CO-COMPOSTING MUNICIPAL SOLID WASTE: ECONOMIC ANALYSIS FOR COST-EFFECTIVE PROCESSING AND MARKETING

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ABSTRACT

Aerobic composting is a promising method to reduce the bulk of municipal solid waste (MSW) after the maximum feasible amount of nonorganic materials have been removed and recycled. Composting converts most of the organic portion of MSW into carbon dioxide gas and water vapor, reducing the original volume and lessening the demand for landfill space. If the contaminants (e.g., glass shards and plastic granules) in MSW compost can be removed to an acceptable level, and if a uniformly safe product can be assured, MSW composting may become widely applied.

This paper illustrates the appropriate analytical methods and tools with a case study of the MSW co-composting facility in Portage, Wisconsin. The economic models developed in this study can be used by other communities to assess the economic viability of composting as a component in MSW management systems.

INTRODUCTION

The increasing volume of municipal solid waste (MSW) has been a critical problem of industrialization and urbanization since the turn of this century. Landfilling has been the most common MSW disposal method. However, increasing public concern about the long-term environmental risk of landfills has led to more stringent regulations. In 1988, the U.S. EPA proposed new Subtitle D regulations setting higher Federal standards for landfills. After lengthy review by the U.S. EPA and OMB, the new regulations for municipal solid waste landfills were published on September 11, 1991. The new EPA standards will raise the construction, maintenance, operating, and closure costs of landfills substantially. This discourages the construction of new landfills as well as the upgrading of existing ones. Many small local nonengineered landfills will no longer be able to operate economically. Since the new EPA standards were proposed, many landfills have already closed; in Wisconsin alone, the number of landfills fell from 896 in 1989 to 164 in 1991.[1] Thus, many communities are looking for alternatives to address their MSW problems.

Composting is one effective way to address the MSW disposal problem because it reduces the volume of MSW that needs to be landfilled. Soaring tipping fees also make composting more cost-effective. Since 1984, cities in Delaware, Florida, Iowa, Minnesota, and Wisconsin have integrated various MSW composting technologies into their waste disposal systems.

To be feasible, composting technologies must be cost-effective and environmentally sound. From an economic point of view, the benefits of composting MSW

[1] "Annual Landfill Report," Department of Natural Resources, Bureau of Hazardous and Solid Waste, Wisconsin, 1989–91.

are the sum of market sales of compost, if any, and the avoided landfill costs. For composting to be economically feasible, the additional costs of processing compost, less any proceeds from selling it, should not exceed the cost of landfilling the MSW from which the compost is made.

Environmental impact is another aspect that needs to be addressed. The composting process needs to be operated in an environmentally sound manner and monitored constantly. States such as Minnesota and Wisconsin have explicit regulations on the application of MSW compost.

The paper presents a case study on the economics of composting at the MSW co-composting facility in Portage, Wisconsin. Portage has a nonengineered landfill built in 1976. According to the new EPA standards, the City needs to either comply with the new landfill standards or close the landfill within 24 months after the Subtitle D's publication in *Federal Register.* This research seeks to help the City identify the most cost-effective way to address its waste disposal problems. The first part of this paper will describe the operation of Portage's MSW Co-Composting Facility, the methodologies, the analytical tools used in the economic analysis. The second part of this paper applies these tools to several scenarios, and discusses the results. Communities that either wish to start an MSW composting program or wish to upgrade their existing facilities may find the research methods and the economic models developed in this study useful for making long-term financial and investment decisions.

CASE STUDY — THE MSW CO-COMPOSTING FACILITY IN PORTAGE, WISCONSIN

In 1986, the City of Portage began operating the first in-vessel MSW co-composting facility in Wisconsin. It processes approximately 80–100 tons of MSW from Portage (half from residential areas and half commercial), along with 9000 gal of sewage sludge, every week.[2] Incorporating composting into Portage's solid waste disposal system was expected to extend the landfill life to the year 2000.

Portage's MSW is transported in packer trucks and dumped onto a concrete tipping floor in an enclosed composting building. No shredding or hammermilling equipment is used to preprocess the MSW before composting. However, large waste items and some recyclables (e.g., corrugated cardboard) are pulled out by hand. The remaining waste is directly pushed by a hydraulic ram through an opening in a dividing wall into a 165-ft long, 11-ft diameter salvaged cement kiln, which is supported by three bearings, and mounted at a 3% slope. A 70-hp electric motor rotates the drum at 1 rpm. The whole system is designed to mix the waste thoroughly and move it toward the lower end of the drum by gravity.

