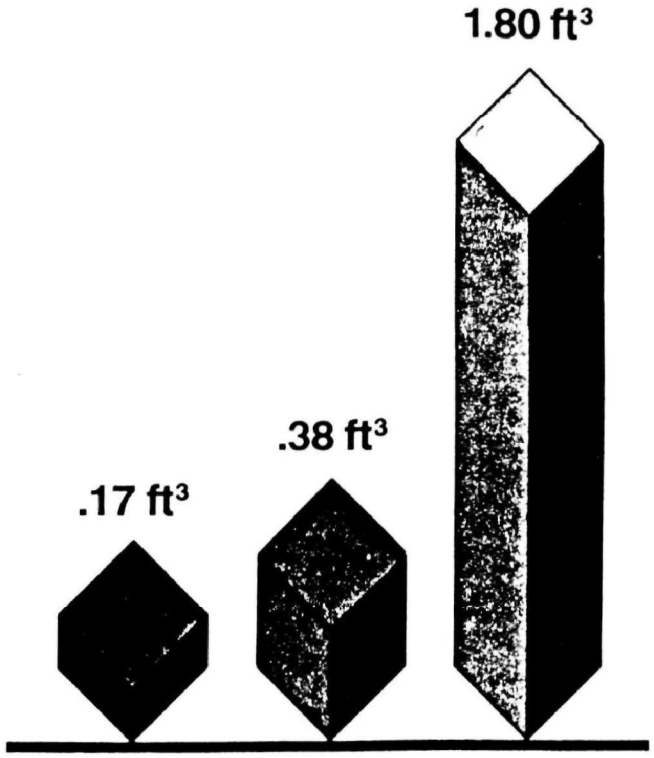
Shrink Film

Paperboard



Weight: Amount of packaging necessary for 1000 6-Packs of 12 oz. cans

ECO | Shrink Film | Paper-board



Volume: Amount of packaging necessary for 1000 6-Packs of 12 oz. cans

ECO | Shrink Film | Paper-board

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ITW Hi-Cone

FLORIDA'S REGULATORY REQUIREMENTS FOR DEGRADABLE MATERIALS

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Presented at the

First U.S. Conference on Municipal Solid Waste Management

June 13-16, 1990

I. Overview of the 1988 Solid Waste Act and Degradability Requirements

A. Florida's 1988 Solid Waste Act is the most comprehensive solid waste legislation in the country.

2. The Wall Street Journal called the Act, "the most ambitious attack on solid waste yet attempted in any state."

3. In the February edition of Waste Age, Pete Grogan said Florida's Solid Waste Act is "perhaps the boldest mandatory state recycling legislation to date."

4. An overall 30% recycling rate must be achieved by the end of 1994.

5. Over 50% of the aluminum cans, glass, newspaper, and plastic bottles sold in the state must be recycled by 1992.

6. Six grant and two award programs were established by the Act with $30 million appropriated for recycling, recycling education, innovative recycling projects, used oil management, waste tire management, and litter control.

7. The Act also includes major provisions addressing the management of special wastes, training, education, research and development, and several other areas.

B. Litter is a key Florida concern.

1. Trash on the roadsides and beaches are major problems.

2. Wildlife entanglement and harm from litter are a growing public concern.

C. Litter receives major emphasis in the Solid Waste Act by:

1. The creation of the Clean Florida Commission which is responsible for coordinating statewide litter prevention program;

2. The creation of Keep Florida Beautiful, Inc., a nonprofit grassroots organization;

3. Grants for litter prevention programs and public awareness; and

4. New and tougher litter control laws.

D. The Solid Waste Act prohibits packaging that is considered to be litter, health, wildlife entanglement and pollution problems:

1. Beverage containers with detachable metal rings (pop tops);

2. Containers made with fully halogenated chlorofluorocarbons;

3. Plastic ring connectors and similar devices unless they will degrade in 120 days;

4. Polystyrene foam and plastic coated paper products used in conjunction with food unless they will degrade in 12 months; and

5. Plastic retail bags unless they will degrade in 120 days.

E. In summary, the SWA is a comprehensive legislative package in which degradability plays a role in litter control and wildlife protection. The Department does not view degradability as a solution to the landfill crisis.

F. Due to the controversial nature of degradability and the lack of uniform standards, the Department developed a rule on degradable materials.

II. Development of the Degradable Materials Rule

A. The first step was to determine if there were any existing standards.

1. States with degradable requirements were contacted.

2. DER met with over twenty industry representatives and talked to many more by phone.

3. We obtained reports from federal agencies (EPA and GAO).

4. Research data from universities was reviewed.

5. The American Society for Testing and Materials was contacted and it was from ASTM members that we received most of the technical assistance.

B. Next, the major issues were addressed and policy decisions were made.

1. The legislative intent of the degradable requirements was determined to be litter, wildlife protection, or both.

   a. We were unable to find litter data that differentiated between different kinds of plastic products.

   b. However, the legislature had clearly targeted litter prone items.

2. Three types of testing would be performed on end products (rather than additives):

   a. An exposure test to simulate outdoor element;

   b. A rate of degradation test to measure change in a physical or chemical property during exposure; and

   c. Toxicity tests to detect toxic compounds that might be released during degradation.

3. A number of product specific decisions were made including:

   a. Which container connector devices must be degradable;

   b. Definition of retail bag; and

   c. Definition of "certified as safe by FDA" and "available in commercial quantities".

C. The rulemaking schedule was as follows:

1. The first draft was available May 1989;

2. A technical panel reviewed the first draft in June 1989;

3. Two public workshops were held in July and September 1989;

4. The Environmental Regulation Commission adopted the rule in Nov. 1989;

5. The final draft was available in Dec. 1989; and

6. The rule went into effect in Jan. 1990.

III. Requirements of the Degradable Materials Rule, Chapter 17-707, Florida Administrative Code

A. The intent of the rule, is to implement the law and to establish standards and criteria by which materials are determined degradable.

B. The rule defines "ASTM", "brittle point", "degradable" (statutory), "heavy metals", "photodegradable plastic", "polyolefins", and "retail outlet" (statutory).

C. The following test criteria apply to the degradability of polyolefins (ring connectors and bags):

1. Shall be exposed to ultraviolet radiation according to one of four ASTM test standards; and

2. After exposure must reach the brittle point (0-5% elongation) as demonstrated by an ASTM standard test method.

D. General test criteria are also included for demonstrating the degradability of other materials (PS foam, plastic coated paper, etc.). While specific tests aren't required, test data must demonstrate a relationship between the rate of degradation and a physical property of the material.

C. The rule includes test criteria for toxicity.

1. For heavy metals manufacturers can choose between one of the following options:

a. Performing an extraction procedure (EP) Toxicity Test; or

b. Certifying that the product has not been formulated with heavy metals.

2. To detect unknown toxic compounds a chronic toxicity bioassay test must be performed on the components remaining after degradation.

D. The rule contains general criteria for test samples.

1. Test samples must be representative of the final product and contain same base polymer, pigments, printing inks and additives.

2. Certain conditions and exemptions are included for example:

   a. The thickest part of the product is tested;

   b. Internal pigments are exempt from testing if they comprise 1% or less of the product by weight; and

   c. Printing inks are exempt from testing if they cover less than 25% of the surface area.

E. The remainder of the rule contains requirements specific to each product type.

III. Current Activities

A. In the past six months over 70 bag manufacturers and two container connector manufacturers have received temporary approval based on a temporary self certification process to use their products in Florida. In order to receive permanent approval, these manufacturers will have to submit the test data required by the rule.

B. Several companies are in the process of testing PS foam in an effort to start the clock on the legislative requirement to make the products degradable.

C. The Legislature is currently in session and while no new degradable requirements are expected, there are lobbying efforts to modify existing requirements.

IV. In Summary, Florida's degradability requirements are part of a statewide comprehensive solid waste management program. Degradability can be viewed as one answer to litter control and Florida's regulatory requirements reflect that point of view.

FOOD PACKAGING AND PLANNING FOR SOLID WASTE MANAGEMENT

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First U.S. Conference on Municipal Solid Waste Management

June 13-16, 1990

FOOD PACKAGING AND PLANNING FOR SOLID WASTE MANAGEMENT

I. Food Packaging

   A. Benefits to society

   B. Contribution to the nation's solid waste problem

   C. Role in solving the nation's solid waste problem

II. FDA and Food Packaging

   A. Federal Food, Drug and Cosmetic Act (FFDCA) and food safety considerations

   B. National Environmental Policy Act (NEPA) and environmental review of agency actions

III. Role of FDA in Solid Waste Management

   A. Use of recycled materials for food contact

      1. Paper

      2. Polymers

   B. Use of degradable polymers and degradation-enhancing adjuvants in contact with food

   C. Environmental review of new food-packaging materials and components for potential impact on solid waste management

IV. Environmental Review Process for Food Additive Petitions

   A. NEPA responsibilities

   B. Environmental review process

V. FDA's Current Approach to Considering Solid Waste Impacts in Environmental Review

   A. Effects on solid waste management strategies: source reduction, recycling, incineration, landfilling

   B. Effects may be beneficial or adverse

C. Effects may be significant or not significant

D. Consideration of disposal impacts is not a new development

E. Setting/context is new

F. Information we request from petitioner about a proposed food-packaging material varies depending on:

1. Market volume

2. Potential for being recycled

3. Potential for competition with and replacement of materials currently being recycled

4. Potential impact on incineration of solid waste

5. Potential impact on land disposal of solid waste

6. Degradability

VI. Hypothetical Examples of Information Requested from Petitioners Regarding Potential Solid Waste Impacts

A. Colorant used in rigid PET containers

B. New polymer that is recyclable

C. New polymer for use in rigid multilaminate containers

D. Chlorinated polymer that produces acid gases during incineration

E. Degradable polymer

VII. What FDA Does if Information Suggests There Are Potential Adverse Impacts

A. Try to mitigate adverse impacts.

B. Determine "significance" of potential impacts; threshold of significance.

C. If adverse impacts cannot be mitigated and are significant, prepare an environmental impact statement.

D. Balance environmental considerations with other factors in decision-making.

E. Relatively few petitions have potential solid waste considerations.

VII. Conclusions

A. FDA is committed to advancing recycling goals. We support the use of recycled resins in food provided that food safety is not compromised.

