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LAND VALUES SURROUNDING WASTE DISPOSAL FACILITIES

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ABSTRACT

The effects that disamenities have on the enjoyment of property are frequently capitalized into the value of property. One example of a disamenity is a hazardous waste disposal facility. While the literature on siting these facilities frequently mentions that opening a new facility depresses property values, there is little empirical evidence available that supports such statements.

An overview of the nature and the problems of the disposal of hazardous waste introduces this report. The liability setting for disposal is then explored to see what effect the burden of liability has on the abatement of externalities. Next, criteria for siting hazardous waste disposal facilities are examined and assumptions of the behavior of consumers in the residential real-estate market are stated.

Three case studies were selected: (1) a publicly owned landfill not suspected of containing hazardous waste, (2) an offsite hazardous waste disposal facility and, (3) an onsite hazardous waste disposal facility. The land market in the neighborhood of these locations are estimated and the results of these estimates are reported and interpreted. Comparisons are made between the case studies.

In conclusion, the existence of a hazardous waste disposal facility distorts property values and distance from the facility can be given a coefficient to estimate the changes in values.

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OVERVIEW OF THE PROBLEM

Public awareness of the problem of the disposal of hazardous waste has only recently become keen. Yet, as the amount of waste that presents an extraordinary risk to health and safety has increased, existing technology and legal requirements begin to be questioned. Any waste that can cause illness or death presents great potential costs to the public: medical bills, paid sick leaves, lost productivity and reduced life expectancy. In addition, the means by which humans are involuntarily exposed to toxic waste imposes costs on those who own or have rights to those vectors as property owners or citizens. Examples include groundwater polluted by landfill leachate, surface water contaminated by runoff, air polluted by improper incineration, ponding and lagooning of volatile chemicals and failure to properly cover landfills, to name a few. These are also social disamenities and private costs, which involve market failure, externalities and unpriced goods. Correction of these problems is still at an early stage. A great deal remains to be done with both the cleanup of existing waste and the proper treatment, storage and disposal of future waste.

There is little information about the risks and costs, and about the short-run benefits. Assignment of liability will affect both economic growth and distribution of income. Because of the uncertainty created by changing technology and the economy, an examination of costs to future generations is difficult to perform. However attractive cost minimization is to maximize short-run profit, the size of the costs that must eventually be paid indicates that an information gap exists. If current technology fails to recognize a reduction in health and safety, then full information of costs has not been considered and the firm has not taken full responsibility.

Many other unknown factors enter into decision making processes. Marketing analysis, product development and other research issues may take priority over the analysis of potential liability for improper disposal of hazardous waste. Thus, imposition of legal requirements may be the only way that environmental research will be undertaken by the private sector.

The tools of economics can be applied analytically and empirically to answer the questions of efficiency and equity. Decision makers must be able to estimate the full impact of their decisions. If they are liable for irreversible damages, What is the amount of compensation to be paid? Who will bear the costs if decision makers are not held liable? Further, how is the allocation of resources affected?

The problem cannot be analyzed in a strictly economic context and still provide meaningful results, because economic considerations are constrained. For example, in the absence of statutes and regulations pertaining to hazardous waste disposal, the relatively unconstrained firm has acted in a least-cost manner. There was little incentive to reduce either wastes or public exposure. The total social costs of improper disposal were not calculated by those who were responsible. The costs involved are sunk. Only remedial and preventive actions are possible.

The regulatory and statutory frameworks for dealing with hazardous waste have scarcely been started. The next few years will be crucial for making policy. This study contributes information which may apply to property tax structure, siting selection for disposal facilities, compensation procedures and other decisions and policies related to this complex area. Although most of the information provided will be in the context of economics, some simplifying assumptions will be made to fit the problem to this context. These assumptions are few, but should be taken into account when the model is used.

Many argue that the current methods of waste disposal are inefficient, that they create social costs and that market failure prevents a better solution. Gainers and losers, however, can be identified and their gains and losses estimated from market information and market proxies. Property ownership is a well-defined legal right. An abridgement of this right could takes place when the value of property is reduced by an externality. Evidence to prove or disprove such allegations would rely heavily on economic research.

Of the economic problems besetting communities with waste disposal facilities, one of the most sensitive and controversial is that of real property values. The ramifications of having these values directly reduced because of location near a landfill or hazardous waste disposal site are twofold. First, homeowners who sell their property can sell only if they accept a price which, _ceteris paribus_ is below that of similar property not located near a disposal site. Second, if this discrepancy is not taken into account, assessment of property values, as determined by hypothetical market value, will be inaccurate. Economic tools can be used to determine the effect on real property values and the magnitude of the effects.

Hypotheses

The model addresses several issues. First, it determines the basis upon which siting decisions are made. Second, it determines whether or not external effects are generated. Third, it evaluates the effects and incidences of these external effects without governmental action. Fourth, it demonstrates how government intervention shifts both initial effects and incidences. Fifth, it explains the framework for empirically testing the presence of externalities that are reflected in market transactions. In the model, criteria for location, size of site and technology utilized are explicit; the existence of governmental action and influence is accounted for; and the actions of consumers are explained.

The primary method used to test the theory is land value studies for real property in diverse areas chosen as case studies. The case studies include property near the following kinds of sites: an open, operating offsite hazardous waste management facility; an open, operating onsite hazardous waste management facility; and an open, operating landfill not suspected of containing hazardous waste.

If there is a perceived disamenity, consumers will be willing to pay to avoid living near it. This translates into lower property values nearer and higher property values farther away. Consumer's perceptions of disamenities are subject to change, which shift their willingness to pay. Generically similar disamenities may have subtle distinctions which generate a difference in consumer's reactions. Events which change the perception of disamenities may be gradual or sudden. Sudden changes in perception can be measured.

Technological Constraints

The firm is limited to using only existing practical technology in its disposal methods.[1]

1. Secure Landfills: land burial operations which have barriers and leachate collection and monitoring systems,

2. Resource Recovery: processes designed to transform hazardous waste into a saleable product,

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[1] Booz-Allen and Hamilton Hazardous Waste Generation and Hazardous Waste Capacity. Washington, DC: US Govt. Printing Off., December 1980 V-8 - V-9.

3. Chemical Treatment: chemical, physical or biological processes designed to transform the hazardous waste into non hazardous material.

4. Incineration: thermal degradation of solids, liquids or gases,

5. Deep-Well Injection: pumping liquid waste into underground porous formations, and

6. Land Treatment/Solar Evaporation: aerobic decomposition of wastes through solar evaporation and soil incorporation.

The only legal methods in New York State and the Northeast at the present time are chemical treatment, resource recovery, secure landfill and incineration.[2] Of these, chemical treatment, particularly aqueous treatment, predominates. The Environmental Protection Agency (EPA) estimates that proper disposal accounts for only 10 percent of all disposed waste.[3] Ninety percent is unsoundly disposed of through unsecured landfill, uncontrolled incineration, untreated discharge into water and roadside dumping. Improperly disposing of substances is, at least in the short-run, much less expensive and gives the illicit disposer a competitive edge over the legitimate operator.

Other constraints that a firm is concerned with include the topography of the region, the soil structure, the climate, the presence of groundwater and the environmental capacity to absorb air and water emissions of incinerated or treated wastes. Such constraints are now included in the firm's decision-making process. As legal precedents were set, industry responded in part by increasing investment in equipment that would give the firm an advantage in meeting the anticipated standards. This translated into increased barriers to entry, along with an increased willingness of state and local officials to close any site that posed a threat to public health or safety. The firms now had to view legal requirements as constraints as real as the technical ones that they had been operating under all along. A brief history of federal and selected state law is worth reviewing.

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[2] Booz-Allen and Hamilton, <u>op. cit.</u> pp. II-7 II-10; Camp Dresser and McKee Technical, Marketing and Financial Findings for the New York State Hazardous Waste Management Program. (Albany, New York State Environmental Management Facilities Corporation, March 1980): II-7 II-14.

[3] Barnaby J. Feder, "EPA Gets Tough," New York Times December 22, 1980.

Legal Constraints

The Solid Waste Disposal Act of 1965[4] encouraged methods to reduce nuisance and public health problems and encouraged recycling and resource recovery. The Resource Recovery Act of 1970[5] funded research, special field studies and demonstration projects, the bases for a new technology to deal with solid waste disposal problems. Yet, comparatively little attention was paid to industrial waste. Furthermore, no agency at the federal level was given the role of implementing the new technology for waste disposal.

In 1976, the Resource Conservation and Recovery Act (RCRA)[6] gave hazardous waste a legal definition as well.[7] Principles and standards followed for the proper disposal, permits for operation, enforcement of compliance, penalties for noncompliance and incentives for innovation in techniques to manage hazardous waste. In the absence of such regulation, and unless such characteristics offered greatly reduced costs, such factors as porosity, permeability, soil/rock chemistry, depth to bedrock, density, depth to groundwater, proximity to surface water, attenuation potential, settlement characteristics and surficial deposits would scarcely be given a second thought. Under the new setting, specific detailed rules have been promulgated for the conditions necessary for a permit for disposal.[8]

The successful implementation of these standards requires that the regulatory agency possess the skills of a geologist, chemical, civil and environmental engineers, regional planner, soil specialist and lawyer. As they now stand, the regulations seek at once to protect public health,[9] worker safety[10] the environment,[11] and to set general standards for

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[4] PL 89-272

[5] PL 91-512.

[6] PL 94-581, 42 USC 6901 et. seq..

[7] 42 USC 6903(5). This definition has a wide ranging importance due to the disaagreement among those in related fields as to what constituted hazardous waste.

[8] 40 CFR 264-265.

[9] 40 CFR 261.10(A)(1), 263.31, 264.15,264.30-264.60.

[10] 40 CFR 262.30-262.34, 264.15-264.16, 264.30-264.36, 264.50-264.56, 265.15-265.17.

[11] 40 CFR 260-265 passim.

industry.[12] It is widely believed that existing regulations dealing with hazardous waste will remain intact. The new attitude toward regulation should increase the scrutiny under which new regulations are promulgated. The executive branch is expected to protect the public in the most cost effective manner and at the same time to do away with harassing, confusing and unenforcable regulations. Compared with the other industrialized nations of the world, the United States has been relatively tardy in developing a set of regulations to deal with hazardous waste. Thus the generators of hazardous waste may relocate in less developed countries. For all the advantages that this would offer--proximity to feedstocks, cheaper labor and less environmental regulation, the disadvantages are also apparent--lack of a skilled, educated labor force, increased distance from product markets and lack of political continuity and stability. The risks of sabotage and nationalization are also much greater in the third world than in the US.

On the other hand, the RCRA placed less of a burden on generators and transporters of hazardous waste than on those responsible for storage and final disposal. The new regulations have transformed an industry which was highly competitive, with low capital investment, few skilled workers and weak barriers to entry to one that is technically complex, requires many skilled and well-paid workers, is capital intensive, displays growing barriers to entry and an oligopolistic or imperfect market structure. There are no reliable estimates of the number of firms that disposed of what was later classified as hazardous waste before the RCRA regulations took effect. Statistics were not kept, and attempts to discover old sites have been frustrating and incomplete.[13]

The industry after RCRA is a different story with a wealth of information on financial, technical and marketing aspects. In 1980, the top four firms accounted for approximately 45 percent of all industry revenues nationally. These four, plus eight or nine second tier firms accounted for almost 60 percent of total revenue and volume of waste handled nationwide.[14] Indeed, one of the factors holding back investment in this growth industry is the uncertainty that EPA

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[12] 40 CFR 260-265.

[13] New York State Department of Environmental Conservation. Hazardous Waste Disposal in New York State. (Albany, New York State Department of Environmental Conservation, 1980): 49.

[14] Booz-Allen and Hamilton, Hazardous Waste Generation, p. V-2.

can enforce the regulations.[15] Superfund, by absorbing certain costs and elements of risk, may further stimulate growth.[16]

The changing legal structure may promote change of technology to as great an extent as changing technology brings about changes in the legal system, particularly with environmental law.[17] Moreover, the present state of the art is much better defined than it was in the past. Increasing concentration has standardized disposal practices and fewer sites have made monitoring easier.

A decrease in the number of sites and firms, however, has had drawbacks. Because production of hazardous materials is not directly regulated by RCRA, there is potential for a shortage of disposal capacity that can meet legal requirements.[18] Failure to provide adequate disposal capacity that meets RCRA requirements will encourage of illicit disposal. In order to meet the shortfall, government will need to either facilitate siting of facilities or undertake policies that will directly reduce hazardous waste production. The former has proved to be undesirable for local communities that are possible sites for new hazardous waste disposal facilities.

Those who once supported government help in siting decisions have expressed concern over relaxation of standards solely to avoid illicit dumping. Industry would prefer to see the greater burden remain on those responsible for disposal. to see the greater burden remain on those responsible for disposal. State governments have been more reluctant than the federal government in regulating generators, for fear of driving industry and jobs elsewhere. Failure to undertake one approach, or a mix of the two, may lead to a critical shortage of hazardous waste disposal capacity, if forecasts of generation and disposal capacity hold true.[19]

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[15] Booz-Allen and Hamilton, <u>Hazardous Waste Generation</u>, p. VI-3.

[16] Superfund, also known as the Comprehensive Response, Compensation and Liability fund, was created in late 1980 to deal with the growing problem of cleaning up hazardous waste. See below, p. 22.

[17] D. Bruce LaPierre, "Technology Forcing and Environmental Protection Statutes," 62 <u>Iowa Law Review</u> 771.

[18] Booz-Allen and Hamilton, <u>Hazardous Waste Generation</u>, n. 1, p. I-2 <u>et seq.</u>

[19] <u>ibid.</u>

Actual siting of hazardous waste disposal facilities is placed in the hands of the individual states. Industry pressure to provide adequate disposal capacity at the same time that growing public perception of disamenities of nearby sites has created a controversy that is in the hands of state governments. Given the technological and legal constraints surrounding the disposal of hazardous waste, what criteria are used in the selection of a site for hazardous waste disposal? The need for such criteria is growing as the regulatory framework becomes more complex. The industry of hazardous waste disposal poses interesting and knotty problems for policymakers.

II

EXTERNALITY AND LIABILITY SETTING OF HAZARDOUS WASTE

The disposal of hazardous and other waste has created uncompensated disamenities and diseconomies. Yet, in a relatively short time, liability for improper and unsafe disposal of hazardous waste has undergone massive changes.