Sludge is trucked from the Portage Waste Water Treatment Plant, stored in a 21,000-gal tank, and added through an opening at the front end of the compost drum. Sewage sludge is 96% water; adding 13 gal of sludge per cubic yard of MSW maintains the proper moisture concentration throughout the aerobic composting process. During the composting process, the DNR requires that the temperature be maintained at 131°F for at least three consecutive days to ensure the destruction of pathogens and weed seeds. The organic fraction of MSW decomposes into a humus-like compost. The process is aerobic, and, no serious odor problem has ever arisen.

After a 2-week retention time, the compost and reject material are discharged from the lower end of the drum, separated through two layers of screens and transported by conveyor belts to outdoor storage.[3] (The full capacity input of this facility is about 30 tons/day. The present 2-week retention time can be adjusted if needed.) The reject material, mostly non-organic, is then landfilled. The composting process reduces the original volume by approximately 45%.

Compost has minimal value as a fertilizer but is an excellent soil amendment. Soil researchers have found that compost can enhance aggregation, increase porosity and aeration, decrease crusting, and improve water permeability, infiltration and retention (Williams and Epstein, 1991). However, many glass shards and plastic granules are not screened out, so the compost produced in Portage cannot be marketed. Instead, it is utilized as daily cover for the landfill, which is adjacent.

The City began a 3-year field study on the application of MSW compost in 1990. The MSW compost is cured for 8–12 months and screened at ¼ in. To date, no specific guidelines have been developed by the DNR for the application of MSW compost, so criteria developed for land-spreading sewage sludge are applied. The preliminary results show that the compost produced from Portage's MSW meets the standards for land-spreading sewage sludge. However, visible contaminants (e.g., broken glass) remain, so the willingness of

[2] Another 170 tons/week of waste from Portage's commercial and industrial establishments are directly disposed of at the Portage Landfill next to the composting facility.

[3] Rejects are separated by successive 2-in. and ¾-in. screens.

farmers to accept MSW compost is unclear. Concerning about the possible long-term liability associated with the use of MSW compost, the City has not developed any marketing plans.

ANALYTICAL TOOLS

The economics of composting MSW vary greatly from one region to another, depending on variables such as local landfill tipping fees and markets for compost. We now construct alternative scenarios to clarify the scope of this analysis, and formulate economic models to assess the economics of Portage's co-composting project.

Scenario-building Technique

Three scenarios depict alternative choices for the City of Portage; our model will estimate the changes in the MSW disposal costs under each scenario, when the present Portage landfill closes. The scenarios are as follows:

(a) The City closes the composting facility and hauls MSW directly to another landfill.

(b) The City retains the composting facility and hauls the rejects and the unmarketed compost to another landfill. The City can either landfill both materials (scenario B1), or find outlets for the coarse compost with insignificant additional costs, and only pay to landfill the reject materials (scenario B2).

(c) The City invests in an advanced technology to process MSW compost into marketable products, and only hauls reject materials to landfills.

There are two accessible landfills for Portage's MSW: the Hechimovich Landfill in Mayville, Dodge County, and the Valley Trail Landfill in Berlin, Green Lake County. Portage could also close its co-composter and haul MSW to the Columbia County Co-Composting Facility in Pacific Township, just 6 miles away.[4] The costs of transportation and tipping fees for these facilities range from $5.75 to $14.00/cy, depending on the content and the density of the wastes.

Our models enable the City of Portage to compare the MSW disposal costs with and without its own composter. The cost comparison among scenarios also serves as a general investment guideline if Portage were to invest in compost processing. If Portage can process their MSW compost and market it for a net cost less than the avoided landfill disposal costs, the processing investment will be cost-effective.[5]

Computer Spreadsheet Models

A computer spreadsheet program is a useful tool for performing a "what-if" as well as a sensitivity analysis to deal with the uncertainty of waste management strategies based on various local parameters. However, the models help ensure that all the costs and returns are considered. To evaluate MSW composting proposals, the computer models developed in this study should be run with relevant local data.

METHODOLOGY

The research steps are as follows, in order: Define primary input variables, estimate costs and revenues, calculate present worth of MSW disposal costs, calculate cost-effective investment margins, and perform a sensitivity analysis. These will now be illustrated with the Portage case.

Primary Input Variables

The MSW disposal system of each community is unique in certain respects. To calculate Portage's MSW disposal costs, population, per capita MSW generation rate, and landfill tipping fees are estimated. These basic parameters determine the appropriate size of the facility and its equipment. In addition, landfill tipping fees are likely to vary from one region to another, depending on the capacity, distance, and competitiveness of available landfills. Therefore, the feasibility of an alternative waste disposal method, such as composting, depends greatly on the cost of disposal at local landfills (or incinerators).

