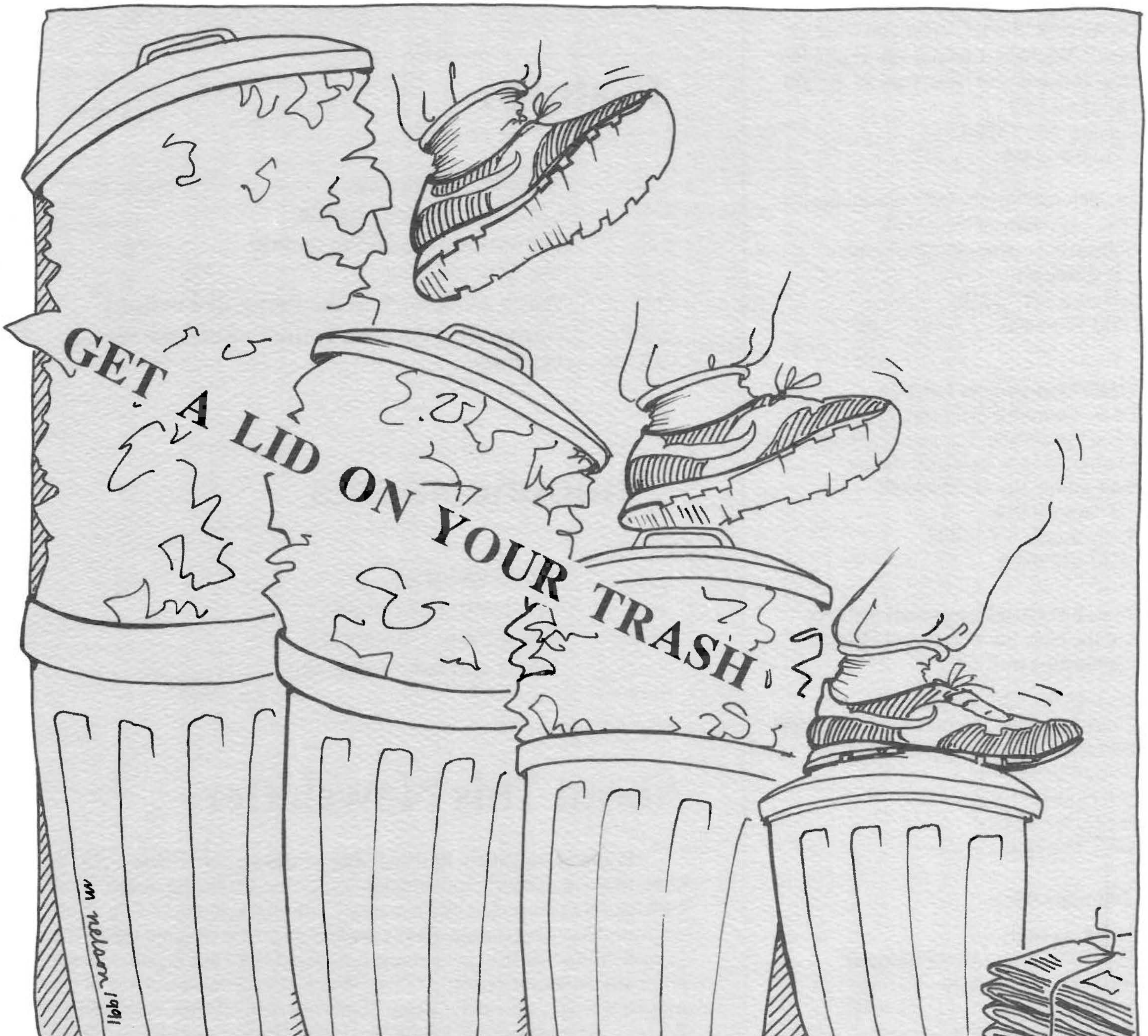
waste management research Report

News from State University of New York at Buffalo and Stony Brook, and Cornell University

Vol. 3, No. 1 1991



Focus On Source Reduction

Waste Management Research Report

Vol.3, No. 1 1991

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Articles in this journal are indexed in *Environmental Periodicals Bibliography.*

Printed on Recycled Paper

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About This Newsletter

Waste Management Research Report appears three times a year in order to share research from the publication's contributing institutiones. Eash issue focuses on one major area of waste management and highlights the institution where researchers concentrate on the featured topic. The Cornell Waste Management Institute is responsible for this *Report*, with the emphasis on source reduction. The Waste Management Institute of the Marine Sciences Research Center, State University of New York at Stony Brook, will be responsible for the next issue. The focus will be on marine pollution.

On the Cover

Illustration by Margaret C. Nelson

Director's Comment

Waste Reduction: Conservation Coupled With High-Technology

By Richard E. Schuler

Richard E. Schuler

Although the three New York State-supported university research centers that publish the *Waste Management Research Report* focus their efforts primarily on advancing technologies for the safe, efficient and environmentally sound processing and disposal of wastes, we also recognize that substantially reducing the volume of wastes to be handled is an important component of any effective system of waste management. Indeed, waste reduction is number one on both New York State's and the U.S. Environmental Protection Agency's hierarchies of preferred methodologies for dealing with solid waste. The problem is, that while reduction has a nice "ring", nobody really knows with certainty how to go about reducing waste, systematically, let alone how to determine whose responsibility that ought to be.

In this issue of the *Waste Management Research Report*, several authors touch on society's imperfect knowledge of why the amount of waste generated per capita varies widely among different developed countries, and a variety of frequently raised policy options are described. Thus, policy options and likely consumer response serve as a preface for discussing needed research and the opportunity for employing new technologies in reducing waste. However, what is clear is that any successful steps in reducing and/or varying the composition of society's waste production will have impacts on the design and operation of waste processing and disposal methods being researched at our institutes today.

In most instances, waste reduction can have beneficial effects on incineration, composting, and recycling, especially if it is accompanied by a more uniform composition of materials. Nevertheless, the size and composition of America's waste stream is a rapidly moving target, and it is the responsibility of our three institutes to devise and refine processes and methods that are sufficiently robust to accommodate these changes in the waste stream.

It is also clear that most efforts to reduce municipal solid waste volumes have the simultaneous beneficial effect of decreasing the generation of hazardous wastes, as well as reducing air and water emissions, so the big winners are the environment and we its inhabitants. While there is much initial finger pointing at the start of a waste reduction campaign (households blame industry and government, business points to their consumers and their desires, and different levels of government wait for each other to act), what is needed are simultaneous efforts on all fronts.

Sustained consumer action is a sure way to attract industry's attention, and when committed in the board room, business can mount massive coordinated campaigns to reduce waste in terms of what products are designed, their useful life, and how they are made, distributed and marketed (and therefore how they are packaged). In the process, there will be tremendous technical opportunities to devise new products, made from new materials, manufactured by novel methods whose wastes are reused and reprocessed by a whole array of new methods.

That is the ultimate technological challenge that lays at our doorstep, if only we can gain the institutional commitment from all sectors of society to proceed.

Dr. Richard E. Schuler is director of the Cornell Waste Management Institute and the New York State Solid Waste Combustion Institute. The latter is an independent entity, funded by New York State, located at Cornell University. Photograph by David Ruether.

Avoided Costs of Waste Reduction and Recycling in New York State:

Applying *WastePlan* in Tompkins County

By Daryl W. Ditz and Mark A. Velicer

Dr. Daryl Ditz is a senior extension associate in the Cornell Waste Management Institute. Mark Velicer is a solid waste engineer with CH2M Hill in Bellevue, WA.

It is the policy of New York State to reduce and recycle 50 percent of its municipal solid waste (MSW) by 1997. As communities across the state encounter the technical, environmental, legal, and political hurdles on the road to waste reduction and recycling, economic questions loom large. How much will it cost? Which materials should be collected and how? What effect will waste reduction and recycling have on the existing waste management infrastructure? This article describes a project undertaken by the Cornell Waste Management Institute to help answer these questions through use of WastePlan, a new computer program designed to assist local planners in New York.

The 1988 Solid Waste Management Act ushered in sweeping changes in how solid waste will be managed throughout New York. One of the most important elements is that by Sept. 1, 1992 local laws or ordinances must be in place that require the separation of recyclable or reusable components for which "economic markets" exist. These markets are defined as "instances in which the full avoided costs of proper collection, transportation and disposal of source separated materials are equal to or greater than the costs of collection, transportation and sale ... less the amount received".

This language prompts communities to take a hard look at the economics of recycling in the broader context of solid waste management. Since literally hundreds of factors influence the total costs of solid waste management, this is no small feat. The composition of the waste stream, prices for recycled materials, the efficiency of collection systems, the value of landfill space, all these variables and many more have a bearing on the bottom line.

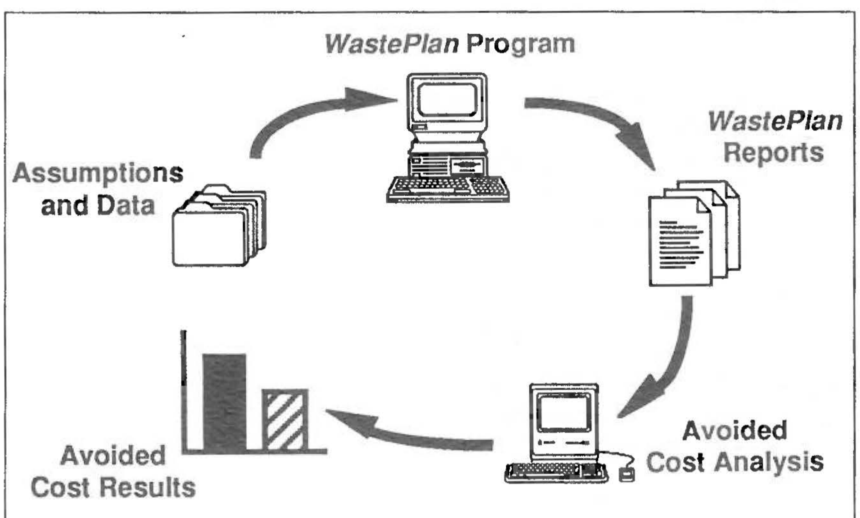


Figure 1. Estimating Avoided Costs with WastePlan

Avoided Costs of Disposal

Landfills receive about 80 percent of the MSW generated in New York, so reducing and recycling waste usually results in avoided landfill costs. To quantify these benefits, it is necessary to know the full costs of disposal. Tip fees (the price charged for the disposal of a fixed quantity of waste) are usually set to cover capital and operating costs. Other important factors, such as the eventual costs of closure and post-closure monitoring, have frequently been ignored.

As the requirements for environmental controls have tightened and siting difficulties have intensified, tip fees have proved to be inadequate to cover replacement costs. To the extent that disposal costs are understated, avoided costs of disposal will be undervalued. Current tip fees are only a partial measure of the true costs of disposal. Tip fees that do reflect long-term costs, including closure and post-closure maintenance, and replacement costs, do provide a reasonable estimate of the avoided costs of disposal.

Avoided Costs of Collection

Diverting waste from disposal also creates savings due to reduced MSW collection. Estimating these avoided collection costs requires a detailed understanding of the MSW collection system. Unfortunately, the simple linear approximation of avoided disposal costs - as the tip fee multiplied by the quantity not disposed - does not provide an accurate method for estimating avoided collection costs. Collection costs depend in a more complicated way on the volume and distribution of material collected.

For example, diverting one ton of newsprint from the solid waste stream will have a smaller impact on MSW collection costs than diverting one ton of aluminum because of the significant difference in density. At higher levels of waste diversion fewer trucks and employees and less time will be needed to collect waste. (Of course the costs of collecting recyclables would rise.) Routes might be re-configured and costs significantly reduced. These savings are generally realized in steps, rather than as a smooth function of the quantity reduced or recycled.

Therefore, in order to estimate the avoided costs of collection, considerable detail is needed on waste and system characteristics. In short, it is necessary to estimate labor, transportation, and other resources for the scenario of interest and compare this with the status quo. Clearly this can be a tedious process, especially if the system is complicated, and if more than a few alternatives are under consideration. Given these complexities, fairly sophisticated methods are needed to quantify avoided costs.

Estimating Costs with *WastePlan*

WastePlan is a practical tool for solid waste planning created by the Tellus Institute in Boston. A user-friendly software program that runs on IBM or IBM-compatible PCs, it was originally developed for the Office of Technology Assessment, a research arm of the U.S. Congress. The program assists in projecting the costs of waste collection, recycling, composting, resource recovery and landfilling based on a combination of data and assumptions that describe waste generation, collection, processing and disposal.

WastePlan requires inputs that are familiar to most solid waste managers (e.g. population, number and type of facilities, type of collection vehicles, labor costs) and offers default data on many routine characteristics (e.g. waste composition, per capita generation rates, truck and facility parameters). Each of these inputs can be tailored to reflect improved information or to explore the impact of particular items on the total cost of the system.

Avoided costs are calculated by comparing the costs of collection and disposal in a base case with an alternative configuration. WastePlan can be used to model both the base case and the alternatives under consideration. Some two dozen pages of summary results on tonnages and costs are generated for each run of WastePlan. From this information, avoided costs can be determined as shown in Figure 1.