B. To fulfill its NEPA mandate, FDA must consider potential solid waste impacts for some petitions involving food packaging materials/components.

C. Premarket environmental review by FDA is one of many factors operating today that encourage manufacturers to consider solid waste management in design of packaging products.

LOCAL POLICY INITIATIVES: ENVIRONMENTALLY ACCEPTABLE PACKAGING

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Presented at the

First U.S. Conference on Municipal Solid Waste Management

June 13-16, 1990

LOCAL POLICY INITIATIVES:
ENVIRONMENTALLY ACCEPTABLE PACKAGING

On March 31, 1989 the Minneapolis City Council passed the Environmental Preservation: Environmentally Acceptable Packaging ordinance. This ordinance has been acclaimed as the most comprehensive local effort to regulate the fastest-growing component in the solid waste stream: product packaging. It is intended to make more than a statement; its purpose is to discharge local government's responsibility to manage solid waste in an environmentally and economically sound manner. While regulating packaging would be best handled at the federal level, the solid waste crisis faced by localities is urgent and we we cannot sit around and wait for direction from Washington.

Discarded packaging from foods and beverages constitutes a significant and growing portion of the municipal waste stream. Regulation of food and beverage packaging, therefore, is a necessary part of addressing the problem at the top end of the solid waste management hierarchy: source reduction, resue and recycling. Siting new disposal facilities is politically unpopular and frankly expensive. More sophisticated and technical means of landfilling and incinerating waste means higher costs for the consumer.

The "environmentally acceptable packaging" ordinance will have two major effects in Minneapolis. First, it will launch plastics recycling in our area as a shared public and private responsibility. Second by regulating the packaging of food and beverages in the city's food establishments, the ordinance will encourage packaging design which is more benign to the environment when discarded.

The ordinance targets the retail food industry within the City of Minneapolis by prohibiting food establishments from selling products in packaging that is not considered environmentally acceptable. "Environmentally acceptable" is defined by the ordinance as packaging which is:*

- returnable: "food or beverage containers or packages, such as, but not limited to, soft drink bottles and milk containers that are capable of being returned to the distributor, such as but not limited to dairies and soft drink bottlers, for reuse as the same food or beverage container use at least once;" or

- recyclable: "packaging made of materials that are separable from solid waste by the generator or during collection and which are currently designated for collection for recycling in an organized manner in a municipally approved program. Packaging made of either polyethylene terepthalate (PET) or high density polyethylene (HDPE) shall be considered to be recyclable if and when it is collected for recycling in teh same manner as here stated."

Exemptions were made in the ordinance for some types of packaging such as:

- flexible packaging of ten (10) mils or less in thickness unless disapproved by the commissioner*;

- packaging used at hospitals or nursing homes;

- paper, cellophane or other cellulose-based packaging that is coated with plastic;

- packaging which is not environmentally acceptable, but for which there is no commercially available alternative.

Industry responded to the ordinance on several fronts. First, a public campaign was launched to convince consumers that the ordinance would remove their favorite foods from the grocery shelves. These efforts backfired when the public responded strongly in affirmation of the ordinance, thus the public campaign was aborted. Efforts then turned to the Minnesota State legislature where lobbyists pressured legislators to apply a statewide preemption of local efforts to

* Originally "degradable" was included as an environmentally acceptable package but was amended to be an exemption to de-emphasize this item.

regulate packaging. A preemption amendment was added to a state recycling bill. However, when this bill was finally passed in the 1989 fall session, it included language which preserved the Minneapolis effort. As a third strategy to oppose the ordinance, industry representatives threatened to legally challenge the ordinance on the Constitutional grounds of undue limitations on interstate commerce. However, Minnesota has a history of tough packaging laws which have withstood constitutional challenge, so litigation has not occured, although the potential still exists.

The ordinance has prevailed and continues to be a key element of environmentally sensitive solid waste management efforts in Minneapolis. The ordinance created an Advisory Committee on Environmentally Acceptable Packaging with membership from local food retailers, plastics manufacturers, restaurant managers, local and national environmental groups, local governments and citizen's groups. This Advisory Committee served as the forum for creative ideas, discussions, challenges and solutions. Its charge was to determine what types of packaging were affected by the ordinance and how to achieve compliance. A final report was submitted to the City Council in January of 1990.

In the meantime, the Council for Solid Waste Solutions (CSWS) approached Hennepin County and Minneapolis to develop three plastic recycling pilot projects to help determine cost-effective approaches to recycling plastics. Plastic packaging which becomes part of the City's curbside recycling program will become "environmentally acceptable" under the terms of the ordinance. The pilot projects will be conducted for six months each beginning in April and May of 1990. A citywide recycling program based on the results of the pilot projects should be in place by January 1, 1991.

The first pilot will collect PET pop bottles and HDPE milk bottles; the second will collect all plastic bottles; and the third will collect all rigid plastics containers. CSWS has provided a viable market outlet for the plastic collected in the pilots as well as the equipment necessary for collection. They also developed promotional and education materials which were provided to households participating in the pilots. The City and CSWS will work cooperatively to secure a long-term commitment to the purchase and processing of the plastic containers that will be collected on a city-wide basis.

In order to facilitate proper monitoring and evaluation of the pilot projects the Minneapolis City Council amended the original ordinance to extend the effective date from July 1, 1990 to January 1, 1991. Additional amendments permitted the Commissioner of Health, who is charged with enforcing the ordinance, to issue temporary administrative exemptions to allow a phase-in of enforcement procedures. Upon the January 1, 1991 effective date, the Commissioner may issue the following <u>temporary</u> exemptions:

1) six months for product groups identified as producing very high volumes of solid waste. Product examples include: milk, carbonated beverages, ice cream/frozen desserts, yogurt and noncarbonated water.

2) nine months for product groups for which "environmentally acceptable packaging" is currently available. Examples include: pasta sauces, mustard, syrups, peanut butter, honey, coffee whiteners, preserves/oppings, edible oils, bouiloon/spices, vinegar, BBQ sauce, ketchup.

3) twelve months for product groups for which "environmentally acceptable packaging was used in the past and is still commercially available. Such products might include: individual serving containers and soft margarine.

4) twelve months for product groups for which there is a probable packaging alternative that is degradable. Examples include: cottage cheese, eggs, meat, whipped toppings, sour cream and substitutes, and produce trays.

5) twelve months for products used in the food service/deli industry. This includes products consumed on premises or off premises as well as those used for catering.

The Minneapolis City Council has directed the Commissioner of Health to develop detailed rules and regulations for the enforcement of the ordinance. Public comment on such rules will be sought at hearings to be conducted in the Fall of 1990.

The pilot recycling projects and an enforcement program are directly related. The more succssful and extensive the citywide plastic recycling program the more limited will be the scope of enforcement. One key reason the effective date was moved to Jaunary 1, 1991 was to allow these efforts to be more closely coordinated.

The success of a city-wide plastics recycling and regulation program will depend on the cooperative efforts of citizens, industry and governments. Dealing with plastics in the solid waste stream is a timely and worthwhile effort. Through source reduction, reuse and recycling, Minneapolis -- and other cities across the country -- can minimize landfilling and incineration problems. These goals -- and the costs that are incurred as we pursue them -- must be shared by public and private interests. Designing packaging and encouraging recycling and reuse are not just trendy; these efforts are critical to managing the solid waste crisis.

June 14, 1990
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Municipal Solid Waste Management:
Solutions for the 90's

MATERIALS USE POLICY -- IS THERE A NEED FOR A NATIONAL EFFORT?

I. INTRODUCTION

1. Greater recycling can only be accomplished through greater industrial use of recyclable materials.
2. Society is at a crossroads as to how it will use its material and energy resources and how it will produce goods and what goods it will consume.
3. Recycling is not just about landfill capacity and environmental harm from improper waste disposal -- it is about materials management, the efficient use of energy resources, industrial production, tax policy, the movement of goods and waste in commerce and virtually every product we purchase in our daily lives.
4. Recycling impacts industrial capacity and the competitiveness of our domestic industries.

a. The decrease in disposal capacity will eventually limit our ability to produce goods.

b. Conversely, the efficient use of energy and materials will make the U.S. more competitive, e.g., number 1 and 2 exports from Port of New York are scrapsteel and paper. Pacific Rim nations use recyclable materials as their raw material supply in

manufacturing because they are cheap materials and energy efficient, thus allowing them to make the same products as from virgin goods, only cheaper.

