

## THE EXTERNAL COSTS OF SANITARY LANDFILLS\*

**EUI-GAK HWANG**

*Research Specialist  
Department of Economics  
University of Chicago*

**GUNDARS RUDZITIS**

*Assistant Professor  
Department of Geography  
University of Texas at Austin*

### ABSTRACT

The problem of disposing of solid waste is an issue of increasing concern. The primary method of disposal is at landfill sites. This paper estimates the external costs of solid waste disposal in sanitary landfills in the Chicago Metropolitan Areas. The results of the study indicate that negative externalities do exist. However, they are small, almost insignificant. Given the negligible size of the externalities there appears to be little rationale for discouraging the disposal of solid wastes in sanitary landfills.

### Introduction

This paper examines the impact on an urbanized population of solid waste disposal in sanitary landfills. The definition of "solid waste" used in this paper refers to garbage, refuse, and other discarded solid materials, including materials resulting from industrial, commercial, agricultural and community activities [1]. They form the clearest threats to health and the urban environment, and so they are the chief targets of solid waste strategies.

\* This work was partially supported by the National Science Foundation, Research Applied to National Needs (RANN), Contract Nos. AG-352 and GI-32989AZ. We gratefully acknowledge the helpful suggestions of George Tolley.

Additionally, solid wastes in the various forms of refuse and litter along streets, highways, parks, and vacant lots can be seen scarring portions of the American landscapes.

The disposal of solid wastes is an issue of growing concern because growing quantities of solid wastes are beginning to produce social, economic, and environmental problems of significant proportions. These problems are particularly acute in metropolitan areas where intensive urbanization and population concentration increases solid wastes and decreases the availability of spatial areas for waste disposal.

The quantity of solid wastes generated annually in the United States is enormous. According to available estimates a national average of 5.3 pounds of solid waste per person per day was collected in 1967 [2, 3]. Most of these solid wastes come from urban areas and require quick removal. The removal problem is intensified since solid wastes are increasing at an estimated rate of 4 per cent per year. The increase in solid waste generated can be considered as a function of the rise in per capita expenditures for all durable and nondurable goods, which represents approximately 4 per cent of the annual growth in recent years. It has been estimated that the amount of solid wastes to be collected will rise to approximately 8 pounds per person per day by 1980 [4].

In this study we focus on the six county Chicago Standard Metropolitan Statistical Area (SMSA). In 1970, solid collection rates totalled over 8.7 million tons in the Chicago SMSA; and this figure is expected to rise to over 10.4 million tons in 1990 [5]. Consequently, proper management of solid wastes is necessary in any efforts to upgrade the environment.

### **Disposal of Solid Wastes**

The major method of solid waste disposal is by landfill. A majority of the landfill disposal in the past has been at open dumps. The relatively recent stricter controls have "outlawed" open dumping in favor of sanitary landfills. The sanitary landfill is generally considered to be a nuisance free method of refuse disposal characterized by competent and continuing engineering control. Sanitary landfills do not produce ground and surface water pollution. The refuse is compacted and covered with six inches or more of earth cover. The effect of the stricter air pollution controls has focused attention on open dump burning. There is no burning of any kind at the sanitary landfill, nor does it produce ground and surface water pollution [6].

If land is available in or within an economic transportation distance from an urban area then landfilling is usually the least costly method of disposing of solid wastes. For example, in 1970 dollars the total cost of disposal at a landfill site is approximately \$3.25 per ton (of which the major portion is transportation cost), as compared to \$7.85 per ton for incineration [7]. Some of the often cited advantages of sanitary landfills are:

1. Initial capital investment is low compared to other disposal methods.
2. Flexibility of a sanitary landfill--sudden increased loads can be disposed of with little additional personnel and equipment.
3. Landfills can receive all kinds of solid wastes. No separate collections or sorting is necessary.
4. Operations can be terminated without loss in equipment or land. The equipment can be used for other municipal functions and the land is no worse off, and may be better off as in filling clay holes, gullies, or marshes.
5. Sanitary landfills can start operations quickly. No plant has to be built as is true of other solid waste disposal techniques.
6. It is a cheap method of waste disposal.
7. It is a final disposal process compared to incineration and compositing where a residue remains to be disposed of.
8. Unusual or bulky items normally do not present operational difficulties.
9. Submarginal land may be reclaimed for various uses, such as parking lots, golf courses, playgrounds, airports, etc.