An Application in Tompkins County

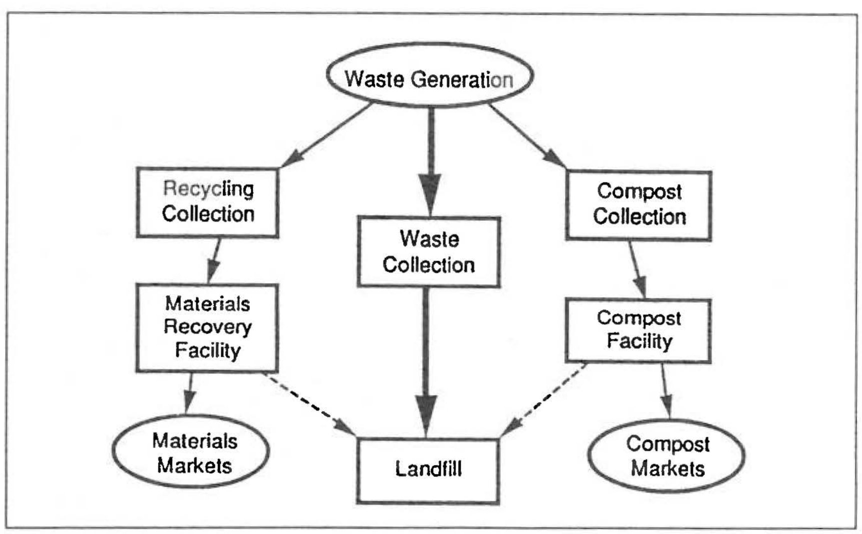
Compared with more urban communities, Tompkins County (population 90,000) is served by a relatively simple solid waste management system (see Figure 2). An estimated 50,000 tons of residential and 30,000 tons of commercial and institutional waste were generated in 1989. Nearly all of this was disposed at the Landstrom landfill, an aging facility expected to close within a year or so. A site for a new county landfill has been selected but is not likely to be available before 1992. When this analysis was initiated in late 1989, there were no transfer stations or incinerators, a small but rapidly growing recycling program, a pilot-scale composting project, and essentially no out-of-county shipment of trash.

In Tompkins County, as in many areas in the U.S., solid waste is collected by a combination of municipal and private haulers. This is also true for recycled materials. The City of Ithaca collects several source-separated materials at the curbside of residents and some commercial establishments: newsprint; corrugated cardboard; green, amber and flint (clear) glass; aluminum cans; and high density polyethylene (HDPE) and polyethylene terephthalate (PET) plastic containers. County residents outside the city limits rely on private haulers for MSW collection. The County has negotiated with these haulers to phase in curbside collection of commingled recyclables in selected areas. In addition, first one and now several drop-off facilities accommodate voluntary recycling.

Characterizing the existing situation is the first step in using WastePlan to assess the costs and benefits of increased waste reduction and recycling. Unfortunately, data are often incomplete and those that are available are sometimes inconsistent. For a system in transition this is especially challenging. Proposed changes, such as the implementation of a new collection program or development of new processing or disposal facilities, will have impacts that are difficult to predict.

Nonetheless, it is possible to take advantage of existing documents (e.g. draft environmental impact statements, solid waste management plans) to obtain a reasonable snapshot of solid waste management. In Tompkins County, analyses associated with the proposed landfill and central processing facility (for material recovery and MSW baling) were helpful in describing the quantity and composition of the waste stream. Even so, an innovative pay-per-bag pricing system and a strong promotional campaign for waste reduction and recycling

Figure 2. Schematic of the Tompkins County MSW System



promise changes in waste generation which can only be estimated.

All scenarios presented below are based on a common set of assumptions about solid waste management in Tompkins County. The cost of disposal was calculated on the basis of a tip fee of $40 per ton (although the County increased the fee to $62 per ton in 1991). Collection costs for MSW were based on the existing fleet of private and municipal vehicles. All of the scenarios assume that recyclables are collected at the curbside throughout the entire county with the same frequency as waste collection.

Markets for recycled materials are notoriously volatile. Like all other inputs to WastePlan, the prices for recycled materials can be varied to investigate the economic consequences of change. However, the following scenarios are based on a set of fixed prices prevailing in Tompkins County in 1989 which are listed in Table 1.

Table 1. Revenues for Recovered Materials

Recycled Material	Residential Supply (tons per year)	Price (dollars/ton)
Newsprint	4,130	0
Corrugated Cardboard	2,569	0
Plastic Containers (PET and HDPE)	1,964	10
Glass Containers (clear, green, amber)	4,936	30
Aluminum Containers	504	1,000
Total Supply	14,103	

Costs with Recycling

Proper sizing of a recycling program is one of the difficult challenges facing solid waste practitioners. The decision to initiate a collection program for curbside recycling involves a kind of gamble. If the community aims too low and captures only a small quantity of the potential supply of recyclables, then the benefits may not justify the expense. This is especially relevant for programs with large fixed costs for facilities, vehicles and administration.

On the other hand, if a recycling program is overly "successful" in capturing recyclables, its processing and marketing capabilities may be overwhelmed. Being forced to warehouse — or even worse dispose of — materials that have been collected for recycling can damage the credibility of the recycling program and dampen community support. Growing too large, too fast can also be economically inefficient. For example, if materials recovery facilities (MRFs) are under-sized, it may be necessary to build multiple facilities rather than expanding the existing structure in an incremental fashion.

The crucial unknown in this equation is the extent to which residential and commercial waste generators will participate in a recycling program. It is not enough to know how many households participate, but also what and how much they actually put out for collection. Ultimately the quantity of recyclables "captured" is the best measure of the success of a recycling program. The capture rate will hinge on the effectiveness of public education and promotional campaigns, the scope of the program, and other local circumstances. This may also change over time.

Rather than simply guessing a capture rate, with *WastePlan* it is relatively easy to repeat a given scenario with a variety of capture rates. In this way a few carefully constructed scenarios can provide information on costs over the full range of possible values. Given the composition of the waste stream in Tompkins County, recycling the entire residential supply of newsprint, corrugated cardboard plus glass, aluminum and plastic containers on a county-wide basis would reduce the total waste remaining for disposal by about 18 percent. Figure 3 presents the results of five WastePlan runs in which the curbside collection program captures between 0 and 100 percent of this residential supply. All other assumptions are held constant.

Figure 3 demonstrates how the costs and benefits of recycling — including avoided costs — vary with the amount of recycled material actually captured. For each scenario, the costs of collection, disposal, and processing are shown. The cost components are stacked to show the total costs. The revenues received from sales are illustrated as negative costs below the axis. For this particular example, the decrease in MSW collection and disposal costs, that is the avoided costs, are greater than the revenues generated. Clearly, planners who fail to account for these savings are ignoring substantial benefits.

Given the assumptions about waste generation, collection, composting, recycling, and disposal, the results are rather startling. In these scenarios, based on the data and assumptions described above, the net system cost increases with increasing capture of recycled materials. That is, the more that people participate, the more it will cost. This does not mean that recycling is a bad idea, simply that the program modeled here will experience higher costs as it succeeds in recycling greater amounts. Fortunately, the two variations on this scenario that follow yield more positive results.

Results with Yard Waste Reduction

Unlike recycling, waste reduction does not require the creation of a collection, processing and marketing infrastructure. Therefore it offers the potential for avoided collection and disposal costs without the expenses associated with recycling. Obviously, the size of these savings will depend on which components are reduced and by how much. The consequences of waste reduction can be explored in WastePlan by changing the quantity and composition of waste generation.

This section builds on the earlier sets of scenarios by considering two levels of waste reduction achieved through decreased generation of "yard wastes" (i.e. leaves, grass, and yard clippings) in the residential sector. As shown in Table 2, these materials account for more than 12,000 tons per year or over 15 percent of the total waste stream. An aggressive campaign to encourage backyard composting could make a significant dent in this area.

Since even in the more ambitious scenario less than half of all residential yard wastes are diverted, these seem to be realistic targets. These scenarios also ignore the potential for reducing yard wastes from institutional and commercial sources. Reductions in other waste components, for example plastic packaging or junk mail, could also be simulated.

The results are given in Figure 4 in the form of excess costs, which are the total costs minus the total costs of the base case. This demonstrates that while costs still grow with the amount of recycling, making large or even moderate reductions in the amount of yard wastes can significantly lower total costs. Yard waste reduction helps to offset the costs resulting from the recycling program. The kinks in the curves result from step-wise savings as the number of vehicles necessary for MSW collection is reduced.

Table 2. Scenarios for Residential Yard Waste Reduction

Material	Base Case (tons/year)	Moderate Reduction (tons/year)	High Reduction (tons/year)
Leaves	7,203	6,203	5,186
Grass, brush, clippings	5,138	3,125	1,152
Total Yard Waste	12,341	9,328	6,338

Results without Plastics Recycling

In addition to varying the quantity of materials recycled, solid waste managers need to consider how changing the composition of recycled materials will affect total costs. The final set of scenarios explore the same alternatives as above — with one difference. In these, the plastic containers (HDPE and PET) are removed from the curbside, commingled recycling program. Instead, they are picked up with the remainder of the MSW and disposed at the landfill. Under this assumption, the revenues from plastics recycling are lost, the recycling program collects and separates a smaller volume of materials, and MSW collection and disposal are increased. Again, this analysis considered the range from 0 to 100 percent capture of the residential supply of the recycled materials as well as large, moderate and no yard waste reduction.

The conclusion is that system costs can be affected dramatically by seemingly minor changes in the recycling program. These results are presented in Figure 5. Unlike the other scenarios, the costs of these alternatives are essentially constant as more recyclables are captured. This means

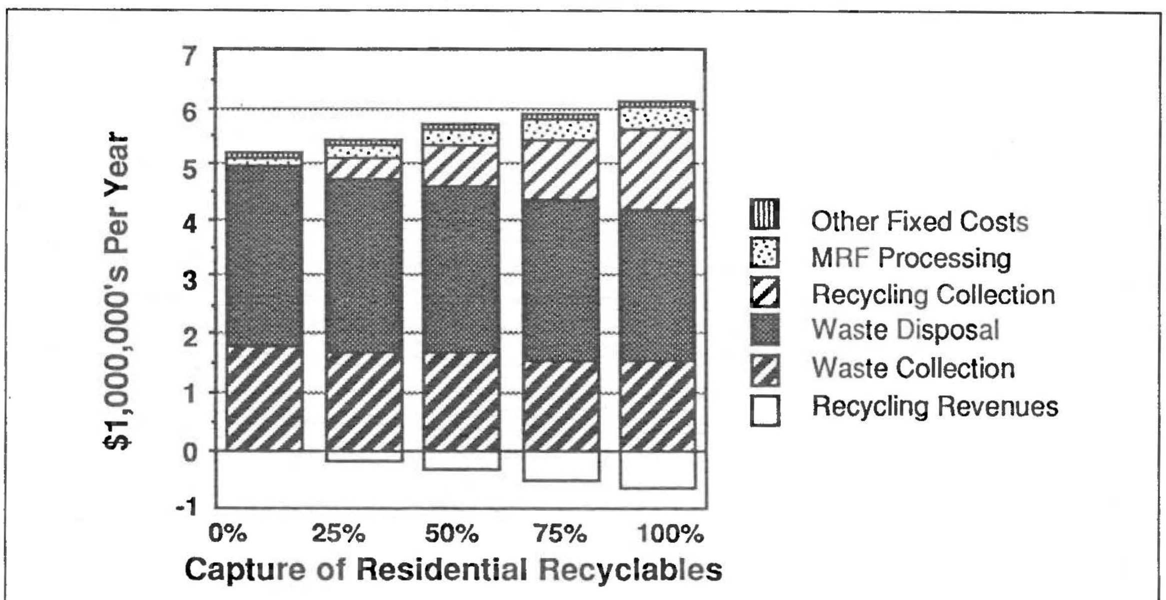


Figure 3. System costs with increased recycling.

that as the recycling program gains greater participation, increasing costs are essentially balanced by the combination of avoided costs and revenues. These results do not consider the possibility of using shredders or other emerging collection technology.

By excluding plastic containers from the recycling program, the total waste diversion is necessarily lower. For this community, this accounts for a maximum of about 2.5 percent of the total waste stream. As above, similar savings result as yard wastes are diverted from the MSW system, thus helping to justify expenditures for reduction programs. Regardless of whether plastics are recycled, the "moderate" reduction of yard wastes results in savings of over $150,000. The "large" reduction scenario offers over $250,000 in savings. Clearly, this suggests that it might be worth the expenditure of funds (perhaps in the form of an additional staff person) to achieve these reductions.

As disposal costs increase or where they are already high, avoided costs of waste reduction and recycling are proportionately greater. A tip fee of even $60 per ton is large enough to yield net savings in all of the scenarios presented above. If tip fees reach $100 per ton, a real possibility with long distance transport, total costs would nearly double. The silver lining of this gloomy cloud is that the benefits of aggressive recycling would expand to nearly a million dollars annually. As disposal or recycling costs increase, waste reduction offers even greater benefits.

Some Caveats

The results of cost estimates are no better than the quality of the input data and assumptions. (There is the old programmer's motto: "garbage in, garbage out".) However, the important advantage of this computerized approach is that it is relatively easy to investigate the effect of specific changes. Given the highly uncertain nature of prices and costs, this ability can help planners to assess the implications of various futures rapidly, cheaply, and with relative ease.