5. In short, the economics of recycling involve a conflict between a society that rewards consumption and a society that structures its laws to reward conservation and the efficient use of its materials and energy. If it is cheaper to waste, more waste will occur. If society rewards conservation and savings, then conservation and recycling will occur.

6. To make recycling an efficient economic activity, we must understand:

   a. Waste is expensive and the public has been shielded from this reality for too long;

   b. Easy solutions are gone; only difficult ones remain;

   c. Most of what the public thinks is recycling (source separation, collection, processing) is not recycling. Recycling occurs only when the processed material is reused to make a new product; and

   d. To make recycling work, you must create markets, and the only market is the industrial use of recyclable materials as its raw material supply in making new products and the commercial, governmental and consumer purchase of items made from recyclable materials. This can occur either by an increase in industrial capacity because more goods are being produced, thus, the utilization of more materials, or by the substitution of recyclable materials for virgin materials in the

industrial process. In the later case, the recyclable material is a substitute for the virgin material, and those industries that rely solely on virgin materials will be impacted.

II. EASY FORMULA, DIFFICULT TO IMPLEMENT

1. Barriers to recycling exist throughout public policy, including social attitudes that products made from recyclable materials are not as good as products made from virgin materials.
2. To increase levels of recycling, significant changes must occur in tax policy, disposal costs and the way the consumer perceives packaging.
3. In effect, to increase recycling, there must be a change in the market share in the use of industrial raw materials, or jump in new industrial capacity.
4. Many vested interests have a stake in the failure of recycling.
5. Change is possible, but it will be difficult.

III. HISTORICAL

1. Prior to 1975, little activity nationwide in the regulation of solid waste or recycling activities. All efforts were local. RCRA House Report discusses this issue.

2. RCRA -

a. EPA

i. Regulator, Government Procurement; and

ii. Tech Asst & Info, state plans, T.A. Panels

b. Commerce

3. DOE/NECPA

4. 1976-1988 -- 12 years of federal inaction made the problem worse and placed the entire burden on state and local government.

IV. RESULTS OF FEDERAL INACTION

1. Statistical

a. 78% of waste still is disposed in landfills;

b. This nation has lost a majority of its landfills in last ten years;

c. 75% of all existing landfills will close in next 15 years;

d. By year 2000, there will be a 56 million ton per year shortfall in disposal capacity;

e. This shortfall represents serious problems for this nation's industrial capacity, thereby driving local and state governments to enact product bans and taxes; and

f. Because states would not site new landfills and have had difficulty constructing and permitting new waste-to-energy facilities, they turned to recycling as something they thought they could sell to the public.

2. State activity: 2000 bills last session, more than on any other issue

   a. 6 states enacted mandatory recycling (all collection statutes);

   b. Landfill taxes;

   c. grants - limits;

   d. 26 states have preferential procurement laws for products made from recovered materials

      i. price preferences; and

      ii. quotas;

   e. tax incentives;

   f. packaging taxes & bans; and

   g. packaging referenda in Oregon and Massachusetts.

3. Recent Federal Activity

   a. EPA's Agenda for Action

      i. 25% recycling;

      ii. information distribution;

      iii. recycling council and planning; and

      iv. no new ideas;

   b. Congress

      i. 25% recycling/50% recycling goals;

      ii. required new state plans and if states do not enact plans then the federal government will and will bill the state;

      iii. little discussion of markets;

      iv. It will take the EPA three years to promulgate new regulations and the regulations will be subject to litigation for three years; and

v. Federal legislation will kill recycling for a decade.

c. Single biggest threat to recycling gains made by states is federal legislation that places new demands on states without any funding.

4. California - the Most Comprehensive Market Development Package

a. Mandatory minimum recycled content standards for newsprint sold in state.

b. Integrated waste management approach, including resource recovery, recycling, compost and market development activities.

c. Attempts to promote changes in manufacturing and consumption habits and to improve markets for recyclable materials.

i. created Source Reduction Advisory Commission;

ii. created Recycled Markets Development Commission (direct liaison with private manufacturing industries to promote increased utilization of recycled feedstock in manufacturing process;

iii. created market development zones;

iv. mandated government purchases in printing and writing paper, compost, plastics, retreaded tires and lead acid batteries;

v. technical assistance;

vi. plastic recycling assistance;

vii. assessment of costs of waste management options; and

viii. Office Paper Recovery Program.

d. Mandated state recycled paper purchase requirements (35% of the total dollar of paper purchases in 1992 must be of recycled paper and it will rise to 50% in 1996).

e. Tax credits ($250,000 limit).

f. Created markets for recycled oil by requiring state and local agencies to purchase lubricating and other petroleum products made from recycled oil.

g. Purchase of paving materials made from recycled materials.

h. Authorizes use of industrial development bonds to facilitate acquisition by private enterprises of property used to process or manufacture products made from recyclable materials.

i. Implementation of a "Buy-Recycled campaign" to encourage business, industry and consumers to purchase items made from recycled materials.

V. DEFICENCIES IN FEDERAL AND STATE RECYCLING LEGISLATION

1. Markets generally absent from discussion in most legislation. Government-based false belief that materials make markets. Compare CA market development

efforts with federal legislation which considers recycling to be the collection, separation & processing of materials for reuse. The federal legislation never addresses the reuse by industry of the reprocessed materials which is the market for recyclable material.

2. Quality requirements are absent from the legislation. In fact, in those states with mandatory recycling, the quality of recyclables actually decreased.
3. Failure to understand mills of the world are the markets. Consider the use of recycled materials by Pacific Rim nations and the impact of avoided costs on national competitiveness.
4. Tendency to displace private sector dealer network with government operation.
5. Failure to understand interrelationships of system: all states compete with each other for a limited market
   a. relationship between the export market of East/West coasts;
   b. How one state can displace another's recycled materials in the market place; and
   c. impacts if East Coast goes avoided costs.

VI. SUGGESTIONS TO CREATE MARKETS FOR RECYCLABLE MATERIALS

1. Kill the Myths, which are that:

a. Materials create markets;

b. Packaging bans and/or packaging taxes create markets (see Atlantic Monthly article on archaeological findings);

c. That easy solutions are available; or

d. The nation can recycle its way out of solid waste problem.

2. Mills are the markets for recyclable materials; therefore, the focus must be on mills using more recycled materials; conversely, there must be more demand for products made from such materials. To increase the use of recyclable materials by mills:

3. Let disposal costs rise -- benefits recycling, requires waste to pay the real cost;

4. Re-focus tax incentives;

5. Non-discrimination;

6. Minimum content requirements (Cal., Pa., Conn.);

7. Tax credits for new equipment for making recycled products; and

8. Government procurement 20% GNP, purchases 7% of all paper products; must get away from absolute terms, e.g. 50% post-consumer waste, and be more conscious of technology - maybe get 20% post-consumer waste or printer's waste. Lower quality standard, e.g. less brightness;

9. Let industry petition government.

10. States Must Act As Regions (Key to recycling as an industrial policy):

a. Uniform procurement requirements;

b. Create larger markets; and

c. Greater economic base to attract industry and to supply its needs.

11. Inventory:

States must know what the industries in its region need or can use; what materials the state can supply industry and it must meet industry's quality requirements. Government must understand industry.

12. Clean Japan Center -- A Prototype for Change and to provide technology transfer and act as a catalyst.

13. States/regions must take lead in siting new disposal and industrial capacity and must share burdens and benefits of this new capacity.

14. National Benefits From This Approach:

a. Energy and materials savings;

b. Costs less to build recycle plant than virgin plant;

c. More competitive internationally, e.g. Japan/Korea steel industry; scrap no. 1 export out of New York; and

d. extend landfill supply and create new capacity while creating new markets for recycled goods.

VII. CONCLUSION

Recycling as industrial policy will require many changes, but if we can undertake them, the nation will better manage its

resources and be more internationally competitive and recycling will be a cost-effective process.

PACKAGING FUNCTIONS AND SOURCE REDUCTION AND REUSE

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ABSTRACT

Packaging is recognized as a major component of the municipal solid waste stream. There is a perception that much of this packaging is not necessary and that there is therefore a substantial amount of packaging which could be removed from solid waste with ease, thereby reducing disposal problems. In fact, though significant reductions in packaging can be made, there are, in many cases, costs associated with these reductions which are not fully appreciated. These costs may include monetary costs associated with the package and its distribution, environmental costs other than solid waste, and impacts on lifestyle of consumers, among others. Evaluation of source reduction and reuse opportunities in packaging, to be accurate, must include these costs. An evaluation based on an understanding of the basic packaging functions served by the current packaging system will be more likely to include these hidden costs. A classification of packaging functions into protection, communication, and utility can be used as a guideline for selection of source reduction and reuse opportunities. Examples are presented.

I. Introduction

Current estimates of municipal solid waste generation in the United States put the total in excess of 180 million tons per year. Of this, packaging is the largest single category, accounting for about 31% by volume and 34% by weight (1,2). Therefore efforts to reduce solid waste generation and disposal requirements frequently target packaging as representing a large potential for source reduction, both because of its major contribution to waste, and also because of the perception that a substantial portion of the packaging we use is unnecessary, and can therefore be eliminated with relative ease.