Costs and Revenues Estimations

Based on the assumptions for each scenario, the relevant cost and revenue streams for 1990 and 1991 are examined and categorized as fixed or variable costs. This forms the base-line cost and benefit structure to estimate the costs and revenues for the following years. Fixed costs are defined as the constant costs that are independent of the volume of waste handled, such as insurance costs, license fees, administrative and over-

[4] The Columbia County Co-Composting Facility, located in Pacific Township, Wisconsin uses composting technology similar to that of the City of Portage. It began operations in 1991.

[5] Because capital investment timing differs among the alternatives, we compare the net present worth of the projected costs of each alternative.

head expenses, and the supervisor's salary. Variable costs, such as labor costs, landfill tipping fees, testing fees, truck maintenance and fuel costs are assumed to be proportional to the volume of MSW handled. To avoid projecting inflation and interest rates over a long period, all the costs and revenues are expressed in 1991 dollars (the first project year). In the case of Portage, base-line costs are derived from the actual spending on MSW disposal in 1990 and 1991 budget.[6] Necessary adjustments are made according to the corresponding assumptions of each scenario.

A contingency allowance of 15% is added to cover all the unexpected costs. Potential revenues from the sales of compost and used equipment are then credited to offset part of the costs. (The sale of compost is initially assumed to be zero.) The annual MSW disposal costs are described by a general linear function as follows:

$$DC_i = [A + (B * X1_i) + (T * X2_i) + I_i] * 1.15$$

where DC_i = disposal costs in year i (\$), A = aggregated fixed costs (\$), B = variable costs (\$/cubic yard, abbreviated as \$/cy), $X1_i$ = the volume of MSW handled in year i (cy), T = tipping fees (\$/cy), $X2_i$ = the volume of MSW transported and disposed of in landfills in year i (cy), I_i = capital investment in year i (\$).

Net Present Worth of MSW Disposal Costs

The "net present worth" (NPW) of MSW disposal costs are calculated to project the aggregate costs of different scenarios over the project years, using 1991 as the base year. Future costs and revenues are discounted to reflect the opportunity cost of capital. By comparing the present value of cost under different scenarios, communities can find the most cost-effective approach to handle their waste. The NPW of the MSW disposal costs is calculated based on the following formula:

$$NPW = (DC_1 - R_1) + \frac{(DC_2 - R_2)}{(1 + r)^1} + \frac{DC_3 - R_3)}{(1 + r)^2} + \ldots + \frac{(DC_{10} - R_{10})}{(1 + r)^9}$$

DC_1–DC_{10} are the annual total disposal costs in 1991–2000, R_1–R_{10} are the revenues in 1991–2000, and r is the discount rate.

To reflect the time value of money, the net costs are discounted at a "real interest rate," from which the influence of inflation has been eliminated. This real interest rate is defined as the market interest rate (7%)[7] minus the estimated inflation rate (3%).[8] Therefore, a 4% real interest rate is used.

Cost-Effective Investment Margins

After the Portage Landfill is closed, the City can no longer avoid disposal costs for the coarse compost by using it as landfill cover. The City will have to either landfill the compost, or process coarse compost into marketable products. Most of the compost processing systems are custom-designed for individual projects, and have not been proven to be effective for wider application. Thus, instead of projecting the costs of an unknown compost processing system, the differences in the projected landfill costs between scenarios B1 and B2 (costs for disposing of coarse compost), B1 and C (costs for processing and disposing of coarse compost) are calculated to show the disposal costs avoided by diverting compost from landfill.

The NPWs of the differences in avoided landfill costs are defined as the cost-effective investment margins for processing compost, representing the maximum amount of money Portage could invest in processing coarse compost without increasing the total disposal costs over the project period (10 years).

Sensitivity Analysis

The ability to efficiently perform sensitivity analysis is another advantage of using computer models. In this study, the NPWs are calculated based on various assumptions to show how the changes in landfill tipping fees and interest rates jointly influence the net MSW disposal costs. This analysis can also be expanded to examine the impact of alternative estimates of other variables, such as the recycling rate and the composting rate.

[6] Space does not permit detailed description of how we estimated each cost and source of revenue for the City of Portage. For specific assumptions and an in-depth discussion, please refer to Ms. Lai's Master Thesis, "The Economic Analysis of Municipal Solid Waste Composting—The Case of Portage, Wisconsin," Department of Agricultural Economics, University of Wisconsin–Madison.