It is also important to recognize that even with the best of data, decisions about solid waste management must be based on other information beyond narrow economic costs and benefits. Environmental, legal and political considerations do—and they will continue to—play a role in the management of MSW. Even though a waste reduction or recycling program may carry net costs, other unquantifiable factors may be seen as worth the cost. These benefits could include the conservation of natural resources, promotion of environmental awareness, and delay of the painful facility siting process.

Finally, in the preceding analysis costs of MSW collection, recyclable collection, processing, and marketing were evaluated as if they are all charged to a single account. In reality, this is not so. The distribution of these benefits among the public and private players is not a trivial problem. But in any case, planners are better off with more rather than less information.

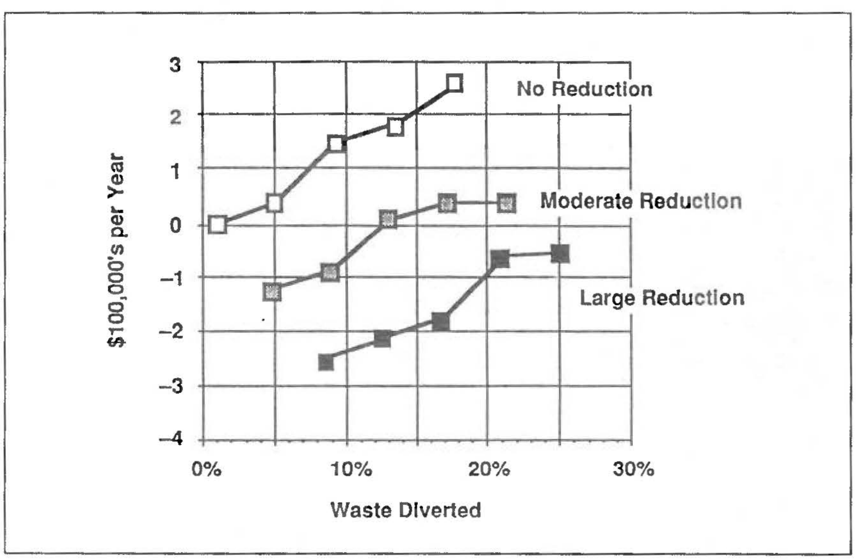
Conclusions

In each of the scenarios considered here, avoided collection and disposal costs are major components of the total benefits of recycling and waste reduction. Therefore, ignoring these savings lead to a significant understatement of the true benefits of such diversions. Yet estimating these elements is a complicated process, even when information is available. Through application of the *WastePlan* software, these costs can be estimated.

This analysis indicates that plausible reductions in the generation of yard waste (e.g. through back yard composting) produce savings on the order of $150,000 to $250,000 thereby helping to offset the costs of solid waste management. Reductions in other materials are likely to offer significant benefits from reduced collection and disposal of solid wastes. Such calculations can help in estimating how much might be allocated to waste reduction programs at the local level.

In contrast with waste reduction, this analysis indicates that recycling of some materials may carry net costs, even with positive prices for the recycled material. Low density, low resale value materials, such as plastic containers, may increase recycling collection costs more than they decrease waste collection costs. But, as disposal costs increase, the economics of recycling and waste reduction improve. *WastePlan* helps solid waste planners to explore the consequences of such circumstances before establishing programs

Figure 4. Excess costs with yard waste reduction.



and it can also aid in evaluating progress.

This methodology also facilitates long-range planning that is vital for communities to attain solid waste objectives. *WastePlan* provides a vehicle for training solid waste planners and exploring some of the intricacies of MSW economics on the local level. At the same time, WastePlan's data requirements might frustrate users, or force them into incomplete or inaccurate analyses. Some communities will probably turn this task over to consultants. Yet in so doing they will miss an opportunity to bolster in-house planning expertise.

This pilot project demonstrates just a few of the many kinds of analysis that can be done once the base case is established. Ongoing changes in the local solid waste management and future changes in the economics of MSW management underscore the need for continuing evaluation of system costs. With adequate training and support, WastePlan can become an effective tool for estimating avoided costs in municipal planning.

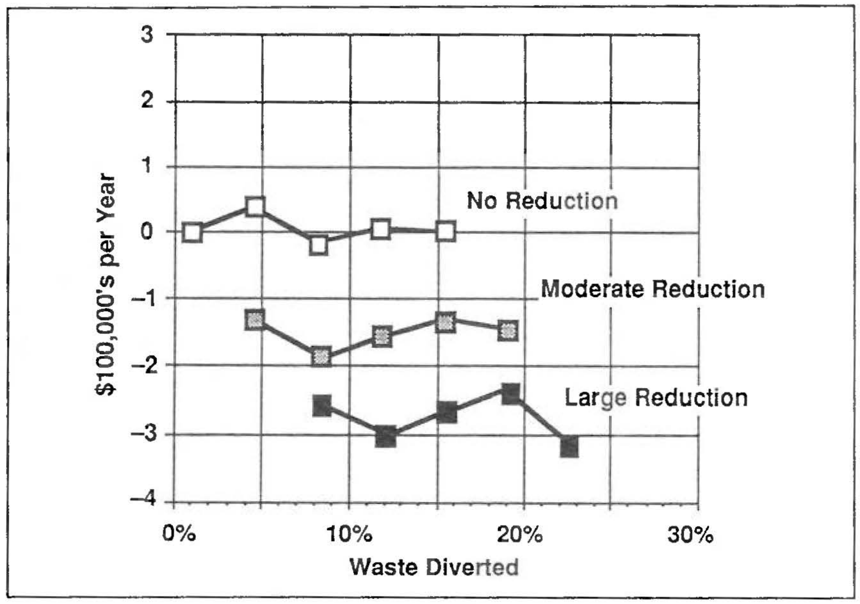


Figure 5. Excess costs with yard waste reduction and without plastics recycling.

NY State Solid Waste Combustion Institute at Cornell University

Funded Research Project Updates

The New York State Solid Waste Combustion Institute supports eight research projects in New York State as part of its $1.4 million research awards program. The awards program is committed to fundamental research leading to the development of combustion technologies and operating procedures that safeguard the environment. The Institute will report periodically on the progress research efforts . A brief update on two such research projects follows.

Improving Sludge Combustion

At Cornell University, Dr. Richard I. Dick, Joseph P. Ripley Professor of Engineering, conducts a three-year research project, "Improvement of Sludge Combustion Properties." The research is both timely and important because of its potential for identifying means to reduce the inefficiencies and high expense of sludge combustion at a time when other sludge disposal options are being discontinued.

Although combustion of wastewater treatment sludge could offer significant advantages to many American cities, fewer than one city in a hundred currently incinerates sludge because combustion is the most expensive of all sludge management options. All conventional methods for dewatering sludge are expensive and energy intensive.

Dick's research effort is aimed at identifying the conditions required for sludge dewatering in order to achieve economically competitive sludge combustion. If sludges could be effectively dewatered, the most significant component of sludge incinerator costs, auxiliary fuel, could be eliminated. However, neither sludge conditioning nor sludge dewatering facilities are designed and operated with the benefit of basic understanding of mechanisms controlling their performance.

Sludge incineration may hold special significance for New York State which now incinerates about 27 percent of its municipal sludge and disposes of another 40 percent at sea. Nationally, only 4 percent of sludge is discharged at sea.

New York will lose the ocean disposal option by the end of 1991 when it is required to move to land-based alternatives. The loss of ocean dumping capability may result in a shift to incineration to handle a greater share of the state's sludge.

The objective of this research is to develop a fundamental understanding of the dewatering behavior of compressible sludges in the complex dewatering devices. The first year's effort focused on the development of appropriate experimental techniques for investigating basic mechanisms involved in increasing the thermal value of sludges by dewatering. Since virtually no basic data have been reported on the most common current sludge dewatering technique, the belt filter press, emphasis was placed on physical conditions that occur in that type of dewatering equipment.

Controlled laboratory experiments were devised to duplicate the range of physical conditions found in conventional dewatering equipment. Analyses were conducted to determine the degree of dewatering required to achieve thermally self-sustaining combustion. The experiment led to development of a model to demonstrate the effect of sludge dewatering on the economic feasibility of sludge combustion. In the model, energy needs were evaluated under alternative operating conditions as was the amount of energy available from combustion of sludge organics.

The results illustrate that a high degree of dewatering is necessary to achieve thermally self-sustaining sludge combustion, and that large energy costs are associated with poor dewatering. The degrees of dewatering for autogenous combustion are beyond the range of most conventional sludge dewatering techniques except expensive thermal conditioning or filter pressing.

As the project moves into its second year, it will use two experimental techniques concurrently. The experiments are expected to permit investigation of variables such as rate of shear, extent of shear, and ratio of axial to lateral loads. Results of these experiments will help define the relative roles of a number of variables and permit mechanistic evaluation of dewatering in other types of equipment. The objective will be to identify dewatering design and operational practices that permit removal of water at a lower cost than through evaporation. The project is expected to continue into 1992.

Leachate Characterization

The combustion of solid waste produces a large volume of ash residue which must somehow be managed. Since ash residue contains a wide variety of chemical and physical properties reflective of the parent material, land disposal of ash may represent a source of toxic contamination to the subsurface environment.

The safe management and disposal of incineration ash is a matter of widespread public interest and is the subject of a research project directed by Dr. Thomas L. Theis at Clarkson University. The project, "Characterization of Leachates from Municipal Incinerator Ash Materials," will develop testing and data analysis procedures to determine reaction parameters that will be used to predict toxic species fluxes from incinerator ash.

Present leachate testing procedures are not representative of the actual environment. Dr. Theis' research is geared toward the development of more realistic testing procedures based on the dynamic behavior of ash in packed-bed column experiments. More complex than batch leaching procedures, this method is superior in terms of realism, time and cost. It is capable of yielding release coefficients that are directly usable in leachate generation and transport models. This method can also provide the major link between conceptualization of a disposal scenario design and the rational design of the disposal system.

New Software

Information from this project is expected to advance our basic knowledge of the leaching behavior of ash materials. The end result of the research will consist of an experimental technique and data analysis software capable of estimating elemental fluxes from solid waste combustion ashes relatively rapidly and under conditions representative of the disposal environment.

Although it was expected that each ash sample would display a different leachate composition with respect to others, laboratory column studies revealed that this composition also varies with time and with the quantity of leachate generated. Sulfate and calcium appear to be removed at about the same rate, perhaps due to their association as gypsum; however, chloride is removed much more quickly and at a substantially higher concentration than either sulfate or calcium. The implications of such changes are not yet clear. However, the aqueous chemistry of most trace metals with respect to their partitioning behavior as well as species distribution, is often affected by major ion concentrations.

The project will extend these column experiments. Data gathered from column experiments will be analyzed. Results are expected to be useful in the design of both disposal facilities and detoxification schemes for municipal solid waste ash.

Workshop Scheduled April 9

The Center for Environmental Information will sponsor "New Technology Options for the Recycling of Nontraditional Materials" from 7:30 a.m. to 5 p.m. April 9 at the Holiday Inn - Rochester South, 1111 Jefferson Road, Rochester, NY. The workshop will focus on recycling tires, plastics, household batteries, household hazardous wastes, and used oil. Dr. Ralph R. Rumer and Dr. Michael Ryan of the New York State Center for Hazardous Waste Management will lead the 8:30 a.m. opening forum.

Options for Waste Prevention

Actions by Government Can Encourage The Reduction of Waste at Its Source

By Ellen Z. Harrison

Whether you call it source reduction or waste prevention, making less trash and less toxic trash is on the top of everyone's hierarchy, but few people or programs seem to be taking action. There is a tendency to pass the buck, with local governments calling for state action and states calling for federal initiatives. The buck is also being passed down to consumers, and through their purchasing power they are exerting influence on manufacturers which is resulting in "green" marketing. While there has been some progress at the state level, on the retail shelves and in individual homes and businesses, these actions are not enough. Governments, citizens and businesses faced with growing bills for disposal need to find ways to produce less trash. This article focuses on the actions governments might consider to encourage prevention.

Ellen Z. Harrison

What Is Waste Reduction?

While there is some disagreement as to the definition of source reduction or waste prevention (this paper will use the term waste prevention), it makes most sense to define it as reducing the quantity or toxicity of the solid waste which enters the collection and disposal management system. Thus wastes remaining "on-site", whether yard wastes composted in residential back yards or industrial scrap recycled at the plant, represent a reduction in the amount of waste which must be transported and managed at solid waste facilities. Activities that increase the amount of waste residents and businesses deliver to off-site recycling facilities is not included within this definition of waste prevention.

Decreasing solid waste can minimize the high monetary, environmental and political costs of disposing of solid waste. Unfortunately in the United States, the amount of waste generated each year is increasing, so that even if we are successful in implementing waste prevention, we are fighting against a rising tide due to both increasing population and an increase in per capita trash generation. At the current rate of increase, if we eliminated 10 percent of our current solid waste, in a little over six years we would be back up to today's level of trash. Looked at another way, if we do not stem the tide with effective waste prevention, our waste stream will continue to grow.

Waste Prevention Targets

There is no magic technique or technology that will reduce the amount of solid waste. Just as the waste piles up piece by piece, so must prevention "divide and conquer." Obvious targets for waste prevention are components that represent a large fraction of the solid waste stream, those that have a short useful life, those for which a less wasteful alternative exists, and those which represent a particular environmental concern in the disposal system. Commonly targeted wastes include:

Yard wastes - estimated at about 20-25 percent of the municipal solid waste (msw) stream.

