INTERNATIONAL REAL ESTATE REVIEW

2010 Vol. 13 No. 2: pp. 134 – 156

Determining Off-Site Damages to Non-Residential Property from Leaking Underground Storage Tanks Using Contingent Valuation Analysis

Robert A. Simons
Maxine Goodman Levin College of Urban Affairs, 1717 Euclid Avenue UR223 Cleveland State University, Cleveland OH 44115; Tel: (216) 687-5258; Email: r.simons@csuohio.edu

Jesse Saginor
College of Architecture, Texas A&M University, College Station, TX, 77843; Tel: (979) 845-6372; Email: jsaginor@tamu.edu

This research evaluates the effect of leaking underground storage tanks (LUSTs) from gas stations on nearby commercial property when the existing data is incomplete or imperfect. While methodologies such as hedonic regression may be preferred for evaluating the effects of LUSTs on property values, the rigorous data requirements of these methodologies often cannot be met. Contingent valuation analysis is one method that enables estimation of losses when the data available is incomplete. A contingent valuation analysis of real estate professionals in South Carolina and Ohio provides estimates of commercial property losses, which ranges from 0-40%, depending on environmental conditions and proximity to the source. This research has developed a methodology for estimating real estate property value losses when data requirements cannot be fulfilled based on the best available data.

Keywords

Environmental contamination; Commercial property; Underground storage tanks; Contingent valuation analysis

1. Introduction

Leaking underground storage tanks (LUSTs) comprise 64% of the listed brownfield sites in the US, and there are over 275,000 LUST sites nationwide (Simons 1998 p 32-33). Unlike manufacturing factories, oil refineries, coal-burning power plants and nuclear power plants which may produce wide-reaching negative environmental impacts, gas stations often have a more localized impact on the surrounding environment. Gas stations are the most common type of LUST. Since most gas stations are in predominantly commercial areas and along major streets, typically, property is usually also commercial. The issues stemming from LUSTs are twofold: the contamination impacts real estate value while the contaminants may impact human health (subject to pathways being open). This article focuses on the real estate aspect of LUST contamination. Specific real estate issues include: a reduction in use and enjoyment of property, which may take the form of difficulties in leasing property, reduced profits, interference with possessory interests in real property, inability to mortgage property, inability to sell property, and the nuisance associated with remediation and monitoring activity on the property. Furthermore, seller knowledge of contamination makes it harder to sell the property.

This research uses a combination of market surveys (contingent valuation (CV) analysis) of real estate professionals, a review of peer-reviewed literature, and examination of public environmental and property tax records to systematically examine a LUST case in South Carolina to determine how many properties are affected and estimate the magnitude of the proximate property value effects. At a time of sustained high oil prices, negative externalities from these LUSTS are damaging property values and the local tax base, making it harder to redevelop property in and around these locations. As such, LUSTs have become a large environmental property management problem pervasive throughout the US.

This research is originally part of a class action litigation (Fairey v. Exxon), which was settled during trial in 2003 for about $43 million. The premise of the litigation is that petroleum releases from LUSTs on gas stations formerly owned or operated by the Exxon Corporation had caused damage to proximate real property in South Carolina. Hazardous chemicals from these LUSTs, including, but not limited to benzene and methyl tert-butyl ether (MTBE), had traveled to real property through soil and groundwater, without the permission of the property owners, and in most cases, remained there. The original case included all gas stations formerly owned by Exxon in the state of South Carolina. It also included damages to the subject properties, which are all former gas stations, as well as residential property. This research deals exclusively with the off-site impacts to primarily non-residential property.

The research approach to assessing property damages uses the following techniques: a review of the peer reviewed literature with respect to similar commercial contamination release incidents, implementation of a survey using a CV analysis of potential commercial property buyers, application of a combination of decision rules from the literature and CV analysis to specific contamination situations which are based on location and other factors, evaluation of actual transactions, and application of the above steps to estimate losses for this incident.

The balance of this article addresses the peer-reviewed literature on environmental contamination, with a focus on LUSTs and non-residential property, including a brief review of CV analyses in real estate. Next, the results of a CV survey are presented, and the methodology whereby the CV results (which provide a few key point estimates of the diminution of value) can guide loss estimates for a wide variety of potentially affected properties typical of the LUST cases, are discussed. The decisions rules are then applied to the off-site (non-source) property involved in the case example. We then tabulate the number of affected properties for this one case.

