ELSEVIER

Ecological Economics 24 (1998) 1–14

ECOLOGICAL ECONOMICS

SURVEY

Undesirable facilities and property values: a summary of empirical studies

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Received 10 September 1996; accepted 13 March 1997

Abstract

Undesirable land uses are expected to impose health or amenity risks on surrounding communities. These risks are expected to be translated economically into negative effects on adjacent property values. These negative effects may be present even when such uses possess offsetting advantages of proximity, such as employment opportunities. The purpose of this study is to summarize empirical studies completed to date that test whether undesirable land uses have observable negative effects on adjacent property values. This information may be useful in assessing minimum valuations of terminating undesirable land uses, such as clean-up of hazardous sites, or compensation necessary to ameliorate the economic impacts of new undesirable uses. © 1998 Elsevier Science B.V.

1. Introduction

People have concerns about environmental risks or nuisances and express a willingness to pay to avoid them (Fischer et al., 1991). These concerns range from worries about health risk to public images of the community, and are rationally related to more than quantitative risk factors (Wandersman and Hallman, 1993). Under conditions of adequate information, the real or perceived location-specific adverse hazard or amenity effects of certain types of land use are, in principle, incorporated in location-related markets as people would be willing to pay to reside or work where risks or nuisances are lower. The most obvious impacted market is adjacent property markets, while a less obviously impacted market may include local labor markets. This study provides a summary of empirical tests of whether the location of undesirable land uses, such as waste sites, hazardous manufacturing facilities, or electric utility plants, have adverse effects on residential property values in surrounding communities or neighborhoods. This is an important issue for several reasons.

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PII S0921-8009(97)00038-4

First, health and amenity risks associated with environmental hazards, whether real or perceived, may become translated into economic risks as well. A broad range of studies has shown relations between adverse general environmental conditions, such as air pollution, and economic effects on wages and property values, raising wages and lowering property values where conditions are poor (Freeman, 1979). Studies have shown that negative attitudes toward facilities which pose nuisance, health or environmental risks are strong and geographically extensive (Council on Environmental Quality, 1980; Lindell and Earle, 1983). These attitudes are frequently translated into reduced likelihoods of economic activities, such as vacationing, taking a job, or locating a business, in regions with such facilities (Slovic et al., 1991).

Second, the issue of siting hazardous or nuisance activities has raised public concern for localized risks to the point where siting such activities, while perhaps necessary in an industrial world, is becoming very difficult. Lober and Green (1994) have found that public opposition to undesirable land uses, such as waste disposal facilities, diminishes with distance from a site in a predictable manner. Some researchers have proposed that it is the mismatch between costs and benefits of such uses that motivates this opposition (Lober and Green, 1995). This aversion has spawned a range of policy responses to siting that are directed toward reducing community perceived costs of siting. For example, opposition to undesirable facilities may be moderated by community compensation grants (Kunreuther et al., 1990). Massachusetts requires private companies to negotiate with host communities in establishing adequate compensation for the location of hazardous waste facilities (Massachusetts General Laws, Chapter 21D, §12). The magnitude of adequate compensation may depend partially on real or perceived adverse property value impacts of siting.

A third reason is related to the emerging concern for environmental justice and the related use of civil rights law to protect citizens from environmental risks. Discrimination, per se, independent of proof of adverse effects of potentially hazardous facilities or nuisance activities, is the focus of this argument (Environment Week, October 14, 1993). However, there must be some presumption that the discrimination has an adverse consequence, otherwise why would there be a concern. A finding of adverse economic impacts of undersirable land uses could provide a substantive basis for concerns of environmental justice. For example, siting a hazardous waste facility in a low income, minority community may adversely impact both the health and economic well-being of that community, providing a basis for concerns that such communities bear both health and economic risks from siting procedures.

A final reason is that property value impact measures serve as indicators of the costs to communities of accepting undesirable land uses, and as measures of potential benefits from remediating the risks associated with those uses. As a cost measure, property value impact studies may be useful in estimating acceptable compensation for undesirable land uses. While a community's acceptable price can be established through bargaining with the individual community, this price will almost certainly depend on community circumstances such as income levels and discrimination in housing and labor markets. Concerns for environmental equity may seek to avoid taking advantage of hardship communities, who could bear disproportionate risks for little compensation. Conversely, communities may strategically set high prices for accepting undesirable land uses as a bargaining strategy. Property value effects from other communities can be useful as a basis for setting bounds for compensation in such cases. As a benefit measure, these studies are useful in estimating benefits of policies such as hazardous site cleanups (Adler et al., 1982).