A distinct disadvantage of landfills is that they require sizeable amounts of land that is economically valuable to a community or region, particularly if the pressure for land demand is great. Acreage requirements depend on a wide variety of factors, including the configuration of the initial site, the nature and density of the incoming refuse, the compaction to be provided, the prescribed amounts of cover materials and the planned elevation of the completed fill above natural ground.

There are forces which make the acquisition by a public body or private individuals of sites for solid waste disposal locations difficult. First, the physical quantity of sites is limited. Second, there may be a strong adverse reaction of communities to having any type of solid waste facility located nearby. One of the major objections raised against having a disposal site located nearby is that the value of surrounding properties will be adversely affected. Such objections may not be without basis since generally no

provision is made to compensate those in a community who may suffer loss, or bear risk of loss because of the externalities which emanate from the solid waste facility. In some rare instances there is little or no opposition to the opening of a landfill. This could occur if the present use of the site is creating such undesirable conditions that shifting its use to a sanitary landfill immediately improves the conditions. Such could be true for a site where uncontrolled dumping and open dump burning had previously been permitted. Furthermore, in situations where the sanitary landfill is truly a land reclamation activity with a rapid realization of benefits comparable to the personal goals of individuals near the site, the landfill is opened with little or no opposition. This has been the case with the filling of ravines and gullies where not only more useable space is created, but the completed landfill may add stability to the surrounding terrain [4].

### Measuring the External Effects of Landfills

An external cost exists wherever a negative externality arises. An externality results whenever an economic action affects parties not directly involved in the activity, thereby falling outside the reach of the price system. A negative externality exists when a person incurs costs for which he receives no compensation. A positive externality occurs when a person benefits from the action of another without being required to make compensation. A person living near a landfill site suffers an external cost because he is not compensated by the owners of the landfill for any damage he suffers.

The rationale behind our analysis is that measures of external effects can be approximated if the source of the external effect is specific to a particular site, or location, and the external effect is not uniformly distributed over the region. The use of changes in land values can be used when one wants to estimate the social cost of an activity producing a number of external effects since a single measurement may capture all of the external costs produced by the activity. In the case of a sanitary landfill the changes in housing values around it will be attributed to the landfill site. The perceived external effects are reflected in property values, and provide a method of approximating the external costs. Past empirical studies of air and water pollution have demonstrated that pollution costs are in fact reflected in property values [8-10].

In an earlier study Havlicek, Richardson, Davies found that housing prices varied with the number of degrees a house is from prevailing downwind, and with distance from a landfill site [11].

The basic relationship was assumed to be linear.<sup>1</sup> The number of degrees downwind is significant because of the possibility of odor from a landfill site. Houses downwind may receive more odor and dust than other houses which may be closer to the site, but not downwind. The Havlicek study also found that housing prices increase with distance from the site. The regression coefficients derived for these two variables are incorporated into our analysis. However, they did not specify the range for which these regression coefficients hold, and this information is required in order to estimate the external costs of landfills in the Chicago SMSA. We determined the range by examining land values around landfills as shown in Olcotts Land Value Statistics [12]. We estimated that land values around a landfill increase for a distance of 1,980 feet which is equivalent to three blocks.

In 1972 there were fifty-five landfill sites in the Chicago SMSA [13]. To calculate the external effect of landfill sites on surrounding properties the first step was to obtain residential values by blocks from each landfill site facing west, north, east, and south. The data source was the 1970 Census of Housing, Block Statistics, Chicago, Illinois-Northwestern Indiana Urbanized Area [14]. The prevailing wind direction in the Chicago area is from west to east. Using the estimated regression coefficients of the absolute angle variable of twenty-four dollars per angle, and the distance variable of sixty-two cents per foot of distance [11], we calculated the external effects of landfills on a block basis to be as shown in Table 1.

Dividing the external effects of a landfill site on surrounding properties by the estimated mean price of property sold (16,300 dollars), a measure for the external effects as a percentage of mean

Table 1. External Effects on a Block Basis  
(Dollars/Block)

<i>Facing</i>	<i>0 Block</i>	<i>1 Block</i>	<i>2 Blocks</i>
West	-1200	- 800	- 400
North	-3360	-2960	-2560
East	-5520	-5120	-4720
South	-3360	-2960	-2560

<sup>1</sup> The functional form of the regression equation in the Havlicek, et al. study was  $Y = f(X_1, X_2 \dots X_{12})$  [11]. The dependent variable Y was the transaction price in current dollars. The independent variables in ascending order included the size of the house in square feet, number of bathrooms, age of house, lot size, amount of encumbrance, year of sale, absolute degrees downwind of landfill site, distance in feet from landfill site, and four dummy variables representing four landfill sites.