[7] Because the City of Portage does not borrow or lend money, the opportunity costs (in this case, a presumed market interest rate) for the City are assumed to be the rate of return, currently about 7%, if the money were invested through the Wisconsin Investment Board, which provides that service for Wisconsin cities.

[8] This estimation is the rounded 1989–1990 inflation rate of industrial commodities-machinery and equipment (2.81%), according to the Producers Price Index, Survey of Current Business, April, 1991.

ECONOMIC ANALYSIS — THE CITY OF PORTAGE

The economic analysis and the functions of the computer models are demonstrated in this section. Two cases will be illustrated to show how the landfill tipping fees influence the economics of Portage's MSW co-composting project. The relevant assumptions made are described as follows:

Primary Input Variables — the City of Portage

MSW Generation

The amount of MSW handled is determined by the population and the per capita MSW generation rate. Portage's 1990 population of 8566 serves as the base population. The annual population growth rate is assumed to be 0.9%.[9] Based on the volume of MSW composted in 1990, Portage's per capita MSW generation rate (not including industrial and part of the commercial wastes) is assumed to be 2.91 cy/year (2.4 lb/day). It should be noted that the "MSW" in this study only includes residential wastes from regular garbage collection service (8 tons/day) and the commercial wastes from downtown business establishments, such as gas stations and restaurants (8 tons/day). The conversion ratios (from tons to cubic yards) used in this study need to be defined to avoid confusion. They are as follows: MSW and recyclables—400 lb/cy, reject materials (moist)—700 lb/cy, and compost (moist)—1000 lb/cy.[10]

MWS Flow (Scenario Descriptions)

It is assumed that approximately 9% of Portage's MSW is diverted from the main waste stream in all scenarios.[11] The City thus has different options for the disposal of MSW collected by the City's garbage truck. In scenario A, the co-composting facility will be closed in 1991. All the MSW is directly hauled to the Hechimovich Landfill, using the present landfill as an intermediate transfer station. In scenario B, the City will retain its co-composting facility. The volume of compost and reject materials discharged from the digester drum are assumed to be 38.3% and 17%, respectively, of the MSW composted. The remaining 44.7% goes into the atmosphere as gas and water vapor. In scenario C, it is assumed that the removed contaminants comprise 10% of the moist coarse compost (by volume).

The disposal fees charged (tipping and transportation) at the Hechimovich Landfill for rejects and coarse compost are assumed to be $10.40/cy and $5.75/cy, respectively. The Valley Trail Landfill will charge $12.50/cy for disposing of both reject materials and compost.[12] Because both of the landfills have abundant landfill cover materials supply, they show no interest in using compost from Portage. This study assumes that Columbia County will charge a $7/cy tipping fee for processing and disposing of MSW.[13]

Annual Net MSW Disposal Costs

In this study, Portage's total MSW disposal costs include: MSW collection costs, recycling costs, administrative and overhead costs, capital investment and replacement costs, composting costs (if applicable), operating costs of an intermediate transfer station (in scenario A), landfill disposal costs, and the costs of landspreading sewage sludge.[14] There are no revenues for the MSW management system except the sales of unnecessary equipment[15] and the sales of compost (if any). In this study, it is assumed that the compost would be given away at the plant if the problem of the glass is solved. (That is, "buyers" take the compost away without paying or charging.) The net MSW disposal costs are the total disposal costs minus total revenues. Table 1 summarizes the estimated base-line costs and revenues of the MSW disposal system of Portage in 1991 for various scenarios if the MSW will be disposed of in the Hechimovich Landfill.

Net Present Worth of MSW Disposal Costs

Table 2 presents the projected net present worth of Portage's MSW disposal costs given the assumptions made in this study. It should be noted that in scenarios B2 and C, the costs for future investment on compost processing are not included. Compared to the MSW disposal costs in scenario A, if the City of Portage continues to compost their MSW, and landfill both the

[9] Wisconsin Department of Administration, Official Population Estimates.

[10] Sources of conversion factors: Wisconsin Administrative Code NR 520.15 and Professor Aga Razvi at the University of Wisconsin–Stevens Point.

[11] The recyclables collected from Portage are donated to the Columbia County Recycling Center.

[12] These are the prices bid for transporting and disposing of the waste from the Columbia County Co-Composting Facility in April, 1991. The actual fees may vary among customers.

[13] The tipping fee for MSW is approximately $35/ton.