The Legal Setting

Before 1976 there were only two avenues open to correct or compensate for damages arising from improper, unsuitable, inadequate, unsafe or negligent disposal of hazardous waste. These actions dealt with public and private nuisances. Nuisance law is divided into private, public and mixed cases. A private nuisance is a tort against an individual and includes any "wrongful act which destroys or deteriorates the property of an individual or of a few persons or interferes with their lawful enjoyment thereof."[1] Standing to sue usually requires one to be an owner of property. Further, the plaintiff must prove that the nuisance is not one suffered by the general public.[2] Once these conditions are satisfied, the plaintiff must demonstrate in what ways his or her property has been destroyed or deteriorated, or how lawful enjoyment has been interfered with.[3]

As applied to landfills and hazardous waste facilities, private nuisance suits are often difficult to bring, to prove and to obtain relief. Numerous restrictions on class action suits increase transactions costs where injured parties sustain relatively small damages in comparison with the cost of bringing suit. If, however, a broad class of persons is affected, the nuisance is likely to be a public nuisance: a public nuisance

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[1] Black's Law Dictionary, Fifth Edition, (St. Paul: West Publishing Co., 1979), p. 961.

[2] Newman v. Marceline, 222 Mo App 980, 6 SW2d 659; Hodges v. Draw, 172 Miss. 668, 159 So. 298, 37 NCCA 209.

[3] Louisville v. Hehemann, 161 Ky. 523, 171 SW 165; Bloss v. Canastota, 35 Misc. 2d 829, 232 NY2d 166; Shearing v. Rochester, 51 Misc. 2d 436, 273 NY2d 464.

> ". . . affects an indefinite number of persons, or all of the residents of a particular locality, or of all people coming within the extent of operation, although the extent of the annoyance or damage inflicted upon individuals may be unequal."[4]

The nuisance must be suffered by the general public and not by specific individuals.[5] Until recently, a public nuisance suit could only be brought by the government officials in the jurisdiction of the nuisance.

Mixed nuisances, having the characteristics of both private and public nuisances, are the least common. The usual remedy for a private nuisance is to compensate for partial or total loss of property, that for public nuisances is to terminate the offending operation. The plaintiff of a mixed nuisance may be awarded both remedies.[6]

Under common law the polluter has not faced zero liability. Nor under the new regulations and laws is s/he totally liable. The change is so great that, for simplicity, it can be considered close to a shift from zero to full liability for simplicity. One very important piece of evidence to successfully prove nuisance is the actual harm or damage. Threatened, anticipated or imminent hazards are not sufficient to claim that a nuisance exists.[7]

Another important consideration has been the balancing of equities, that is, comparing in strict economic terms the net benefits of terminating the operation causing an acknowledged nuisance with the net benefits of continuing the operation,[8] or comparing the number of persons benefitted with the number of persons harmed.[9] Perhaps the most relevant to the courts is the balancing of equities when injunction to stop an operation would create greater nuisances than would be continued without the injunction.[10]

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[4] Black's Law Dictionary, p. 961.

[5] Phoenix v. Johnson, 51 Ariz. 115, 72 P2d 30.

[6] Morgan v. Danbury, 67 Conn. 484, 35 A 499.

[7] Restatement 2d Torts sec. 933, comments on subsec. (1) 1977.

[8] City of Chicago v. Commonwealth Edison, 24 Ill. App. 3d 624, 321 NE2d 412.

[9] Kreiner v. Turkey Valley Community School District 212 NW2d 526; Barber v. School District No. 51, 335 SW2d 527.

[10] Harrison v. Indiana Auto Shreader Co. 528 F2d 1107.

Most nuisance claims filed against hazardous waste disposal facilities and landfills are public nuisance suits because the nuisance is a direct and widespread annoyance or threat to public health. The transactions costs in a public nuisance claim are first borne by the taxpayer. The remedies also vary in their actual costs, depending on the amount of the losses suffered by the offending party.

New Legislation and Regulation

Although communities are increasingly unwilling to accept hazardous waste, state and federal governments can overide local authority and shield corporatons from public nuisance lawsuits as long as certain minimum standards are met. Conversely, federal or state intervention also gives greater protection to citizens where a conflict of interest exists. This intervention further permits preventive action to be taken, something that could not be done under common law.

The Resource Conservation and Recovery Act of 1976 (RCRA) provided for criminal sanctions against those who violated the hazardous waste section of the act.[11] It further assigned criminal penalties against anyone who knowingly . . .

> transports, treats, stores or disposes of any hazardous waste either without having a permit or (is) in knowing violation of any material condition or requirement of such permit;
>
> makes any false material statement or representation in any document used for compliance (with Subtitle C of RCRA);
>
> generates or handles any hazardous waste and knowingly destroys, alters or conceals any record required to be maintained;
>
> handles any hazardous waste and whose conduct manifests unjustified and inexcusable disregard or extreme indifference for human life.[12]

Further provisions of the act give EPA the authority to revoke permits, seek injunctions and levy fines if there is

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[11] 42 USC 6903 (8) (a).

[12] Paraphrased from 42 USC 6903 (8) (d) through 42 USC 6903 (8) (e).

> ". . . evidence that the handling, storage, treatment, transportation or disposal of any solid waste or hazardous waste may present an imminent and substantial endangerment to health or the environment."[13]

The intention of RCRA was not solely to broaden the liability of those responsible for generating, transporting, treating, storing or disposing of hazardous waste. Rather, it saw the state and local government as being overburdened with the enforcement of existing liability.[14] In addition, the existence of 50 different sets of standards and regulations at the state level created numerous distortions in the actual disposal of hazardous waste. States could not block hazardous waste from entering their borders because of the Interstate Commerce clause of the constitution. Moreover, several states had very lax standards, and, at the time the RCRA was passed, four states were mute on the issue.[15] The law's enactment represented a significant change from previous policy and has withstood legal challenges from both environmental groups and industry.[16] While RCRA sought to address the proper avenues of disposal it did not change the basic liability structure.

The Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA)[17] addressed the liability structure and stressed an active role by the federal government in the prevention of and response to releases of hazardous materials. Rather than on a case by case basis, the problem was approached on a broad scale. CERCLA was also designed to deal with a diverse range of problems including costs of cleaning up offshore petroleum spills, land transportation accidents, abandoned hazardous waste landfills and the purchase and monitoring costs of closed disposal sites.[18] Unlike any previous act dealing with the environment, CERCLA contains an explicit funding mechanism.[19] Superfund, a $1.6 billion cleanup fund, obtains 85 percent of its revenues

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[13] 42 USC 6907 (3)(d).

[14] US Congress, House, Resource Conservation and Recovery Act of 1976 Hearings, (Washington: usgpo, 1976), pp. 158-72.

[15] Ibid., p. 167.

[16] Michael Deland, "EPA's Hazardous Waste Regs Challenged," Environmental Science and Technology 15(1) (1981): 23.

[17] P.L. 96-510; 94 Stat 2767; Text in 126 Cong. Rec. 14988-15002.

[18] P. L. 96-510, section 111(b) & (j).

[19] P. L. 96-510, title II.

from excise taxes on chemicals, chemical feedstocks (primarily petroleum) and hazardous waste disposal. The other 15 percent comes from general government revenues. If fully implemented, CERCLA will clarify the responsibilities of polluting parties, will stiffen liability for damages arising from illicit, unpermitted disposal and may alleviate financial responsibility for damages that arise from permitted disposal.[20] Strict, joint and several liability on generators, transporters and disposers of hazardous waste was proposed in several early versions of the bill[21] The final bill contained provisions for such liability through subrogation,[22] but was otherwise silent on the issue.

The passage of CERCLA made the allocation as well as the sources of compensation more well defined, although not completely removed from the courts. Speculation has ensued as to how certain provisions of CERCLA will be interpreted in court cases.[23] Speculation has also arisen over the administratitive implementation of CERCLA.[24] Yet, if given a chance, CERCLA has the ability to solve the multifarious problems of releases of hazardous materials.

RCRA leaves to the states such major decision-making powers as where to site new facilities, whether or not to permit existing facilities, ancilliary services to facilities and standards to supplement those provided by the federal government. New York State has been an innovator in regulating hazardous waste. Because the cost of cleaning up old sites must be shared by both the federal superfund and state monies, many states have created their own "minifunds" for this purpose. New York has again been a leader in in this area sites.[25] Those found to be a threat to public health and the environment will be remedied by whatever means is deemed necessary by the New York Department of Environmental Conservation and the Environmental Facilities Corporation.[26]

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[20] P. L. 96-510, section 107(k).

[21] H. R. 5790 96th Cong. 2d Sess. (1980) (The Florio bill); S. 1480 96th Cong. 2d Sess. (1980) (The Muskie bill) as submitted on June 12, 1980.

[22] P. L. 96-510 section 112(c)(1).

[23] Michael Deland, "Superfund," Environmental Science and Technology 15(3) (1981): 255.

[24] "Allocating the Costs of Hazardous Waste." Harvard Law Review 94 (1981): 599.

[25] NYS ECL 27-1105 (2).

[26] NYS ECL 27-1303.

costs will be recovered through civil penalties assessed against offending parties.[27]

The law is deficient, however, when firms that harm or threaten public health and the environment become insolvent. In these cases, the state cannot remedy the situation until an appropriations bill is passed by the legislature or until state and federal response funds are used. Many states and municipalities now require firms to establish bond and escrow accounts.[28] If a firm goes bankrupt, the government has preferential claim on these accounts.

Liability Setting and Abatement

The market failure brought about by hazardous waste disposal creates a social cost in excess of private cost. There are two possible liability settings: the person adversely affected by such disposal bears the social costs, or the person disposing bears these costs. The distinction makes a difference in how much the polluter will abate polluting. In the absence of liability, the polluter will have no economic incentive to abate. Whereas, if the polluter is liable, the social cost will be the economic incentive to abate.[29]

Hazardous waste is more complicated in external costs than is true for most other forms of pollution. This is due to the time lags between disposal, exposure and illness. These time lags make proof of the cause of damages difficult, thus clouding the liability issue even with recent clarifications in the law.

Another factor that affects liability and its incentives is transaction costs, the largest government cost in environmental matters which includes collecting information, negotiating, bringing suit, enforcing agreements and other costs incidental to allocating of external costs. Yet, the government does not always bear transaction costs. In the absence of any statute to the contrary, transaction costs are always paid by the liable party. Transaction costs are also frequently assymetrical[30] By paying transaction costs, the

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[27] NYS ECL 27-1313 (3).

[28] Gary Hall, Vice President of CECOS International, Niagara Falls, NY, 18 April, 1981.

[29] Alan Randall, "Market Solutions to Externality Problems: Theory and Practice," Amer. J. Agr. Econ. 54 (1980): 176-83.

government can frequently reduce the costs involved in environmental policy making. The government has a better capacity for many of the administrative functions involved in transaction costs than does the private sector. The cost of finding the polluters can be lowered by registering them and tracking their hazardous waste through the manifest system. Another way that transaction costs are reduced is by reaching bargaining decisions through administrative actions. Finally, because the government has already been invested with police power, it is much less costly and more effective to leave enforcement to the government than to let private parties attempt to enforce agreements. The government will change the amount of pollution abated by bearing transaction costs. Conversely, a polluter will abate more when faced with transaction costs. If the user must pay transaction costs, the firm will abate less.

Future costs are also highly uncertain. Financial requirements for clean-up and compensation are likely to be underestimated. Fiscal burdens placed on future generations will result from failure to act swiftly in the mandated cleanup of abandoned sites. Laissez-faire failed to prevent, compensate or mitigate resulting external diseconomies. Yet, government intervention alone will not correct externalities; indeed, some actions could conceivably worsen external diseconomies. Cooperation from key industry groups and business is important, and consumers must be willing to share increased costs for some products to internalize the external costs. A coordinated program of regulation, compensation and education is likely to yield the most successful results.

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30 Peter J. W. N. Bird, "Environmental Policy Making in the Presence of Transaction Costs," Nat. Res. J. 20 (1980): 487-99.

III

LOCATION OF HAZARDOUS WASTE FACILITIES AND RESIDENCES

Houses and disposal facilities compete for the same scarce resource, land. The characteristics that make a particular site desirable for residential development are often those for a secured landfill. Although submarginal land is often used as landfill, such land usually presents problems if used for hazardous waste disposal.

Disposal sites should not be on a steep slope, in wetland or prone to flooding. Depth to bedrock and to groundwater must both be reasonable. The soils must be tight, not subject to shifting and not too porous. In addition, the site must be accessible. Because these are also the preferred attributes of residential land, many landfills are relatively close to residences.

Both natural and artificial factors play a role in the siting process (fig. 1). The site selection process can be wholly private, wholly political, or a mixture of the two. A modified decision-making process will become the norm, with state governments either directing the siting process, or providing positive and negative incentives for firms deciding to open and operate hazardous waste sites. It is institutional factors, more than market forces, that will decide where disposal facilities are sited, and, more importantly, how much of society's scarce resources will be allocated to disposal. The decision-making process can be viewed as being comprised of profit-maximizing firms and satisfaction-maximizing individuals. The role of the government in the siting process considered here is negative -- that is, to prevent firms from endangering public welfare by making firms meet minimum technical requirements in siting.