Packaging - (including goods and foods) estimated at about one third of the msw stream. (note: Contrary to popular belief, due to lightweighting - the substitution of lighter or thinner materials - the weight percentage of msw attributable to packaging is decreasing.)

Junk mail - estimated at about 1.5 percent of msw stream. (note: The quantity of junk mail was estimated to double between 1980-1986.)

Disposable diapers - estimated at about 2 percent of msw stream and 4 percent of residential waste stream.

Batteries - heavy metals including lead, cadmium and mercury make batteries an environmental concern.

Hazardous wastes - from households, small businesses and farms include items like paints, solvents, cleaning agents, and pesticides some of which may legally end up in municipal disposal systems.

Consumer electronics - contain significant levels of lead, cadmium, and mercury.

Paths to Waste Prevention

There are a number of paths that can lead to waste prevention, some of which are more appropriate to federal or state action, others to local government or businesses and individuals. The techniques that may be used to implement these approaches are discussed in the next section and include: increasing the life of products through increased durability/longevity and repairability and design for reuse; decreasing the amount of material used in a product or package by methods such as lightweighting packaging; reducing the toxicity of products entering the waste stream by minimizing the toxics in packaging or products or making feasible the separation and removal of toxic components prior to disposal; reducing the use and consumption of "wasteful" products by individuals, government, and businesses; increasing the management of on-site wastes (*e.g.*, backyard composting).

Simply increasing the biodegradability of wastes does not contribute to waste prevention unless those wastes become part of an on-site composting program.

Techniques for Waste Prevention

There are three basic techniques which can be used to implement the approaches to waste prevention mentioned above. Governments should evaluate the potential usefulness of each of these techniques.

Ellen Z. Harrison is the associate director of the Cornell Waste Management Institute.

Financial incentives and disincentives, including: taxes (*e.g.*, a tax on packaging), tax credits, deposits on reusable products, and volume-based disposal fees (pay by the bag).

Regulations and restrictions or bans, including: banning certain products, uses of a product or constituents in a product; banning certain items from the collection/disposal system; labeling, product design, and government procurement (*e.g.* purchase preferences) requirements.

Education and facilitation, including: public information, technical assistance for business, labeling, youth education, waste exchange programs, environmental shopping campaigns.

Issues and Concerns

In developing a waste prevention program, there are issues which should be addressed. Measurement of success is one issue since with limited available funds, programs need to document their success and measuring waste that was prevented is a difficult problem.

The likely "side effects" of any program need to be assessed. These may be environmental or administrative. For example, banning non-degradable fast food packaging is likely to lead to an increase in the use of paperboard packages. Does this substitution improve the situation or does it add weight and volume to the waste stream? Does a proposed change decrease the chance for recycling? Will there be additional administrative demands such as enforcement? Will enacting volume based disposal fees lead to increased illegal dumping? If so, how will that be dealt with? Will new enforcement or educational efforts require additional staff? How much will it cost? Who will do it?

Economic implications are also crucial and require analysis. How does the program change who pays? Is the change equitable? Volume based disposal fees, for example, would fall on everyone approximately equally (there is not a large difference in the amount of waste generated by different income groups). Subsidies for poor people may be called for. In addition, there are tax implications in shifting from waste fees imbedded in local taxes to volume based user fees since the new fees would not be deductible from an individual's federal or state income taxes. There are also tax implications for the municipality since the amount of federal revenue sharing is based on the level of local taxes and if waste disposal costs are removed from taxes, the local tax level will decline.

Specific Programs

Ideally, the true costs of disposal would be taken into account in the market place. Products difficult to dispose of would cost more than similar products without the disposal problem. In reality, no one has come up with a means to accomplish this ideal. Some of the financial approaches which have been proposed or enacted are discussed below.

Volume based disposal fees (charging people according to the amount of waste they generate) are one means of giving people an incentive to produce less trash. Generally implemented at the local level, they have been used since 1981 in Seattle and are gaining rapid acceptance elsewhere in the United States. One benefit of such a system is that it places a strong incentive on the waste producers to reduce and recycle their wastes. In many programs there is no charge for wastes put out for recycling or composting. Seattle has the longest track record and believes fees are the key to their successful waste reduction program. One drawback to such an approach is the potential increase in illegal dumping or backyard burning. Administrative problems in applying the charges and the burden on the poor are other concerns.

There are several ways to administer volume based fees. In Tompkins County, NY residents must purchase "trash tags" to stick on their cans or bags. There are two "sizes" of tags, one for up to 35 pounds and a mini-tag for small cans. Residents can put out any number of cans or bags and pay the same cost per container regardless of the number they put on the curb (there is a subsidy program for people unable to pay). In Seattle, residents subscribe to a certain level of service (*e.g.*, how many containers of what size will be collected each week). If the amount of trash they put out exceeds the amount subscribed for, there is a steep charge for disposal of the additional trash. In an experimental program, Seattle is using a weighing garbage truck so that residents can be charged for the exact weight of trash they generate each week.

In New York and other states "packaging" taxes have been proposed. These generally seek to promote recycling (rather than prevention) through application of taxes on packaging that is not recyclable or not composed of recycled materials. Specific taxes have also been proposed in various items including "disposables", "litter" (items likely to end up as litter) and "hard to dispose of items". There is considerable support for such approaches, but there are also concerns. Major concerns raised are that the amount of tax imposed would be too small to have a significant impact on purchasing habits and that screening products to determine the application of such taxes would be a problem.

Tax incentives are used by governments to encourage desired actions. In the waste management field they are being used to promote recycling by providing incentives to use secondary materials. It is less obvious to see how they could be used to encourage waste prevention.

Deposits on particular products are another financial technique for waste management. While not particularly applicable to waste prevention, their primary purpose is to ensure that particular wastes get returned. Initially a litter control effort, deposits on beverage containers in many states have encouraged recycling. Deposits have also been enacted in some states on special wastes that are a hazard if improperly handled, such as automobile batteries. Tires and unwanted appliances which are difficult to manage are sometimes banned from disposal facilities and may end up illegally dumped along roadsides. Deposits have been proposed to ensure that these items find their way back into the managed waste stream.

Regulations/Bans/Requirements

Bans and restrictions can be implemented through laws and regulations. While it may be desirable to have national laws addressing some of these waste prevention issues, even a local law can have a large impact since manufacturers are likely to find it impractical to market different items in different locales depending upon their regulations. This also means, however, that manufacturers are very concerned

Residents Favor Volume-Based Fees

Recent research conducted by the Cornell Waste Management Institute in cooperation with Tompkins County and the Department of Consumer Economics and Housing at Cornell have shown strong public support for volume based fees as a means for equitably covering the costs for disposal. A survey of residents showed that over 60% favored the trash tag program while only 27% were opposed. Similarly, a majority of those answering a question regarding how to pay for future higher disposal costs favored increasing trash tag fees rather than flat fees or property taxes.

Another notable finding was the increase in recycling and backyard composting in response to the volume based fees in Tompkins County. An increased number of people are recycling and composting and they are including more items. The program has also encouraged waste prevention through purchasing decisions. Half of the residents say they are recycling more since the program started and 50% of the respondents report that they are composting in their backyards, up from 43% before the trash tag program was implemented. Over 75% of the residents reported that the implementation of trash tags has led them to try and buy products with less packaging.

Following the adoption in March 1990 of volume based disposal fees - known locally as "trash tags", the changes in the behavior of Tompkins County residents and their attitudes towards the trash tag program was studied through a survey of homes selected at random in a project involving the county, a faculty/student team from the Department of Consumer Economics and Housing at Cornell and the Cornell Waste Management Institute.

Sample Trash Tag

Tompkins County Solid Waste Management Program
Trash Disposal Tag ● Max. wt. 20 lbs.
Superior Disposal Service, Inc.
Authorized Hauler

PEEL LABEL FROM SHEET AND ATTACH TO CONTAINER, BAG OR TRASH. ALL REFUSE MUST HAVE TAG TO BE PICKED UP

with local attempts to control products and packaging and are likely to mount legal challenges. State governments have also stepped in to preempt local laws in several cases including Minnesota and Washington. An ordinance set to take effect in June 1990 in St. Paul and Minneapolis that would have restricted packaging to materials being actively recycled (not just potentially recyclable) was put on hold by the state as they work on statewide guidelines. While thus subject to challenges, laws at the local level can have a strong influence on the waste management agenda.

Some examples include ordinances and bans targeted at specific materials or contaminants. A number of states (including NY), for example, have passed legislation developed by the Coalition of Northeast Governors which over several years progressively lowers the amount of six toxic heavy metals which packaging may contain. While passage of such a measure by the federal government would be desirable, it seems likely that the impact of its passage by a number of states will have a similar impact. Manufacturers will develop packaging that meets these requirements in order to market in the states with this law and they are likely to sell the same product/package nationwide.

A number of communities, including Portland, OR, have passed ordinances addressed at plastics. These laws may ban the use or sale of "non-biodegradable" packaging or specifically polystyrene foam and usually target packaging of food items, (a very small fraction of the waste stream). The stated goals for such laws usually have to do with concern over the potential use of blowing agents that harm the ozone layer and general concern over degradability and recyclability. In Portland, where a significant portion of the mixed municipal waste stream will be composted, biodegradability is a very valid concern. Elsewhere, substitution of disposable paper products for disposable plastics may not have a beneficial impact on waste management. Another more direct approach being considered elsewhere is a ban of the use of disposables at "eat-in" restaurants and in certain institutional cafeterias. Communities need to analyze the cost, water use and waste water impacts of such proposals. Bans on specific products have also been instituted, such as the ban of juice boxes by the state of Maine. This type of packaging is not practically recyclable, hence the ban.

The laws discussed above generally are applied at the point of sale meaning that they prohibit retailers from selling certain items. Another approach is to ban the disposal of certain items. Yard wastes or certain recyclables have been banned from landfills and incinerators in some states and communities. These laws promote recycling and composting and may not impact on waste prevention.

The extent to which individual communities could adopt laws and win legal challenges to them in an attempt to "design" their waste stream to meet particular needs is unclear since it is a new area with little case law.

Required labeling has been proposed for a number of products. Such proposals would require certain products, disposable diapers for example, to carry a label stating the impact they have on the waste problem. Similarly, labels could be required on products like batteries, which contain toxics that may pose a problem in disposal. The effectiveness of such labels is questioned by some, and the imposition of labels is opposed by manufacturers.

A more direct approach would be product design requirements. The limitations of heavy metals in packaging discussed above may be seen as such a design requirement. Other possibilities would include a requirement that certain durable products come with a specific manufacturers or retailers warranty which would presumably influence both the durability and repairability of the product. Standardization of products might also be addressed since interchangeable parts can promote repair.

Governments and businesses can use procurement requirements and guidelines to address some of these same issues. Specifying that disposal impacts are among the items to be considered in procurement and taking a long-term view of costs in procuring items would tend to promote durable and repairable items. Similarly, a presumption in favor of buying items that are compatible with other items already purchased for ease of repair and replacing parts would serve to enhance waste prevention.

Finally, communities and states may require waste plans that address waste prevention. New York State, for example, requires that waste prevention to be part of community solid waste plans. To be effective, the plans should be specific about the methods to be employed and the funds that will be required to implement the plans. Similarly, a state or community may require that businesses develop waste plans that include prevention. The State of Rhode Island has adopted a requirement that businesses employing over 100 persons submit waste plans that address recycling and waste prevention.

The Future

Waste Prevention programs are new and growing. The Cornell Waste Management Institute is compiling information and developing answers to some of the issues which may arise in order to provide technical assistance to those establishing waste prevention programs. A bibliography and examples of some innovative programs are available from the Institute. Please contact us to share any programs you may know about or to obtain the information we have in hand.

Study to Identify Barriers to Environmental Shopping

What problems arise for consumers who try to shop "right" for the environment? A team including Suffolk County, Cornell Cooperative Extension in Suffolk County, a faculty/student pair in the Department of Consumer Economics and Housing at Cornell University, and the Cornell Waste Management Institute are embarking on a one-year, EPA-funded study to answer questions about pro-environmental shopping. The team will work closely with selected households and supermarkets in Suffolk County. Families recruited into the project receive education on environmental shopping and will keep track of their purchases for several months. The effectiveness of educational efforts, the amount of waste reduction realized, and the difficulties in finding acceptable products will be evaluated.

"We the People:"

The Missing Link In Reducing Municipal Solid Waste

By Richard E. Schuler

While New York and several neighboring states have adopted ambitious goals for reducing and recycling our society's wastes in order to lessen the burden on disposal facilities, why is it, to begin with, that the United States produces almost three times as much waste per capita as many other advanced economies? What should or can we do about it?

Many experienced municipal officials recognize the difficulty in mobilizing a majority of their residents for any extended period of time to reduce voluntarily the volume of wastes they put out on the curb. (Albeit, a small number of ecologically-spirited individuals have always composted, recycled, and in general tried to minimize the waste burdens that they place on the environment.) But the leaders responsible for being sure that the garbage doesn't pile up on the streets frequently take the only certain solution they think is available to them. They open new landfills and build larger incinerators to reduce and dispose of the mounting volume of wastes. Since the public, by-and-large, pays no direct unit fee for waste disposal, or, if they do, the charge covers only a small fraction of the total disposal costs, it is not surprising that this "free lunch" is beginning to cost taxpayers enormous amounts. Still, there is a long-lagged, missing link in our "toss-now, pay-later" society.