[14] Portage's co-composting facility only utilizes a third of the sewage from Portage. The other two-thirds of the sewage sludge is spread on farmland. To account for the avoided costs for spreading sewage sludge by composting with MSW, the costs of land spreading sewage sludge for each scenario are included in the calculations of benefits.

[15] It is assumed that all the equipment will be sold at a terminal value using a straight-line depreciation method.

TABLE 1 COST AND REVENUE ESTIMATION ($) 1991, PORTAGE, WISCONSIN

Items / Scenario	A	B1	B2*	C*
MSW DISPOSAL COSTS				
MSW Collection				
Fixed Cost	7,750	7,750	7,750	7,750
Variable Costs	78,900	78,900	78,900	78,900
Sub-total	86,650	86,650	86,650	86,650
Recycling Costs				
Fixed Costs	47,000	47,000	47,000	47,000
Variable Costs	1,000	1,000	1,000	1,000
Sub-total	48,000	48,000	48,000	48,000
Administrative & Overhead				
Fixed Costs	4,370	4,370	4,370	4,370
Variable Costs	-	-	-	-
Sub-total	4,370	4,370	4,370	4,370
Sewage Spreading				
Fixed Costs	-	-	-	-
Variable Costs	14,472	9,648	9,648	9,648
Sub-total	14,472	9,648	9,648	9,648
Interm. Transfer				
Fixed Costs	7,150	-	-	-
Variable Costs	70,610	-	-	-
Sub-total	77,760	-	-	-
Co-composting Costs				
Fixed Costs	-	7,300	7,300	7,300
Variable Costs	-	104,560	104,560	104,560
Sub-total	-	111,860	111,860	111,860
Landfilling Costs				
Hechimovich	237,955	90,840	40,452	49,566
Capital Investment				
Equipment	20,220	25,820	25,820	25,820
Sub-total	20,220	25,820	25,820	25,820
Total Cash Operating Costs	489,427	377,188	326,800	335,914
Contingency Allowance (15%)	73,414	56,578	49,020	50,387
Annual Operating Costs	562,841	433,766	375,820	386,301
minus REVENUES				
Equipment Sales	(82,770)	(77,600)	(77,600)	(77,600)
Sales of MSW Compost	(0)	(0)	(0)	(0)
Total Revenue	(82,770)	(77,600)	(77,600)	(77,600)
NET OPERATING COSTS	480,071	356,166	298,220	308,701

* The additional costs for compost processing to remove glass are not known and so are not yet included.

TABLE 2 PROJECTED NET PRESENT WORTH OF MSW DISPOSAL COSTS (1991-2000) — THE CITY OF PORTAGE, WISCONSIN

(in $1991, r=4%)

Scenario Options	A	B1	B2	C
Hechimovich	4,718,979	3,564,333	3,056,729	3,148,539
Valley Trail	5,548,755	4,242,502	3,139,015	3,249,363
Columbia County Co-Composting	3,154,624	-	-	-