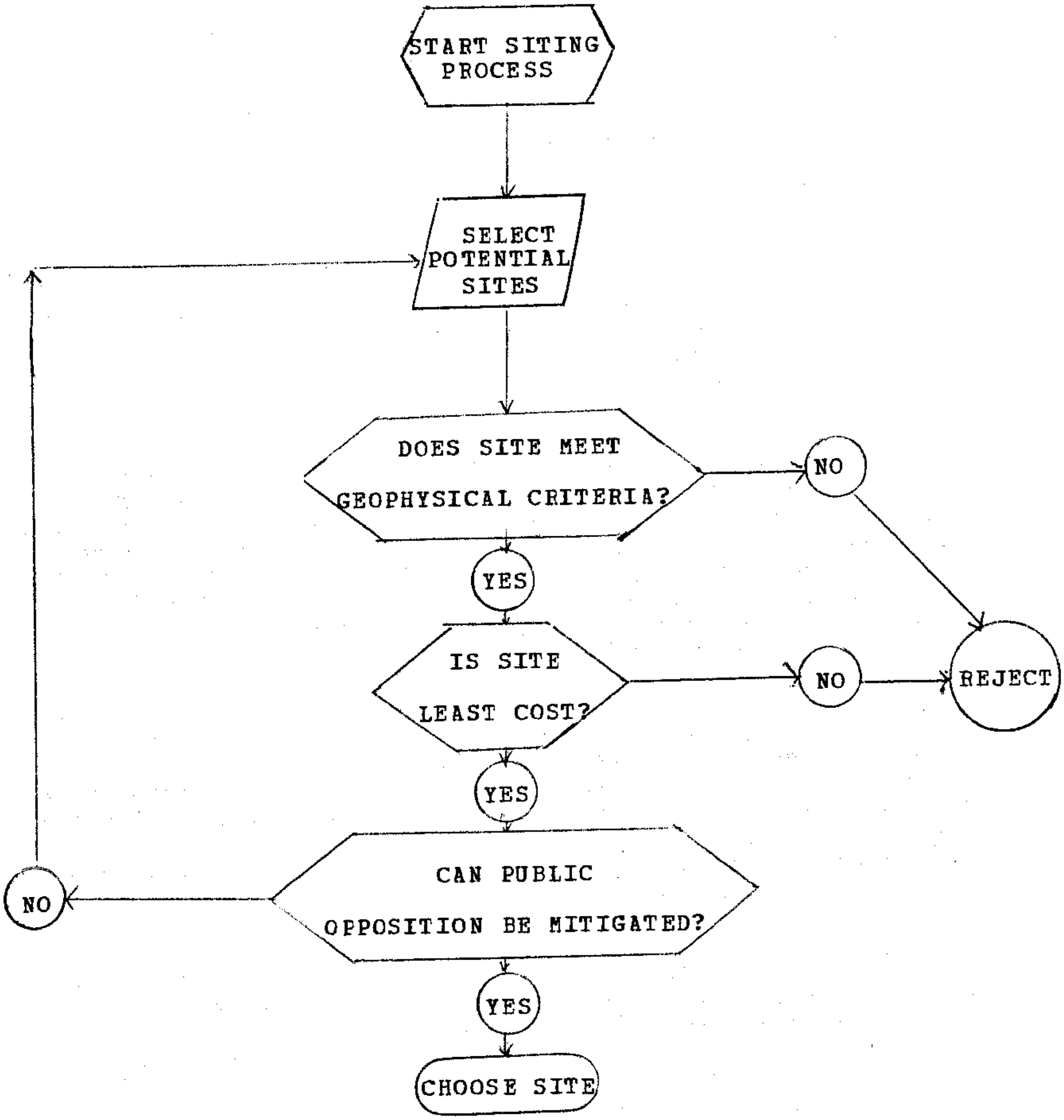

FIGURE 1: SCHEMATIC OF SITE SELECTION PROCESS

Cost Considerations by Disposing Firms

Numerous considerations impinge on the viability of a given facility. Assuming equipment costs, labor costs, input costs and closure costs do not vary significantly between sites, what criteria lead to rational selection of one site over all others available? In the setting of imperfect competition that exists in the industry, location is very important to the commercial success of a firm. The criteria upon which siting is based stem less from a general equilibrium context and more from a constrained, partial-equilibrium context. From a given set of sites that meet legal and technical requirements, those costs which vary from site to site must be minimized. The important ones are transportation and land costs and infrastructure investment. The siting problem is inextricably linked to the externalities that a new facility produces.

For the firm, the price of land is certainly an important consideration but it is not the only consideration.[1] The most important factor in determining the competitive advantage of one site over another is transportation costs, which may represent as much as 80 percent of total offsite disposal costs.[2]

The high cost of transporting hazardous waste makes location near both generating sources and major roads an important competitive consideration for the firm. A programming model can minimize transportation costs, given a limited number of sources and potential sites.[3] One element that is ordinarily omitted from such models is the risk involved in transportation. Risk is particularly important when transporting hazardous waste.

Transportation of hazardous waste differs from an ordinary transportation problem in two important respects. The first is that the supplier (generator) must pay the recipient (operator), i.e., costs are charged to point of origin rather than destination. The economic importance of this is that the cargo is a liability, rather than an asset. The second difference is that losses from an accident are much greater with hazardous than with ordinary cargo.

Because the cargo is of negative value, there is no incentive for the transporter to insure against loss, even though damages from an accident could be extensive. Risk can be defined as the probability times damage under all possible conditions. Because potential damage is related to the variability of population density and amount of property along the route, risk is not necessarily a linear function of distance.

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[1] Raleigh Barlowe, Land Resource Economics, Third edition, (Englewood Cliffs, NJ: Prentice-Hall, 1978): pp. 304-11.

[2] Booz-Allen and Hamilton, Hazardous Waste Generation. p. V-35.

[3] A detailed and sophisticated model which does this can be found in Larry Clayton Parcel's A Model for the Sequential Location of Resource Recovery Facilities. Ithaca, NY, Cornell University Unpubl. Ph. D. thesis. 1979.

A profit-maximizing firm that is risk neutral can be assumed to minimize expected costs, given both prices and quantities, as in a perfect competition setting. It is necessary to have all information relevant to an accident, including population density, property at risk, type of waste, quantity of waste involved, distance travelled and probability of an accident along the given route. The notion that the cost of risk is simply the expected value of loss to the firm has also been attacked by economists.[4]

Incidents involving hazardous materials are not uncommon.[5] The information required to derive the probability and expected costs of accidents gives decision makers the ability to compare expected losses and to choose among alternatives. The firm will then act to minimize expected costs, taking into account the provisions made in CERCLA to deal with accidental spills, and the availability of insurance to pool the risk of discharge.

Decisions on where to locate are also influenced by state and local regulations. Imposition of a minimum set of liability standards at the federal level has decreased but not eliminated differences between states, given moves to deregulate interstate transportation. Approaches other than direct regulation may be effective in reducing risk to the population.

Because a major source of cost and risk in handling hazardous waste lies in moving it from generation to disposal, onsite disposal is a significant consideration. Onsite disposal takes place on the property of the generator near the source of generation.

Onsite disposal is often not preferred by generators because they would then be subject to regulations as rigorous as those for disposal firms. Furthermore, the applications for federal, state and local permits serve as a disincentive because of their complexity, and their requirements for environmental monitoring and worker-safety inspections. Finally, the firm must acquire the technology to dispose of hazardous waste and must hire the skilled personnel to operate it.

The firm disposing onsite is not given automatic advantage over firms that specialize in contracting to dispose of waste offsite. Several factors must be weighed. One is the

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[4] H. S. Burness, R. G. Cummings, and R. D. Norton, "Perceived Risk and Catastrophic Events," (Paper presented at the Western Econ. Assoc. Meetings, San Diego, June, 1980), p. 23.

[5] US EPA, Hazardous Materials Incidences, Compiled annually.

distance from the point of generation to the point of disposal. A second factor is the hazard level of wastes to be disposed. Onsite disposal may be favored for less toxic wastes, while wastes that require special treatment are usually handled by a specializing firm. In some cases, regulations, market factors and technology combine to give firms incentives to recycle certain by-products in the plant so that the problem is internalized. A third factor is the homogeneity of waste streams. For an onsite facility, the techniques for handling waste are usually tailored to the needs of the plant or operation. Such a waste stream reduces the cost of dealing with onsite disposal. On the other hand, where waste is highly variable, the average firm cannot ordinarily maintain the facilities to deal with such a broad range of disposal problems. The exception would be the waste produced by research laboratories. In this case, the firm would not want third parties to gain content information from waste for fear it would lose competitive advantage.

In terms of political support, onsite disposal facilities have a clear advantage over offsite facilities. Local residents may be more willing to trade the costs of waste disposal for the employment and tax base benefits of the generating plant. Waste disposal facilities usually create few jobs hence isolated offsite disposal is unpopular in communities that do not contain major generators of hazardous waste. Onsite disposal offers tangible evidence both of benefits of hazardous waste disposal (employment, products, tax revenues) and of costs (environmental degradation, health risks, increased demand for public and quasi-public goods and services). If the perceived benefits are great enough, opposition to an onsite operation may be bought off.

An advantage usually attributed to offsite disposal is economies of scale.[6] While the financial barriers and risks facing firms considering onsite disposal are great, this alternative becomes more attractive as monopolistic prices are translated into higher costs. The weakness of most arguments favoring few, large, offsite disposal facilities is that only average fixed costs are considered in the estimates.[7]

Major diseconomies of scale were not considered in most of the studies done on facility siting. Yet, the potential for diseconomies of scale is great. Concentrating hazardous waste in a few facilities, rather than spreading the risk of mishap invites the weaknesses associated with virtual monopoly.

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[6] Booz-Allen and Hamilton, Hazardous Waste Generation. pp. V-5 - V-8; Camp Dresser & McKee, Technical, Marketing and Financial. pp. IV-16, ff.

[7] Camp Dresser & McKee, Technical, Marketing and Financial Findings. figures VII-11, VII-12, VII-13.

Capital expenditures on plant and equipment comprise a major cost of opening a facility. In most cases, the investment in equipment would not be site specific. Some, however, may be site specific and could be deciding factors. Government should be interested as well insofar as it may have to pay some or all of the costs. These costs are generally related to the existing transportation facilities and compensation for special problems related to the local environment.

A hazardous waste disposal facility that handles any meaningful quantity of waste requires capacity to handle many heavy trucks daily. A 1979 study estimated that 94 percent of all offsite hazardous waste was transported over the highway.[8] Thus, if a site is not located near or on a major road capable of surviving heavy truck traffic, the firm operating the site will be at a competitive disadvantage. Further, roads unable to handle this increased traffic will increase the probability of accident. The required investment to upgrade the highway structure leading to the plant could be undertaken by the government, the firm or both. A firm that creates a demand for such public investment is almost sure to have that demand reflected in increased taxes or compensation payments.

A site may require investment for environmental conditions in the area. This may include extra clay lining for especially permeable soils near groundwater. For earthquake and flood prone areas, investment in redundant systems may be needed. Federal and state regulations clearly discourage facilities that imperil groundwater, or that may be disaster prone. Regulations affect existing facilities less severely than proposed facilities. With new sites, state regulations frequently prohibit such environmentally unsound practices. It is more difficult to control existing sites in terms of potential threat, but the regulations may discourage expansion of existing capacity when such expansion would require extra costs related to alleviating threats to the local environment.

Other Management Objectives

In New York State, all operating hazardous waste facilities are managed by the private sector. These firms are presumably trying to maximize return on investment and acting similarly to a cost-minimizing, profit-maximizing firm. Yet, a hazardous waste facility might be operated with objectives other than profit maximization. New York State has considered

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[8] Arthur D. Little, Charaterization of Hazardous Waste Transportation And Economic Impact Assessment of Hazardous Waste Transportation Regulations. (Washington: US Environmental Protection Agency, 1979), p. I-3.

a state owned, privately managed firm responsible for the disposal of hazardous waste in the state. Under contract by the state, the private management firm would build a high technology facility, preferably on state land.

The state expressed a number of program objectives; maximizing return on capital investment was not one of them. The objectives included

1. Minimizing continued land burial in preference to high technology methods of disposal,

2. Implementing a transportation manifest system in conformance with federal (EPA) requirements,

3. Promulgating disposal facility siting criteria,

4. Promulgating regulations for existing facilities,

5. Continuing development of compliance and enforcement criteria,

6. Providing technical assistance to industry and local government and information to the public,

7. Encouraging reduction of amounts of waste at the source, and recycling.[9]

Even in the hands of the private sector, objectives such as long-term stability, growth, maximization of market share or sales may each lead to a solution other than profit maximization.

Land Requirements

The location of a hazardous waste facility must meet all legal and economic criteria. Offsite location will also be influenced by the availability and price of land, as well as by the requirement of land as an input necessary for the continued maintanence of the operation. Because land costs can form a considerable portion of the initial investment in a new facility, firms prefer to locate in an area of low land prices.

Finding a location with all necessary geological features and adequate access can be time consuming. Yet, sufficient alternatives exist to make the task manageable. The factor

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[9] Camp Dresser & McKee, Generic Environmental Impact Statement for a Hazardous Waste Treatment Facility in New York State. (Albany: NYS Dept. of Environ. Cons., 1980), p. III-1.

that can most sharply curtail the availability of land for waste disposal is public opposition, generally strongest from the immediately surrounding community.[10] Pressure from local opposition may reduce the available options. The problem of illicit and unsound disposal practices has lead legislative bodies, administrators and industry groups to seek ways to contain improper disposal by expanding the capacity of permitted, regulated, safe facilities. To do so, government has imposed eminent domain and police power to enforce siting decisions.

By using this enforcement power to prohibit uncontrolled dumping, government creates a shortage of needed disposal facilities. This has put state governments in the bind of promising adequate capacity for industry in a number of areas where capacity is expected to fall short.

In a world with perfect mobility, siting a new disposal facility would be accomplished painlessly and efficiently. The market mechanism allocates the land required for a facility and those who do not like it move away. Government, if it has a role at all, acts only to keep hazardous waste safely disposed. Yet, because the system does not have perfect mobility for all resources, the government has a greater role to play. Sometimes government acts as mediator, sometimes as the broker for one or both parties. There is a need to find alternatives to both the laissez-faire system of siting and the approach which gives the state absolute power in deciding where to site a new hazardous waste disposal facility.[11]

The issue of where to locate a new facility is controversial. Most people recognize that disposal sites are necessary and are quite reasonable in discussing where sites should be, as long as it is far enough away from them. The NIMBY syndrome (Not In My Back Yard) is common to all communities faced with a possible disposal facility. In this respect, such facilities are similar to prisons, power plants and airports.[12] Increased visibility and notoriety often require the coercion of local governments by higher authorities to force acceptance. Only when the disposal of

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10 Michael O'Hare, "Not on My Block You Don't," Public Policy 25(4) (1977): 409. Public Policy

11 David Goetze, "An Evaluation of Incentive-Compatible Decisionmaking Mechanisms as Alternatives to Regulatory and Market Approaches: Applications to the Siting of Hazardous Waste Disposal Facilities." (Washington, DC, Resources for the Future, April 1981).