Dr. Richard E. Schuler, the director of the Cornell Waste Management Institute and the New York State Solid Waste Combustion Institute at Cornell University, is a professor of economics and civil and environmental engineering.

Variations in Per Capita Wastes

What are we to do? The only certain way to reduce the burdens of waste on society is to produce less of it.[1] This also seems to be a step with few potential unintended environmental side effects. The greatest fear is that the only way that substantial reductions in waste volumes can be achieved is by slowing economic growth, but perhaps we can learn something from an international comparison of per capita waste volumes. As shown in Figure 1, the three less developed countries for which there are consistent waste production data show substantially lower levels of waste per capita than do the industrialized nations, but among developed countries whose per capita gross national product varies almost fourfold there appears to be little systematic variation in trash production per capita with per capita income. In fact, a statistical fit of the data that accounts simultaneously for other possible sources of variation in per capita waste generation suggests that for each ten percent variation in per capita income across countries there is only a two percent variation in per capita municipal solid waste.

What is equally obvious from Figure 1 is that Australia, Canada, New Zealand, and the United States sit high on top of the rest of the world as the most prolific per capita producers of trash. What do these nations have in common besides predominant use of the English language? (Note: the United Kingdom is not among them.) One possibility is their colonial settlement by people outside the mainstream and power structure of British society, in some cases convicted criminals sentenced to penal colonies of the crown. (Is deviant behavior or unorthodox belief the source of trash production?) A more likely explanation is that all four countries are sparsely settled compared to European and Asian nations, and they all have abundant natural resources - in sum, the cost of being wasteful is much lower. Nevertheless, Figure 1 is encouraging primarily for what it doesn't show. There does not appear to be a strong positive relationship between per capita income variations and per capita waste generation among developed nations. Therefore, the United States may be able to cut the amount of waste it generates substantially in ways that are consistent with our current high standard of living.

Doing so, however, may require substantial changes in the way we do business and the characteristics of products we consume. Keeping and using products longer and repairing them when they fail means less to dispose of. How products are displayed and sold, the way they are packaged, how they are shipped, distributed and advertised, and the manufacturing materials used all determine our society's total waste burden. American business requires a new revolution, like those which occurred in marketing in the 60's and manufacturing in the 80's. From the earliest stage of product inception, managers would explore not only which products consumers might buy, but also how the products could be manufactured economically, and what the product cycle waste disposal implications are. In fact, many American corporations from manufacturers to retail chains are organizing environmental and/or waste management divisions, but those groups should be represented at the highest level of corporate decision-making when new product lines or business strategies are being conceived. Business must discover how it can profit by being environmentally conscious and by reducing society's waste burdens, but the problem is: all Americans share in any environmental improvement, therefore how can individual producers benefit from their efforts other than through institutional advertising proclaiming "How Green We Are!"?

Consumers as the Missing Link

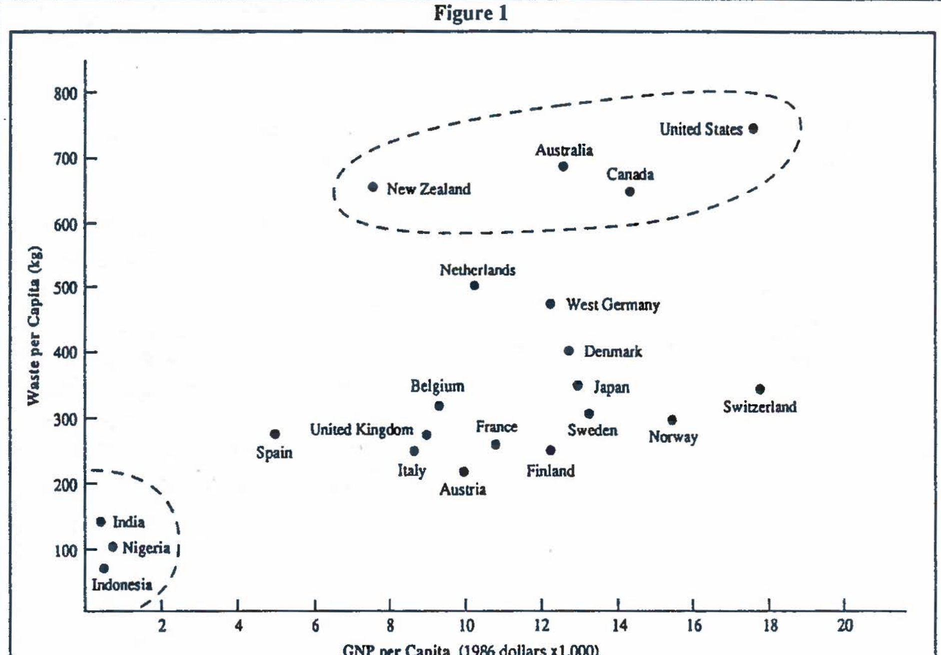
This brings us back to the one sector of society that is capable of attracting business's attention - the consumer. If customers begin to make their purchasing selections based in part upon the environmental consequences of activities all along the chain of each product's manufacture, distribution and disposal, American industry is bound to stand up and take notice. In turn, how can we spur the consumer to action? Public-spiritedness is an important first step, but again because of the collective nature of benefits from environmental improvement, consumers may become increasingly less willing to boycott otherwise attractive products just because of environmental problems if "everyone else" is buying them. Furthermore, the public's attention span on any single societal problem seems to be limited to two years, but the environment and waste disposal problems are perpetual. We need to institutionalize desirable consumer behavior.

While public education should help in reducing waste volume, we must also find ways to overcome both inertia and an extremely strong force that exists in modern America where several household members are employed – the importance of saving time. In fact much of the packaging associated with "convenience" goods like ready-to-microwave gourmet dinners that contribute to society's waste burden also relieve the tremendous time pressures on such a household. As an example, if using a pre-packaged food product saves a household with two working adults 30 minutes in meal preparation time and each worker is worth $15.00 per hour ($30,000 per year), then even if they value their leisure time at half of their earning capability, the use of pre-packaged products may be worth $7.50 per day to that household. Question: should we ban that type of packaging if its safe disposal cost is only $1.00?

This illustration emphasizes why Americans may generate so much trash; we are a highly impatient society. But also, we rarely confront the economic choice outlined in the illustration since the cost of disposing of products is not directly assessed on consumers. That is the missing link!

One way of establishing this link is to add a disposal fee to the purchase price of each product. With the total waste collection and disposal costs in large metropolitan areas mounting to $500 per household per year and more, this means that a cost-based disposal fee might average 10 cents per item for the

Figure 1



The international scene: Per-capita waste vs. per-capita income in industrialized and less-developed countries.

household that buys 100 items per week. While 10 cents might not dissuade the professional household from purchasing an extravagantly packaged food item, many households may respond to the increased prices of some items, as evidenced by their willingness to clip and return coupons.

Undesirable aspects of a per item disposal fee, if properly designed with different charges for different products related to their disposal cost, include the substantial cost of administration. Will we also need a "Commissar of Fees" to estimate and assign a disposal charge for every product? Alternatively, we might look for some common denominator for all products that reflects their disposal costs. As an example the product's price is a common denominator to which a percentage increment can easily be added, but such an additional sales tax is a poor indicator of actual disposal costs since a $1,000 diamond ring is less costly to dispose of than $1.00 worth of packaging material. A product's volume (required landfill or incinerator space) might prove to be a better common denominator, except some bulky food products with minimum packaging like popcorn are consumed entirely and add little to society's solid waste burden. Therefore, different levels of charges might be designed per unit volume, depending upon the ultimate disposal cost of the product and its package. One advantage of this charging method is that the volume of the product plus its packaging can easily be added to its bar code so the information can be sensed at the cash register electronically. Imperfect as this system is, if disposal cost stickers are added to each product's label or noted at the price display on the shelf, consumers will be confronted with the disposal costs of their consumption decisions every time they make a purchase. For administrative ease, a uniform charging system should probably be adopted statewide, or even nationwide, but each community should be allowed to include its own percentage add-on to reflect their different disposal costs. To be worthwhile, the cost of administering this system should be less than the resulting savings in disposal costs. A disadvantage of this system of including disposal fees in the purchase price of commodities is that consumers receive a modest incentive to buy in communities with low disposal costs with no guarantee that the municipality receiving the revenue is where their trash will wind up.

That is why economists prefer to assess the fee as close to the point where the cost is incurred or the damage is done. Many communities have moved to per bag trash disposal charges, which use the grossest sort of yardstick, the number of bags tossed, as the charging mechanism. Obviously, many bags of the same size will have different amounts of trash and, more importantly, different types of trash representing varying disposal costs, but this charging system is easy to administer and each community can assess different fees reflecting their own disposal costs. Mandatory waste separation can lead to a greater homogeneity of trash in all households' bags, but spot checking to encourage compliance raises administrative costs. The greatest potential problem with charging per bag for disposal is that it dissuades households from throwing away trash. This is desirable if instead consumers compost their food and yard wastes, as an example. But, if per bag charges lead to increased roadside dumping, the biggest public benefit that was originally derived from municipal trash collection will have been diminished. And certainly in our largest urban areas, it would be difficult to identify the sources of untagged trash on the curb if there is widespread non-compliance. Because of the potential dumping problem in large urban areas, it may be preferable in those locations to include disposal fees in the price of products at the store.

Benefits: Facility Planning, Financing

Proper pricing for the disposal of society's solid wastes isn't merely a boon for advocates of recycling and waste reduction. By providing a cash flow that represents the true benefits to society of disposing of its wastes, these revenues might be put to work to unlock the siting deadlocks that surround most proposals to open new landfills, build new incinerators and transport trash across political boundaries. This would represent cost-benefit analysis in action, rather than as a paper planning exercise, wherein residents in the neighborhood of a proposed waste disposal facility could anticipate substantial reductions in their taxes, for example, if they approve of the facility. Otherwise, different communities might get the benefit.

The idea of providing "host community benefits" to reduce opposition to waste disposal facilities is not new, but up to now those payments have usually come from general taxes rather than disposal fees assessed upon the communities that generate the trash.[2] In the scenario described above, if no community were willing to accept the trash from New York City, as an example, the disposal fees on New Yorkers could be raised until a benefit of sufficient magnitude could be offered that would encourage some community to accept the waste voluntarily (in this example, the potential benefit to the host community could be enormous, like no local taxes). Simultaneously, the higher disposal fees, whether assessed at the supermarket or as a per bag fee, would work to reduce the volume of trash generated, so the volume of waste and the available disposal capacity would begin to converge automatically.

In summary, what this furor over household sorting and recycling of trash and whether or not and how to charge for its disposal does create is a raising of consciousness that getting rid of some products after they are used is almost as costly as acquiring them to begin with. Once consumers have been forced to stop and think about the public cost of their consumption decisions, the next step is to use that period of reflection to confront consumers with the broader environmental impacts associated all along the chain of product manufacture, distribution, and sale. At last we have caught the consumer's attention, and through them, the producer's too, so we may have an opportunity to close the missing link.

Adapted from an article that originally appeared in Engineering: Cornell Quarterly, Vol. 24, No. 4, Summer, 1990.

Notes:

[1]Recycling is not generally considered to be a source reduction step since it usually requires some government activity.

[2]An exception is New Jersey.

Waste Avoidance in the Restaurant Industry

By Sheldon J. Reaven and David J. Tonjes

Rising waste disposal fees and public awareness of environmental issues have led to recent changes in waste disposal practices in the restaurant industry. Some restaurant owners and chains always have been concerned with the volumes and materials they discard, for pragmatic financial reasons, or because of traditional thrift (*i.e.* reprocessing food waste until it has no further value). Such attitudes have spread to restaurant owners who previously had few worries about the content of their dumpsters, as the nation-wide trends of closed landfills, rising tipping fees, and interest in recycling and appropriate disposal of wastes have spread.

Restaurants have a more difficult task in reducing their wastes than the usual commercial establishment: because their waste streams contain a much higher proportion of organic wastes, and do not contain one overwhelming component — as opposed to an office building, where paper wastes predominate. The readily recyclable materials a restaurant does produce are often contaminated by food; and because of the diverse nature of the waste stream, small, medium, and even larger restaurants may not produce enough of one particular recyclable to entice a recycler's services. Restaurants command a great deal of the public's attention: one-half of the public's food dollar is now spent at restaurants.

The public is well-aware of the garbage generated by this patronage, and often very concerned about the composition of these wastes, no doubt because of the visibility of fast-food trash. Restauranteurs, perhaps because of the service nature of the industry, and because their profits depend on being attuned to public tastes, are cognizant of these concerns, and are aware of the need to persuade the public that the restaurant industry is part of the solution, not the problem.

The restaurant industry is perhaps most easily divided into two segments, the fast-food sector, dominated by large chains such as McDonald's and Burger King, and what can be called the full-service sector (usually thought of as individually owned and operated establishments where "dining out" occurs). These distinctions are easily blurred. Into which category does a chain such as The Palm steakhouse fall, or the local Chinese takeout or pizza parlor? However, the chains, with their ability for bulk purchasing and desire for chain-wide consistency, can have a different approach to waste management from the restauranteur who answers only to himself (but lacks the corporate resources available to the chain-store operator).