This review of property value studies first outlines the theoretical foundations for the statistical analysis of disamenity effects on property values in Section 2. Section 3 outlines the details of the reviewed studies. Section 4 presents a broad summary of these studies along with a discussion of the results for a range of facilities and incidents.

2. Theory

The fact that neighborhood and community amenities affect the relative desirability of residential locations is well known (Bartik and Smith, 1987). It is also well known that certain types of facilities are considered disamenities which people would rather avoid in making residential location decisions. Research on communities near hazardous waste landfills, for example, has found serious concerns for health as well as property values and community image. Residents near such facilities had greater fears of cancer than more distant residents. These perceived risks were supported by sensible beliefs and outrage factors stemming from unfamiliarity, uncontrollability, and inescapability (Wandersman and Hallman, 1993). A study of residents in an industrial area of Rijnmond, Holland, with a high number of chemical plants and refineries, found that 60% of persons living within 4 km of a facility felt extraordinarily defensive or vigilant (Stallen and Tomas, 1988).

The willingness to accept risky land uses, such as a nuclear waste disposal facility, may depend more on subjective risk factors than on objective factors such as likelihoods of events (Kunreuther et al., 1990). In general, perceived risks may differ substantially from statistical risks, albeit in logical ways. A considerable literature has developed showing that perceived risks are a function of statistical risks as well as subjective risk factors, such as dread, involuntariness, controllability, severity of consequences, etc. (Slovic, 1979). However, regardless of whether the source of the perception is quantitative or subjective, the impact on property markets can be the same. Property markets are not behaving irrationally when subjective risk factors enter as price determinants.

These studies are useful in substantiating the nature and intensity of reactions to local adverse land uses. However, they fall short in providing quantifiable estimates of harm sufficient for measuring economic damages. The economic methods for quantifying this harm have consisted of both revealed preference and hypothetical survey techniques. The former method consists primarily of property or wage market studies; the latter is typically a variant of contingent valuation (CV) methodology. Each of these methods is discussed below.

The revealed preference method seeks to observe what individuals apparently really pay or require in compensation associated with adjacent adverse land uses. The typical method is to use information on related markets, usually property and labor markets, to determine compensating differentials associated with the land use. In cases where the land use is so localized as to have little impact on general economic conditions of a community, adjacent property values are expected to capitalize adjacent land use impacts. The theoretical argument is that property provides a flow of services which becomes monetized and capitalized in property markets, and that flow is diminished by adverse adjacent land uses. In practice, however, there can be considerable difficulty in identifying the property market impact of a disamenity.

The market values of properties and their structures depend upon an array of factors associated with characteristics of those properties and structures, ranging from physical features, such as lot size and age of structure, to relational features associated with the proximity of those sites to relevant economic activities such as job and population centers, beaches, lakes, etc. Economic theory suggests that each feature will have its own implicit price (Palmquist, 1984). For example, each mile that the property is closer to an undesirable amenity the lower the market value of the site; hence, each mile of proximity has a negative price and each mile further distant has a positive price.

Many factors impact property markets, and adjacent land use is only one of them. Hedonic pricing methods (Rosen, 1974) are helpful in this regard, since they attempt to identify the price effects associated with each of the many dimensions impacting property values. This technique has commonly been applied to urban housing markets (Follain and Jimenez, 1985). The implicit values of a wide range of environmental amenities and disamenities have been estimated using this technique (Harrison and Rubinfeld, 1978; Freeman, 1979). Control group methods attempt to explicitly control for variations in value determin-

ing factors by selecting comparison properties that are comparable in every respect except for the adjacent adverse land use. This is the typical appraisal technique.

Hedonic methods are limited in several respects. First, property markets may not be in equilibrium. Price differentials associated with disamenities may be more or less than what they would be when all relocations have taken place (Freeman, 1993). This is particularly problematic when attempting to estimate the impacts of a new disamenity or removal of an old one. Second, there is an inherent problem in statistically identifying from property-distance value gradients the willingness to pay to avoid a disamenity (Freeman, 1993). For example, selectivity plays a strong role in residential location decisions. When persons most willing to accept the disamenity, or who have limited housing options because of income or discrimination, locate adjacent to a disamenity, property value differentials will overestimate the disamenity effect for the general population. Third, to the extent that the adverse activity may be locally job enhancing, adjacent housing values could be elevated and apparently perverse because of positive wage effects associated with the land use. Although there could still be a negative amenity component, it may be offset by a positive wage effect. A hedonic study that does not allow for labor market effects would underestimate the adverse amenity effect.