In actuality, the situation is considerably more complex. There are examples where "excess packaging" can be reduced with few costs, but unfortunately the more common situation is that changes which reduce packaging have associated with them a variety of effects, some positive and some negative, whose costs are frequently not appreciated or evaluated. Recognition of real opportunities for source reduction must take into account these hidden costs, as well as the more obvious waste reduction benefits.

Evaluation of the true costs of changes in packaging can best be guided by an understanding of the functions the package system is designed to perform. While various authorities have promulgated long lists of packaging functions, they can all be accomodated by a classification

into three simple categories, protection, communication, and convenience, which can then be used to evaluate the effects of changes in design.

II. Packaging Functions

The protection function of packaging encompasses both protecting the product from the environment to which it is exposed, and protecting the environment from exposure to the product. It includes aspects as diverse as limiting the escape of carbon dioxide from a soft drink container, maintaining the oxygen and moisture levels within a food package, and protecting a computer from mechanical or electrostatic damage during transportation and handling. Furthermore, it includes protection aspects that at first thought are less evident, such as child-resistant features on aspirin, prescription drugs and other products to protect children (part of the environment) against harm from the product; and the oversize card on a tiny watch battery, to protect the product from harm resulting from shoplifting.

The communication function of packaging has a variety of aspects. It includes all the legally required information about a product, such as product and manufacturer identification, quantity of contents, required warnings, nutritional information, etc. It also includes the "buy-me" features of retail packages, such as bright colors, distinctive logos, recipe information, etc. Such information

as how to open the package, how to use the product, etc., are also part of the communication function.

The third packaging function is to provide convenience. This includes dispensing features, such as the flip-top cap on a tube of toothpaste, packages in a variety of sizes to suit consumer desires, packaging for ready-to-eat meals, etc. The convenience feature may be for the consumer, or for the retailer, the shipper, or some other user of the package. It includes such aspects as a cut-out hole in the package to provide for rack display, hand-holds for carrying, bundling of articles in convenient size groups, packages which hold several components which are commonly purchased and used together, etc.

It should be emphasized that the relative importance of each of these packaging functions is dependent on the product, the distribution system, and even the opinion of the person doing the ranking. Further, many packaging features perform more than one of these functions simultaneously.

III. Evaluation of Source Reduction Opportunities

We can now look within these basic functions for opportunities to identify excess packaging, or overpackaging - packaging which is not needed and can therefore be eliminated without loss. This excess packaging is, then, an obvious target for source reduction.

If more protection is provided for the product (or

environment) than is needed, this represents an opportunity for waste reduction. For example, one often hears a complaint like "I just bought a new TV and I had half a box of styrofoam to throw away!" Appropriate design of products for durability, design of packages for optimum protection, and accurate testing of products and packages to determine protection requirements and package performance, can result in selection of an appropriate degree of product protection without excessive packaging. There are at least three factors involved here, however, that complicate design for source reduction. One is our lack of knowledge about just what a product is likely to be exposed to and how damaging that exposure may be. Another is that even when the product's potential environment is well-understood, it is inherently variable - each individual product will be exposed to a somewhat different set of distribution environments. Therefore the manufacturer of that TV set had to make some estimates about the severity of the environment, and then had to package the products to survive something between the worst and the best of the expected conditions. In doing so, the manufacturer attempted to maximize profits by minimizing expenses, both those due to packaging and those due to package failure (product damage, loss of consumer good will, transportation costs for returned goods, etc.). For a costly product such as a television set, the product would be packaged to survive something close to the worst expected

conditions. Therefore in one sense most of the TV sets would be "overpackaged." For instance they may be packaged to survive a 20 inch drop when actually most of them were only exposed to a 15 inch drop or less. For a less costly product, more damage could be tolerated and therefore the package would not be as protective, hence there would be less "overpackaging." This type of "overpackaging" is necessary to the efficient functioning of our distribution systems, and therefore cannot be eliminated without increasing the costs of consumer goods. To be sure, there are cases where the proper balance between the amount and type of packaging and the distribution system has not been achieved, where there are opportunities for source reduction. It should be kept in mind that the product manufacturer has a vested interest in not using excess packaging, simply because it costs extra money. Therefore the normal industry tendencies towards cost-cutting and maximizing profits will usually result in this type of source reduction in the long run. In fact, changes of this type are frequently made, often without the consumer being aware of any changes. Plastic milk bottles, steel food cans, plastic bags, glass bottles, and many other packages are being made lighter, with thinner walls, than they used to have, thus conserving both resources and landfill space, while saving money for manufacturers.

The communication aspects of a package are, in general, more vulnerable than the protection aspects to charges of

excess packaging. It is easy to look at packages and say we do not need the bright colors, the fancy pictures, etc. However these aspects of the package rarely add significantly to the volume of packaging material to be disposed of. More significant is packaging designed to increase the space the product occupies, and hence its visibility. In a free enterprise system such as ours, with our self-service style of merchandising, a package that does not communicate effectively to the consumer is unlikely to survive in the marketplace. Therefore decisions that increase the amount of packaging and its cost, but increase sales to a greater extent, are economically sound decisions for the packager. Regulatory action or voluntary cooperation by industry is needed to achieve source reduction of this type. It should also be mentioned that costs are associated with failure of effective communication. Product misuse can lead not only to waste generation, but in some cases to serious detriment to the health and well-being of consumers or the general public. For example, it was a package communication failure that led to PBB being inadvertently mixed with cattle feed a number of years ago in Michigan, resulting in tremendous economic, social, and environmental costs.

The convenience aspects of packaging are also likely to yield examples of excess packaging. We can survive without dispensing caps and no-drip spouts, for instance. It is certainly true that much more packaging is used to contain ten

or so frozen microwave-ready roast beef dinners than to package a beef roast, a sack of potatoes, and some green beans. However, if we were to outlaw such packaging (and, thereby, at least sometimes such products), the consumer outcry would be enormous. As a society we demand convenience products, and we demonstrate this demand by our willingness to pay for that convenience with higher prices. In fact, instead of rebelling against such packaging, trend analysis shows our society is demanding more and more of it. We can live without many convenience features of packaging, but doing so may demand significant changes in lifestyle, changes which the majority of the population will probably not tolerate at the present time. Industry is, however, beginning to offer products which sacrifice some convenience with the goal of waste minimization. Laundry detergent in a refill pouch is currently in test market in the U.S. The user is expected to cut open the pouch and pour it into the previously purchased plastic bottle for dispensing and use. Significantly less material is required for the pouch than the bottle, but it is less convenient to use. This concept has had some success in Europe, but it remains to be seen whether it will work here. Convenience for users of the package other than the retail customer, such as that provided for merchants and transporters, often cannot be eliminated without adding significant costs. For example, a production facility which makes a large variety of sizes of products is likely to use

only a few standard sizes of corrugated boxes for product distribution. This can easily result in larger packages for some products than is actually required. However, stocking a larger variety of sizes of packages will require more warehouse space, a larger cost in handling this larger variety of sizes, and probably a larger purchase price for the boxes since each size will be purchased in smaller numbers.

IV. Reuseable Packaging

Reuseable packages can offer a large potential for reducing the volume of waste requiring disposal, but also illustrate some of the difficulties with, and costs of, translating these opportunities into action. In contrast to source reduction, packages designed to be reusable are generally larger and heavier than those designed to be disposed of after a single use. The extra strength is needed to provide adequate performance through multiple use cycles. This means, obviously, that there is a larger investment in material and in energy than in a disposable package, so if the package is not reused, there are environmental and economic losses, along with a larger contribution to solid waste.

Reuse of packages requires a reverse distribution system to be in place, to achieve the return of the containers. This results in energy expenditure along with economic costs. At least some cleaning of the containers will probably be necessary. For some types of packages, this cleaning will be

very extensive. Cleaning typically will involve the use of water and detergents, and will result in emission of detergent and product residues which will increase demands on sewage treatment systems. Reuse of packages involves significant loss in convenience compared to disposables. Implementing such systems and running them successfully can be blocked by resistance at any point along the reverse distribution channel. An inability to gain the cooperation of grocery retailers, for example, is reportedly the major factor in blocking the wider use of refillable plastic milk bottles. Failure of consumers to return refillable glass beverage bottles has been cited as the major factor in the slow demise of these containers (though the success of bottle deposit legislation calls this interpretation into question). Adoption of reuseable containers has been most successful for distribution packages, rather than retail packages, since the distribution channel is shorter and more controllable. The most success has been obtained where the ultimate destination of the distribution package is owned or at least partially controlled by the original packager, and therefore where the avoided cost of disposal can directly impact the decision to use a reuseable package (3).

IV. Other Environmental Impacts

It is important in evaluating the costs and benefits of source reduction and reuse opportunities to include

environmental impacts other than solid waste. Changes in packaging systems often have very widespread effects, which can be easy to overlook and very difficult to evaluate. Energy effects are those other than solid waste most likely to be evaluated. For example, a switch from disposable to refillable glass beverage containers will require more initial investment in energy for the refillable, but the equation will favor the refillable <u>if</u> (and only if) it is actually refilled some minimum number of times. Combining this information with the number of fills actually obtained will allow a conclusion to be drawn about which of these alternatives is the most energy efficient. However an evaluation of total environmental impact should also include, for example, the air emissions during manufacture of those containers. Here again the emissions will be larger originally for the heavier refillable, but will be less in total for the refillable if it achieves some minimum number of refills. Where the situation would get very complex is if, for instance, by an energy standard the obtainable refills were not enough to balance the initial excess energy cost, but by air emissions the refillable container was preferred. Then we are in the situation of somehow balancing air emissions with depletion of energy resources in determining overall environmental benefit. Of course, we should not leave solid waste considerations out of this equation, either. In practice, these comparisons can easily become even more complicated by adding in the potential

for switching from one material or combination of materials to another. Then in addition to solid waste amount and energy consumption, we may have to balance not only air emissions but the relative importance of different types of air emissions. We may have to try to balance depletion of relatively scarce natural resources with water pollution, soil erosion with energy use, etc., etc. The methodology for dealing with these life cycle issues of packaging is not yet well developed, and may always unavoidably contain a good deal of subjective judgment, yet these issues cannot be ignored if we wish to make decisions which are truly environmentally sound.