Fast-Food Restaurants

McDonald's dominates the fast food arena, claiming over 10 percent of the nation's restaurant dollar, and its decisions on any subject reverberate throughout the restaurant world. McDonald's has an avid desire to be seen as a corporate good guy, as evidenced by such programs as Ronald McDonald houses for children, and has been progressive in attempting to reduce its waste stream. Fifteen years ago, it began to reduce the weight of its plastic packaging. The decision was made to cut costs; savings were felt in the purchasing department, and small savings were realized in garbage costs.

Under fire for its use of polystyrene, McDonald's strived valiantly for several years to institute recycling programs, going so far as to ask its customers to separate plastics from food wastes as they threw out their garbage. It supported several fledgling recycling plants, notably the plant in Leominster, MA. McDonald's recently announced plans for the most ambitious recycled product buying plan in the nation, and also has agreed to work with the Environmental Defense Fund to attempt to find ways to minimize wastes. McDonald's has been exploring the possibility of composting portions of its food wastes. The company stunned the plastics recycling community with the recent announcement of a switch from polystyrene containers to paper. The shift to paper products may make it possible to compost a larger fraction of the overall waste stream. McDonald's has also led waste avoidance, working with Coca-Cola to develop tanker systems for soda syrups, and in re-use, as in using plastic films from packaging as garbage bags.

Taco Bell, Burger King, Kentucky Fried Chicken and other chains have active waste management plans. Taco Bell has begun talks with its suppliers aimed at decreasing packaging wastes. Kentucky Fried Chicken has pilot projects in food waste composting; initial reports suggest that contamination by non-compostable materials has been troublesome. Burger King is also developing a composting program, and an alternative to the dumpster/compactor method of waste disposal with Dr. Leland Nichols of the University of Wisconsin-Stout. In a "through-the-wall" waste storage system, using compaction, and refrigeration to control odors, a computerized scale would monitor waste generation. In its most ambitious version, a specially designed containerized truck would allow the restauranteur to deliver source-separated recyclables to recyclers, and non-recyclables to a landfill or other disposal point, eliminating the commercial carter altogether. Nichols says such a plan may require several stores to work together, as capital costs are certain to be high.

Not all innovations are brainchildren of the largest chains. Subway Sandwich Shops re-use meat packaging as containers for large take-out orders. The packaging design incorporates soda cup holders and carrying handles, and bears the logos of the name-brand meat-packer and Subway. The chain offers a discount to customers who bring a previously issued box when picking up orders.

With its advantages of bulk ordering, and uniform practices on the part of franchisees and company-owned stores, the fast-food sector offers great opportunities for widespread changes in restaurant waste management. On the other hand, the large number of operators involved also results in a great deal of inertia, and the corporate chain of command may discourage innovations or slow their adoption. The reliance on single-service items, and the large proportion of products consumed off-premises may limit the ultimate effect of changes undertaken by these giants.

Full Service Restaurants

Here individual initiative is paramount. An owner can decide what materials to eliminate from the waste stream, train employees, make purchases, and arrange for suitable disposal. Recycling and waste minimization occur as often for purely economic reasons as for reasons of environmental principles. As an example of the latter, the Hard Rock Cafes have formed an entire "Save the Planet" department that promotes the use of environmentally friendly products, including organically grown produce, as well as in-house recycling and waste reduction. As an example of the former, one Long Island restauranteur explained that by the time his European-trained kitchen staff has finished with an item, "you can be sure it is garbage." He explained that his restaurant had, for reasons of thrift, never thrown anything away unless the last degree of use had been extracted from it. To this man, recycling, by reducing the amount of money he must pay for waste disposal, is good business.

There are a few government-sponsored pilot programs in which recyclables are collected from restaurants. Ten restaurants, bars, and delis are participating in a project in Mississauga, Ontario. Twelve restaurants participate in a small business recycling project in San Jose, CA. In both cases, the municipalities expect private recyclers to take over and expand the programs.

In San Jose , each business gets a lockable, three-cubic-yard container for recyclables (corrugated cardboard, metal, glass, and plastic containers, and wood). Based on data on waste generation by restaurants, these materials may comprise more than half a restaurant's waste stream by volume. Food contamination is unacceptable, so restaurants must wash containers and protect the cardboard. The recycler, Zanker Resource Management, reports initial difficulties with contamination have been resolved.

Most restaurant recycling is not government sponsored or supported. Waste stream diversions of up to 50 percent, and a commensurate reduction in tipping fees, are often claimed by the most industrious recyclers. As an example of a large operation, the Chicago Hyatt reports a 50 percent cut in its several hundred thousand dollars annual waste cost. The hotel devoted a room for waste handling, and hired personnel to sort all hotel garbage, not just restaurant waste, although this is the largest source of their waste.

Corrugated cardboard, metal and glass containers, and recyclable office paper are separated. Despite large expenses, the hotel is satisfied with the program, and claims to be breaking even, at the least. The Bullfinch, a restaurant in Massachusetts, recycles corrugated cardboard, metal containers, color-sorted glass, and composts certain kitchen scraps for on-site landscaping. This has required considerable additional time and labor, and the construction of 14 extra feet of storage bins. Still, the owner is satisfied, having cut her waste bill in half, and having received much favorable publicity. Shreiner's Restaurant and Pandl's Restaurant in Wisconsin are among others who have pioneered similar programs.

One difficulty typically encountered in self-run recycling programs is finding recyclers who are willing and able to accept materials. Glass must usually be color-sorted, a labor-intensive effort many restaurants are unwilling to undertake. One big-city restaurant found a street entrepreneur willing to provide this service, and he found a recycler for the sorted material. The same restaurant, unable to find a legitimate recycler for its cardboard, discovered the material would be stolen if simply set aside at night.

The largest component of a restaurant's waste stream is food wastes. Composting food wastes appears technically feasible, but very complex and fraught with perils. Our extensive research has found no food composting programs in North America that can be deemed a success, although Dr. Tom Richards of Cornell is doing pilot work with cafeteria wastes. There are some European programs, but these also are encountering processing difficulties.

Food scraps have long been fed to swine, but logistical difficulties, and, in many states, regulatory obstacles have restricted this practice. Rutgers University Foodservice has the most extensive program still in operation, diverting some 200,000 pounds from its waste stream each year. An unpublicized option for reducing foodwastes in the dumpster is to use a kitchen disposal to place wastes in the sewer system. Many sewer system operators are not taken with this idea; its utility is obviously limited to those restauranteurs who have access to a sewer system that will accept these wastes, and who are billed in such a way that the process makes economic sense. The capital costs are significant, and the disposal of certain items, such as rolls, may be inordinately time-consuming.

At State University of New York at Stony Brook we received a grant from the Environmental Protection Agency (EPA) to develop a comprehensive approach to restaurant recycling and waste reduction, in co-operation with the Town of Islip. A central feature of this national demonstration project is development of an "audit service" for individual restaurants, akin to energy conservation audits offered by utilities.

Participating restaurants receive a detailed, tailor-made "menu" of (voluntary) measures for recycling, waste reduction, and the use of recyclable and recycled materials. A waste composition study sorts each restaurant's garbage into more than 30 categories, both "before" and "after." The recommendations are based on waste stream analysis; extensive research into new developments in restaurant and commercial recycling and waste reduction; packaging and distribution by manufacturers, suppliers, and purveyors; dumpster and collection systems; restaurant equipment and supplies; food waste composting; and the associated regulations and economics. Discussions with trade associations, recyclers, carters, and governmental officials are integral to the project, since some of the most promising opportunities for recycling and waste reduction require these parties to co-operate.

Dr. Sheldon J. Reaven directs the EPA project described above. He is a professor at the Waste Management Institute, Marine Sciences Research Center, and in the Department of Technology and Society, SUNY-Stony Brook. Graduate student David J. Tonjes is a project research assistant.

Targeting Research Needs For Hazardous Waste Reduction

By Michael E. Ryan

Research directed at pollution prevention or waste minimization must be focused at key problems since the research dollars and resources are scarce. A priority list of specific research needs and waste reduction strategies is needed. The first step in this process is the identification of the major waste streams or contaminants being released to the environment. Consideration then can be given to additional factors such as their potential risk to human health, exposure threat, or geographic region where releases may be particularly high. The next critical step is the identification of the industrial sources and specific manufacturing process associated with the generation of the major hazardous waste streams. Finally, research needs may be identified and prioritized. This article will provide a general outline of this targeting exercise.

Hazardous Waste

The term hazardous waste has a specific legal meaning that, in general, refers to discarded materials that pose a risk to human health, safety, property, or the environment. The Resource Conservation and Recovery Act (RCRA) was enacted in 1976 to establish a comprehensive, national regulatory scheme for managing hazardous waste. In New York State the Department of Environmental Conservation (DEC) has been authorized since 1986 to administer the original RCRA statute. Under RCRA a waste is considered hazardous if it exhibits any of the characteristics of a hazardous waste as defined by standard analytical test protocols and procedures, is a listed specific hazardous waste, is a mixture that contains a listed hazardous waste and other wastes, has not been excluded from RCRA regulations as a hazardous waste, or is a by-product from the treatment of any hazardous waste. Listed wastes include generic wastes from nonspecific sources, wastes from specific sources, and specific chemical substances or compounds. Except for the inclusion on the New Yorkl list of polychlorinated biphenyls (PCBs), when present at certain levels, the state and federal lists are identical.

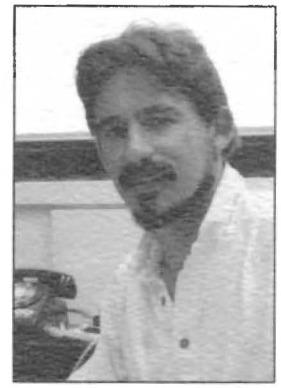
Exclusions from RCRA include household wastes, wastes from municipal resource recovery operations, and agricultural wastes.

Source Reduction

The remediation of inactive hazardous waste disposal sites and the treatment and disposal of hazardous wastes are of paramount concern to the entire nation. It has become imperative for the private sector to manage their production and manufacturing facilities in an environmentally sound and effective manner. The ability to detect the presence of trace substances in the environment has increased dramatically in recent years, leading to increased public awareness and demand for stricter emission controls or even zero discharge of pollutants from industrial operations. End-of-pipe treatment technologies to meet required performance have therefore become increasingly expensive and impractical in some instances.

Due to a variety of social, political, economic, and other factors, the focus continues to shift from treatment of effluent waste streams to the minimization or elimination of waste generation at source. The New York State Legislature has enacted the Solid and Hazardous Waste Management Policy and Planning Law (Chapter 618 of the Laws of 1987), which established a hierarchy of preferred waste management practices. The hierarchy calls for the reduction or elimination of the generation of hazardous wastes to the maximum extent practical. This parallels the preferred waste management hierarchy being promulgated at the federal level. This past session, the New York State Legislature enacted bill S.5276-B which requires hazardous waste generators to certify to the DEC that they have a program in place to reduce the volume and toxicity of their waste streams. Facilities failing to meet the requirements of the law will be prohibited from generating hazardous waste in New York State. This Hazardous Waste Reduction and RCRA Conformity Bill was signed into law by Governor Mario M. Cuomo.

Source reduction refers to any activity that reduces or eliminates the generation of hazardous waste at the source, usually within a process. Source reduction measures can include some types of treatment processes but may also include process modifications, feedstock substitu-



Michael E. Ryan

Michael E. Ryan is director of the Business-Industry Affiliates Program of the New York State Center for Hazardous Waste Management at State University of New York at Buffalo.

tions or improvements in feedstock purity, various housekeeping and management practices, increases in machinery or process efficiency, and recycling within a process. Source reduction implies any action that reduces the amount of waste emanating from a process. Historically, source reduction was indirectly achieved through cost reduction programs and related efforts.

Targeting Waste Streams

The delineation and definition of specific research needs and objective for facilitating the reduction of hazardous wastes generated in New York requires an identification of the major waste streams generated annually in the state and a ranking or prioritization of these waste streams. The task is formidable since thousands of waste streams are generated annually and a voluminous amount of data are reported under a variety of environmental legislative requirements. At the national level, more than 28,000 waste streams produced annually by large quantity generators fall under the provisions of RCRA. Every manufacturing company with 10 or more employees using or manufacturing certain quantities of 322 toxic chemicals and chemical categories is required to file annual Toxic Chemical Release Inventory (TRI) information with the United States Environmental Protection Agency (EPA) and the appropriate state agency. This requirement is part of the federal Emergency Planning and Community Right-to-Know Act, Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). For manufacturers or processors, (those that produce, compound, import, or prepare chemicals), the threshold for reporting was set at 75,000 pounds in 1987, 50,000 pounds in 1988, and 25,000 pounds subsequently. For a company using 10,000 pounds or more of a chemical annually, reporting is also required. Only companies with Standard Industrial Classification (SIC) codes 20 to 39 are required to report.

A total of 4.57 billion pounds of toxic substances were reported to be released to the nation's air, water and land in 1988. When discharges into sewage treatment plants and shipments to off-site commercial treatment, storage, and disposal facilities are included, the total increases to 6.64 billion pounds. New York State ranks 17th in total releases nationally.