The CV method essentially establishes a hypothetical choice situation (Mitchell and Carson, 1989). There are a wide variety of choice formats. The most straightforward variant would be to ask individuals a question such as: 'what would you pay to avoid living (or accept in compensation to live) next to a Superfund site?' A more complex variant, conjoint analysis, would present individuals with a set of options, with each option characterized by several dimensions, and ask the individuals to choose or rank the options.

In principle, CV is a very direct method of obtaining valuation information when the real situation is muddled by lack of information or confounding variables. It is useful in this context because it has the potential of singling out the particular amenity or disamenity to be valued. In practice, there are many pitfalls associated with the proper specification of CV scenarios and interview techniques. Perhaps the most severe problem in this context of valuing environmental disamenities is the incentive to misrepresent values, or strategic bias. This may be especially true if the respondent thinks that actual compensation or policy may depend upon their response (Freeman, 1993). For example, there would be a serious potential bias problem if the respondent believes that compensation under litigation for hazardous site related damages will depend on CV responses; or if the respondent believes that the policy to locate a nuclear power plant would depend upon responses. When an individual does not see or believe a connection between responses and policies, such circumstances do not arise and strategic bias may not be a severe problem with CV techniques. In this case, consumer choice theory suggests that CV valuations will be less than or equal to hedonic based valuations. Brookshire et al. (1982) show this is the case in a study of air pollution in the Los Angeles, CA, basin.

3. Studies of undesirable facilities and property values

The empirical studies of effects of undesirable facilities and activities on surrounding property values have been limited to the analysis of residential properties. Micro scale studies estimate the distance gradient effects of undesirable land uses, while the macro scale studies estimate community-wide property market effects after controlling for broad housing value determinants. Both cross-sectional and time-series methods are used. The cross-sectional method would consider property values for different properties during essentially the same time period. For example, it may compare housing prices in neighborhoods or communities having undesirable facilities with those in areas where such facilities are absent; or it may compare contemporary housing prices at various distances from an undesirable land use. The time-series method would investigate values over time, possibly using repeat sales and including periods before and after undesirable facilities or activities were revealed.

There are reasons to expect that observed property market impacts of undesirable land uses may differ according to local conditions, such as the strength of economies and housing markets, tastes and preferences of impacted communities, and the real or perceived risk or adversity compared with the benefits of locating nearby. For example, an industrial facility may pose health and amenity risks, but offer employment, resulting in increased property values observed near the facility. People have degrees of aversions to different types of facilities. For example, a study of Boston residents (Smith and Desvousges, 1986) found that only 23, 33, and 48% of the surveyed population would willingly live within 5 miles of a nuclear power plant, hazardous waste landfill, or coal-fired electric generating plant, respectively. These are all facilities from which benefits of the services provided, electricity and waste disposal, can be obtained without being adjacent to them. However, employment opportunities may create demands for adjacency to the power plants, but not the waste facility. If tolerance to risk is a function of both perceived risk and benefits (Slovic et al., 1980), we might expect that negative property value effects from proximity to the waste facility would be more severe than for the power plants. The point is that we would not necessarily expect the property value effects to be similar across types of facilities and land uses.

Table 1 presents a brief summary of relevant studies. Ten of the twenty-five studies summarized pertain to hazardous waste (HW) or National Priority List (NPL) sites. NPL sites are hazardous waste sites that pose such high risks that they are listed under the Superfund program. They receive a higher level of scrutiny and public visibility than non-listed sites. One study pertains to a closed municipal landfill site and six to open solid waste landfills and incinerators. One study considered the effects of a coal-fired electric utility, while two studies estimated the effects of existing nuclear facilities. One study estimated the impacts of chemical facilities while another considered a broad range of undesirable facilities. Two studies considered the effects of disastrous events: a PCB spill and a nuclear disaster. The hazardous waste site studies include both NPL sites and closed or active non-NPL sites. There are four potential estimable effects for NPL sites: distance effects prior to NPL nomination announcements; announcement effects; effects after NPL announcements; and effects after cleanup. Housing value effects are converted to 1993 dollars when possible.

The Michaels and Smith (1990) hedonic study showed that property values increased with distance from HW sites in suburban Boston, both before and after the announcement that those sites would be NPL sites. However, only the effect after the announcement was statistically significant, implying that values would increase 1.3% to 1.9% per mile, depending upon the quality of the housing market. This implies average annual housing cost increases for each additional mile from a site of $124 per year for the full sample; or a capitalized average of $1168 per mile. This capitalized value can be indexed up to 1993 dollars, and is equal to $3310 per mile. The major effects were only in the 'Premier' and 'Average' quality housing markets.