2. Methodology

The procedures followed to conduct this research are as follows:

1. Peer reviewed literature is reviewed on diminution of property value and difficulty on obtaining financing for contaminated property, and applicable discounts are determined. This step provides a benchmark for possible property damage valuation outcomes based on academically-accepted literature. A review of the existing literature acts as a measuring stick for the comparison of the applied research conducted in this article.

2. A survey is conducted in the form of a CV analysis to obtain a three point estimates of potential commercial diminution of value. The CV analysis is based on local conditions known by commercial real estate experts in South Carolina and Ohio. By conducting CV on professionals with real estate expertise, a more realistic and feasible discount rate of contaminated property could be discovered. Unlike most uses of CV in the peer-reviewed literature, performing CV on a random sample of residents would not be applicable for this study since the majority of the affected properties were zoned for commercial uses. Recognizing that some buyers for commercial property are based out-of-state, we also survey commercial real estate professionals in Ohio.

3. A range of losses is generated based on the literature and surveys that cover properties known to be contaminated, and those suspected of being contaminated, at various distances from the source of contamination (the

LUST). The range is from zero loss for unaffected property to a high of 40%. This range is based on the value loss from each source of data, and has been benchmarked to other literature, where available. A more in-depth discussion of this process is discussed in the section on the CV results and their application to discounting the affected case study properties.

4. Cases of LUST release events are selected (in our case, we focus on a single release event) and base property values, property ownership, presence of environmental contamination from pollution maps, and distances from the source property are determined, while controlling for other potential sources of contamination.

5. The losses are calculated based on steps 1-4, and the results are tabulated.

Where actual market sales data are known to exist, it can replace or corroborate step 2 (CV - see later discussion). Therefore, benchmarking the CV is an essential step in estimating environmental damages in this context.

3. Literature Review

It has been demonstrated that proximity to or the presence of environmental disamenities, such as petroleum damages and gasoline releases from LUSTs, can have a negative effect on property values. Economic theory tells us that all else being equal, buyers would avoid purchasing a property believed to be contaminated with hazardous substances because of the potential health risks, difficulty in reselling the property, uncertainty, and nuisance associated with environmental damages, property value diminution and/or stigma. Therefore, properties affected by environmental problems are expected to sell for a discounted price, in comparison with uncontaminated properties. While it is well-documented in the peer-reviewed literature that LUSTs reduce property values, these values are often site-specific and not easily applicable to other properties due to the uniqueness of the market characteristics.

The peer-reviewed literature contains numerous studies that address the effects of various types of environmental contamination on property values, well beyond LUSTs. Literature reviews by Farber, (1998) Boyle and Kiel (2001) and Jackson (2001) cumulatively summarize over 70 articles on the subject. Representative studies include Superfund sites (Kohlhase 1991, Kiel 1995), operating petroleum refineries (Flower and Ragas 1994) and landfills (Nelson, Genereux and Genereux 1992, Reichert 1999). The effects of these environmentally undesirable facilities have been shown to reduce residential property values one mile or more away, with negative effects being higher close into the undesirable land use.

Hedonic price studies are based upon actual sales transactions. In theory, properties can experience a loss in value without being sold. In addition to the reduction in sale price of properties which make it to the transaction stage, owners of property perceived to be threatened with petroleum contamination or actually contaminated may also experience difficulty in selling the property in the form of delayed or failed transactions. This may be evidenced by a substantially reduced number of transactions after an environmental event compared with the previous time period, or default or other discontinuation of payments. Potential buyers may also face difficulty in getting financing for contaminated property. A survey of lenders indicated that they are less likely to provide financing for contaminated (non-residential) property, especially prior to remediation (Jackson 2001). Also, commercial property owners wishing to transfer their property are more likely to have to provide financing, rather than engage in an outright sale (Simons, Bowen and Sementelli 1999). In a weaker market, owner financing may be the only way to convey property, and is generally considered less desirable than an outright sale.