12 "Not on My Block You Don't," Public Policy 25(4) (1977): 407-12.

waste can be linked to jobs in the area is local opposition alleviated.

Most hazardous waste is generated in older industrial centers and in petroleum producing areas.[13] If some states continue to tighten regulations, making expansion of capacity difficult, capacity will be expanded in those states which have laxer restrictions. Distances between generation and disposal will grow, although new offsite facilities will likely encourage building new plants that generate hazardous waste in the immediate vicinity of disposal sites. Onsite facilities may be permitted where offsite permission would be unthinkable, for example, Kodak's incineration facility in Rochester, New York. Although a community will not want to be the dumping ground for another community, it may accept waste disposal related to local employment. Nevertheless, public opposition may be sufficiently strong to cause a significant national shortage of offsite capacity.

Experience with land disposal suggests that the productive capacity and usefulness of land containing hazardous waste can be irreversibly impaired. Costs from this irreversibility would mount if land were to become more scarce relative to population. The foregone rent is a deadweight loss to society once the land is removed from productive use. As long as it must be left idle, the supply of land is effectively decreased.

Landfill has been the predominant method of hazardous waste disposal in the US because of the abunduce of inexpensive land. As recently as 1966, landfills were also considered least risky to public health. Incineration has continued to present emissions problems and chemical neutralization is still relatively more expensive than untreated landfilling. Aqueous treatment through lagooning is another widely used method of ultimate disposal in the Northeast. Yet, even with emerging technologies and increasingly stringent regulation, landfilling is expected to continue to be the predominant method of disposal.[14]

Landfilling is land intensive, requiring a much greater area than any other method. Even with attempts to induce managers to use other methods, economic incentives and technological simplicity make landfilling the preferred method. The introduction of more capital-intensive methods of disposal will not eliminate the need for land for the disposal of some by-products of treatment processes. Incineration, neutralization and treatment generally reduce the amount of

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[13] Booz-Allen, pp. IX-17, IX-23.

[14] Julian Josephson, "Hazardous Waste Landfills," Environ. Sci. Tech. 15 (1981): 250.

waste to be disposed of by landfilling. There are also usually solid waste by-products of these processes, though not always hazardous waste. Thus, as long as land remains cheap and abundant, relative to capital, land-intensive methods will continue to be the least cost alternative.

Residential Housing Market

There are behavioral characteristics of consumers in the housing market that differ from those in other markets. Because conclusions depend on assumptions made these will be stated.

Value can be thought of as function of price-determining attributes. In the case of a home, these may be tangible articles associated with the residence itself, such as available living space, amount of land and number of rooms. There may also be amenities and conveniences associated with a location, including accessibility, privacy, low crime rate and good schools. Disamenities, too, may be associated with a neighborhood and property values reflect these attributes. When evaluating the housing market, the intrinsic qualities that differentiate one house from another need to be accounted for. The theoretical basis for such an approach was provided by Kelvin Lancaster[15] This framework is suited to discerning the utility of attributes derived from goods that are essentially similar, yet have attributes which differentiate their quality.

Model of the Housing Market

A great many attributes contribute to the value of a home. Of these, only a small number can be measured without error. Land market studies have a history of poor fit because of the effect that intangible attributes have on sale price.

Attributes which can be measured quantitatively with reasonable accuracy are the most important to the model. These include the date of sale, square feet of living area, amount of land with the property, total number of rooms, number of bedrooms, bathrooms and kitchens, and age of the house when sold. The interior measures present obvious collinearity problems.

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15 "A New Approach to Consumer Theory," J. Pol. Econ. 74 (1966): 132-154.

There are also a few qualitative attributes which are measurable as discrete choice variables, i.e., school district, type of siding and source of water. These variables can be expressed as dummy variables. The remaining variables present problems. Examples are condition of the home, type of neighborhood, view, security and other subjective considerations. Yet, these influences on the value of a home must be taken into account or they will contribute to bias in the model. Proxy variables may help. For instance, one may use elevation as a proxy for view. Problems with calculations arise, however, when the area is relatively homogeneous in terms of the proxy, yet heterogeneous in terms of the actual, but unmeasurable variable.

One way consumer preference for such amenities as a clean environment can be revealed is by where the consumer chooses to live. The demand for housing includes implicit demands: quiet,[16] clean air[17] and freedom from potential natural hazards such as flooding.[18] These implicit demands reflect a willingness to pay for amenities or for the absence of disamenities. These attributes are capitalized in value much the same way that tangible features are. The sale price of a house is assumed to be the net present value of future rents discounted into the future. These are the general characteristics assumed to occupy all consumer's preferences for space. They hold over all markets for real estate.

The model of the market for residential real estate presented here contains a number of assumptions. The most critical to the interpretation of statistical results are the assumptions that consumers maximize utility subject to income constraints and firms maximize profits subject to prices and costs as given. The market for housing is assumed to be in equilibrium at all times for the period observed. With this theoretical background,[19] the original hypotheses.

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[16] Arthur DeVany, "An Economic Model of Airport Noise Pollution" in Stephen A. Y. Lin, (ed.) Theory and Measurement of Economic Externalities. (New York: Academic Press, 1976).

[17] A. Myrick Freeman, "On Estimating Air Pollution Control Benefits From Land Value Studies." J. Environ. Econ. & Mgmt. 1 (1974): 74-83.

[18] Demetrios Damianos, The Influence of Flood Hazard Upon Residential Property Values. (Washington: NTIS, 1975).

[19] For a more thorough treatment of hedonic price theory, see Sherwin Rosen, "Hedonic Prices and Implicit Markets: Product Differentation in Pure Competition" J. Pol. Econ. 82 (1974): 34-55.

IV

EMPIRICAL WORK

The basic procedures to estimate the explanatory variables can be explained in four steps:

1. the statistical methods used in estimation,
2. The specification of the basic model;
3. the collection and augmentation of the data, and
4. the criteria for selecting cases.

Statistical Methods

Understanding the effect that disposal sites have on property values, requires knowledge of basic statistics and econometrics. The important statistics of an econometric analysis are the estimated slope coefficients, standard deviations, correlation coefficients, F-statistic and the condition of the X matrix.

The estimated slope coefficient states a linear relationship between the dependent and independent variables. It can also be interpreted as the mean value of the dependent variable given the values of the independent variables.

The estimated standard deviation is the average absolute difference between each data point and the mean of the distribution. This statistic gives an idea of the dispersion of the variables.

The t-statistic is the estimated slope coefficient divided by the estimated standard deviation. A t-statistic is said to be significant for our purposes when the t-statistic is greater than the table t for a given level of significance.

The correlation coefficient R^2 gives a measure of the degree of association between the independent and dependent variables. $\bar{R}^2$ is the correlation coefficient corrected for degrees of freedom. The main criterion for selecting variables to explain housing values was maximizing $\bar{R}^2$. The adjustment for degrees of freedom prevents the correlation coefficient from increasing when variables which do not sufficiently reduce the sum of squared residuals are introduced. Another criterion for variable selection was minimizing multicollinearity problems.

Model Specification

Specification of the models was straightforward. The following explanatory variables were selected: square feet of living area, acres of land with the parcel, age of the house, number of stories, number of rooms, number of bathrooms and source of water. The amount of space is thought to be positively correlated with the value of a house. The preference for more spacious housing is reflected by consumers willing to pay more for a house with more floor space inside and a larger yard outside. The coefficient of the age variable gives the average annual depreciation of the house from the time that it was built to the time that it was sold. The number of stories, the number of rooms, and the number of bathrooms measure quantitatively and qualitatively the attributes of a house. Finally, the source of water is related not only to the generic value of the home but may also have special significance to those homes which are in the vicinity of a landfill.

The model then may be specified as follows:

$$PRICE=a_0+a_1*WATER+a_2*TOWN+b_1*AREA+b_2*SFLA+b_3*AGE+ b_4*STORIES+b_5*ROOMS+b_6*BATH+b_7*DISTANCE+e$$

where: PRICE is the reported sale price of the house,

WATER is the source of the water supply, a dummy variable with a value of 1 if the source of water is private, 0 otherwise,

TOWN is a dummy variable with a value of 1 only if the house is within the same town as the disposal site,

AREA is the number of acres attached to the parcel with the house,

SFLA is the square feet of living area within the house,

AGE is the number of years between the date the house was built and the date of sale,

STORIES is the number of stories of the house,

ROOMS is the total number of rooms in the house,

BATH is the number of bathrooms in the house, and

DISTANCE is the distance of the house from the disposal site in hundred feet.

This is a linear model with the dependent variable being either a linear function of the explanatory variables, or a transformation of some or all of the explanatory variables.

The assumptions of the classical linear model are expected to hold throughout the estimations of the equations of the model. These assumptions are:

1. The disturbance term has an expected value of zero. The random error of the predicted minus the actual values of the endogenous variable will cancel out, so that their sum will assymptotically approach zero.
2. The error terms have a constant variance and are not correlated with each other.
3. The matrix of all the independent variables is one of fixed numbers. These numbers are known and are measured without error.
4. The number of observations is greater than or equal to the number of independent variables. The matrix of independent variables is of full rank and has no linear relationship between variables.

Of these four assumptions, the last one is probably the most troublesome for this model. In the real-estate market, there are many interactions; some may be linear. The correlations between explanatory variables caused some variables to be dropped from the model.

For land value regressions to work successfully, the neighborhood examined must be fairly homogeneous. None of the cases are as homogeneous as urban or suburban neighborhoods. The concept of neighborhood is much less uniform to rural homeowners and would reflect a poorer fit of the model, as given by the correlation coefficients.

In addition to delimiting the neighborhood of the model, the treatment of time posed a problem. Perceptions of landfills have changed over the given period. Therefore, using time as an exogenous variable was unacceptable. Prices change over time in the housing market. Rather than use date of sale as an independent variable, an index was used to deflate prices to their current level. An attempt was made to find the regional sectorial deflator that best described the housing market of an area. Two deflators were used. One was the shelter component of the Consumer Price Index for Buffalo. The other was the house sales index in Construction Review.

Another way that time entered the model was by having the distance variable equal to the distance only after a certain date. This specifies a conditional probability for the effect, and means that before a certain date, distance from the landfill did not matter. After a certain date, distance became important. This is a mixed estimation method, not purely conditional, because the actual value of distance is used, rather than a simple 0, 1 dummy variable.

A number of transformations were inspected to estimate the proper specification of the distance parameter. The ones that seemed to work best were the logarithmic and square-root transformations. These specifications make intuitive sense. The slopes of these functions continuously increase at a decreasing rate. The functional form of distance as it relates to housing values probably would affect those who live closer to the site more than those who live farther away. This is opposed to a linear function which implies that the effect is constant throughout all observations. With a logarithmic or square-root transformation, the change in the effect, as measured by the slope, becomes assymptotic to zero.

Data Collection

The data used in the study were collected by or for counties to assist them in property revaluations. As a result of Hellerstein v. Islip, localities relying on property taxes as a source of government revenue are required to assess properties at their full value.[1] One of the incentives that the state offered local communities was technical assistance and partial funding for the collection of a real property sales data file to perform a comparable sales analysis as the basis of full value assessment.

The comparative sales file contains a description of the parcel, the lot, the building and improvements. Each piece of real estate is identified by a section, block and lot number.

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[1] Hellerstein v. Islip NY Rep. (1975).

Only those localities which undertook the sanctioned property tax reforms had the detailed data required. At the time this study was initiated, only a few of the counties in the state had completed the surveys. Of these, only two had had problems with hazardous waste disposal. Both were included in the study. The important variables were selected and screened for such problems as incompatibility of hardware, and survey and keypunch error. Values for the distance from the disposal site were then measured from tax maps and then keyed to each observation. This variable was the only one not present in the data as collected. The data were read into a statistical package: TROLL.[2]

Criteria for Selection of Case Studies

The case studies for empirical investigation were chosen from a pool of 680 sites in New York State known or suspected to contain hazardous waste,[3] plus many more landfills. The three chosen reflect criteria necessary to confirm or deny the central hypothesis of the study: that hazardous waste disposal sites affect real property values. The selection mirrored the geographic diversity of existing sites. All were in either exurban or rural settings.

To measure the phenomenon of how the real-estate market is affected by a single variable, it was assumed that the market was behaving properly. Taking knowledge of the consumer into account, only those sites which were accepting waste through the period of the sale were considered. These two factors led to the disqualification of the Love Canal area of Niagara Falls. Love Canal is unique in that, so far, it has been the only instance where the government has bought homes in the vicinity of a hazardous waste dump. It was also disqualified on the second count because it stopped accepting waste in 1952.[4]

To measure the phenomenon of diminished property values, three other factors must also be present: a critical mass of properties to warrant a study, the publicity that the sites

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[2] MIT Center for Computational Research in Economics and Management Science, <u>TROLL Primer,</u> Third Edition. (Cambridge: MIT Information Processing Service, 1979).

[3] New York State Department of Environmental Conservation, <u>Hazardous Waste Disposal In New York State.</u> (Albany, NY Department of Environmental Conservation, 1980).

[4] New York State Department of Environmental Conservation, <u>Hazardous Waste Disposal Sites in New York State.</u> (Albany, NY Department of Environmental Conservation, 1980): 250.

handled hazardous waste, and the data relating to the land market. For the two facilities that handle industrial waste, these criteria were met. For the landfill that did not accept hazardous waste, only publicity was absent. Neighborhoods were defined as homogeneous in terms of access and all other locational factors, save for distance from the site. Thirty observations were needed to give enough degrees of freedom to yield a meaningful regression.

Public knowledge of the sites was also critical to measure effect. Inactive, surreptitious or abandoned dumps cannot have an effect on the land market until the public is aware of them. This eliminated many of the landfills recently discovered by county Environmental Management Councils and by the Department of Environmental Conservation. The final criteria, availability of data was constraining on selection of case studies.

Each case study was unique in some sense. The sites chosen differed in terms of location, topography, local markets and price levels. The sites also differed in terms of the kinds of wastes they accepted, and the capacity to hold certain wastes. Media attention and local awareness was another factor that varied.