A similar pre- and post-NPL announcement pattern was found by Kohlhase (1991) in a hedonic study of Houston. Pre-announcement housing prices increased between $880 and $1180 per mile from future NPL sites; but increased by $2364 per mile after announcements with one site showing a $3310 per mile distance effect. It is important to note that there were no distance effects observed after the cleanup of sites.

A hedonic study of smaller communities in the suburbs of Toledo, OH, found that each additional mile from an active hazardous waste landfill increased property values between 16 and 25%, or between $9000 and $14 000 for the study area (Smolen et al., 1991). This effect is greater than those estimated for the larger urban areas of Boston and Houston. This larger effect for a smaller community is consistent with Greenberg and Hughes (1992) conclusions that Superfund sites had greater negative impacts on property values in rural communities than in more urbanized communities. The Smolen et al. (1991) study also investigated the effects of the announcement, and subsequent cancellation of a proposed low level radioactive waste site. The announcement

Table 1
Summary of studies of hazardous facilities/incidents and residential property values

Study	Years	Event/Facility	Region	Effect	Special comments
H	62–70	Solid waste landfills	Fort Wayne, IN	Each additional mile from site increases values approximately $3200 [$14,016 per mile]	+effect of degrees away from downwind direction
B	70	Coal-fired electric utility	Winnetka, IL	Each additional mile from site increases values $3256 [$14,261 per mile]	+effect limited to three miles
S and R	70–75	Solid waste landfills	Los Angeles, CA	No price effect for two sites; negative distance effect for one site	The site with the negative distance effect was to close and become a golf course course within several years of the study
RPC	70–80	Sanitary landfills	Houston, Baltimore, Minneapolis, Atlanta	No adverse effects on property values using projected values or comparison communities for three of four sites; positive effect at one site	Study funded by Browning Ferris in regions BFI anticipated developing site
A	74	NPL HW site	Pleasant Plains, NJ	After contamination discovered, each additional mile from site increased values $2700 ($9468 per mile)	+effect limited to 2.25 miles
K	76–85	Announce NPL HW site	Houston, TX	Each additional mile from site increases values $880–1180 [$1250–1676 per mile] prior to announcement, and $2364 [$3357 per mile] after announcement	Non-linear distance effect is highest at site ($5000) and decreases with distance. No effect after cleanup
M and S	77–81	NPL HW site	Suburban Boston	Insignificant effect prior to announcement but after announcement additional mile from site increases values $124 per year; capitalized to $1168 [$3310 per mile]	Major effects in 'Premier' and 'Average' markets
N	79	Three Mile Island event	TMI, PA	No TMI event effect on sales prices	No analysis of time on market
C and N	79	Various undesirable facilities	U.S. counties	Higher property values when density of refineries in count decreased but lower wages. Net annualized effect is $468–1764; capitalized to $4412–16,629 [$9974–37,585 per home]	No HW site effect, but data pre-superfund
KK	80	HW sites	New Jersey	More HW sites in a municipality reduces median home values: one additional site reduces median values 2–2.5%; or $1255–1600 [$2410–3072 per home]	Correlation: number sites, % non-white, property tax rates (controlled in hedonic model)

Table 1 (continued)

Study	Years	Event/Facility	Region	Effect	Special comments
G	77–81	Sanitary landfills	Pennsylvania	Positive effect of distance to landfill on property values in only one of two study years; no effect in other two years (based on anay-sis of only one site	Large landfill (>500 t/day) had lower rates residential new construction and sales than small landfill
G and D	75–80	Nuclear power plant	Pennsylvania and East Coast	Additional mile from PA plant increased property values by $163 [$313 per mile]; but no effect for East Coast plants	PA plant could have been located in depressed housing market
G and H(a)	75–88	NPL HW sites	New Jersey	Number of Superfund communities with property prices increases was less than for control communities	Superfund site effect most marked in rural communities; and in 'Hot' markets
M	69–88	PCB incident	New Bedford, MA	Loss in value in zones proximate to impacted areas ranges from 3% to 8%; or $7000–10,000 [$8190–11,700 per home]	Negative effect increased after 1981, at least doubling by 1985
M and S and H	83–85	HW landfill	Los Angeles, CA	Health risk beliefs adversely affected values and closing landfill reduced risk beliefs. Expected $5000 [$7100 per home] gain in value after closing	Distance from site reduced perceived health risk
Z and A	82–87	Solid waste landfill and solid waste incinerator	Landfill-Tacoma, WA; Incinerator-Salem, OR	No effects of distance from landfill or incinerator (during any siting phase)	Maximum distance from sites in sample not clear; possibly broader effects than testable in sample
S and D	84	HW landfill	Boston, MA suburbs	Respondents willing to pay $330–495 per year more for housing one additional mile from site; capitalized to $2472–3199 [$3708–4799 per mile]	na
D	84–85	Chemical facilities	Charleston, WV	Each additional mile from nearest facility increased price by $157 [$222 per mile]; houses beyond 3 miles of any facility worth $1330–5978 [$1885–8472 per home] more	Announcement of Bhopal reduced prices 2.5%
S and C and S	85	Hypothetical HW landfill	Rural central IL	Property tax reductions necessary to induce respondents to live closer to hypothetical site: a 75% tax reduction increased willingness to live within 5 miles from 10% of sample to 20%	Sample was a small rural community