The peer-reviewed literature indicates several ways that property owners experience a loss in value without a sale (Simons, Bowen and Sementelli, April 1999). These include loss of commonly held property rights, such as the right to enjoy and the ability to dispose of a property. This last item implies an unrealized capital loss because homeowners are unable to access capital tied up in their residential asset. The delay of the sale is itself a modest loss because of the present value of funds received. Properties believed to be contaminated because they are in close proximity to contaminated property or have not had environmental tests performed, or for other reasons, may experience property value diminution and/or stigma, especially before they are remediated. The price reduction can be exacerbated if contamination is not well documented, by large amounts of adverse publicity, and where the responsible parties have not offered to indemnify impacted parties (Roddewig 1999). This discount can be substantial. A study by Syms (1996) in the UK estimates that contamination from a moderately hazardous substance, such as petroleum, depresses sale prices by about 22% before remediation, declining to about 10% after remediation is completed. Both benzene and MTBE (among other substances) as components of gasoline may be considered hazardous substances, and the discount that real estate participants place on them in the marketplace can be expected to equal or exceed this range.

The economic loss to real property is incurred at the time of the contamination event, and loss of value and use and enjoyment of the property go forward from that day. Some economic loss is typically permanent. Depending on ownership particulars, the economic loss may be absorbed by owners, sellers, buyers under a contract for deed arrangement, or in some cases, those that lease real property. These persons or entities are similarly situated because they have been affected by the contamination, although the loss may be assigned to one or more parties.

Property value is directly connected to the use and enjoyment derived from the property through the discounted cash flow/present value approach. Thus, a reduction in use and enjoyment (such as profits derived from leasing or rents, or value derived from use of the land for growing crops, or enjoying the land for a range of typical personal activities) would translate into an economic loss to the property owner.

Turning now to empirical evidence, four articles address the effects of environmental contamination on commercial property values, and LUSTs on residential and commercial property. Guntermann (1995) evaluates the effect of sanitary landfills on industrial land values. He looks at both opened and closed solid waste landfills with typical problems, such as methane gas, from the non-hazardous landfills with possible ground water contamination. A sample of 153 transactions of industrially zoned land within 1,000 feet from open and closed landfills in metropolitan Phoenix, Arizona, between 1984 and 1994 was analyzed using descriptive statistics and a hedonic regression model. The results indicate that while property values rise as soon as landfills close, industrial property values decrease by an average of 45% while landfills are open. The results are not affected by the presence of methane gas controls and ground water monitoring systems. However, the results are based on very few sales near the landfills. Dotzour (1997) evaluates the effects of groundwater contamination on commercial property in Wichita, Kansas. He finds that all commercial lending activity ceases after discovery of the problem, and no transactions occurred during the study period. Also, a multi-state case study by Page and Rabinowitz (1993) considers groundwater contamination and its effects on both residential and commercial property values. The contamination (volatile organic compounds (VOCs), pesticides, polychlorinated biphenyls (PCBs), total petroleum hydrocarbons (TPHs), petrochemicals and cyanides) was underneath each of the affected properties, and had been there for several years. The toxic chemical contamination resulted in a reduction of property value in both commercial and industrial property of 15% to 50%, with the average of reported outcomes being just over a 30% reduction. Patchin (1994) covers theories of contamination loss, and also sets forth several case studies of contaminated commercial properties. He finds losses between 21% and 94%, depending on several factors, including cleanup duration, remediation status, type of contamination, and presence or absence of buildings.

In terms of LUST research in regards to commercial real estate, Simons and Sementelli (1997) consider the experience of LUSTs and registered UST properties in Cuyahoga County, Ohio. They find that the transaction rates of these properties (most of which were existing or former gasoline service stations) are significantly lower than for uncontaminated properties without USTs. Properties with USTs are less likely than uncontaminated property to have mortgage financing. The study took place in the early 1990s.

Simons, Bowen and Sementelli (1999) address commercial properties affected by petroleum contamination from LUSTs in Cuyahoga County. Using a sale-resale analysis, the losses to commercial properties are in the 28-42% loss range. Properties also experience significantly higher rates of seller financing (up by about 1/3) and lower transaction rates (down by about 1/3). Finally, Simons, Saginor and Throupe (2005) perform a meta analysis of the effect of environmental contamination on commercial property values, by pooling over 100 case study observations of contamination.