In 1988, New York State manufacturers released 172.1 million pounds of chemicals to air, water, land, underground injection, and transfers to public sewage treatment plants and commercial waste treatment and disposal facilities. Total releases by SIC code are given in **Table 1**. The chemical industry accounted for approximately one third of the total. The geographical distribution by county is given in **Table 2** for the top ten counties. The ten companies that released the most toxic chemicals accounted for 88 million pounds, or approximately one-half of all reported releases. Of the total, 92.8 million pounds were released into the air, 2.1 million pounds were released to surface water, 1.1 million pounds to land, 25.6 million pounds to POTWs, and 50.4 million pounds were off-site transfers. A listing by chemical substance for the 25 largest chemicals is given in **Table 3**. A comparison of the 1987 and 1988 TRI data for New York indicated a significant 25 percent reduction in reported releases. Although this may indicate that manufacturers are making progress towards reducing toxic chemical releases, valid comparisons are hampered by several factors. Changes in annual toxic releases may reflect changes in manufacturing output rather than in the level of toxic waste associated with a unit of production. Differences in the data will reflect more accurate or better reporting. A third offsetting factor is the lower threshold for reporting and the consequent increase in the total number of facilities reporting. The 1987 data include sodium sulfate which does not constitute a significant risk to health or the environment and has been delisted.

In addition to the quantitative data, other factors may be considered in order to prioritize waste minimization efforts. One possible factor may be the consideration of the transport and ultimate environmental fate of the waste stream. Emission rates and multimedia transport models may be used to estimate human exposure levels. Another factor could be the potential risk or threat to human health that is posed by a particular chemical species or compound. Recently, Citizens Fund analyzed the 1988, TRI data for New York State and categorized the 322 chemicals (that manufacturing facilities are required to report under the law) into their known or suspected effects. The classification is based on EPA's Office of Toxic Substance's assessment of the chemicals and includes the following categories: carcinogens, heritable mutagens, developmental toxins, reproductive toxins, acute toxins, chronic toxins, and neurotoxims.

Targeting Sources

The data also provide information on the specific facilities reporting releases. In addition, any hazardous waste generator who produces more than 100 kg (220 lbs) per month or stores more than 100 kg (220 lbs) on-site at any one time is required to file a Generator Annual Report. The New York State Industrial Hazardous Waste Management Act of 1978 requires the DEC to prepare an annual report for the state legislature, identifying the quantity and types of hazardous

Table 1. Total Releases in Pounds by Manufacturing Industry in NYS (1988)

SIC	Industry	Air Releases	Water Releases	Total
28	Chemicals	13,276,087	604,729	57,805,098
38	Instruments	25,095,050	613,638	29,902,840
26	Paper	7,387,931	233,712	8,983,535
36	Electrical	4,181,474	68,027	8,309,553
33	Primary Metals	4,334,436	67,417	7,108,194
34	Fabricated Metals	4,945,445	107,763	6,487,863
37	Transportation	3,313,105	73,276	6,031,839
30	Plastics	3,455,712	16,117	4,379,861
35	Machinery	2,629,515	32,522	3,830,287
32	Stone/Clay	1,501,002	3,733	3,283,362
22	Textiles	2,503,797	14,923	2,757,961
27	Printing	1,825,585	0	2,209,665
20	Food	274,206	154,244	1,448,636
25	Furniture	1,189,063	0	1,336,517
39	Misc. Mfg.	964,383	1,205	1,279,723
29	Petroleum	19,603	15	653,390
31	Leather	298,595	250	508,519

waste generated and disposed of in New York and the number of sites that generate hazardous wastes. In 1988, 4162 large and small quantity generators reported a total of 11.68 million metric tons of hazardous waste generated. Approximately 96 percent of this total comprised aqueous hazardous waste which is predominantly pre-treated where it is generated.

The distribution of the non-aqueous hazardous waste by waste type is shown in **Table 4.** Of the 415,510 metric tons of non-aqueous hazardous waste generated in New York State, 259,335 were disposed of in-state and 156,175 metric tons were disposed of outside New York. The 55 largest generators in the state account for over 75 percent of the non-aqueous hazardous waste generated. Hazardous waste manifest data may also be analyzed to provide information on generators by quantity as well as by waste type generated. Such an analysis of the New York State Manifest information has been recently made by Recra Environmental, Inc. in conjunction with the Department of Environment and Planning of the County of Erie and the New York State Center for Hazardous Waste Management. These data are summarized in **Table 5** for large quantity generators in Erie County. Small quantity generators in the county add another 1,570,358 pounds per year.

All of this information may be used to compile a list of specific companies or facilities.

Identifying Research Needs

Although waste reduction efforts are highly site- or process-specific, some generic methods or practices may be defined as follows:

- ❒ good housekeeping practices and simple technology to eliminate leaks or spills and to minimize fugitive emissions during storage, processing, and transportation
- ❒ technological improvements in the separation or segregation of wastes in an isolated or concentrated form
- ❒ substitution or purification of input raw materials to eliminate the need for hazardous constituents or reduce the generation of hazardous waste by-products
- ❒ process modifications such as changes in operating conditions, introduction of new process technology, or redesign of equipment
- ❒ in-plant recycling of hazardous con

Table 2. Total Releases by Pounds in 10 NYS Counties (1988)

	County	Releases
1.	Monroe	30,245,171
2.	Warren	20,520,038
3.	Onondaga	13,345,114
4.	Niagara	11,785,541
5.	Broome	10,532,987
6.	Erie	10,394,056
7.	Albany	8,716,601
8.	Rockland	6,035,051
9.	Rensselaer	5,445,983
10.	Nassau	4,869,423

stituents directly back into the manufacturing process

❐ end-product modifications or reformulations that permit the use of less polluting upstream process or technology

The identification of research needs as well as opportunities for source reduction can best be achieved through the development of a properly designed waste tracking system, specifically a waste flow diagram or flowsheet of the process. This is inherently an activity of the process engineering and design group since it requires expertise related to quantitative material and energy balances, process chemistry, operating characteristics of the process, the design basis, and plant layout. This evaluation will be useful in identifying specific process technologies and other innovative techniques for achieving source reduction within a particular process.

Some common activities that would be beneficial on an industry-wide basis include the following:

❐ improved filtration practices and equipment so as to minimize the generation of spent filter media or improve the efficiency of the filtration process

❐ improved drying or dewatering techniques to provide a more concentrated solids residue or thickened sludge

❐ improved methods for source capture and return

❐ purification of spent solvents and materials for recycle and reuse

❐ use of alternatives to solvent cleaners and degreasers

❐ recovery of heavy metals from metal finishing waste streams

❐ alternative methods for paint stripping and coatings removal

❐ improvements in VOC reduction technology

❐ ion exchange techniques to produce concentrated agents

❐ use of ultrafiltration or membrane technology

Since the chemical industry accounts for a significant portion of the generation of hazardous wastes, source reduction efforts need to be undertaken in the process design and synthesis stage. The basic objective is to develop a process flowsheet or configuration that results in an overall minimum generation of hazardous waste. An integral part of the design process would be the development of a waste flow diagram to trace quantities of impurities and other undesirable byproducts. The waste flow diagram essentially entails material balance calculations of the form

{Raw Material inputs} = {Product Outputs}
+ {Materials Discharged}
+ {Wastes Discharged}
+ {Wastes Disposed}

The waste flow diagram can be very helpful for waste management decisionmaking. Various engineering tools and optimization techniques could then be applied to minimize the waste generated by a process. Considerable effort needs to be directed to the development and application of these concepts to the synthesis and configuration of reactors and separation units.

Summary

Implementation of waste reduction research programs has been uneven but the potential benefits are significant. In addition to lowered costs for waste management and regulatory compliance, long-term risks and liabilities are reduced, and profitability and competitiveness can be improved. Waste reduction is not some unique or specialized technology but is essentially a philosophy that becomes instilled as part of the corporate culture. Waste reduction research provides a means of identifying targets of opportunity based upon one or more criteria including: risk to human health, worker exposure, technical feasibility, economic potential, lack of adequate treatment capacity, attainment of environmental emission standards, etc. The best manufacturing options (process change, product reformulation, raw materials substitutes, etc.) require sound scientific and technical information based on research projects offering the greatest promise and potential benefit. By identifying or targeting research needs for hazardous waste reduction, both the public and private sectors will have a sound basis for focusing efforts, optimizing scarce resources, and maximizing beneficial results.

Table 3. TRI Release Data by Chemical Substance, in Pounds, NYS, 1987

Chemical	Release	Chemical	Release
Aluminum Oxide	21,521,659	Dichloromethane	1,063,954
Sulfuric Acid	13,804,441	Hydrochloric Acid	1,017,517
Ammonium Sulfate	12,028,150	Barium Compounds	978,004
Sodium Sulfate	7,644,811	Methyl Ethyl Ketone	959,609
Asbestos (friable)	5,222,370	Chlorine	929,740
Sodium Hydroxide	4,327,813	Lead	912,575
Copper	3,456,962	Methyl isobutyl ketone	897,802
Lead compounds	2,635,599	Acetone	888,149
Methanol	1,883,736	Trichloroethylene	800,932
Xylene	1,721,226	1,1,1,Trichloroethane	778,303
Chromium	1,574,190	Tetrachloroethylene	762,774
Toluene	1,170,682	Aluminum	748,080
Ammonia	1,070,763		

Table 4. Distribution of Non-Aqueous Hazardous Waste Generated in NYS by Type (1988).

Waste Description	Waste Code	Amount (tons)	Percent of total
Characteristic Waste:			
Ignitable	D001	48,218	11.6
Corrosive	D002	47,155	11.4
Reactive	D003	2,049	0.05
EP-Toxic Metals	DC04-D011	56,048	13.5
Listed Waste:			
Halogenated Solvents	F001-F002	104,006	25.1
Non-Halogenated Solvents	F003-F005	72,088	17.4
Listed Non-Specific	All other F wastes	41,812	10.1
Listed Specific	All K wastes	17,402	4.2
Commercial Products (Acute)	All P wastes	195	---
Commercial (Non-Acute)	All U wastes	5,638	1.4
PCB Wastes	All B wastes	20,859	5.1
Total		415,510	100.0

Table 5. Distribution, Hazardous Waste, Large-quantity Generators, Erie County, NY (1989)

Range (Lb./Yr.) of Waste Generation	Number of Generators	Percent of Generators	Quantity of Waste (Lb./Yr.)	Percent of Total Waste
>26,000 <50,000	39	37	1,380,368	5
>50,000 <100,000	31	29	2,179,072	8
>100,000 <250,000	18	17	2,993,156	12
>250,000 <500,000	5	5	1,710,442	7
>500,000	12	12	17,454,596	68
Total	105	100	25,717,634	100

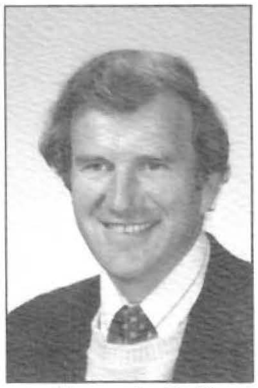
Major Waste Types:

Waste Type	Quantity (Lb./Yr)	Percent of Total Waste
Ignitable (D001)	3,889,742	15
Corrosive (D002)	3,161,139	12
Heavy Metal (D004-11, F006)	2,288,183	9
1. Heavy Metal (Listed) (F006)	251,888 (11 percent of total heavy metal waste)	
2. Heavy Metal (characteristic) (D004-11)	2,036,295 (89 Percent of total heavy metal waste)	
Non-Halogenated Solvents (F003)	1,573,942	6
Halogenated Solvents (F002)	752,000	3
Halogenated Solvents (Degreasing) (F001)	380,769	1
Non-Halogenated Solvents (F005)	346,189	1

Waste Minimization Management Advisory System

WAMMAS Offers Help with Waste Reduction

By Anthony G. Collins and Joseph V. DePinto



Anthony G. Collins

Joseph V. DePinto

Dr. Anthony G. Collins is an associate professor in the Clarkson University Department of Civil and Environmental Engineering. Dr. Joseph V. DePinto is a professor in the Department of Civil Engineering at SUNY Buffalo and director of the university's Great Lakes Program.

Source reduction should be the highest priority of any well-conceived hazardous waste management program. It can be accomplished by a variety of means, including input material changes, alterations to process technology, product substitution/modification, good operating practices, and recycling/reuse. The approach currently being evaluated at Clarkson is the extent to which expert system technology can be applied to aid process management so that hazardous waste can be minimized.

An example of such a management aid could be an expert system to help control fluctuations in the mass flow rate of contaminants from multiple wastewater sources to a discharge point. If treatment occurs before discharge, a consistent mass flow rate will maximize treatment efficiency and minimize the potential for discharge violations. The latter would also be true for situations where treatment does not exist. The rules to control the various wastewater flows can be both algorithmically and heuristically based. For example, if two processes which both generate excessively high concentrations of a contaminant are running simultaneously, a possible solution may be simply to schedule the processes to run at different times. The expert system could check for violations in waste generation, investigate alternatives for correcting the problem, and disclose its conclusions to the user.

Clarkson personnel work with the ALCOA-Massena (NY) facility to develop example expert systems to aid hazardous waste management. In developing background information for the project it became obvious that while a number of techniques to control, monitor, and reduce the production and disposal of industrial hazardous materials exist, implementation lags far behind, particularly for waste reduction. One reason for this situation is the reluctance of many industries to allow external assessment of their production processes in areas often viewed as sensitive. This attitude slows the transfer of existing technology and the development of new approaches. The WAste Minimization Management Advisory System (WAMMAS) has been developed to address this issue. This software is designed to aid management in the minimization of hazardous waste. It also provides a training/reference tool to promote industry-wide appreciation of hazardous waste management issues and potential approaches that can be applied.