Table 1 (continued)

Study	Years	Event/Facility	Region	Effect	Special comments
S	85–86	Inactive Municipal landfill	Kitchner, Ontario	Positive effect of distance from landfill site up to 500′: values $4264–7018 [$5714–9404 per home] lower within 140′ of site than at 500′ or beyond	Sample was small city; housing development occurred after site closed
N and G and G	79–89	Solid waste landfill	Ramsey, MN	Each additional mile from facility increased price by $4900 [$6948 per mile]	+effect limited to 2–2.5 miles
S and M	86–90	HW landfill and low level radioactive disposal site announcement	Toledo, OH	Positive effect of distance from HW site up to 2.6 miles: an additional mile increased values $9000–14,000 [$9990–15,540 per mile (16%–25% of sales price). Announced radioactive disposal facility created $4000 [$4440 per mile] gradient (up 5.75 miles); but cancellation eliminated gradient	Landfill neighborhood is blue-collar
G and H(b)	92	Superfund hazardous waste sites	New Jersey	Survey of assessors found 28% believing sites adversely impacted values within 1/4 mile of site; 21% believed adversely impacted number of sales; 16% believed existing land uses harmed; and 23% believed new land uses deterred	Only 26% response rate. Few believed impacts extended beyond 1/4 mile
K and M(a)	74–92	Solid waste-to-energy incinerator, from rumor to operations	North Andover, MA	No effect prior to construction; during construction, additional mile increased values $2283 [$2671 per mile]; during on-line phase, $8100 [$9497 per mile]; and during operations, $6607 [$7746 per mile]	+effect limited to 3.5 miles
K and M	74–92	Solid waste-to-energy incinerator, from rumor to operations	North Andover, MA	Appreciation rates 2% to 3.5% lower for samples community during construction to operations phases than prior phases; repeat sales showed positive effect of distance from site only for operations phase	na

$1993 in parentheses.

The 'Shelter' component of the CPI was used for adjustment. Annual values capitalized at 10% over thirty years.

Key to Study Abbreviations:A: Adler et al. (1982); B: Blomquist (1974); C and N: Clark and Nieves (1991); D: Dunn (1986); G: Gamble et al. (1982); G and D: Gamble and Downing (1982); G and H(a): Greenberg and Hughes (1992); G and H(b): Greenberg and Hughes (1993); H: Havlicek et al. (1971); K: Kohlhase (1991); KK: Ketkar (1992); K and M(a): Kiel and McClain (1995a); K and M(b): Kiel and McClain (1995b); M: Mendelsohn et al. (1992); M and S: Michaels and Smith (1990), Per mile estimate = MWTP/Mean distance change; M and S and H: McClelland et al. (1990); N: Nelson (1981); N and G and G: Nelson et al. (1992); RPC: Research Planning Consultants (1983); S: Skaburskis (1989); S and D: Smith and Desvousges (1986); S and C and S: Swartzman et al. (1985); S and M: Smolen et al. (1991); S and R: Schmalensee et al. (1975); Z and A: Zeiss and Atwater (1989).

immediately created a positive and significant distance gradient of roughly $4000 per mile per house; but the gradient became insignificant after the proposed site was cancelled.

McClelland et al. (1990) combine psychological and economic analyses for estimating the impacts of hazardous waste sites on property values. This study found that health risk beliefs did affect property values, and adverse risk beliefs declined with distance from hazardous waste sites. After estimating the property value response to reduced risk beliefs, they were able to conclude that closing hazardous waste landfills would increase average property values by $5000.