4. Contingent Valuation in Real Estate

A CV analysis is a survey technique of market participants based on stated preferences. This can be contrasted to revealed preferences (actual sales) that typically form the basis for a market-based analysis of diminished property values. CV is useful as a corroborative technique if sales data are available. However, sometimes no sales of comparable contaminated properties have taken place, or the number of sales is not sufficient to conduct an appraisal or otherwise prepare a sales-based estimate of value or diminution of value. This situation is especially true in the case of rural areas located outside of metropolitan areas where market data are scarce or inadequate. Then, a CV analysis may represent the only primary research methodology (along with review of the literature) that is available to the analyst. Also, a recent meta-analysis of the effects of environmental contamination on residential property in the US shows that surveys in general yield a 6% higher loss figure for losses than regression studies (Simons and Saginor 2005, Tables 2 and 3). One explanation is that hypothetical bias exists (e.g., that CV overstates the losses), while the other is that regression sales do not have complete information on the contaminative event, and tend to underestimate property discounts.

CV is generally accepted in the real estate literature. CV in real estate grew from a previous body of literature developed for the estimation of property damages to public lands, such as the Exxon Valdez incident in Alaska. The process by which CV surveys for damaged property are to be conducted is set forth by The National Oceanic and Atmospheric Administration (NOAA):

> *"A survey-based approach to the valuation of non-market goods and services that relies upon a questionnaire for the direct elicitation of information about the value of the good or service in question… (Federal Register 1994).*

Thus, the NOAA guidelines are not intended to pertain to a private market good, such as real estate. The NOAA guidelines are designed for large, public good contamination problems, with equally large research budgets. The real estate literature has evolved its own approaches that are more focused and still

meet peer-reviewed standards. The following section addresses a commercial CV study conducted for this research. Its aim is to determine the stated discounts for commercial property contaminated with petroleum from a LUST.

Since this time, the real estate literature has developed a growing body of CV articles used to guide measurement of loss amounts for property from environmental contamination. It has been generally accepted in the peer-reviewed real estate literature (see for example, Jenkins-Smith, Silva, Berrens, and Bohara 2002; McClelland, Schultze and Hurd 1990; McLean and Mundy 1998; Mundy and McLean 1998; Simons 2002, Simons and Winson-Geideman 2005, Simons and Throupe 2005, and Simons, Karam, Saginor and Baloyi 2008).

5. Commercial CV Survey Results

Under the direct guidance of the senior author, Midlands Research (based in Columbia, South Carolina) contacted a stratified random sample of real estate professionals (e.g., brokers, appraisers, consultants, developers) in South Carolina. The calls were made in November and December 2002. The overall sample frame for South Carolina was 320, with 79 respondents and a response rate of 25%. In order to supplement this number, represent potential out-of-state buyers, and facilitate benchmarking to the Ohio data cited earlier, we also obtained interviews with 48 real estate professionals in the greater Cleveland, Ohio area. This was drawn from a sample frame of 400 real estate professionals, but not all the sample was utilized. The survey results were collected and data input under the direction of one of the authors and the results are reported below. Thus, a total of 127 surveys are useable for this analysis. The Cleveland commercial sample represents 38% of the sample, and was selected primarily to provide potential corroboration of existing literature on the effects of LUSTs on commercial property values. As investment capital is mobile across state lines, it was also desirable to obtain a substantial (but not overwhelming) portion of the sample to reflect potential commercial buyers from out-of-state. The authors had ready access to real estate professionals in northeast Ohio, which facilitated this portion of the data gathering (see Tables 1 and 2).

The first question of the survey determined the role of the respondent in relation to real estate. Professional positions have the most representation with the highest response from real estate brokers (45 respondents or 35%) followed by real estate consultants (37 respondents or 29%) and appraisers (27 respondents or 21%). Other respondents include developers (19 respondents or 15%), professionals who build and develop (17 respondents or 13%), and builders (5 respondents or 4%). The remaining respondents are all real estate investors (9%).