On a final note, good decisions about packages cannot be made independently from decisions about the products they contain. Just as environmental impacts encompass more than just solid waste, environmentally sound design encompasses both products and packages. Packages are designed to perform certain functions for the products they contain. Product design can place larger or smaller demands on packages. For instance, products which are more robust require less protection from packages. Both products and packages affect solid waste generation, as well as many other aspects of our environment. An environmentally sound approach to product design which encompasses but is not limited to environmentally sound packaging design would benefit us all.

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PLASTICS: PART OF THE SOLID WASTE SOLUTION

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I have been asked to provide the plastics industry's perspective on materials use policies. The plastics industry believes that plastics should be used whenever possible. Thank you.

Seriously, though, it is difficult to discuss materials use policies as the representative of a material rather than a particular product. But the question we're addressing today is the effectiveness of materials use policies as waste management practices, so let me share the experiences of the plastics industry with you.

As you are all, no doubt, aware, the plastics industry has taken a lot of heat on the solid waste issue. As Americans grow increasingly concerned about the environment, more and more consumers are willing to adopt materials use policies of their own. Far too many times, those policies come down to one thing: avoid plastics. But the consumer's reasoning is rarely based on factual information.

Consider: a shopper wanting to be environmentally conscious will probably choose a paper sack rather than plastic at the grocery store check-out line. But that paper sack, in my community at least, is not being recycled. It goes into a landfill -- where 80 to 85 percent of our waste still goes -- and takes up five times more space than its plastic alternative would have. That paper sack probably won't degrade during the working-life of the landfill.

My point here is that materials use policies are only as good as the information that goes into making them. You folks in the waste management industry have to remember that the vast majority of Americans -- including American policymakers -- never thought about solid waste management until a couple of years ago. But now we're running out of landfill space and everybody is running around trying to find waste management alternatives -- working from an information base that is incomplete, at best.

Consider the lack of information at the Federal agency responsible for much of our nation's environmental policies. The Department of Interior recently called for a halt to polystyrene use in its cafeterias and by concessionaires in the nation's park service, noting that polystyrene recycling is not yet widespread. But the alternatives to polystyrene -- you know what they are -- are not currently being recycled anywhere. And, again, those alternatives -- like all other materials -- do not degrade rapidly in a modern sanitary landfill.

So why did the Department of Interior ban polystyrene? Because it was politically necessary to take some kind of action, and polystyrene was a relatively easy target. The emergence of the quick-fix approach to solid waste management -- bans, degradability requirements and the like -- posed a real threat to our progress in developing an effective long-range approach to waste management.

The ban mentality undermines efforts to expand recycling. It produces no real waste management progress because it is based on public opinion research rather than scientific research. And it can have the effect of eliminating the best material for a given application.

With the tremendous emphasis being placed on the solid waste issue, it is easy to lose sight of the fact that disposal considerations are just one factor in the materials use decision process. Safety, durability, energy efficiency -- all of these must be considered, as well.

In 1988, concerned companies in the industry formed The Council for Solid Waste Solutions to address the role of plastics in the waste stream and stem the spread of the quick-fix mentality. But more than that, the Council was charged with taking a leadership role in developing long-term solutions to America's waste management needs, building on the EPA's four-part approach to solid waste management: source reduction, recycling, waste-to-energy incineration and landfilling.

The Council's Government Affairs Department works to rally legislative support for this integrated approach. Our Technical Department develops the technology to back it up. And our Communications Department is working to make sure the public understands and is ready to participate in integrated waste management.

But we know that recycling is where we need to put our work. Plastics recycling has to happen now and it has to happen fast. Therefore, our primary goal is to make plastics the most recycled material -- by application -- by the year 2000.

We understand that all the good intentions in the world aren't going to make recycling work unless there is a marketable use for recycled materials. That means our industry needs to make it a policy to use recycled materials whenever possible, and to help others use them, as well.

Fortunately, plastics are a particularly versatile family of materials and, therefore, a wide variety of markets already exist for recycled plastic resins. The Council's member companies are in the forefront of this effort and their research and development departments are committed to finding new ways to incorporate recycled plastics into their products. Procter & Gamble, for example, uses recycled plastic in their Spic 'n' Span Pine bottles and in many of their detergent bottles.

PET, the type of plastic used in soft drink bottles, and high density polyethylene, used in milk and juice jugs, are in high demand as recycled resins in making a variety of other products, as well. Carpets are being made from soft drink bottles, trash cans from milk jugs and office products from recycled polystyrene foam, to list just a few examples.

As more and more manufacturers appreciate the cost benefits of using recycled plastic resins as a feedstock, the variety of recycled-content plastics products will continue to expand. Manufacturers are also beginning to recognize the marketing appeal of recycled-content products.

The plastics industry believes it can assist in developing those markets in two ways. First, we can help identify potential markets for recycled plastics. Second, we can work to improve plastics recycling technology at all steps in the process -- from collection to end-use -- to improve cost-efficiency.

The Council is therefore working to develop a framework for the plastics industry's recycling efforts -- a blueprint, if you will -- piecing together the progress that has already been made in order to identify what has yet to be done. We expect to have our Blueprint completed this summer, and we will share what we have learned with all communities and entrepreneurs interested in taking part in plastics recycling.

Already, we have identified certain barriers that will benefit from the industry's technical expertise. For example, it is clear that plastic containers have a comparatively low weight-to-volume ratio -- which can result in higher collection costs. The Council is therefore pursuing possible ways to compact plastics, ranging from truck-mounted compactors to consumer education programs encouraging recycling households to stomp on their milk and soda bottles before putting them out to be collected.

The Society of the Plastics Industry provided a solution to another challenge in plastics recycling by establishing a coding system for the six most common plastics resin types. So far, recycling in America tends

to rely on hand sorting, so the SPI codes facilitate the recovery of specific resins.

Already, the majority of plastic bottles and containers you find on your grocery store shelves carry these codes. And, because 22 states have now adopted the system as law, we'll be seeing these codes on nearly all plastic products very soon.

The future of recycling, of course, is in automated sorting, and the Council is supporting a number of research programs on that front.

But recyclability is not the only waste management attribute plastics have going for them. Nor can recycling alone solve the solid waste problem. That's why the Council and its member companies are working to utilize plastics' full potential in integrated waste management.

Fact: plastics can ease the burden on landfills through source reduction. The EPA credits thinwalling and lightweighting efforts with decreasing containers and packaging as a percentage of municipal solid waste over the last few years. For example, a milk jug weighed 95 grams in the early '70's. Today, a milk jug with the same volume weighs only 60 grams. The thickness of plastic grocery bags has decreased by more than 50 percent in the last five years alone.

Plastics can also replace heavier, bulkier materials in a wide variety of applications. Diapers are now being packaged in a plastic pack which produces 50% less waste by volume than the paperboard box it replaced.

Fact: plastics are a valuable fuel for waste-to-energy incinerators. Plastics have the highest stored energy value of any commonly used material, and can be safely burned in modern incinerators equipped with pollution control devices. Don't just take it from me; this was the

conclusion of a blue-chip international panel of scientists and experts convened by the U.S. Conference of Mayors last fall.

Fact: plastics are extremely stable in landfills. It's somewhat ironic to list this among plastics' positive attributes because this fact is often used against plastics. But the truth of the matter is that plastics are much less likely to break down and release potentially dangerous materials into the environment. They can be thought of as inert materials, much like glass.

When it comes to developing materials use policies, the criteria ought not be limited to "is this material recyclable?" or "is this material safe for incineration?" The criteria ought to be: "can this material contribute positively to waste management efforts regardless of the specific disposal option used."

Clearly, plastics offer that flexibility.

The plastics industry believes that plastics should be used whenever possible. Thank you.

THE SOCIETAL AND RESEARCH ENVIRONMENT OF ENHANCED DEGRADABLE PLASTICS

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Current political, social, and technical concern for the degradability of plastics in the environment is heavily swayed by adverse ecologic effects of terrestrial and aquatic litter. Widely publicized data show that plastics comprise 6 - 8% of landfilled wastes. Observations are documenting that plastic materials, along with many other material compositions, appear to remain un-degraded after many years of landfill burial. Industrial producers and plastic product users are concerned about retention of useful material properties and product utility, balanced against ecological desires for discarded plastics to decompose in a short time after discard.

Along with unresolved clear definitions of "degradable plastics", there is concern for a rapid rate of decomposition of material discarded as litter. Plastics degradable in the environment should comprise a different set of materials and user-products from those materials earmarked for waste recycling systems. The fate of a plastic material and product must be clearly specified so that it can be considered in the formulation of the plastic material. Compounds included as part of a plastic material to impart useful properties significantly impact decompositional rate and may affect environmental properties of degradation byproducts.