These studies are quite consistent in the direction and magnitudes of observed effects of hazardous waste facilities. The higher negative impact in smaller communities simply points to the fact that property value impacts will vary with community characteristics. This suggests, for example, that compensation for economic damages or the economic values of site cleanups may differ with circumstances.

Kiel and McClain (1995a,b) hedonic studies considered price and distance effects of a municipal solid waste-to-energy incinerator in Massachusetts. They estimated effects for different stages of the siting process, from rumor to operation stages. Although there were no observable effects prior to construction, adverse effects were evident during construction, and during initial on-line and operations phases. An additional mile from the site raised residential property values by $2671, $9497 and $7746 per mile for each of these three phases, respectively. Furthermore, housing appreciation rates were 2–3.5% lower during these phases in the impacted community compared to non-impacted communities. The above studies suggest that the timing of observations across various phases of site use are important in estimating the magnitude of adverse impacts. A hedonic study by Havlicek et al. (1971) found that each additional mile from a municipal solid waste landfill increased property values by $3200 in a medium-sized midwestern town. The relative magnitudes of the impacts of these two types of municipal solid waste disposal facilities make some sense, in that landfills may have more nuisance than health effects, and incinerators have a perception of creating pervasive potential health risks (Kiel and McClain, 1995b). It may not be meaningful to make too much of these relative magnitudes, however, since the Havlicek study is dated and risk perceptions and environmental concerns may have increased considerably over time.

A hedonic study of Charleston, WV, chemical facilities showed that distance from such facilities significantly increased residential property prices, even after controlling for other amenity factors such as pollution (Dunn, 1986). A one-mile increase in distance from the nearest facility increased prices by $157, or 0.24%, a rather small amount. However, other estimates showed that houses within 3 miles of any chemical facility, the 'danger zone,' sold for nearly $3000, or 4%, less than homes outside these danger zones. The Bhopal, India, incident appeared to have had a significant adverse impact on all sales prices in the study area. It would not be surprising to find property value impacts of chemical facilities to be less than impacts for hazardous waste disposal facilities, since chemical plants may offer a positive benefit of employment opportunities. However, these employment effects may be regional and not localized enough around a plant to offset its potentially negative risk or nuisance effects.

Adverse adjacent property value impacts may be limited geographically. The Toledo, OH, study (Smolen et al., 1991) found a significant depressed housing value effect up to only 2.6 miles from an active hazardous waste landfill site with this effect tapering off to zero beyond 5.75 miles. A study of an inactive municipal landfill in a small city in Ontario found that distance from the site significantly increased housing values (Skaburskis, 1989). The adverse effect of the site impacted properties up to 500′ from the site. Property values were between $4264 and $7018 lower near the site. An interesting feature of this study is that all properties were developed after the site was closed. These measured adverse effects would likely be less than if the site were active or if the site was developed after the housing development. A study by Nelson et al. (1992) found that an additional mile from a landfill site in Minnesota

had a positive $8393 effect on sales prices and this effect was limited to between 2 and 2.5 miles. The apparent fact of adverse property value effects from undesirable land uses does not necessarily translate into professional valuation assessments. An opinion survey of assessors found only 28% of respondents believed that Superfund sites adversely impacted property values within 1/4 mile of a site (Greenberg and Hughes, 1993).

Several hedonic studies considered the property value effects of electric utility facilities. Blomquist (1974) found that each additional mile from a coal-fired plant increased property values by $3256. Gamble and Downing (1982) found no significant distance effect for nuclear power plants along the East Coast. However, there was a positive, but very small, distance effect with distance from the Three Mile Island nuclear facility prior to the incident at that facility (Nelson, 1981). This was attributed to the fact that the area around that facility was an economically depressed area even prior to the construction of the nuclear facility. However, this observation does not consider whether the facility further depressed the housing market.

Results of other hedonic studies contrast with the above micro type studies. Zeiss and Atwater (1989) found no effect of a hazardous waste landfill and a hazardous waste incinerator on residential sales prices in two communities they studied. However, they suggested that sellers holding out for higher prices could explain this, and that market effects may be observable in time on the market. Gamble et al. (1982) found no evidence of negative effects of sanitary landfill sites on the rates of residential construction. However, the study did find that larger landfill sites were associated with lower rates of residential construction and sales than smaller sites. In one of the three study years, property values did increase with distance from the site; but there was no relation for two of the study years. Only one site was considered for the property value analysis. Another study (Research Planning Consultants, 1983) found no adverse property value effects of sanitary landfills in three of the four study sites; and a positive property value effect for one site. This study was funded by Browning Ferris Industries and sites were selected on the basis of BFI's interest in developing landfills in those regions, so the integrity of this study is suspect. A study of solid waste landfills in Los Angeles, CA (Schmalensee et al., 1975) found no distance price effect for two of the three studied landfills, and a perverse negative distance effect for one site. However, the latter site was scheduled to close and be converted to a golf course, suggesting a positive amenity effect. This latter case is interesting since it suggests that undesirable land uses can become desirable.