Table 1 Background of Respondents

	Number of Respondents	Percent
Primary activity related to real estate		
Appraiser	27	21%
Broker	45	35%
Builder	5	4%
Developer	19	15%
Combined builder/developer	17	13%
Investor	12	9%
Real estate consultant	37	29%
Job level		
Owner	45	35%
Manager	45	35%
Other	56	44%
Years of experience		
1-5	11	9%
6-10	25	20%
11-15	39	31%
More than 15 years	52	41%
Had lead role with contaminated property		
Yes	55	43%
No	71	56%
Don't know	0	0%

Source: Authors

Of these respondents, there are an equal number of owners and managers which account for 70% (each having 45 respondents or 35%) of the total. An additional 56 respondents answered other, which account for 44% (this totals to over 100% due to people who occupied multiple jobs). A majority of the respondents (72%) have more than 10 years of experience in real estate. Only 9% of the respondents have less than 5 years of experience and 20% have 6 to 10 years of experience. Despite the level of real estate experience, only 43% of the respondents have a lead role in a transaction that concerns environmentally contaminated real estate.

To determine the investment decision factors used most frequently, respondents were asked to rate several investment criteria on a scale that ranged from 3 to –3, where a score of 0 is either not important or neutral, –3 is an important negative factor (to avoid) and +3 is an important positive factor. The investment criteria provided are the rate of return, property taxes,

environmental problems, location, structural integrity, and visibility. The rate of return has the highest average (+2.78 out of 3) followed closely by location (+2.59), and structural integrity (+2.46). Avoidance of environmental contamination (–2.46) has the expected negative sign.

Table 2 Scale and Importance of Responses to Real Estate Purchase Decision Factors

	Scale Average*	Most Important Factor	2nd Most Important	3rd Most Important
Rate of return/ capitalization rate	2.78	**69%**	14%	6%
Property taxes	1.35	0%	14%	15%
Presence of environmental problems	-2.46	6%	6%	6%
Location	2.59	11%	**28%**	19%
Structural integrity of the building	2.46	9%	24%	**35%**
Visibility	1.86	0%	9%	13%
Other		6%	5%	6%
None		0%	0%	0%

Source: Authors
The scale ranges from 3 for an important positive factor to -3 for an important negative factor. A response of 0 indicates that the example is either not important or the respondent is neutral.

Respondents were then asked to rank the three most important investment criteria. Based on responses, the rate of return is the most important, with location as the second most important and structural integrity as third. The rate of return is the most important factor for 69% of the respondents, followed by location (11%) and structural integrity (9%). Additionally, 97% of all respondents rank the rate of return as one of the three most important factors. Location is the second most important factor (28%) with structural integrity at 24%. The third most important factor is structural integrity (35%), with location at 19% and property taxes at 15%. These results are reflective of the criteria most often discussed in the peer-reviewed real estate investment literature.

Despite the inclusion of environmental contamination and its impact on real estate, no more than 6% of the respondents rated it as important at any level. These responses provide a general framework of the decision-making factors to real estate professionals based on their experience.

6. Interpreting Results

Moving away from the background information to the meat of the survey, three factors are of key importance in evaluating the CV results. The first is the portion of respondents that would bid on a modest income property scenario, used as a baseline for further analysis. The ratio of no bid to total number of respondents reflects the loss of market demand. The second factor pertains to the value loss on sale. Of those that bid, the ratio of the maximum bid to the baseline (uncontaminated) case reflects the percentage they would pay. One minus this percentage reflects the discount. The third factor is the belief of the potential buyer that the property could attain bank financing. This question was asked directly after the other scenarios were set forth.

In regards to the interpretation of the discounted bids, not all bids would necessarily affect market-clearing price. Due to search costs, the reduced number of bidders for contaminated property, and the relatively large number of contaminated sites, the chances are diminished that any of the potential bidders with smaller discounts (higher bids relative to full value) would find a suitable investment property and place a bid that would be accepted by a seller. On the other hand, hugely discounted "bottomfishing" (very low) bids would have little value in the market because it is the bids with the smallest discounts that would get the attention of likely sellers and culminate in a sale. Thus, it is appropriate to examine the top bids (smaller discounts) in the top half and top quarter of the market, rather than evaluating average bid prices. This will be discussed in more detail below. Thus, we use the marginal bidder theory to estimate property damages, rather than the average willingness to pay approach utilized in a CV analysis for public goods (Simons 2002).