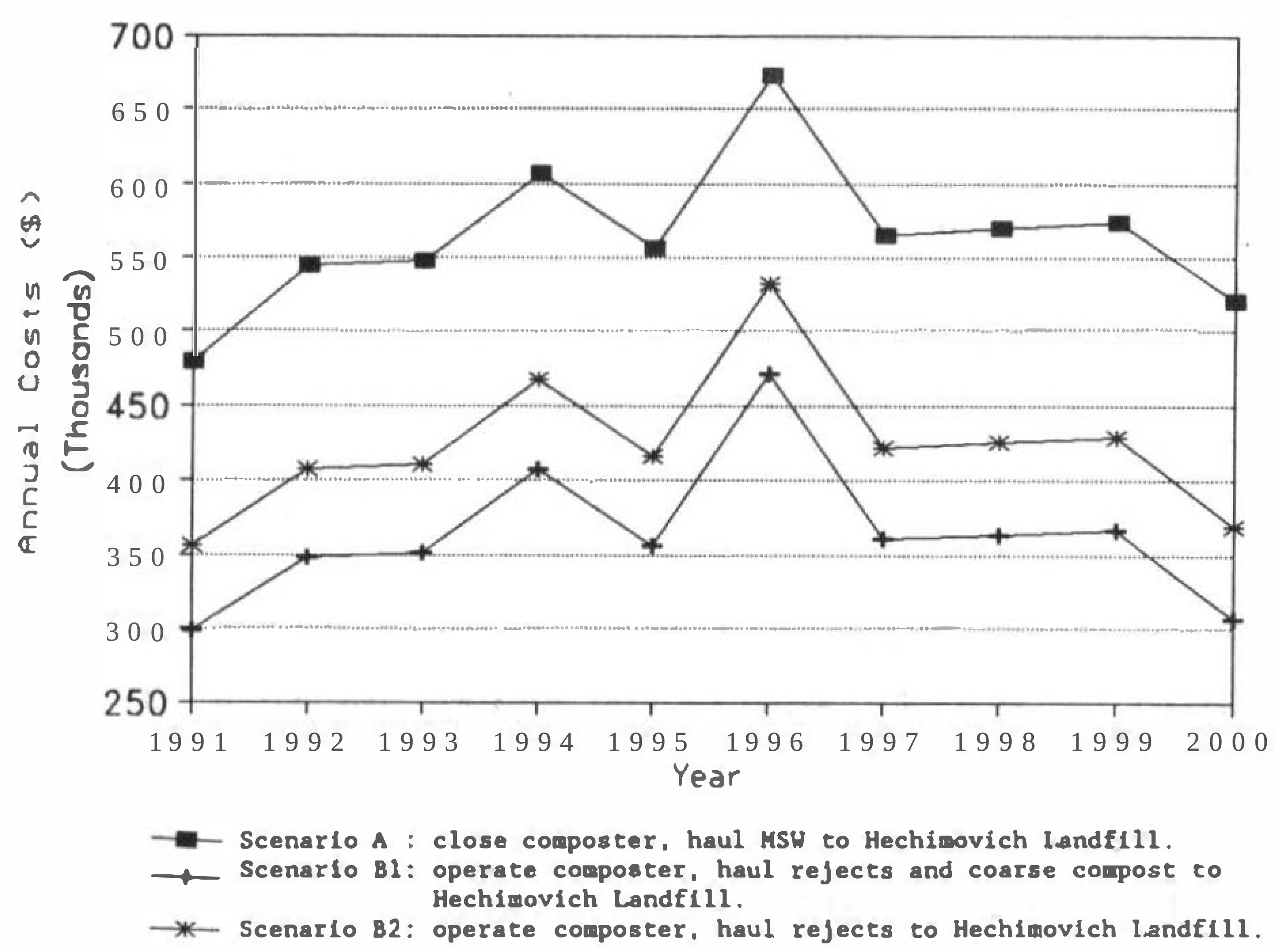

FIG. 1 PROJECTED MSW DISPOSAL COSTS, 1991-2000, CITY OF PORTAGE
(Landfill Costs Remain Constant, in $1991, Hechimovich Landfill)