The overall structure of WAMMAS is shown in Figure 1. The MAIN segment provides the user with an overview of the basic concepts of waste minimization. The program components are outlined, fundamental terms are defined, and the currently accepted strategies of a hazardous waste management program are reviewed. Once a user is familiar with this material, this segment can be traversed rapidly during subsequent sessions by use of the space bar.

The Waste Audit Example component is designed to help individual New York State industries (and others) undertake a waste audit of their facility. It concentrates on an example mass balance model for the flow of all waste materials. This component provides fundamental concepts for developing a mass balance on waste, with emphasis on often-ignored or unrecognized pathways and sources and sinks of waste materials. It is designed to give users a conceptual base from which they could develop models of their own plants. The conceptual model would guide an actual waste audit of the user's industrial process that would form the data gathering stage of their own model. The model they build would, in turn, be the foundation around which waste minimization alternatives could be evaluated and from which a waste minimization program could be developed.

The Specific Process Hints component affords the user the opportunity to reinforce the waste mass balance concepts by constructing a simple schematic of their own industrial process. Another aim of this component is for the user to gain insight into their process from the perspective of waste generation rather than from the usual view of manufactured product. Construction of the schematic, therefore, stresses the flow of wastes within the overall process rather than the flow of raw materials and manufactured goods. Currently about 15 unit operations are stored in the program library.

The third component, the Case Studies, draws together a wide range of information regarding proven waste reduction approaches. (About 25 examples are currently in the program inventory). The examples can be approached from either a waste reduction strategy direction or by industry. Some very simple elements of intelligent tutoring systems are incorporated in the program so that, based on the schematic of their process produced by the user, a list of examples that may be of most interest to the user are suggested initially. Of course, the user is free to choose whatever examples may of interest.

The final component, the Expert System will provide an example of a rule-based management aid that will minimize contaminant mass flow fluctuations. Equalization of such fluctuations will carry with it benefits for treatment and/or reduce risk of discharge permit violations. The system is being developed with the cooperation of ALCOA-Massena.

To increase user interaction, consideration is being given to further developing the intelligent tutoring aspects by evaluating user understanding of waste minimization opportunities. After reviewing the waste minimization examples, the user would be returned to their own process schematic and asked to identify where any of the reviewed examples would be appropriate. Their response could then be compared to the program's response and an explanation of inconsistencies would be provided.

To date, a number of techniques exist to control, monitor, and reduce the production and disposal of industrial hazardous materials; yet implementation is sporadic. Frequently industry prefers end-of-pipe management as this is perceived as less disruptive to industrial processes. A need exists for educational/instructional aids to nurture the understanding and encourage the implementation of waste source reduction techniques, the highest priority of waste minimization strategies. To this end, WAMMAS is being developed.

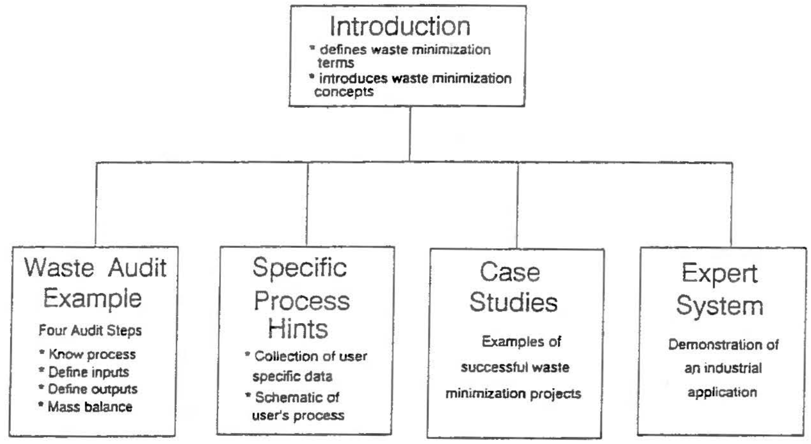


Figure 1: Sructure of WAMMAS

New York State Center for Hazardous Waste Management

Publications on Hazardous Waste Management Available from Buffalo-Based Center

The New York State Center for Hazardous Waste Management recently published a revised second edition of *Research and Development in Hazardous Waste Management,* an inventory of hazardous waste research at centers and institutes throughout the country. The editors identify each research project by title, principal investigators, and center or university affiliation and give a contact telephone number. The publication also includes a brief description of each center or institute.

The cost of the publication is fifteen dollars ($15.00), payable to the University at Buffalo Foundation. Interested persons may write or call the New York State Center for Hazardous Waste Management, 207 Jarvis Hall, Buffalo, NY 14260, (716) 636-3446.

In addition to the new edition of *Research and Development in Hazardous Waste Management,* the New York State Center for Hazardous Waste Management offers the other publications listed at right. Again, the cost is payable to the University at Buffalo Foundation, and interested persons may write or call the New York State Center for Hazardous Waste Management, State University of New York at Buffalo.

Publication	**Price**
Annual Report, 1990	Free
Research and Development Projects, *Summary Descriptions*	Free
Report on the Roundtable Discussion on Source Reduction of Hazardous Waste (Large Quantity Generators)	$2.00
Report on the Roundtable Discussion on Source Reduction of Hazardous Waste (Small Quantity Generators)	$2.00
Impediments to the Implementation of Alternative Technologies	$2.00
"Mathematical Simulation Models for Evaluating the Biological Fate of Organic Contaminants in Groundwater," Stewart W. Taylor, State University of New York at Buffalo	$2.00
Project Summary Report: "Use of Metal Adsorbing Compounds to Mitigate Heavy Metal Toxicity in Suspended Growth Biological Treatment Systems (Part I)," Mary R. Matsumoto, State University of New York at Buffalo	$5.00
Research and Development in Hazardous Waste Management (A Survey of U.S. Centers and Institutes), Revised 2nd Edition, November, 1990	$15.00

Great Lakes Conference Set for June

The 34th annual conference on Great Lakes Research will open with registration on June 2, 1991, and continue until June 6 on the North Campus of State University of New York at Buffalo. The Great Lakes Program of SUNY-Buffalo and the New York Great Lakes Research Consortium (GLRC), from its host campus, State University College of Environmental Science and Forestry in Syracuse, will host the meeting.

Participants will exchange information about applied and basic research directly related to the Great Lakes and applicable to the understanding and management of large lakes in general. In addition to the general program, the conference will include several special symposia and sessions. Among the topics will be: Progress on the Green Bay Mass Balance Study, Progress in the Assessment and Remediation of Contaminated Sediments (ARCS), Toxic Chemicals and Human Health in the Great Lakes Basin, and Ecosystem Approach in Great Lakes Decision Making.

Other topics are: Interactions Among Various Great Lakes Management Strategies, Evidence for the Restoration of Lake Erie, Research and Management of Wetlands in the Great Lakes Basin, Zebra Mussel Research in the Great Lakes, Transport of Particle-associated Contaminants in Large Surface Water Bodies, Neurotoxicology of Great Lakes Contaminants, Fish and Fisheries Ecology in the Great Lakes, Bioindicators of Ecosystem Health, and Lake Levels and Coastal Stability.

Interested persons may write or call Dr. Joseph V. DePinto, director of the SUNY-Buffalo Great Lakes Program, or Dr. Ralph R. Rumer, executive director of the New York State Center for Hazardous Waste Management, SUNY-Buffalo, 207 Jarvis Hall, Buffalo, NY 14260 (716) 636-2088.

Notes and Announcements

Cornell Sponsors Precycling Workshop

"Precycling," a term coined in Berkeley, California to capture the idea of producing less waste before recycling, was discussed by more than 150 people at a workshop sponsored by the Cornell Waste Management Institute in Syracuse last October.

With the goal of helping participants implement source reduction programs in their communities and businesses, the workshop included speakers from Washington state and Minnesota as well as discussion groups.

Topics of interest included "environmental shopping," legislative options for source reduction, and lifecycle assessments. Interaction among the attendees sparked ideas and enthusiasm. A packet of resource materials was provided to help conference participants bring home some of the ideas.

Cornell Offers Video

"Life After the Curb: Recycling Processes"

An animated grape juice can, "Grapey," leads students in grades K - 12 through metal, glass, plastic, and paper recycling processing plants via a video tape available from Cornell University. The video, produced by Biomedical Communications, Cornell Cooperative Extension, and the Cornell Waste Management Institute with funding from New York State, shows how recycling plants operate and teaches good waste management. Grapey talks about waste prevention and reduction, reuse and recycling, and the need to buy durable and recycled items. The video is available from the Cornell University Distribution Center, 7-8 Business and Technology Park, Ithaca, NY 14850.

Solid Waste Topic of Cornell Disks for Schools

The Cornell Waste Management Institute, in cooperation with a committee of educators, has developed an educational supplement on solid waste for use with WordPerfect 5.0 on IBM or compatible computers. A laser printer is necessary to keep format intact.

The exercises on disks are divided into four grade groupings, K-3, 4-6, 7-8, and high school. The content can be adapted to individual communities in terms of population, rates of solid waste generation, recycling rates, and dates. The series will be available this spring.

April Deadline Set for Colorado Conference Abstracts

April 30 is deadline for submission of abstracts of papers and poster presentations for the Colorado Hazardous Waste Management Society conference to be Oct. 3 and 4 in Denver. Send one-page, double-spaced abstracts to Rupert Burtan, TRIDEM Services, Ltd.; 1660 S. Albion St., Suite 916, Denver, CO 80222, Telephone (303) 758-1482, FAX (303) 758-1544. Include author's name, affiliation, address, and telephone number with each abstract and indicate topic category and whether the abstract is for a paper or a poster presentation.

New NETAC President Named

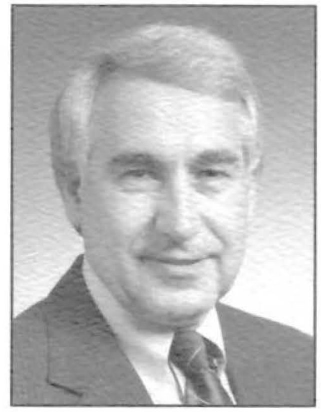
Dr. Edgar Berkey is the new president of the National Environmental Technology Applications Corporation (NETAC) at the University of Pittsburgh. He fills the position previously held by Samual Schulhof, who now directs the new GE Environmental Research Center in Schenectady, NY.

Berkey was executive vice president of NETAC from 1988 and with Schulhof was a co-founder of the corporation. NETAC was established under an agreement between the EPA and the University of Pittsburgh Trust.

Guest Comment

Intelligent Management Of Municipal Solid Waste

By Irvin L. (Jack) White



Irvin L. (Jack) White

Although waste management has clearly become a high visibility, high priority public problem, most of us consider resolution of the problem to be someone else's responsibility. Until a waste management issue is raised locally, *e.g.*, by a proposal to site a facility, we tend to take waste management, including waste disposal, for granted.

The category of waste we know most about is municipal solid waste (MSW). This is because most of the waste we personally "manage" falls into this category.

Historically, MSW management has been a local responsibility. MSW management has meant putting the garbage can out once or twice a week. All we have known about the system is that someone, either a municipal or private service, picks our garbage up. Most of us still assume that our responsibility begins and ends at the curb.

The problem is growing because the amount of MSW being generated is increasing, largely as a consequence of population growth. But waste generation per capita has also been increasing.

According to the U.S. Environmental Protection Agency, we generated an estimated 160 million-plus tons of MSW in 1986. The rate of increase is a little more than one percent per year. On a per capita basis, the expected increase is from an estimated 3.6 pounds per day in 1986 to 3.9 pounds per day by 2000.[1]

So, reducing waste is a logical step to take in dealing with our MSW management problem. It seems obvious that if we produce less there will be less to be processed and disposed of. But as is always the case, it's not that simple. As Richard Schuler indicates in his director's comment, "... nobody really knows with certainty how to go about reducing waste, systematically, let alone how to determine whose responsibility that ought to be."

Reducing or preventing waste will require both consumers and producers to change their behavior. As consumers, we have to assume responsibility beyond delivering our garbage cans and recyclables to the curb. And producers have to assume responsibility beyond the fence. They must consider either modifying or replacing processes so they use less energy, produce less waste and wastes that are less environmentally insulting.

But to be beneficial, waste reduction has to be intelligent. Well informed waste management decisions must be based on an in-depth understanding of the waste stream, the alternatives for managing it, and the consequences of using these alternatives.

There are no silver bullets. Every alternative produces consequences, some desirable and some undesirable. This is the case with inadequately informed reduction just as it is with inadequately informed recycling, resource recovery/incineration, and landfilling. A sound, well informed, thoughtfully designed MSW management program will almost certainly include all four.

[1]See, United States Congress, Office of Technology Assessment, *Facing America's Trash: What Next for Municipal Solid Waste?* (Washington, DC: Office of Technology Assessment, 1989).

Dr. Irvin L. (Jack) White is president of the New York State Energy Research and Development Authority (NYSERDA) and a member of the Executive Committee of the New York State Solid Waste Combustion Institute at Cornell.

Back Cover

Educational materials for specialists, government officials, schools and the general public can help to promote sound waste management. Photo by David Ruether

Waste Management
Research
Report

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