Town of Dryden

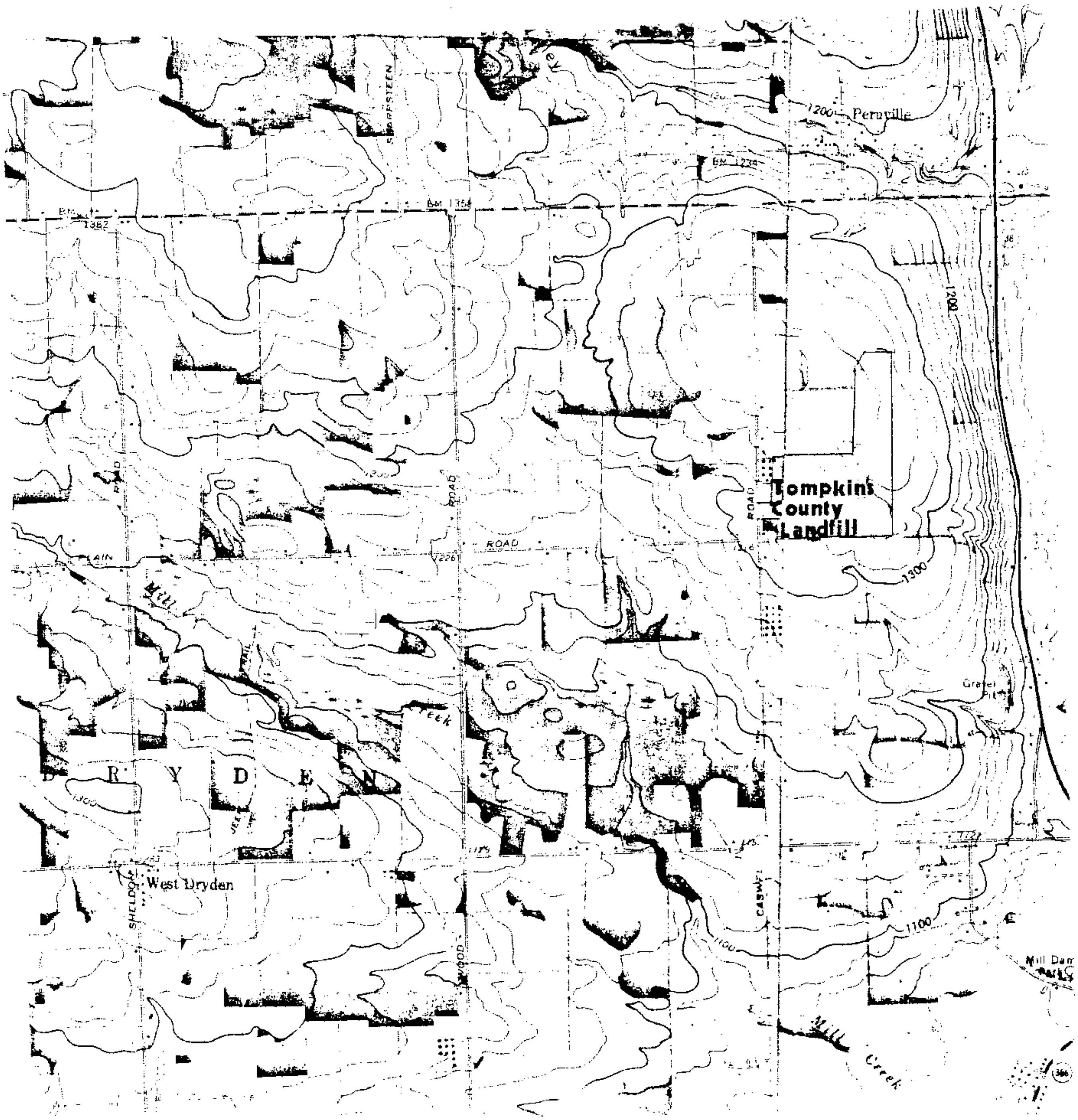
Operating the only public landfill in Tompkins County, the Town of Dryden is a relatively sparsely populated community between the cities of Ithaca and Cortland. The Tompkins County landfill was included for contrast and comparison. It is not a hazardous waste disposal facility. Although the focus of the study is on hazardous waste, other solid wastes create disamenities. While ordinary sanitary landfills present much less danger to the public than hazardous waste disposal facilities, landfills may have as bad an image. Sanitary landfills provide a reference point for the effects of a more run-of-the-mill disamenity.

Tompkins County was a logical choice for several reasons. Foremost was the availability and easy accessibility of the data. Tompkins County Real Property Tax Service has a state-wide reputation for excellence and innovation. The data files maintained on sales inventories are no exception. The site is also located near Cornell University, the study's origin.

The Tompkins County Landfill in the Town of Dryden is situated on a 95-acre knoll overlooking NY State Rt. 38 to the east. (figure 2). The landfill itself has been leveled because of fill activity, and sand and gravel, used as cover, have been removed from the southwest corner creating a retention pond.

Figure 2: Map of West Dryden

Source: USGS Topographic Survey Maps, Groton and West Groton quads. Location of landfill determined from tax maps and deed descriptions. Not to scale.



Most of the surface material at the site consists of Bath and Valois gravelly silt loam.[5] A smaller amount of Erie channery silt loam is also present. The slopes of the soils are moderately uniform creating an erosion problem. The Erie soils are relatively deeper and more poorly drained. Together, the soils form a low lime glacial till. One of the properties of this soil is that it is very dense and slowly permeable at a depth of 12 to 18 inches. The soil types at the site have little value for agricultural use but are well suited for landfill.

The site is in the Owasco Lake drainage basin and is at the headwaters of a small, eastward-flowing stream which enters the headwaters of the Owasco Inlet. The flow pattern of both ground and surface water is controlled by the existing topography and the distribution of unconsolidated aquifers. The recharge to groundwater aquifers is mainly from precipitation, local and seasonal surface streams and bedrock hills surrounding valley aquifers.

The groundwater gradient is moderately steep because of topographic control. The aquifer most likely to be affected by the site is at the bedrock/till interface. Because of the lack of permeability, no immediate threat to groundwater is perceived. The measured depth to the groundwater table ranges from about 8 to 13 feet, and to bedrock even deeper.

The landfill is open Monday through Saturday from 7:30 A.M. to 3:30 P.M. and accepts mainly household refuse which is compacted daily and covered to control rats, insects and blowing debris.

The landfill does not accept hazardous industrial material, septic tank pumpings, radioactive materials or other harmful substances. All operators are instructed to watch for hazardous waste and to refuse entry. Locking gates prevent surreptitious dumping during off-hours and routine Department of Health monitoring confirms that this has not been a problem. Some resource recovery takes place on site, mostly by local metal scrap salvagers and reprocessors.

When the county bought the land in 1970 for a landfill, local landowners protested, expressing fear of noise, dust, rodents and scattered debris from the trucks. At least one of the landowners tried to have his assessment lowered specifically because of the opening of the site. Despite opposition, plans and specifications to operate were approved by the state in 1970 and the landfill began operations later that year. At no time has the operation been closed as a threat to public health and safety by state or county officials. Protests by local landowners have faded although

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[5] New York DEC files on the Tompkins County landfill.

the landfill is mentioned in the local media because it is to be closed in the near future.

Housing in the area is diverse and although most houses are below average in price a few are well above average. Since the landfill opened, there has been some new construction in the immediate vicinity including a small subdivision. Realtors in the area had mixed opinions as to how the landfill affected sales, although the market in that area was agreed to have been quite slow. Yet even before the landfill began operations that particular area of Dryden had had a history of being less desirable than other available neighborhoods. The land near the site is not well suited for crop farming and it is too far from Ithaca and Cortland for many commuters. A few realtors said that the landfill was a factor contributing to low sales and that the psychological effect of proximity would discourage many buyers.

The results for the town of Dryden showed the lack of uniformity and the general diversity of the area. The neighborhood defined included sections 22, 23, 28, 32, and 33 in the town of Dryden, and sections 35 and 36 in the Town of Groton. Price was standardized using the US Department of Commerce Construction Index base year 1974. There were 37 observations in the case study, the fewest of all the case studies. The results of the estimation are given in table 1.

TABLE 1

Dryden Linear Model Results

Variables	Estimated Coefficients	Standard Error	T-Statistics
Intercept	5018.79	6823.38	0.74
Water	308.65	1551.85	0.20
Acres	-1.68	2.46	-0.68
SFLA	8.36	5.30	1.58
Age	-98.10	38.99	-2.52
Stories	232.57	448.91	0.52
Rooms	-1033.29	1185.03	-0.87
Baths	447.47	209.41	2.28
Distance	32.88	47.59	0.69

$R^2=0.50$ $\bar{R}^2=0.36$ $F(8,28)=3.53$
Condition of the X Matrix=25.43

The correlation coefficients were below average, even for land value studies. Only two of the t-statistics were greater than 2 and the sign for acres seems amiss. Sensitivity analysis showed that by dropping several observations, t-statistics could be improved for square feet of living area (SFLA), and acres would have the correct sign. Dropping variables, however, would probably have impaired the corrected correlation coefficient and would leave fewer degrees of freedom. The estimated coefficient for distance has the correct sign but is smaller than the standard error for distance. The square feet of living area seems to be interacting with age. Newer homes in the area tend to be smaller than older homes and these are on larger lots.

Some transformations on the distance variable were introduced to better explain the data. The first such transformation took the natural logarithm of the distance variable (table 2).

TABLE 2

Dryden: Log Model Results

Variables	Estimated Coefficients	Standard Error	T-Statistics
Intercept	-8155.80	10308.00	-0.79
Water	497.55	1470.91	0.34
Acres	-1.79	2.29	-0.78
SFLA	9.28	4.98	1.86
Age	-102.59	37.06	-2.77
Stories	196.85	428.97	0.46
Rooms	-1104.22	1131.08	-0.98
Baths	512.90	200.75	2.55
Distance*	3651.43	2029.54	1.80

$R^2=0.55$ $\bar{R}^2=0.42$ $F(8,28)=4.21$
Condition of the X Matrix=36.41
* Logarithm of Distance.

The results are not very different for the explanatory variables except for distance. Sensitivity analysis identified the same outliers. The coefficient of the distance variable exceeded its standard error. The t-statistic rose accordingly and the correlation coefficients improved somewhat.

The second transformation of the distance variable took the square root of distance for each observation (table 3).

TABLE 3

Dryden: Square-Root Transformation

Variables	Estimated Coefficients	Standard Error	T-Statistics
Intercept	318.24	8081.69	0.04
Water	-437.01	1519.33	-0.29
Acres	-1.82	2.38	-1.73
SFLA	8.94	5.16	1.73
Age	-101.02	38.22	-2.64
Stories	-223.73	440.70	0.51
Rooms	-1073.75	1163.28	-0.92
Baths	492.80	205.76	2.40
Distance*	821.02	660.12	1.24

R^2=0.52 $\bar{R}^2$=0.39 F(8,28)=3.79
Condition of the X Matrix=26.17
* The square root of distance.

The results of the square-root transformation were not as good as the logarithmic transformation, but were better than the linear model. The sensitivity analysis was consistent in discovering outliers. The outliers were retained. Moving a house from one-half mile to one mile away from the landfill appears to improve its value by $1,750. The margin of error means that a confidence interval that covered a probability of 95 percent would include housing values improved by moving from one mile to one-half mile. The estimated change was $2,530 with the logarithmic model and $868 with the linear model.

To see if public perception affected housing values, distance was omitted for the observations before the news of Love Canal appeared in the media. The model as specified suggests that before 1978, distance from the landfill made no difference but that from 1978 on, distance was relevant. The results of this model are summarized in table 4.

The results appear rather striking when compared with the other models. A formal t-test reveals that the slopes differ at the 95 percent level. The reason for this may be a changing awareness of the landfill, or it may be other

TABLE 4

Dryden: Landfill Distance After 1978

Variables	Estimated Coefficients	Standard Error	T-Statistics
Intercept	7857.23	4751.48	1.65
Water	-1833.45	5355.43	-0.34
Acres	-0.02	2.12	0.00
SFLA	4.33	4.57	0.95
Age	-78.15	34.07	-2.29
Stories	57.91	397.03	0.15
Rooms	-311.41	1058.31	-0.29
Baths	465.91	182.83	2.55
Distance*	116.92	38.64	3.03

R^2=0.62 $\bar{R}^2$=0.51 F(8,28)=5.67
Condition of the X Matrix=24.53
* Zero if the house sold before 1978, distance if sold during or after 1978.

factors. The square-root transformation of this model was estimated (table 5).

This time, a formal t-test accepted the null hypothesis that the effect of distance from the landfill has not changed. The differences between the Dryden results stem from the relative changes that the linear and square root models had on the coefficients of interest. The linear model changed a great deal. The coefficient almost tripled, while the standard error was reduced by almost a quarter. The use of the information from the transformation made the confidence intervals for both consistently above zero for a 95 percent level of probability of type I error.

TABLE 5

Dryden: Square Root Transformation of Distance After 1978

Variables	Estimated Coefficients	Standard Error	T-Statistics
Intercept	8031.99	4792.66	1.68
Water	-1784.02	5401.16	-0.33
Acres	-0.04	2.14	-1.02
SFLA	4.59	4.60	1.00
Age	-79.31	34.33	-2.31
Stories	63.14	400.41	0.16
Rooms	-366.03	1064.86	-0.34
Baths	454.16	184.49	2.46
Distance*	871.85	184.49	2.92

R^2=0.61 $\bar{R}^2$=0.50 F(8,28)=5.51
Condition of the X Matrix=24.53
* Square-Root of Distance if property sold after 1978, otherwise 0.