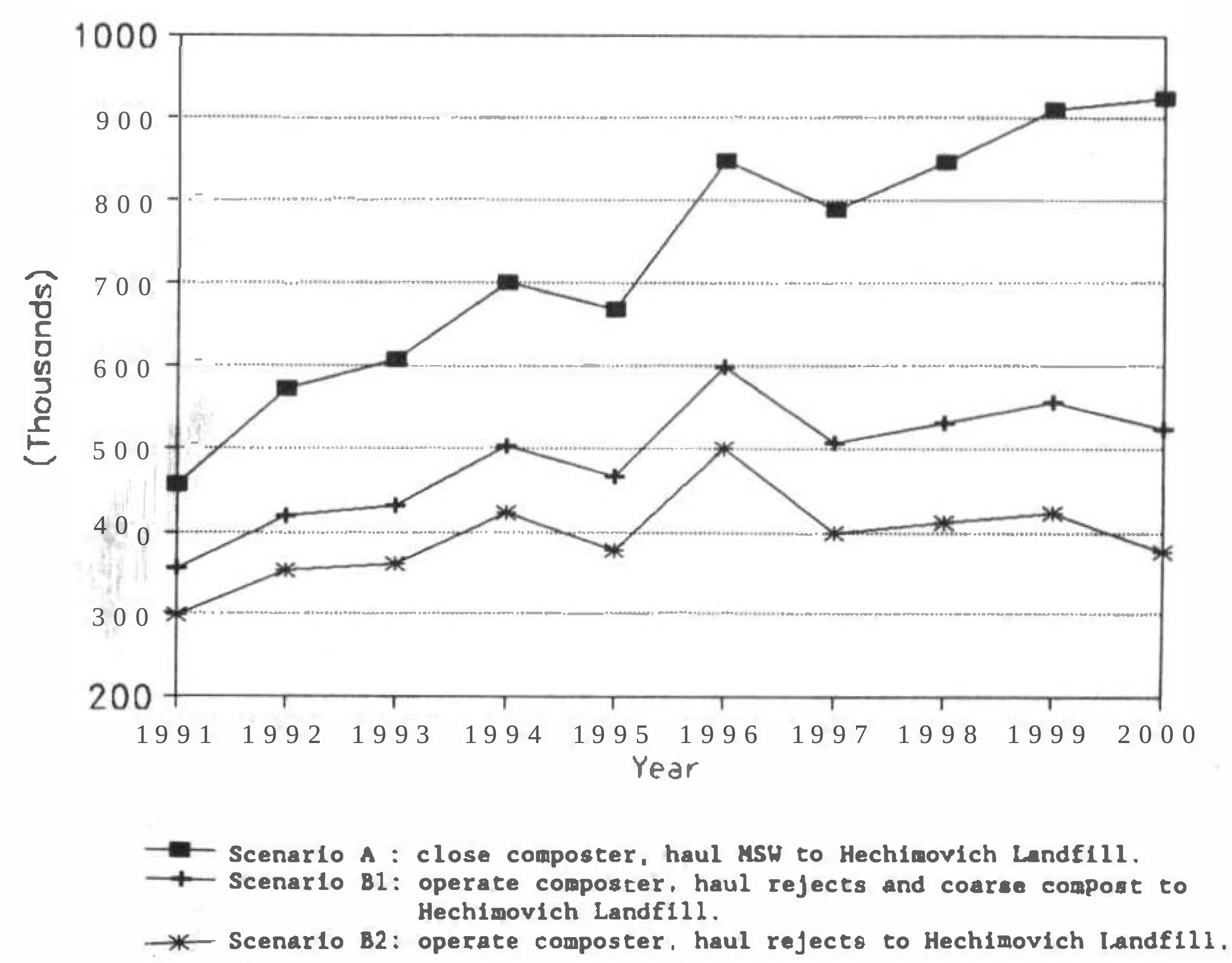

FIG. 2 PROJECTED MSW DISPOSAL COSTS, 1991-2000, CITY OF PORTAGE
(Landfill Costs Increase 10% Annually, in $1991, Hechimovich Landfill)

compost and the reject materials (scenario B1), Portage will save approximately $1 million over the next 10 years.

Sensitivity Analysis (Landfill Costs and Cost-Effective Investment Margin)

The complete sensitivity analysis for landfill costs and cost-effective investment margins cannot be displayed in this brief paper. To recapitulate these analytical methods, the costs for two selective cases are examined to show how landfill disposal costs affect the economics of composting. A sensitivity analysis of the cost-effective investment margins is included, presenting the projected MSW disposal costs under various landfill disposal costs and discount rates.

Sensitivity Analysis — Landfill Costs

Figure 1 depicts Portage's annual net MSW disposal costs for the various scenarios based on the above assumptions, if the landfill disposal costs are constant over time. Figure 2 depicts Portage's annual net MSW disposal costs for various scenarios based on the above assumptions, and an annual 10% increase in landfill disposal costs.

Sensitivity Analysis — Cost-effective Investment Margins

Tables 3 and 4 summarize the sensitivity analysis of cost-effective investment margins for disposing of coarse compost (scenario B2) and processing compost (scenario C), respectively. The cost-effective investment margins are the NPWs of landfill costs avoided (compared with scenario B1), when the landfill disposal fees (for both Hechimovich and Valley Trail Landfill) increase 0%, 5%, 10% and 15% per year, and when the

TABLE 3 COST-EFFECTIVE INVESTMENT MARGIN FOR DISPOSING OF COARSE COMPOST: (Scenario B2) — CITY OF PORTAGE, WISCONSIN (NPWs of the Avoided Disposal Costs, in $1991)

Disposal Fees Increasing Rate (%)		Discount Rates (%) 2	4	6
Hechimovich	0 %	552,135	507,604	468,820
	5 %	691,454	630,743	578,112
	10 %	872,585	790,144	718,970
	15 %	1,107,500	996,079	900,238
Valley Trail	0 %	1,200,294	1,103,487	1,019,174
	5 %	1,503,161	1,371,180	1,019,174
	10 %	1,896,924	1,717,705	1,562,978
	15 %	2,407,609	2,165,389	1,957,039

TABLE 4 COST-EFFECTIVE INVESTMENT MARGIN FOR PROCESSING AND DISPOSING OF COARSE COMPOST (Scenario C) — CITY OF PORTAGE, WISCONSIN (NPWs of the Avoided Disposal Costs, in $1991)

Disposal Fees Increasing Rate (%)		Discount Rates (%) 2	4	6
Hechimovich	0 %	452,271	415,794	384,025
	5 %	566,391	516,661	473,549
	10 %	714,761	647,232	588,930
	15 %	907,187	815,919	737,413
Valley Trail	0 %	1,080,265	933,139	917,256
	5 %	1,352,845	1,234,063	1,131,088
	10 %	1,707,232	1,545,934	1,406,680
	15 %	2,166,849	1,948,850	1,761,336

MSW disposal costs are discounted at 2%, 4% and 6%.