sale price is obtained for each block and each direction. Multiplying this value for each block and direction by property value (residential value) obtained from the 1970 Census data gives the total external value of each landfill site on its neighborhood properties:

$$\sum_{i=1}^4 \left[ \left( \frac{\text{Effects of each landfill site on property value}}{\text{Estimated Mean Sale Price of residential site}} \right) \times \left( \frac{\text{Property value obtained from Census data for each block}}{\text{Total external effect of a landfill site on property value}} \right) \right]$$

The results indicated that the average total external cost per landfill site was \$60,500. However, a more appropriate measure is the external cost on a per ton per year basis, and this was calculated as follows. The number of operating days of each landfill site is assumed to be 275 days per year. Multiplying daily receiving volume of solid wastes (tons) by yearly operating days (275), and dividing into 10 per cent of the total external effect of each site (assuming an average of ten life years for the existence of externalities) gives the external cost per ton per year.

As of 1970 within the Chicago SMSA there were thirty-one out of fifty-five landfill sites which had negative externalities. The remaining landfills were located between highways, canals or forests such that there was no economic impact from their externalities. However the other thirty-one landfills imposed an external cost that ranged between five to seven cents per ton of solid waste per year depending upon the daily volume of the landfill site.

### Summary and Implications

In this study we have estimated the dollar value of the external effects of sanitary landfills. We found that negative externalities, although very small do exist. The external cost is estimated to be between five to seven cents per ton of solid waste. This is an almost insignificant amount. In comparison, the annual costs of operating a landfill is approximately \$3.25 per ton. Historically, policy makers have not always taken total social costs into account when making decisions. Total social costs are defined as the sum of private and external costs. Our analysis indicates that the external costs of landfills are negligible and thus does not offer any justification for discouraging the disposal of solid wastes in sanitary landfills.

The estimates of this study pertain only to the sites studied in the Chicago SMSA. Areas around sites differ, but given the small size of the externality, differences between sites in the Chicago SMSA and other metropolitan areas would have to be quite large to change the thrust of the conclusions. The perception of significant external effects from landfills is not confirmed by our work, and offers no evidence for limiting the use of sanitary landfills for solid waste disposal.

### REFERENCES

1. National Association of Counties Research Foundation, *Guidelines for Local Governments on Solid Waste Management*, U.S. Environmental Protection Agency, Washington, D.C., 1971.
2. J. R. Black, et al., *The National Solid Waste Survey—An Interim Report*, U.S. Public Health Survey, Washington, D.C., 1969.
3. Editor, Per Capita Figure of 5.1 Pounds of Matter Daily Indicated by National Survey, *Solid Waste Management/Refuse Removal Journal*, March, 1968.
4. J. R. Schaeffer and G. S. Tolley, *Decision Making and Solid Waste Disposal*, Center for Urban Studies, University of Chicago, April, 1971.
5. Argonne National Laboratory, Energy and Environmental Systems Division, *Domestic, Industrial and Total Solid Waste Loads for the Chicago Metropolitan Area*, June, 1974.
6. B. J. L. Berry and F. E. Horton, *Urban Environmental Management*, Prentice-Hall, Englewood Cliffs, 1974.
7. B. Baum and C. H. Parker, *Solid Waste Disposal*, Ann Arbor Science Publishers, Ann Arbor, 1971.
8. T. D. Crocker, *Urban Air Pollution Damage Functions*, U.S.E.P.A., Office of Air Programs, Washington, D.C., June, 1971.
9. R. G. Ridker and J. A. Henning, The Determinants of Residential Property Values with Special Reference to Air Pollution, *Review of Economics and Statistics*, May, 1967.
10. D. M. Dornbush and S. M. Barrager, *Benefit of Water Pollution Control on Property Values*, U.S.E.P.A., Office of Research and Development, Washington, D.C., October, 1973.
11. J. Havlicek, R. Richardson and L. Davies, *Measuring the Impacts of Solid Waste Disposal Site Location on Property Values*, Urban Economics Report No. 65, University of Chicago, November, 1971.
12. *Olcott's Land Value Statistics*, Chicago, Illinois, various editions, 1945-1974.
13. Northeastern Illinois Planning Commission, *Solid Waste Report*, Chicago, 1972.

14. U.S. Bureau of the Census, *1970 Census of Housing, Block Statistics, Chicago, Illinois-Northwestern Indiana Urbanized Area*, U.S. Government Printing Office, Washington, D.C., 1973.

Direct reprint requests to:

Gundars Rudzitis  
Assistant Professor  
Department of Geography  
University of Texas at Austin  
Austin, Texas 78712