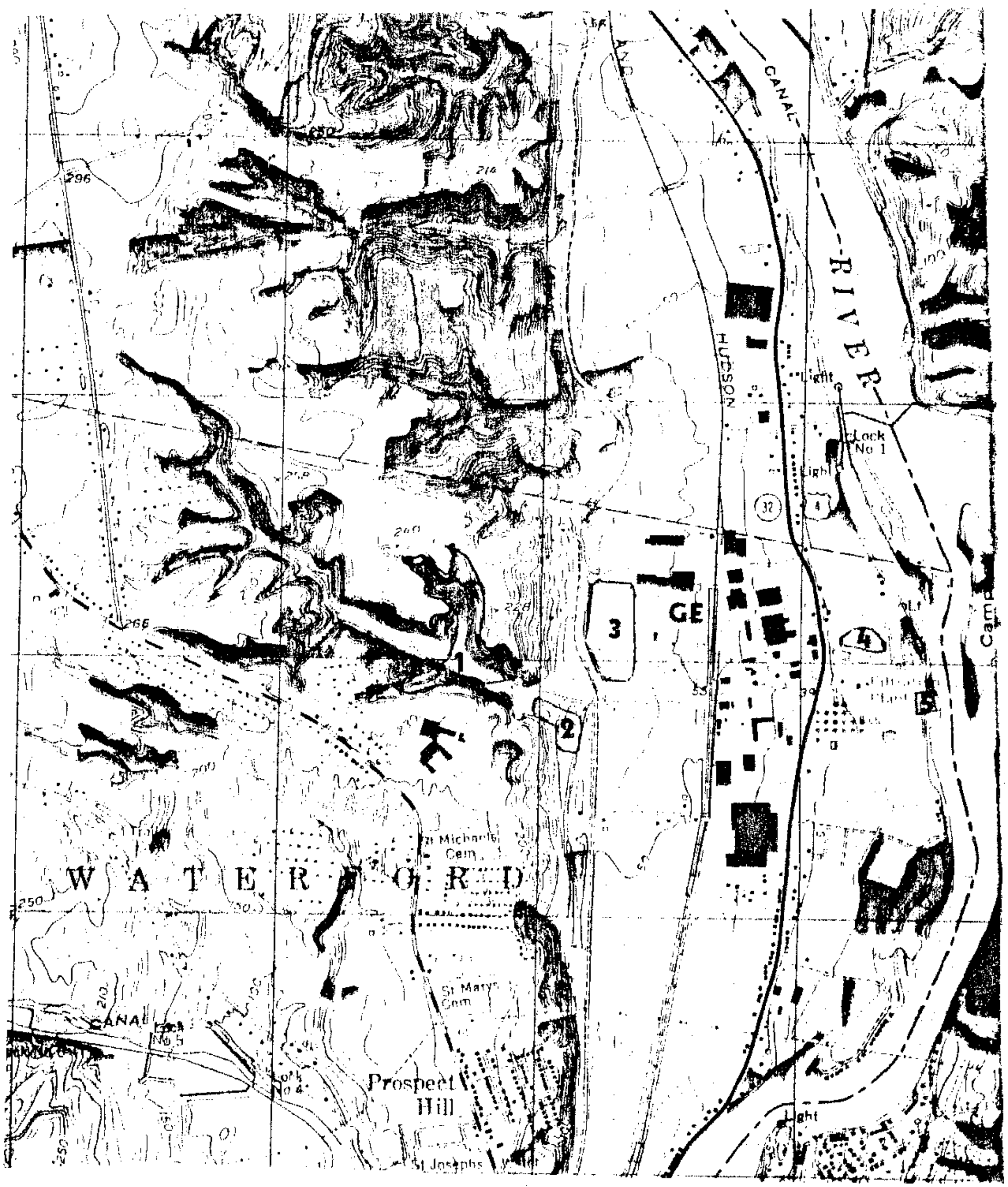
Town of Waterford

The Town of Waterford is located at the confluence of the Hudson and Mohawk rivers in Saratoga County (figure 3). Like many of the towns in the area, Waterford's local economy is manufacturing based and General Electric is by far the largest single employer. Waterford is the site of the company headquarters and primary manufacturing facility for GE's Silicone Division. The plant employs about 1500 people.

The plant is located north of the Village of Waterford and occupies over 300 acres mostly between the Hudson River and the Old Champlain Canal. The facility began operation in 1947 and had, since that time, done most of its own disposal of waste on site, either by incineration or landfilling. On the grounds of the facility are five landfill disposal sites, of which only two were being used for the disposal of waste at the beginning of 1981. Of these two, one was for disposal of paper trash and refuse and the other for solids from waste-water treatment and some solid waste from the plant's industrial processes. Most wastes, however, are discharged into the Hudson or are incinerated. GE recently installed a rotary kiln incinerator capable of breaking down most of the toxic by-products of the plant. The other inactive areas also contain industrial by-products of the plant. Landfill areas 2 and 4 are generally regarded to pose the greatest risk to health and environment.

Figure 3: Map of Waterford

Source: USGS Topographic Map, Troy North Quad. The sources for the location of the disposal areas are NY Dept. of Environ. Cons. files. Not to scale.



There have been a number of complaints arising from the plant's operations, mostly in regard to well-water contamination, which has been confirmed by State DEC officials. There have also been complaints about odors and particulates emitted which do not necessarily come from hazardous waste disposal. The groundwater contamination does. Public water supply may not be a better alternative because Waterford's supply is drawn from the Hudson, which is also subject to great impurities that treatment cannot reasonably correct. The GE plant contributes impurities to the Hudson upriver from the intake for the Waterford water treatment system. Water samples taken by the NYS Dept of Environmental Conservation (DEC) disclosed significant amounts of chloromethane, vinyl chloride, 1,1,1, trichloroethane, trichloroethylene and tetrachloroethylene. These substances were believed to have come from GE discharges. Although the finished water for the town was declared safe to drink, traces of the above remain in the water after treatment.

Landfills contribute to groundwater and well contamination in the vicinity of the site. Water samples taken from drillings were contaminated with benzene, toluene, xylene and vinyl chloride. The samples taken from private taps nearby did not have the levels of concentration that the excavation samples did but the potential migration of contaminants is a concern of area residents.

Most of GE's operations are located in the floodplain. Landfill areas 2 and 3 are at the western edge of this floodplain. The upper stratas of soil are predominately alluvial fan deposits of silt, sand and gravel. Above the bedrock are a series of unconsolidated glacial deposits. This consists of three major varieties: silt, fine sand and fine gravel; coarse, silty sand and gravel; and lodgement till. The entire area is underlain by a bedrock of Canajoharie shale. The water table is 10 to 18 feet below most fill activity. The selection of a site that has such permeable soils reflects the different requirements at the time the facility was built.

The organized public opposition to hazardous waste disposal is not very strong. This is perhaps because GE is such a large employer. Some realtors thought that the newer developments uphill from the plant were desirable because of nearness to the GE plant. Others felt that the noise and smoke from plant activity would detract from the desirability of nearby residences. Many were reluctant to speak openly about GE activity. The local media have given a great deal of coverage of landfill operations at the plant in recent years. Both the Saratogian and the Times-Record gave extensive coverage about the possibility of water contamination. The realtors said that the psychological effect of this has not been positive on the Waterford/Stillwater area in general.

The same procedures as in Dryden were used for the area surrounding the GE plant facilities in the town of Waterford. Prices were indexed using the Construction Review index for Northeastern homes, standardized to 1974 dollars. The neighborhood included sections 285, 286 and 291, and 98 valid sales were observed. Distance was measured in hundred feet. The water variable had a value of 1 for well water and 0 for public supply (table 6).

TABLE 6

Waterford: Linear Model

Variables	Estimated Coefficients	Standard Error	T-Statistics
Intercept	16506.60	3646.07	4.53
Water	-2439.60	2457.83	-0.99
Acres	1.25	1.36	0.91
SFLA	5.44	1.49	3.63
Age	-123.58	24.88	-4.97
Stories	-106.40	167.92	-0.63
Rooms	-623.18	786.93	-0.79
Baths	1281.94	969.15	1.32
Distance	50.86	27.39	1.86

$R^2=0.48$ $\bar{R}^2=0.43$ $F(8,89)=10.31$
Condition of the X Matrix=33.42

The results for the linear model were stronger than those for the Tompkins County Landfill although the t-statistic of the distance parameter was less than 2. The data all had correct or reasonable signs. Yet, only the intercept, age and square feet of living area had strong coefficients in determining the value of a home in this model.

A logarithmic transformation was also used on distance (table 7). This transformation improved the explanatory power of the model only slightly. The coefficients other than distance changed very little. The condition of the X matrix also increased, signalling greater intercorrelation among variables in the model.

The model using the square root of distance was also estimated (table 8). This model has many of the desirable properties of the logarithmic model without the undesirable ones. The sensitivity analysis was a little discouraging.

TABLE 7

Waterford: Log Model

Variables	Estimated Coefficients	Standard Error	T-Statistics
Intercept	7515.56	6374.21	1.18
Water	-2411.00	2451.84	-0.98
Acres	1.21	1.30	0.57
SFLA	5.51	1.49	3.68
Age	-121.38	25.01	-4.85
Stories	-122.36	168.23	-0.72
Rooms	-680.85	789.66	-0.86
Baths	1351.61	972.20	1.39
Distance*	3017.40	1525.73	1.98

$R^2=0.48$ $\bar{R}^2=0.44$ $F(8,89)=10.41$
Condition of the X Matrix=54.92
* The Logarithm of Distance.

TABLE 8

Waterford Square-Root Model

Variables	Estimated Coefficients	Standard Error	T-Statistics
Intercept	13550.00	4231.51	3.20
Water	-2424.38	2554.23	-0.99
Acres	1.23	1.36	0.90
SFLA	5.48	1.50	3.66
Age	-122.37	24.95	-4.81
Stories	-114.50	168.00	-0.68
Rooms	-655.01	788.08	-0.83
Baths	1319.32	970.40	1.36
Distance*	796.83	412.86	1.93

$R^2=0.48$ $\bar{R}^2=0.44$ $F(8,89)=10.37$
Condition of the X Matrix=35.27
* The square root of distance.

Problems of collinearity existed for newer subdivisions, where houses are very similar. Most of the results, including distance, were not very sensitive to changes with the three models. Even the deletion of several outlying rows gave a higher R^2 without changing the coefficients very much. The slopes were not determined by outliers. In this respect, the model was quite robust. None of the distance coefficients had t-ratios greater than 2. Moving a house from one-half mile to one mile away, on the average, resulted in its value increasing by $1,327 in the linear case, $1,682 in the logarithmic case and $3,121 in the square-root case.

The data were then re-estimated, this time assuming that 1978 was when people began to be concerned about living near hazardous waste (table 9).

TABLE 9

Waterford: Distance After 1978

Variables	Estimated Coefficients	Standard Error	T-Statistics
Intercept	16558.90	3020.25	5.48
Water	-2885.29	2081.54	-1.39
Acres	0.40	1.15	0.35
SFLA	5.34	1.27	4.22
Age	-98.13	21.25	-4.62
Stories	-90.07	141.71	-0.64
Rooms	-86.33	625.62	-0.14
Baths	415.64	797.39	0.52
Distance*	73.35	11.60	6.33

R^2.=0.63 $\bar{R}^2$.=0.59 F(8,89)=18.78
Condition of the X Matrix=30.72
*0 if sold before 1978,
1 if sold during or after 1978.

A comparison between the two linear models suggests a greater difference after 1978. Yet, because the standard error was so high in the case of the sales before 1978, the t-test was not even close to significant at the 5 percent probability level of type I error.

The square-root transformation of this same series was also estimated (table 10). Of interest is the reduction in the standard error. Part of this is because a large proportion of the numbers are zero, greatly reducing the variability of the vector. As with the linear model, the coefficient itself did not change very much. The formal t-test turned out negative.

TABLE 10

Waterford: Square-Root of Distance After 1978

Variables	Estimated Coefficients	Standard Error	T-Statistics
Intercept	15736.10	2960.53	5.32
Water	-3120.97	2034.50	-1.53
Acres	0.18	1.13	1.16
SFLA	5.46	1.24	4.41
Age	-101.88	20.55	-4.96
Stories	-67.15	138.44	-0.49
Rooms	42.41	611.60	0.07
Baths	317.00	779.93	0.41
Distance*	644.55	94.82	6.80

R^2=0.65 $\bar{R}^2$=0.61 F(8,89)=20.22
Condition of the X Matrix=30.84
*Square root of distance if property sold after 1978, otherwise 0.

Town of Porter

The town of Porter is a rural community near the mouth of the Niagara River in Western New York. Agriculture, important to the local economy, centers on grape, dairy and apple farms.

SCA Chemical Waste Services hazardous waste disposal facility in the town of Porter includes a secure landfill for chemical wastes, resource recovery and reprocessing operations, liquid processing and treatment facilities and sludge disposal. The plant began commercial operations in November 1971 under the management of Chem-Trol Pollution Services, which purchased the site, an old Air Force reservation, through the General Services Administration. North of the site is a Bell Aerospace plant. To the South, the Lake Ontario Ordinance Works Site is adjacent to the property. The United States Government still holds the title to the remainder of the old Air Force Reservation.