This paper states the current societal, industrial, and regulatory concerns about degradable plastics, and their relationships. The status of product availability and usage, and research studies are cited. Needs for

credible and reliable information that is unique to this relatively young field of environmental concern are identified.

BACKGROUND

The rate of decomposition of plastic consumer items is an area of primary concern to industry, consumers, environmental organizations, and the regulatory community. The impact of plastics degradation rate on societal and scientific approaches to characterization of plastics and usage of plastic products will be addressed in the following outline.

The photo-catalyzed and biologically-catalyzed degradation of plastic polymers used in commerce has been studied almost since the first formulation of these materials.

At least 20 years ago, the plastics raw materials industry began to provide raw polymer formulations, or resins, which either lacked additives to preserve against natural deterioration, or contained polymer modifications or different blends of chemical compounds which enhanced the breakdown of the plastic after its intended commercial use.

Newly developed polymers were introduced by manufacturers to meet the demand for "environmentally acceptable plastics". Although numerous plastic materials claimed to be " degradable" are now in the marketplace,

standard criteria or methods to quantify the rate and extent of degradation have not yet been widely accepted by the scientific community.

Imposed upon this relatively young area of objective determination of meaningful degradation properties of plastics, their decomposition rate and environmental impacts of the products, is a social urgency declared by ecologic organizations and legislators. Responses from polymer scientists and engineers are evidenced by the extensive citations within the recent reports noted in the bibliography of this paper.

SOCIETAL CONCERNS

Uncontrolled discard of plastic materials results in litter found both in soil & water environments. EPA, 1990 reported that one-third of all plastics sales for 1987 was for packaging use.

The significance of a decrease in plastics wastes placed into landfills is being argued in environmental and industrial publications. Industry, environmentalists, and governmental bodies are beginning to recognize that landfills designed and constructed according to modern technologies are expected to be unreactive containment structures.

Degradability of plastics in the environment has not been clearly defined. There appears to be a broad desire for plastic litter to be harmless to flora and fauna.

Recyclability of enhanced degradable plastics has only recently begun to be examined. Post-consumer reuse of uncleaned wastes and complex formulations usually pose more difficult recoveries (Fig. 2).

Convenient and easy-to-use plastic consumer products must be low-cost and economical. Changes in the composition of plastics from current formulations, or substitution of other materials such as paper or metals, will result in cost differences.

Consumers and environmentally-concerned citizens alike appear to demand honesty from the producing and marketing industries. Regulatory agencies are looked upon to provide unbiased conclusions regarding the environmental impacts of the fate of plastics in the environment.

INDUSTRY CONCERNS

Economic production and distribution of products are desired by consumers. Manufacturers have a natural reluctance to change the formula of plastics which have a proven commercial success record.

A major factor in choice of plastics for a product is the performance of the material during the expected use and lifespan. Preprogramming of degradation initiation and processes into plastic formulations has been claimed by several manufactuers of enhanced degradable plastics.

Growth of plastics and packaging trade organizations has been joined by formation of new societies and councils. The ASTM Subcommittees D-20.95 on Recycled Plastics and D-20.96 on Degradable Plastics are currently working with industry in developing standardized methods and practices.

REGULATORY CONCERNS

Current environmental policies emphasize that products and materials that enter the waste stream conform to the four-stage approach: Waste minimization, recyclability, treatment or destruction, landfill disposal of final residues.

The hazard or toxicity from ingestion, mechanical entanglement, or chronic exposure to degradation products of all waste materials is a major concern.

To date, at least 26 states have enacted legislation dealing with the degradation of plastics in the waste stream; 21 states specifically require degradable six-pack beverage carrier rings. Two states have adopted technical criteria to define and support enhanced degradability requirements. All other aspects of the known state regulations only superficially address definitions, measurement methods or criteria, or other decision points.

There appears to be essentially no concern about enhanced degradable plastics by Congress in current waste management reauthorization bills. This is in concert with the USEPA's position of seeking a substantial credible base of data before embarking on far-reaching regulation. The EPA's Office of Research and Development has for many years emphasized the requirement for sound quality assurance in the conduct of data-gathering studies, and in credible peer-review of findings before public release.

DEFINITIONS

The current consensus definition of degradable plastics by ASTM is, "A plastic that, by design, undergoes a change in its chemical structure under specific environmental conditions that results in a loss of properties(1) in a specified length of time(2). Superscripts (1): loss in properties as measured by ASTM tests, and (2): as agreed upon by the interested parties." Additional definition of "biodegradable" and "photodegradable" types is still in the discussion stage, with expected consensus by the time of the July, 1990 ASTM Subcommittee meeting.

STANDARD TESTING METHODS

Test measurements to identify the amount of degradation, deterioration, decomposition, or other mode of chemical or physical breakdown of plastics have normally used methods published by the American Society for Testing and Materials. At the present time, ASTM Committee D-20.96 has drafted

seven Standard Practices and four Test Methods to evaluate degradable plastics.

At least ten U. S. universities are investigating biological, bioassay, or bioassessment test methods for applicability to enhanced degradable plastics.

Widely reported findings from examination of excavated landfills fail to emphasize quantitative approaches to stating the extent of deterioration of materials found and studied. As can be seen in many fields of technical study where new materials or processes are evaluated, available procedures that are related but not specifically validated are first applied. Initial findings are quickly followed by development of specific procdures for the new materials at hand. This young stage of development and verification of methods uniquely applicable to enhanced degradable plastics is the present condition for these materials.

CURRENTLY USED SUCCESSFUL PRODUCTS

Agricultural mulch films have been made and successfully used for many years. These types of plastics appear to be good candidates for use in bags to contain homeowners' yard wastes destined for composting. At least 75 communities in the U. S. are now known to be actively pursuing composting as a means to decrease the load to their municipal waste landfills.

Manufacture of 6-pack beverage carrier rings from plastics modified for more rapid decomposition in open air environments has been common for two decades.

Some plastic formulations specifically synthesized for rapid decompostion after product use are currently available but too expensive for high-volume use. Formulas such as PHBV are in use for medical devices implanted after surgery.

RECENT RESEARCH AND RESULTS

Scientific and technical publications from polymer researchers have reported on plastics degradation for many decades. Current development efforts are aimed toward specific biodegradable polymers including poly-lactic acid copolymers, enzyme enhancement additives, aliphatic polyesters, and modifications of starch additives.

The U.S. Environmental Protection Agency's Office of Research and Development has initiated several studies to provide a sound data base for the Agency's regulatory activities. One study is identifying and assessing degradation test parameters recently or currently in use. Methods used in reported studies have mostly been industry-standard techniques for measuring physical properties such as strength, brittleness, and similar engineering parameters. However, with the wide variety of industrial and academic approaches to evaluating the properties of a variety of plastics

claimed to be environmentally degradable, each individual study possesses unique products and their requisite test method adaptations. One goal of this research project is to provide a basis for comparing results of studies already reported in technical literature.

Another project will focus on exposure of several types of commercially-available degradable plastics to several different soil and aquatic environments. Subsamples will be examined periodically to assess extent of degradation. The two major types of plastics with enhanced degradability--bio and photo--will be included in this work. Equipment will also be set up to capture physical and chemical products of degradation for use in bioassessment testing. Test methods both currently included within the ASTM standard methods, and those under final development by ASTM Committees for particular application to enhanced degradable plastics will be applied.

In another study, selected commercially available degradable plastics will be mixed into plastics recycling processes in known proportions. Adverse or complementary effects on the properties of resulting products from mixed plastics will be measured. These latter two projects are just beginning the field-exposure stage, following a lengthy experimental design and quality assurance review process.

Rate of degradation of a plastic product after its normal use by consumers constitutes an area that has not been well defined or addressed

by either scientists or society. Each major type of product disposal scenario requires definite useful product lifetime and quite different rates of decomposition after the product has been discarded.

Societal and environmental activists need to provide objective input to researchers indicating their temporal goal for the various fates of used materials. Both scientists and production engineers can provide the compromise product specifications which result in plastics which retain their useful and practical properties, yet meet reasonable and practical goals for ultimate fate.

CONCLUSIONS

The bibilography for this paper provides a wealth of background resources. Numerous data may be found among the 285 citations contained in USEPA, 1990. SPI, 1987, and IWDM, 1989, report the majority of technical studies which describe the performance of enhanced degradable plastics.

To meet environmentally conservative waste management goals, design and implementation of integrated systems of material production, use, and disposal are needed---indeed for not only plastic but also paper, metals and other materials of commerce.

Plastics have many physical and chemical properties in common with metals. Refining of ores into useful metallic products not found in nature

may be considered a process similar to converting raw hydrocarbons into refined plastic polymers. The thermodynamic energy put into converting ore into metals or hydrocarbons into plastic polymers will inevitably be released as metals revert back to oxides and plastic polymers naturally degrade. People with intense environmental concerns desire a more rapid rate of degradation of plastics than will naturally occur. A rapid degradation rate and the nature of degradation products that are environmentally acceptable have not been well defined or even clearly stated. Thus the plastics producing industry and regulatory bodies are caught in a dilemna to guess the optimum plastics degradation rate and endproduct composition which is most acceptable to the greatest number of concerned consumers and voters.