Hedonic studies are useful in estimating localized impacts, but would be less helpful where impacts are more community-wide, i.e. where all regional housing markets are jointly impacted. Macro type studies have investigated the community-wide impacts of adverse activities. A study of municipalities in New Jersey, both urban and rural, found that increasing the number of hazardous waste sites requiring cleanup reduced average home values in a municipality (Ketkar, 1992); each additional site reduced average values by 2–2.5%, or between $1255 and $1600 per property (1980 dollars). Although there was a high positive correlation between the number of sites, percent non-white and property tax rates, these factors were controlled in the hedonic study. This study suggests a rather large geographic area of impact.

Housing and labor markets are related at a regional level. One study addressed the possibility that some types of facilities may enhance employment opportunities while still creating disamenities in regional housing markets (Clark and Nieves, 1991). It found that there was a positive wage effect of refineries at the county level, but a negative property value effect. The net effect of increasing the density of refineries in a county was negative, ranging from $468 to $1764 per household per year. There was no observable effect of hazardous waste sites; however, the study period was pre-Superfund. Slovic et al. (1991) allude to adverse potential regional economic impacts of land uses having negative images in their study of nuclear waste repository in Nevada. They show that preferences for vacation, retirement and new business locations depend on perceived images of

cities and states, and that these images are adversely affected by the image of a nuclear waste storage facility or nuclear test site. Unfortunately, they do not go further to estimate the magnitude of economic impact.

Contingent valuation (CV) studies have been much less prevalent than the hedonic or control group studies. A study by Smith and Desvousges (1986) found that survey respondents would be willing to pay between $2472 and $3199 more for residential properties located a mile further from a hazardous waste landfill. A study of a rural community in central Illinois (Swartzman et al., 1985) found that a 75% reduction in property taxes would be necessary to increase from 10 to 20% the share of survey respondents willing to live within 5 miles of a hypothetical hazardous waste landfill. Only 10% of the population would willingly live within 5 miles of a hypothetical hazardous waste landfill; 60% wished to live at least 50 miles from such a facility. Mitchell (1980) administered a national survey in which he found that only 10% of the population would willingly live within one mile of a nuclear power plant or hazardous waste disposal site.

The above studies focussed on potentially undesirable land uses. Several studies have sought to estimate property value impacts of potentially hazardous events or degradation in adjacent water quality. A panel study of PCB pollution in the harbor of New Bedford, MA, found a negative effect of the discovery of pollution on surrounding property values within 2 miles of the site (Mendelsohn et al., 1992). After statistically controlling for sales price determining characteristics, losses in property values ranged from 3 to 8% of value, or up to $10 000 per property (1989 dollars), with the larger impact on more proximate properties. This negative impact increased considerably with time after discovery. The adverse effect could have been a combination of loss in amenity value, as well as concern for financing cleanup. This result is consistent with Epp and Al-Ani (1979), who found lower values for properties adjacent to polluted Pennsylvania streams than those adjacent to clean streams. In contrast, Page and Rabinowitz (1993) found no assessed value effect of incidents of groundwater contamination on residences in impacted communities, although there were pronounced negative effects on the commercial and industrial properties directly contaminated. The authors suggest there is no residential property effect since householders do not envision themselves as being liable for any damages. However, another explanation may include the possibility that assessed values may not accurately reflect prices. The incident at the Three Mile Island nuclear facility, did not depress housing market prices as expected (Nelson, 1981). However, the author noted that any potential effects of this accident could have been offset by government assurance programs. He also suggested that housing markets may be slow to react and effects would not be noticable within the short nine month post-TMI study period. Also, costly facility cleanup resulted in a considerable influx of new residents and an enhancement of the local labor market.