The landfill operations, initially located on 200 acres of the site, contain heavy metal sludges, metal-finishing solids, chemicals rejected as off-specification, contaminated chemicals, filter press sludges, fuel oil sludges and polychlorinated biphenyls (PCBs).[6] There are seven separate

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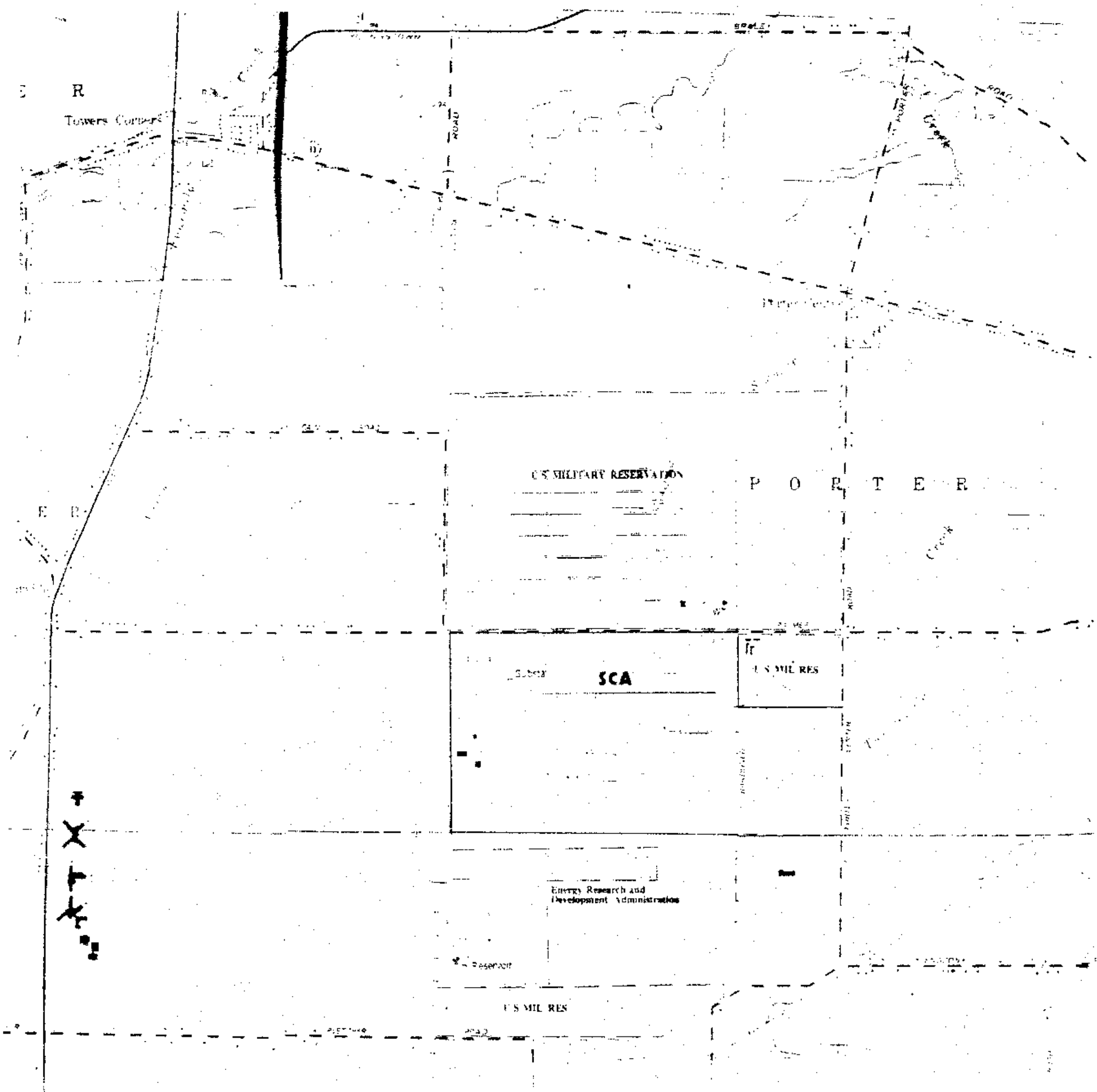
[6] NYSDEC Hazardous Waste Disposal Sites Report v.3, (Albany,

Figure 4: Map of the Town of Porter

Source: USGS Topographic Survey. Area of SCA estimated from tax maps and other descriptions. Not to scale.



areas that contain hazardous waste. Six have been closed. The seventh contains five cells, each containing different types of hazardous waste. Each cell is lined with a synthetic liner and two feet of clay. The topsoils are a composite of alluvial silts, glacial till and muckland over approximately twenty to thirty feet of clay. The clay is well suited for the containment of hazardous waste because it is relatively impermeable, and the site is not near any major geological fault. Beneath the clay is bedrock. The topography slopes gently toward Lake Ontario to the north.

Not all of the waste at SCA is buried. Many types of wastes accepted are not permitted to be landfilled, e.g., liquid solvents, which are treated at one of the holding ponds, then released. SCA has been granted permits to discharge effluents into Four-Mile Creek and the Niagara River. Discharge into Four-Mile Creek began in 1978. Despite a great deal of protest by residents of the area, a five-mile pipeline to discharge liquid waste into the Niagara River was completed in 1981. The firm has also applied for permits to operate an onsite incinerator.

SCA is, by most reports, one of the most modern and competently operated commercial disposer of hazardous waste in the country. These reports originate not only from public relations within SCA, but also from some of its most ardent competitors and from governmental officials. Still, there is some measure of discontent with SCA.

Two local groups based in Porter have been active and vocal critics of SCA. These are Operation Clean and Citizens Against Pollution. Operation Clean considers itself an educational organization devoted to expanding resident's knowledge about SCA operations and other disposers in the area. Citizens Against Pollution has been more political in its action, trying to have SCA denied permits to operate and organizing protest movements against the expansion of plant facilities, such as the pipeline to discharge effluents into the Niagara River.

These actions have brought local and regional attention to the operation of the facility. Contributing to publicity was the discovery of buried explosives dating to when the site was part of the ordinance works. Charges of redlining (banks refusing to mortgage homes in areas considered unsafe) were made by one Buffalo newspaper.[7] Although the charges have been denied by both banks and local officials, the appearence of such charges may have affected the market for homes in the area.

NYSDEC, 1980): C-9-139.

[7] Buffalo Evening News, December 6, 1980.

Realtors in the area were reluctant to speak at length about the effect that SCA might have on real-estate values. Nor would any confirm the redlining charge. Yet, the area immediately surrounding the site was described as below average demand. Realtors pointed out that newer subdivisions between two and five miles west and northwest of the site have been built in the past ten years that are average or above average demand.

The plant is scrutinized by four levels of government, each with different powers and responsibilities. There is at least one inspector from the US EPA on site at all times that it is accepting deliveries. This inspector sees that the manifest system is properly followed. State DEC officials regularly sample effluents, nearby surface water and groundwater for contamination. The County Environmental Management Council and County Board of Health also monitor the site. Finally, the Town Environmental Council reviews the site's operation and makes recommendations, holds hearings and advises the other levels of government as well as the company on how the site is being run.

The positive result of this monitoring has been the improvement of operation relative to what it had been under the management of Chem-Trol and during the first years of its operation under SCA management. Local officials are now resigned to the fact that the site is there. The tax revenues it pays are significant. The general feeling is that since it is there, and it is not likely to be closed down in the near future, all efforts should be focused on keeping the operation as honest and as clean as possible. A few people interviewed felt that the constant scrutiny of SCA has significantly improved the operation. This scrutiny has, however, made SCA a daily topic of discussion in some circles. The facility receives frequent local press coverage and has been occassionally mentioned in the national press. Thus, while the plant's operation has, by most accounts, improved over the years, it has also generated tremendous publicity.

The data used for the Town of Porter were collected by KVS Services and were in preliminary form at the time of this study. After necessary corrections were made, the observed values for distance were entered into the data. The preselected neighborhood was based on sections that were contiguous to or near the site and included sections 46, 47, 59, 60, 61 and 62 in the Town of Porter and sections 74, 75, 76, 88 and 89 in the Town of Lewiston. In all, 93 observed valid sales were observed and included in the data set.

Prices of homes were deflated to 1974 dollars using the Consumer Price Index Shelter Component for the City of Buffalo. The indexed prices differed from the other two cases because the Buffalo index was more localized giving a better idea of price trends in the Niagara Frontier.

A linear model for the site was estimated (table 11). The fit of the model was good although the signs for the number of stories and of rooms appear wrong. One explanation is preference for smaller families and thus for fewer bedrooms. Also, the coefficient for stories reflects a taste for split-level and ranch style homes rather than two-story homes. The two coefficients related to proximity to waste - distance and water - have the expected signs. The result for water, however, could be misinterpreted. What the coefficient suggests is, all other things being equal, a home connected to a public water main is worth about $16,000 more than one with a private source of water. In addition, homes which have connections to public water sources also tend to have other conveniences.

TABLE 11

Porter Linear Model Results

Variables	Estimated Coefficients	Standard Error	T-Statistics
Intercept	26371.60	7895.00	3.34
Water	-16264.40	5296.67	-3.07
Town	-869.78	1931.98	-0.45
Acres	20.09	5.06	3.97
SFLA	18.71	3.53	5.30
Age	-107.55	31.20	-3.45
Stories	-375.43	265.11	-1.42
Rooms	-2890.33	1139.36	-2.56
Baths	6278.77	2456.52	2.56
Distance	91.25	32.87	2.78

$R^2=0.65$ $\bar{R}^2=0.61$ $F(9,83)=16.95$
Condition of the X matrix=30.53

The estimated coefficient for distance also suggests a gain in property value as the house is located farther from the facility, a relationship assumed to be linear up to where the neighborhood runs out. This assumption may cause omission of some affected properties. Simple diagnostics were undertaken to see if outliers unduly influenced any of the key variables. Most outliers were sold before 1977. The elimination of outliers had a significant effect on the coefficient for water source. The other variables were more robust.

The linear assumptions of the model may not fit the real world. One way to avoid the problems of linear assmptions is by making nonlinear transformations. Because the linear results for most of the other variables seemed sufficient, only distance was transformed (table 12). This transformation makes intuitive sense, because homes located close to a stationary disamenity should be affected more than homes located farther away.

TABLE 12

Porter: Log Transformation of Distance

Variables	Estimated Coefficients	Standard Error	T-Statistics
Intercept	4827.86	10392.20	0.47
Water	-12837.40	4454.88	-2.88
Town	636.49	1626.32	0.39
Area	17.89	4.24	4.21
SFLA	13.11	2.97	4.41
Age	-75.09	26.37	-2.85
Stories	-232.38	223.50	-1.04
Rooms	-2243.66	959.11	-2.34
Bath	5382.37	2063.50	2.61
Distance*	4653.00	1948.81	2.39

R^2=0.60 $\bar{R}^2$=0.55 F(9,23)=13.60
Condition of the X Matrix=48.25
*Log of Distance.

The results of the transformation show little difference from the untransformed variables. Distance transformed by logarithms has a much larger coefficient, but this does not translate into a significant change in dollar terms. The variable for water was also significant and subject to great changes with the deletion of the outlier rows. The rest of the model was quite robust. The condition of the X-matrix suggested more multicollinearity in this model than in the linear one, but was still not debilitating.

A square-root model was also estimated (table 13) with results quite similar to the logarithmic transformation. In general, the correlation coefficients and individual t ratios improved over the linear model and multicollinearity problems were fewer than with the logarithmic transformation.

TABLE 13

Porter: Square-Root Transformation of Distance

Variables	Estimated Coefficients	Standard Error	T-Statistics
Intercept	19036.60	8519.11	2.23
Water	-16035.30	5285.94	-3.03
Acres	20.20	5.03	4.01
SFLA	18.67	3.51	5.33
Age	-104.69	31.09	-3.37
Stories	-379.32	265.04	-1.43
Rooms	-2870.98	1126.73	-2.55
Baths	6405.14	2451.31	2.61
Distance*	1558.17	565.14	2.76

R^2=0.64 $\bar{R}^2$=0.61 F(8,85)=19.00
Condition of the X Matrix=30.46
* Square-Root of Distance.

Because of their location, the people of Porter should have been sensitive to the issue of waste disposal before the rest of the state. For this reason, to test for a change in the distance variable, 1977 was chosen. Both a linear model and a model with distance transformed to its square-root were used to test this hypothesis (tables 14 and 15).

Limiting distance to sales only after 1977 reduced the coefficient for distance. The t-test was not significant for the difference between the linear model with distance from 1972 to 1981 and the linear model with distance from 1977 to 1981. The square-root model showed a greater change than the linear model. The t-test showed that the coefficient for distance for 1977 to 1981 was less than the one for distance for all observations at a significance level of 5 percent. This contradicts the hypothesis that the effect of distance is greater after the publicity of Love Canal.

TABLE 14

Porter: Distance After 1977

Variables	Estimated Coefficients	Standard Error	T-Statistics
Intercept	21043.80	5994.12	3.51
Water	-12561.50	4311.98	-2.91
Acres	18.23	4.10	4.45
SFLA	12.81	2.86	4.48
Age	-84.35	25.30	-3.33
Stories	-166.90	215.77	-0.77
Rooms	-2285.77	920.30	-2.48
Baths	5080.86	2003.83	2.54
Distance*	60.59	18.78	3.23

R^2=0.62 $\bar{R}^2$=0.58 F(8,84)=16.83
Condition of the X Matrix=28.04
*Distance After 1977.

TABLE 15

Porter: Square-Root Transformation of Distance after 1977

Variables	Estimated Coefficients	Standard Error	T-Statistics
Intercept	19874.30	6224.61	3.19
Water	-12212.80	4379.36	-2.79
Acres	18.83	4.16	4.50
SFLA	12.79	2.90	4.40
Age	-85.32	25.70	-3.32
Stories	-143.16	219.52	-0.65
Rooms	-2289.20	934.54	-2.45
Baths	5312.06	2030.30	2.62
Distance*	630.16	228.75	2.76

R^2=0.60 $\bar{R}^2$=0.57 F(8,84)=16.01
Condition of the X Matrix=28.35
*The square-root of distance if house sold during or after 1977; otherwise 0.

V

SUMMARY AND CONCLUSIONS

The housing market in three different cases in New York State has responded to the existence of hazardous waste disposal or landfilling. The results varied between sites and the conditions under which each site operated varied. All were outside city or village limits in sparsely populated areas. Yet, even among the three sites, density varied.

The first underlying assumption of the model is that hazardous waste disposal and landfills are nuisances, a perceived disamenity and that they create external diseconomies. This disamenity may be tolerable for the net benefits generated to society but some people are more subject to the disamenity than are others. Thus, costs are not borne by those who benefit. A shift in liability in the direction of the polluter would result in reduction of the disamenity.

Further, one facet that the location assumptions have in common is that neither the firm nor the household will necessarily choose to locate where real property values are lowest. Firms have other costs which might overrule choosing a site based simply on the low cost of land. Transportation and construction costs must be taken into account and firms must also contend with such institutional factors as siting regulations.

For consumers, maximizing satisfaction subject to budget constraints yields the result that consumers choose the best housing they can afford. This assumes that consumers have the same ordinal preference functions in choosing where to live, i.e., all consumers prefer more over less spacious houses and newer over older, and so forth. In addition to homogeneous preferences, the model also assumed that utility is a monotonic function of the attributes yielding satisfaction. While consumers may not be able to agree on which factor is the most important in choosing a place to live, they would probably agree to live in a house with more of everything.

These assumptions are crucial to the interpretation of the results. These assumptions may be rigid and terse, but they have basis in fact. Little more was done with the data than present it. Thus explanation of the results is required.

Interpreting the Results

The results in general supported the hypothesis that land values change in relation to location near a hazardous waste facility. Because of the wide margins of error, however, point estimate of these damages is problematic. Some of the results were counter to expectations.

The town of Dryden's results exhibited many of the undesirable properties of a small sample. The model's goodness of fit as measured by the t-statistics and $\bar{R}^2$s were usually the lowest of the sites studied. In the case of Dryden, the model was also more sensitive than the other sites to the deletion of rows and other diagnostic analyses. The coefficients were the most inefficiently estimated.