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SOLID WASTE (SOURCE) REDUCTION IN MINNESOTA COUNTIES

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The Minnesota Office of Waste Management (OWM) established a model county project for solid waste reduction. The project and preliminary results are described below.

Based on this project, the OWM developed guidelines for counties to address solid waste reduction in their solid waste management plans. The plans have been required to address waste reduction since their inception, but it was felt until recently that counties had little ability to affect waste reduction except through citizen education. The new guidelines are part of the OWM's County Implementation Manual/Solid Waste Reduction and Recycling Programs published May 1990 to help counties comply with the new Solid Waste Reduction and Recycling (SCORE) legislation which passed in September 1989. The chapter "Waste Reduction Strategies" appears below.

The Itasca County Solid Waste Reduction Pilot Project has three overall goals:

- To show that waste reduction is a realistic goal and waste reduction practices can make a difference in the amount of waste generated, at a specific location;
- To provide decision-makers an opportunity to see what waste reduction is, and to see waste reduction in action; and
- To show that actions, and not only education, can be used to reduce the generation of solid waste.

These goals are being accomplished through working together with staff at each facility to

- choose and evaluate waste reduction measures to implement in county government and other facilities;
- implement those measures; and
- evaluate and document their success.

This work has been completed in the county courthouse and Road and Bridge Department garages, and is in progress at the county hospital and nursing home. Several local businesses will be added to the project this summer.

A committee is established at each facility and has the following goals:

- To reduce waste generated in the facility;
- To help measure the amount of waste reduced by specific methods; and
- To identify for other counties the problems encountered and solutions found in putting waste reduction methods to work.

The steps followed by each committee are described in the "Waste Reduction Strategies" paper. Below is a summary of waste reduction practices implemented since January 1990 in the Itasca County Courthouse and Road and Bridge Department garages.

WASTE REDUCTION PRACTICES IN THE ITASCA COUNTY COURTHOUSE AND ROAD AND BRIDGE DEPARTMENT

Note: New hard data on air filters, paper, junk mail and hand towels will be available in June.

▸ ***Reusable air filters in furnaces and air conditioners.***

Materials Conserved:
There are about 60 furnace and air conditioning filters in road and bridge garages and about 50 in the courthouse. They are changed an average of once a week, more frequently in winter, less in summer. That adds up to more than 5700 disposable filters per year. If you took all the filters we threw into the landfill last year and stacked them flat, they'd reach higher than the IDS tower in Minneapolis -- over 57 stories high. By switching to reusable filters, we reduce waste and save money. The reusable air filters are made of stainless steel and are washed with high-pressure water hoses. They cost more but are expected to last at least ten years.

Cost Savings:
Over 10 years, the use of reusable filters will save $86,000, a savings of $8,681 per year, over cost of disposable air filters. Disposable filters cost $1.56 each, and stainless steel reusables cost $10.58. Our estimate compared the cost of 110 disposable filters, replaced an average of once per week, to the cost of 220 reusable filters, each lasting over 10 years.

▸ ***Reusable coffee cups instead of disposable ones***
The Neutral Corner coffee shop loans ceramic coffee cups for meetings and washes them afterward. Employees who attend the waste reduction seminar receive a ceramic mug. To further encourage employees to avoid disposable cups, the coffee shop charges 5 cents extra for coffee in a disposable cup.

Materials Conserved:
If one out of every three county employees (100 people) each use one disposable cup each day, that's 500 cups thrown into the landfill every week, 25,000 per year.

Cost Savings:
Estimating 15 cups per meeting, 10 times a week, the savings is $4.20 per week or $218 per year. This estimate uses six-ounce styrofoam cups, which cost $1.40 per pack of 50, or 2.8 cents each. If 100 courthouse staffers use one every day (five days a week, 50 weeks a year), that's about $700 per year that could be saved.

▸ ***Reducing junk mail by sending pre-printed postcards asking to be taken off mailing lists.***

Cost:
A thousand printed post cards costs $23, and postage costs $150, for a total of $173 per 1000 cards.

▸ ***Reducing office paper waste by***
Photocopying on two sides of a sheet of paper.
For big jobs, the Human Resources Department's copier is available. It will duplex automatically.
Using scratch pads made out of paper used on one side only. Made in-house or sent to printer for gluing and backing.

Materials Conserved:
Right now in the Human Services Department, about 50 percent of the 75,000-100,000 copies per month are 2-sided. If we can increase two-sided copying from 50 to 80 percent, we will save 22 and a half reams of paper per month, or 270 reams per year.

Cost Savings:
If we increased two-sided copies to 80 percent, we would save about $78 a month, or $942 a year, based on a conservative paper price estimate of $3.49 per ream of 500 sheets.

Using scratch pads made out of paper used on one side only will save 30 to 50 cents per 50-cent pad. The average price of a new 100-page scratch pad is 50 cents. The Human Resources Department staff saves paper and makes pads. The Social Services Department has used-paper pads professionally glued and cut at a cost of about 20 cents per 100-page pad, plus a $2.00 cutting charge for every 1000 pages.

▸ Purchasing long-lasting, repairable products, with standard brands used to promote repairability through interchangeable parts.
This process was in place long before our waste reduction project began, but it is still a part of our model. Diesel fuel injectors are remanufactured over and over, reusing the main portion of the injector. The Road and Bridge Department "remans" about 10 sets of eight injectors each year.

Cost Savings:
The particular example of diesel engine fuel injectors saves over $2500 per year. Remanufacturing 80 injectors costs $29.04 per injector, or $2323 a year. Buying new injectors would cost $62.37 each or $4986 a year, a cost savings of $2666.

▸ Purchasing cleaners and other products in reusable 5-gallon pails (and finding uses for those pails when they are empty.)
This is another practice that has been in place at the courthouse for a long time. Cleaning products vary as to the amount needed for a job. Often, the product in the pail is in concentrated form and can be diluted with water in a reusable spray bottle, while the product in the can is already diluted with propellent. Even though we can't compare directly, we avoid excess packaging by purchasing cleaning products for the courthouse in five-gallon pails instead of aerosol cans or throw-away plastic jugs.

Cost Savings:
Significant savings, but difficult to quantify. As a generic example, a 24-lot case of cleaner costs about $50, while a five-gallon pail of the same product costs about $25. Usually, the product in the pail is in a concentrated form, then diluted with water for use, while the product in the can is already diluted with propellent. Although we can't compare costs directly, buying in bulk five-gallon pails clearly saves money.

▸ Replacing paper towels with cloth hand towels in restrooms.

Materials Conserved:
When we used paper towels in the courthouse, we used -- and landfilled -- a case of paper towels every week -- over 1400 pounds of waste paper each year. The cloth towels can be washed and reused more than 100 times. When the cloth towels wear out, they will be recycled into rags.

Cost Savings:
This will save $287 a year. Until recently, the courthouse used one case of disposable paper towels each week at a cost of $2065 a year. Fifteen to 18 rolls of cloth towels provides the same number of servings as a case of 12 paper towels. Based on the most conservative estimate, 18 rolls of cloth, the cost is $1778 a year, a savings of $287.

GOOD WASTE REDUCTION IDEAS THAT DIDN'T WORK OUT

- Pop Machine With Reusable/Refillable Bottles.
  No longer available.

- Cloth Rags in Road and Bridge Department Garages.
  Wastewater treatment system doesn't handle grease and oil very well.

- Make Scratch Pads Out of Computer Paper Used on One Side.
  Too much paper. Recycling makes more sense in this case.

- Use Bulk Spray Paint Instead of Throw Away Cans for Marking Timber.
  Washing out containers and using more paint or ink may limit waste reduced.
  Inconvenience = low acceptance by foresters.

B. REVIEW OF WASTE REDUCTION STRATEGIES

1. Definition of waste reduction

Waste reduction is the first priority among waste management options because it has few if any negative environmental effects, conserves resources, and does not require new facilities to process waste.

The Waste Management Act defines waste reduction as:

> an activity that prevents generation of waste including reusing a product in its original form, increasing the life span of a product, reducing the material used in production or packaging, or changing procurement, consumption, or waste generation habits to result in smaller quantities of waste generated. Minn. Stat. § 115A.03, subd. 36a.

It is important to distinguish between waste reduction and other waste management methods. Recycling and other waste management methods are processes used to handle products and materials that no longer serve the purpose for which they were designed. In contrast, waste reduction occurs before waste is generated, and requires forethought by the consumer. For example, replacing disposable products with reusable products or procuring long-lasting, repairable items instead of shorter-lived, non-repairable items are waste reduction practices.

Buying recycled and recyclable products result in stronger markets for recycled products; they do not result in smaller quantities of waste.

2. Requirements under SCORE

The SCORE law goes beyond the current county planning rule by requiring that local governments institute solid waste reduction measures. Under the new legislation, counties have the following waste reduction responsibilities:

- Political subdivisions, educational institutions, and other public agencies shall aggressively pursue procurement practices that encourage solid waste reduction.

- Each county shall include in its solid waste management plan mechanisms for providing financial incentives to solid waste generators to reduce the amount of waste generated.

The SCORE legislation states that the highest priority use for SCORE pass-through funds

is "to reduce the amount of solid waste generated." The Waste Management Act also identifies waste reduction as the highest priority "waste management" practice. Minn. Stat. § 115A.02, item (b).

3. Implementing solid waste reduction at the local level

In the past, most counties have equated waste education with waste reduction in their county plans believing local governments could do little else. It is now clear that local governments can actively affect and promote solid waste reduction.