Because landfill disposal costs will also be incurred for landfilling the "secondary reject materials" from processing compost (i.e., glass and other contaminants), the cost-effective investment margin in scenario C is smaller than the margin in scenario B2. However, it should be noted that the investment margins represent the net costs of additional processing. Any return from the sales of refined compost would need to be credited.

DISCUSSION

Crucial Factor: Level of Landfill Tipping Fees

From the above results, we can conclude that landfill disposal fees play an important role in determining the economic feasibility of an MSW composting project. If the City of Portage contracts with the Hechimovich Landfill for waste disposal, they can dispose of the compost more cheaply ($5.75/cy). If the City contracts Valley Trail Landfill ($12.50/cy), the cost savings from composting MSW, as well as the cost-effective investment margin, will be less. However, the initial landfill disposal charges of different landfills and their corresponding potential to increase rates will also affect Portage's final decision.

The economic feasibility of MSW composting is influenced by two factors: market prices of compost and local landfill tipping fees. Presently, in the U.S., none of the MSW composting facilities can generate enough revenues from the sales of compost to offset the costs. The compost produced from the Delaware Reclamation Plant at New Castle once was sold to licensed landscapers at $4.50/cy in 1989. However, because of liability concerns, the Plant discontinued the compost sales a year later (Watson, 1990). In Minnesota, contractors of the Minnesota Department of Transportation paid $16–18/ton for using the compost from St. Cloud on highway planting projects (Spencer and Goldstein, 1990).

The markets for MSW compost are limited, and the prices for MSW compost will fluctuate greatly, especially when competing with compost made of yard waste or sewage sludge. However, because of more stringent regulations on waste disposal and increasing environmental concerns, landfill tipping fees are likely to rise. At a certain point, market prices for compost may not be the main factor that affects the feasibility of composting. Communities can identify potential local markets, ascertain landfill disposal fees, and then design the most cost-effective investment plan for composting their MSW.

Cost-effective Compost Processing

In Columbia County, Wisconsin, an experimental water-separation, glass-removal system will be installed to process compost produced from the Columbia County Co-Composting Facility. If it is proven to be cost-effective and markets are found for the "refined" compost, the City of Portage may consider processing their compost in the same way. To date, no specific cost figures have been released.

The MSW Composting facility in St. Cloud, Minnesota, utilizes a "stoner," a compost processing system which was originally designed to remove grit, sand and rock out of grains, to separate glass shards from compost using vibrating screens. This compost processing system is proven effective to make size and density separation on MSW compost. However, the relatively small amount of compost produced in Portage may not reach the volume required for efficient operation of that system.

Application and Modification

From the experience of Portage, composting MSW is an economically sound method to address their MSW disposal problems. However, it should be noted that for the City of Portage, the initial capital costs for the present composting facility are considered as "sunk costs." They cannot be recovered as salvage value, and thus are not included in the economic analysis. The initial construction cost for Portage's co-composting facility was $1.1 million. If a co-composting facility like that of Portage is built now at the same costs, and fully financed through a 15-year debt service at an 8% interest rate, the total disposal costs would increase $126,146 every year.[16]

To make the models more useful, one needs data from surveys and fundamental research, such as waste characterization, the effectiveness of the composting facility (% of reject materials and compost discharged), and the recycling rate. The above factors sometimes are interrelated. For example, a successful recycling program is likely to reduce the non-organic materials in the waste stream. This will indirectly decrease the costs of composting and processing.

CONCLUSION

The main purpose of the computer model design is not to provide a comprehensive cost and benefit analysis. Instead, it is a convenient analytical tool to make a preliminary evaluation of the feasibility of composting under various assumptions. The computer spreadsheet program is also an excellent tool to perform sensitivity analysis, which can readily show the economic consequence if parameters (or variables) change.

At a minimum, composting reduces the volume of MSW. If local landfill tipping fees keep rising, the cost of landfilling may exceed that of composting. Thus, communities may still find composting economically feasible, even if compost is landfilled for lack of an economical method of processing the compost into a marketable product.

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[16] Estimated by Tom Pinion, Portage's Acting Director of Public Works.