The town of Waterford gave the most consistent estimate of the three studies. While the R^2 was not as high for Waterford as for Porter, the model's results were subject to few diagnostic problems. The Waterford sample did have a higher degree of multicollinearity than the other two, but this did not seriously detract from the results. The removal of outliers would have changed the actual value of the coefficients very little, but would have decreased the sum of squared error, thus improving goodness of fit appreciably. As there was no other reason to remove those outliers, the data were left intact.

The estimates for Porter had the best fit of the case studies examined. The $\bar{R}^2$s and the t-statistics were consistently quite high. While some of the coefficients, especially the one for water supply, seemed sensitive to diagnostic probing, most of the estimates seemed quite robust. The strong results from Porter, combined with the nature of the facility, make it a good candidate for approximating the distortions such a site creates.

Comparison of Case Studies

Although direct comparison across sites is not appropriate, several generalized conclusions may be drawn about the relative effects of disposal sites. Most pertinent among these are the comparisons between onsite and offsite disposal effects and the comparisons between hazardous and nonhazardous waste facility effects.

There was little difference in effect on property values between onsite and offsite disposal. Firms that dispose of hazardous waste onsite have, by definition, other activities that take place on the company property. The two things that set onsite apart from offsite disposal are (1) jobs other than waste disposal exist at the facility, (2) nuisances other than waste disposal, such as air and noise pollution, are created by industrial processes. In addition to the differences in activity, there are also differences in accountability to the public. Offsite facilities are more accountable than onsite facilities.

One might assume that as commuting distance becomes an important criteria for housing decisions, there would be premiums for housing near onsite disposal facilities. This is because the demand for labor is greater at onsite facilities. Also, because offsite facilities generate a large amount of truck traffic bearing hazardous waste, one would think this traffic would detract from housing values along nearby roads. Empirical evidence from the case studies does not support the hypothesis that offsite disposal has a greater effect than onsite disposal on housing values.

For the period between 1974 and 1981, hazardous waste disposal facilities had a greater effect on land values than did sanitary landfills, which had essentially no effect on property values. That none of the hazardous waste disposal facilities observed presented immediate threats to public health and safety may have played a large part in the lack of contrast. While the potential for threats to public health and safety are much greater with hazardous waste management facilities, sanitary landfills not accepting hazardous waste can also damage public health or create nuisances if not properly maintained. The inclusion of a landfill that presented a groundwater problem, or had a history of open burning would probably have yielded much different results.

The results for the town of Dryden using distance after 1978 suggested that the reaction of homebuyers to the presence of a sanitary landfill was relatively greater than the reaction of homebuyers to hazardous waste disposal facilities. This contradicts rational risk analysis by consumers. Quantitative comparisons between cases, however, do not have much meaning. Few sales were observed in the period from 1978 on. That there were fewer observations is reason to discount the findings, yet not sufficient to rule them invalid. Was it the landfill itself, or other factors which made the area less desirable? Only a qualitative and relative comparison would be appropriate, and this only in the context of the limitations of the data. A longer time series might show whether the effect after Love Canal was an aberration or a trend. If there is a trend, reactions by homebuyers to landfills and hazardous waste disposal facilities may have not yet stabilized.

The results seemed contrary to expectation in the Porter case. It is possible that outliers had undue influence on the full data set. One possible explanation is the awareness of homebuyers in Niagara County predates the famed exposure of Love Canal. This certainly seems a plausible explanation for the coefficient for distance to be the same, rather than greater in the Porter case. This still does not satisfactorily explain why the relative magnitude of the coefficient would go down.

One possible reason for the change in the distance coefficient might be that in the period before Love Canal became a household word, a problem with a very noticable disamenity existed, yet little was done about it. In the period that attention was focused on Love Canal, disposers of hazardous waste, in general, and SCA in the town of Porter, in particular, became more accountable to the public. A great deal of effort was put into making SCA a more tolerable disamenity and into making Porter a better place to live. If this explanation holds, then the reduction in the amount that the facility distorted property values is a measure of the success of these efforts.

Conclusions

The data exhibited some undesirable tendencies which eroded the significance of the coefficients. And, although problems with multicollinearity were not severe, other problems, such as wrong signs and low t-ratios for some of the explanatory variables, were more difficult to diagnose and correct. The elimination of outliers might have been a partial solution to these problems.

The statistical information requires a few warnings. Most of the confidence intervals estimated are quite wide. A point estimate would make little sense.

Because the study is dealing with an existing phenomenon, rather than a hypothetical one, specifics are more important and relevant to the effects than generalities. In fixing compensation, one should not conclude merely that people who move near an existing facility should be compensated for loss in property values. While the families that live near hazardous waste disposal facilities that present a danger to public health may very well need to be moved for their protection, diminuition of property values has already been capitalized into the market. In fact, an argument can be made that those who made the decision to move near a hazardous waste disposal facility may have done so with some knowledge of health risks, hence the lower prices. This argument would conclude that it is not the duty of government or business to protect people from their own folly. A rebuttal to this argument would propose that the homebuyers did not have the knowledge necessary to make a rational decision as to the danger involved. The homebuyers may have known the potential effects, may even have known the probability of, say, leachate contaminating their water supply. Yet, they probably were unaware and uninformed of the extent of such hazards. In other words, the prices may not be low enough to adequately compensate the higher health risks through more shelter for the dollar.

As long as damages to health do not occur, there is little basis for compensating homeowners living near a landfill or hazardous waste disposal facility simply because there is some evidence of devaluation. The market has already capitalized those land values.

The homes in the vicinity of hazardous waste disposal facilities were not all rendered completely worthless, although there were some distress sales reported in each case. Sales forced because of bankruptcy or back taxes were not markedly greater than average. Most of the homes had selling prices near what the regional markets suggested to be normal, with a fractional adjustment for location near a hazardous waste disposal facility or landfill.

When a facility moves into an area, however, the market will change from being undistorted to distorted by the facility. These distortions will cause those living near a disposal facility to perhaps suffer a decline in property value. This study cannot be used to directly estimate the effect of a new facility on a given area. More information about the local real-estate market needs to be collected in order to efficiently estimate how much property is subject to distortion and how great the distortion is.

The problem of forecasting the effects of a hazardous waste disposal facility on land values is compounded by general confusion and uncertainty in the housing market. The process of adjusting compensation to local communities for locating such facilities remains more a political art than an accounting science. There is a wide margin of error in estimating how great the effect on property values alone are. While other burdens requiring compensation are agreed to be better defined, these, too, involve margins of error. The process for resolving these differences must take the flexibility of these estimates into account.

BIBLIOGRAPHY

Abelson, P. W. "Property Prices and the Value of Amenities." J. Environ. Econ. & Mgmt. 6 (1979): 11-28.

"Allocating The Cost of Hazardous Waste." Harvard Law Review 94 (1981): 584-604.

Anderson, Robert J. Jr. and Thomas D. Crocker. "Air Pollution and Property Values." Urb. Stud. 8 (1969): .

________. "Air Pollution and Property Values: A Reply." Rev. Econ. & Stat. 54 (1972): 470-73.

Baker, Brian P. Land Values and Disamenities: The Case of Landfills and Hazardous Waste Disposal. M.S. Thesis, Cornell Univ., 1982.

Barlowe, Raleigh. Land Resource Economics: The Political Economy of Rural and Urban Land Use. 3rd ed. Englewood Cliffs, NJ: Prentice-Hall, 1978.

Beecher, John L. and Arthur J. Fossa. "The Problem With Toxic Waste." Conservationist 34 (March-April 1980), pp. 33-35.

Bird, Peter J. W. N. "Environmental Policy Making in the Presence of Transactions Costs." Nat. Res. J. 20 (1980): 487-99.

Booz-Allen and Hamilton. Hazardous Waste Generation and Commercial Hazardous Waste Management Capacity. Washington: US Govt. Print. Off., 1980.

Burck, Charles G. "There's Big Business in All That Garbage." Fortune April 7, 1980: 106-112.

Burness, H. S., et. al. "Perceived Risk and Catastrophic Events." Paper presented at the Western Economic Association Meetings, San Diego, California, June, 1980.

Calabresi, Guido. "Transactions Costs, Resource Allocation and Liability Rules--A Comment." J. Law Econ. 11 (1968): 67-73.

Camp Dresser & McKee. Generic Environmental Impact Statement for a Hazardous Waste Treatment Facility in New York State. Albany: NY Dept. of Environ. Conserv., 1980.

______. Technical, Marketing and Financial Findings for the New York State Hazardous Waste Management Program. Albany: NY Dept. of Environ. Conserv., 1980.

Dales, J. H. Pollution, Property and Prices. Toronto: Univ. of Toronto, 1968.

Damianos, Demetrios. The Influence of Flood Hazard upon Residential Property Values. Washington: NTIS, 1975.

Damianos, Demetrios and Leonard Shabman. "Land Prices in Flood Hazard Areas: Applying Methods of Land Value Analysis." Blacksburg, VA: VPI & SU Dept. Agr. Econ., 1976.

Deland, Michael. "EPA's Hazardous Waste Regs Challenged." Environ. Sci. & Tech. 15 (1981): 23.

______. "Superfund." Environ. Sci. & Tech. 15 (1981): 255.

Freeman, A. Myrick III. "Air Pollution and Property Values: A Methodological Comment." Rev. Econ. & Stat. 54 (1972) 468-69.

______. "On Estimating Air Pollution Control Benefits from Land Value Studies." J. Environ. Econ. & Mgmt. 1 (1974): 74-83.

Goetze, David. An Evaluation of Incentive Compatible Decisionmaking Mechanisms as Alternatives to Regulatory and Market Approaches: Applications to the Siting of Hazardous Waste Disposal Facilities. Washington, Resources for the Future, 1981.

Havlicek, Joseph Jr., et. al. "Measuring the Impact of Solid Waste Disposal Site Location on Property Values." Paper presented at the annual meeting of the Amer. Agr. Econ. Assoc., Carbondale, IL, August 15-18, 1971.

Josephson, Julian. "Hazardous Waste Landfills." Environ. Sci. & Tech. 15(3) (1981): 250-53. Keystone Center. "Siting Non-Radioactive Hazardous Waste Management Facilities: An Overview." Keystone, CO: Keystone Center, 1980.

Koch, Kathy. "Seeping Out From Under The Carpet." Congr. Quart. Wkly. Rep. 38 (March 22, 1981): 795-804.
Lancaster, Kelvin. "A New Approach to Consumer Theory." J. P. E. 74 (1966): 132-154.

LaPierre, D. Bruce. "Technology Forcing and Environmental Protection Statutes." Iowa Law Review 62: 771. Lin, Stephen A. Y. (ed.) Theory and Measurement of Externalities. New York: Academic Press, 1976. Little, A. D. Characterization of Hazardous Waste Transportation and Economic Impact Assessment of Hazardous Waste Transportation Regulations. Washington: US Govt. Print. Off., 1979.

Marchand, James R. and Keith P. Russell. "Externalities, Liability, Separability and Resource Allocation." Amer. Econ. Rev. 63 (1973): 611-20.

Mishan, Ezra J. "The Post-War Literature on Externalities." J. Econ. Lit. 9 (1971): 1-28.

MIT Center For Computational Research in Economics and Management Science and MIT Information Processing Service. TROLL Primer. Cambridge: MIT Press, 1979.

MITRE Corporation. Draft Environmental Impact Statement on Subtitle C, Resource Conservation and Recovery Act of 1976. Washington: US Govt. Print. Off., 1979.

Morrell, David. "Siting Hazardous Waste Facilities: A Political Perspective." Los Angeles, Hearings Sponsored by the State of California, 1980.

Moshman Associates. Financial Responsibility for Transporters of Hazardous Waste. Washington: US Govt. Print. Off., 1979.

New York State Department of Environmental Conservation. Hazardous Waste Disposal Site Reports. Albany: NY Dept. of Environ. Conserv., 1981.

New York State Interagency Task Force on Hazardous Wastes. Hazardous Waste Disposal in Erie and Niagara Counties, New York. Albany: NY State Printing Office, 1979.

Nourse, Hugh O. "The Effect of Air Pollution on House Values." Land Econ. 43 (1967): 181-89.

O'Hare, Michael. "Not on My Block You Don't." Public Policy 25 (1977): 407-58.

"One Man's Garbage." Forbes June 26, 1978, pp. 37-38.

Parcels, Larry Clayton. A Model for the Sequential Location of Resource Recovery Facilities. Ithaca: Cornell Univ. Ph. D. thesis, 1979.

Randall, Alan, "Market Solutions to Externality Problems: Theory and Practice." Amer. J. Agr. Econ. 54 (1980): 176-83.

Ridker, Ronald G. and John A. Henning. "The Determinants of Residential Property Values With Special Reference to Air Pollution." Rev. Econ. & Stat. 49 (1967): 246-57.

Rosen, Sherwin. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." J. P. E. 82 (1974): 34-55.

Urban Systems Research & Engineering. A Handbook for the Private Sector on the Use of Compensation and Incentives in the Siting of Hazardous Waste Management Facilities. Cambridge: by the author, 1980.

US Congress, House, Committee on Interstate and Foreign Commerce, Subcommittee on Transportation and Commerce. Resource Conservation and Recovery Act of 1976. Washington: US Govt. Print. Off., 1976.

_______. Waste Disposal Site Survey. Washington: US Govt. Print. Off., 1979.

US Congress, Senate, Committee on the Environment and Public Works, Subcommittees on Environmental Pollution and Resource Protection. Disposal of Hazardous Waste. Washington: US Govt. Print. Off., 1974.

US Environmental Protection Agency. Development of an Emergency Response Program for Transportation of Hazardous Waste. Washington: US Govt. Print. Off., 1979.

_______. Hazardous Materials Incidents. Washington: US Govt. Print. Off., 1980.

_______. Hazardous Waste and Consolidated Permit Regulations. Washington: US Govt. Print. Off., 1980.

_______. Waste Disposal Practices and Their Effects on Groundwater. Washington: US Govt. Print. Off., 1977.

US Interagency Task Force on Compensation and Liability for Releases of Hazardous Substances. The Superfund Concept. Washington: US Govt. Print. Off., 1979.