Actions that local governments can take to encourage solid waste reduction fall into four categories:

- Implement waste reduction measures in government facilities (including procurement practices to reduce waste);
- Implement volume-based garbage collection fees (required by SCORE legislation);
- Educate the public specifically on waste reduction; and
- Provide assistance to local businesses and institutions on how to reduce the amount of waste generated.

a. Implementing waste reduction measures in government facilities

The major benefits of implementing waste reduction measures in government facilities are:

- citizens and staff see clear examples of waste reduction in action;
- the amount of waste generated at government facilities is reduced, resulting in cost savings and landfill abatement; and
- staff members can transfer experience in identifying and evaluating potential waste reduction measures to other government facilities or private businesses.

The OWM and Itasca County are currently working on a pilot project demonstrating how a county can implement solid waste reduction measures. As of January 1990, the Itasca County staff has implemented several successful waste reduction measures in the courthouse and in the County's road and bridge department. These measures have

saved money and reduced waste. Appendix C describes the project and gives information available so far. The county hospital and nursing home have recently joined the effort and information from these institutions and local businesses will become available later in the year.

Here are recommended steps for implementing waste reduction programs in government facilities.

1. Identify a facilitator to oversee the project. The facilitator can be the county solid waste officer, the county (or city) recycling coordinator, or anyone else who can be authorized to use work time to facilitate the project. The facilitator should have a clear understanding of waste reduction and have several examples of waste reduction methods. (OWM can provide these.)

2. Form a committee of interested staff members representing various departments within the facility. The custodial/ maintenance and purchasing departments are particularly important.

3. Make an informal survey of waste generated in the building. This may consist of simply looking in wastebaskets and storage rooms or setting aside a day's waste from the building and going over it at the landfill or waste management facility. Provide this information to the committee along with an estimate of disposal costs for the building. This information can be used to identify priorities for waste reduction.

4. Hold a committee "brainstorming" meeting to generate ideas on how to reduce waste in the building. Members draw on their knowledge of waste generated in their own departments and information from the informal waste survey.

5. Have each committee member investigate several of the ideas generated in the brainstorming session to discover what work may be required and what costs or savings may result from implementing the measures. Keep in mind that some ideas that may reduce waste in one way may cause pollution in another.

   For example, the Itasca County project found that switching to cloth rags instead of disposable rags in county garages would have caused pollution because local laundry facilities could not properly handle grease and oil in the rags. In areas served by specialized laundry services the idea may have been feasible.

6. Have Committee evaluate waste reduction ideas based on members' findings about each measure and decide which practices to implement.

7. Committee members implement chosen waste reduction measures and record the amount of materials conserved and money saved by each practice implemented.

8. Committee members individually and collectively educate all the facility's staff about waste reduction and the waste reduction actions taken.

b. Implementing volume-based garbage collection fees

A volume-based garbage collection rate is one where the generator is charged on a per can, per bag, or a weight basis. Typically commercial generators are charged in this way but many residential generators are not. Experience in Seattle, Washington has shown that volume-based fees encourage the general public to reduce waste. Section N of this chapter contains information regarding financial incentives for waste abatement.

c. Educating the public on waste reduction

Education is an important component of any waste reduction program. County waste education campaigns should single out waste reduction, explaining what it is and why it is important, and giving specific examples how citizens can reduce waste. Leaving grass clippings on the lawn is a waste reduction example.
Counties can also publicly recognize businesses that implement programs to reduce waste. This recognition creates an incentive for other businesses to reduce waste and it informs the public about waste reduction.

d. Providing assistance to local businesses and institutions on how to reduce the amount of waste they generate

Counties should be prepared to provide information and give referrals to local businesses and institutions interested in reducing waste. The OWM has a variety of materials that provide examples of waste reduction in businesses. In addition, counties may be able to assist local businesses in identifying waste reduction opportunities.

For help in reducing industrial waste and hazardous wastes, counties can refer generators to the Minnesota Technical Assistance Program (MnTAP) at (612) 625-4949 or toll-free in Minnesota at 1-800-247-0015. See Appendix D for additional information on MnTap.

4. Measuring the results of waste reduction

Although it is important to measure the success of a waste reduction program, measuring waste that is not generated presents a problem. Money spent on measurement may be better spent on implementing additional waste reduction programs.
Waste reduction can be successfully measured on a small scale in discrete situations such as the Itasca County example discussed earlier. Itasca County is using purchasing records and abatement estimates to project waste reduction savings.

Large-scale waste reduction is more difficult to measure but here are two possible methods:

- Perform detailed waste sorts to measure specific materials, and compare these levels over time. Many materials must be measured to account for possible substitutions of one material for another (e.g., plastic for glass bottles.) This method is very expensive.

- Use professionally-designed attitude surveys to assess the extent to which sectors have incorporated the various aspects of waste reduction into their activities. This method may be the most feasible for measuring large scale waste reduction, but it will not provide hard numbers on the amount of waste reduced.

5. Additional information

The OWM's Waste Education Clearinghouse has an extensive collection of materials available on waste reduction, including fact sheets, checklists, examples of business waste reduction, guidelines for initiating programs, case studies, and bibliographies.

The Clearinghouse provides these materials free of charge upon request. To learn more about what is available or to request information call the Clearinghouse's toll free number (1-800-877-6300) or call (612-649-5482).

SOURCE REDUCTION STRATEGIES

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SOURCE REDUCTION STRATEGIES

Introduction

Municipal solid waste (MSW) touches every thread of social fabric

- everybody can relate, because generated just about everywhere
- example of how industrialized societies treat natural resources

Fundamental question is how to reduce amount and toxicity of MSW that we generate in first place

- means considering entire MSW "system"
  - extraction of virgin materials (e.g., from mines and forests) and secondary materials (e.g., from MSW)
  - product design and manufacturing
  - distribution and merchandising
  - actual purchase and use

MSW Source Reduction

What does it mean?

- whose definition to use?
- dual aspects of toxicity and volume
- manufacturers and consumers

How will we know when it happens?

- need to know current situation and how to measure deviations
  - therefore need standardized techniques for measuring generation and reduction, at both national and local levels
  - are Franklin estimates sufficient for national measurements?

- need existing baselines for specific toxic constituents
- need existing baselines for specific product categories, yard wastes

Are we focusing on the right things?

- many small actions probably will be way source reduction is achieved, so everything matters in long-run
- but are first efforts focusing on most important components?

For toxic constituents:

- are we identifying most important risks?
    - some good data on 3 metals, little on organic chemicals
- much attention to identifying products that contribute Cd, Pb, Hg
    - are we seeing major changes in levels of these in consumer products?
        - e.g., trend for Cd in plastics?
        - e.g., trend for Pb in plastics, inks, etc.?
        - e.g., trend for Hg in fluorescent light bulbs?
    - should substitutes be publicly identified?
        - e.g., what is substitute for Hg in household batteries?
        - is actual risk reduction occurring?

For products and yard wastes:

- biggest components in general are paper, yard waste, plastics
- lots of attention to packaging (which covers many materials)
    - toxicity and recyclability, reduction to some extent
    - CONEG guidelines
- lots of attention to disposable diapers
- what about backyard composting?

- what about paper products in general?
    - oversized newspapers?
        - would you pay more for a smaller newspaper (i.e., fewer ads)?
    - direct mail, packaging from catalog shopping
- what about Americans' general appetite for products of all types?

National Policies

Provisions in proposed legislation:

- Federal agencies to have reduction policies; waste reduction officer
- clearinghouse at EPA
- packaging and product design, labels in general
    - variations on theme: special commission to study, or National Packaging Institute, or Products and Packaging Advisory Board
    - national packaging standards?
    - national seal/logo?
        - West German and Canadian programs
        - ASR's Green Seal program
        - difficult to develop procedures/criteria for assessing most products on basis of lifecycle environmental costs
        - credible information needs to be available and easy to interpret if consumers are to make informed purchasing decisions
- public education campaign
- EPA Office of Waste Reduction/Minimization
- identification and regulation (including possible bans) of toxics
    - ban on non-essential uses of cadmium
- tax on virgin materials (more for recycling, revenue raising than for reduction)

- what about awards?
- what about Federal procurement of "reduction" products?

What if these aren't enough? What then?

- (recall we won't know this without better measurement protocols)
- could forget about source reduction
    - but reduction popular idea now
    - probably irresponsible, given implications for natural resources and international environmental policy in general
- note most proposed provisions involve incentives (with some exceptions, e.g., possible packaging standards, cadmium ban)
- should we consider sequence of deadlines (based on progress towards reduced toxicity and volume)??
    - beginning primarily with positive incentives
    - moving over time to more prescriptive measures
        - regulations on product design
        - mandatory labeling
        - bans on additional substances
        - taxes or fines for categories showing no progress
    - ???

<u>Concluding Remarks</u>

On local and personal scale, individuals can make changes in how they design and consume products, and use energy and materials

- sum of these actions can be important
- from broader perspective, these efforts provide lessons for larger issues
    - e.g., demands for "environmentally friendly" products highlight links

between system, mounds of waste discarded daily, and other problems (including energy use, global climate change)

- larger issues seem overwhelming at times

- ethic that drives individual actions, if expressed politically, can spur national policies and international action

- as individuals and as a nation, we can choose to move in a new direction, towards better materials and energy use