4. Summary of quantified adverse impact estimates

Table 2 provides a highly condensed summary of these studies, grouped by type of facility or incident. All impacts have been converted to 1993 dollars. Impacts of undesirable facilities are measurable as a gradient effect, such as increased property values per mile from a facility, as well as a zonal effect, such as reduced property values for homes with proximate facilities. The greatest number of studies are for hazardous waste facilities. There is considerable agreement in the gradient effects across three of the post-announcement studies, with the effect being on the order of $3500 per mile, and ranging roughly from $3000 to $15 000 per mile. A proposed, but later cancelled, low level radioactive waste disposal facility had a comparable gradient effect prior to cancellation. Pre-announcement effects of hazardous wastes sites were considerably smaller than post-announcement effects. Sanitary landfills and coal-fired utilities had comparable, and very large, gradients; roughly $14 000 per mile. These gradients are larger than those for hazardous waste facilities. One should not make too much of this

Table 2
Summary of gradient and zonal effects by type of facility or impact in $1993

Type of facility or incident	Gradient effect	Zonal effect
Sanitary landfill	$14 016/mile (H)	
	$6948/mile (N and G and G)	
		$5714
		–9404/home (S)
Solid waste incinerator		
During construction	$2671/mile	
On-line phase	$9497/mile	
Operations phase	$7746/mile (K and Ma)	
Hazardous waste site-pre announcement	$1250–1676/mile (K)	
Hazardous waste site-post announcement	$3357/mile (K)	
	$3310/mile (M and S)	
		$2410
		–3072/home (KK)
	$3708–4799/mile (S and D)	
		$7100/home (M and S and H)
	$9468/mile (A)	
	$9990	
	–15 540/mile (S and M)	
Chemical refinery	$222/mile (D)	$1885
		–8472/home (D)
		$9974
		–37 585/home (C and N)
Coal-fired utility	$14 261/mile (B)	
Nuclear utility	$313/mile (G and D)	
Proposed radioactive waste disposal site	$4440/mile (S and M)	
PCB contamination		$8190
		–11 700/home (M)

Study sources are noted in parentheses and refer to Table 1.

difference, since the number of studies is limited. Chemical refineries and nuclear power plants had roughly comparable gradients, $200–300 per mile. The zonal effects of the existence of refineries and sanitary landfills, and the effects of PCB contamination were quite comparable and substantial.

One would expect the property value gradient away from undesirable land uses to be the result of two competing forces: amenities and employment opportunities. The gradients from the studies presented above do not suggest any obvious pattern consistent with this competing forces hypothesis. Lower perceived risk facilities that offer job opportunities should result in the smallest land use impact; yet that does not appear to be the case. Coal fired utilities have a higher gradient than nuclear power plants when Smith and Desvousges (1986) have found that fewer people would like to live near the nuclear plants. It is equally odd that sanitary landfills have a higher gradient than hazardous waste facilities. Perhaps the number of studies is so small that these differences in gradients are not meaningful.

5. Conclusions

The studies summarized clearly show that some types of undesirable facilities or incidents reduce property values in their vicinity. Property value effects reflect the costs of such facilities and incidents. These adverse effects diminished with distance from some facilities or events, resulting in increased property values as distances from these sites increased. Housing markets are sensitive to the real or perceived risks associated with those adverse risks. Hazardous facility studies have been dominated by consideration of hazardous waste sites, including National Priority List (NPL) sites. Some studies show that there were adverse property value effects at these sites even before their listing. These adverse effects were only magnified after listing, but appeared to become more moderate after clean-up was commenced or completed. This suggests a rational response of housing markets to real risks. Increases in property values after clean-up can be used to estimate the localized benefits of site improvement.

There was considerable agreement across studies on the effects of hazardous waste facilities. There was evidence that more moderate risk facilities, such as municipal landfills or refineries, also created adverse property value effects in some instances, although these results are more mixed than for hazardous waste sites. One study jointly tested the wage and property value effects of hazardous industrial facilities, finding some employment enhancement at the county level but a negative property value effect. There was also evidence that the adverse property value effects of undesirable facilities could be more severe in the 'thin' housing markets of rural areas than in urban areas. One study (Greenberg and Hughes, 1992) suggested this may be due to the natural diversity of a city. The effects of the existence of sanitary landfills, chemical refineries, and PCB contaminated sites all had comparable effects on housing values.

A typical argument for the location of hazardous facilities is economic development, either from employment at the facilities or at facilities which use the hazardous sites. This report does not address this more complicated issue. It should be noted that even if there is a positive employment and income effect (Smith et al., 1986), some localized neighborhoods in the proximity of these facility may experience asset losses from reduced property values. Employment effects, if they arise at all, are likely to be geographically broad. However, those studies cited above which explicitly consider distances from sites are quite clear in finding that adverse property value effects are relatively localized. Therefore, 'who gains and who loses' from these facilities is a very important question.

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Attachment F
Exhibit 4007-000014-CWF
Columbia Waterfront LLC