6.1 The Fact Scenarios

The paragraph below represents the baseline investment opportunity. The property is typical of one that would be found near a corner of a major street with a non-gas station tenant. The baseline scenario is uncontaminated, and reads as follows:

> *You are in the market for a small commercial investment property. You become aware of a 5,000 square foot stand-alone commercial property on about a half-acre of land. It has a single tenant and 7 years left on a ten-year lease term. The tenant is a successful regional retail chain. The facility has ample parking, has appropriate zoning, and is located near the corner of two main streets. The demographics for the market area are average for your city. The property has triple net cash flow of $40,000 per year (tenant pays all expenses). Investors in your market typically prefer an unleveraged rate of return before income tax of 10%. Assuming this is a cash transaction, what is the most you would be willing to offer (in dollars) for this commercial property?*

The average bid price on this baseline (uncontaminated) commercial property among survey respondents was $411,000. The South Carolina result is $420,848 and the Cleveland figure is $395,625. All 127 respondents bid on this scenario, and the two groups show average values within 6% of each other.

6.2 The LUST Scenarios

The baseline scenario was followed by contaminated property scenarios, each independent of the other, that has petroleum contamination issues of varying degrees. Two pertain to this research and are discussed in detail[1]. The first commercial LUST (A) scenario determines the discount related to a gas station with a LUST event that was readily contained with no known off site contamination. It reads as follows:

> *The commercial property is located next to a well-maintained, attractive operating gasoline service station built a few years ago. Prior to that time no gasoline service station ever existed on that site. The property had a registered underground storage tank leak, but contamination was quickly contained and did not leave the gas station site. An environmental study indicates that the property you are interested in purchasing has no known contamination attributable to the adjacent gasoline station or any other source. Except for this one factor the commercial property is just like the one you initially considered purchasing.*

The bidding was determined using the same scale; the respondents were asked to state: from –3 where they definitely would not make an offer to +3 where they definitely would make an offer, how likely is it that they would make any offer on this property? One hundred percent of the respondents made a bid on this property.

When asked the most they would bid, the average discount is 15%, the discount for the top half is 2% (98% of the full value), and the top quarter has no discount. For the South Carolina sample, the average discount is 16%, the discount for the top half is 2%, and the top quarter has no discount. For the Ohio sample, the average discount is 14%, the discount for the top half is 4%, and the top quarter has no discount. Furthermore, 94% of the respondents believe they could get bank financing for a property of this type. Compared to the other scenarios, 92% of respondents later stated that they would buy this one above the others.

---

[1] In the original interviews for litigation, there was a third scenario that asked about the discount related to a former gas station site with a LUST, suspected of contaminating the groundwater with gasoline and benzene. The results are presented in Table 3, but are not covered here for the sake of brevity and because this paper focuses on off-site property damages. The overall discount for the top half of the market is 42%.

The second commercial LUST (B) scenario determines the discount related to a gas station with a LUST event that was proximate to the investment opportunity, but had been subjected to environmental testing and was found to be contaminated with gasoline and benzene. It reads as follows:

> *The commercial property is located next to a recently remodeled, operating attractive gasoline service station. The site of the station has been registered as having had leaking underground storage tanks. While the leaking tanks have been repaired, the contamination that escaped from under the station has not been removed. The commercial property you are interested in is located where groundwater from below the service station could flow underneath it. Results of environmental testing showed that gasoline, containing benzene, has migrated from the service station under the commercial property. Except for this one factor the tenant and commercial property are just like the one you initially considered purchasing.*

The bidding was determined using the same scale. Eighty-six percent of the respondents (81% of the South Carolina respondents and 94% of the Ohio respondents) made a bid on this property. The average discount is 41% (34% for South Carolina real estate professionals and 51% for Ohio), the discount for the top half is 22% (17% for South Carolina respondents and 35% for Ohio), and the top quarter has a discount of 15% (for South Carolina, it is 13% and 27% for Ohio). Furthermore, only 59% of the respondents believe that they could get bank financing for a property of this type. Compared to the other scenarios, only 6% of the respondents later stated that they would buy this one above the others.

The CV methodology used in this case is quite similar to existing published work (Simons 2002, Simons and Winson-Geideman 2005), except that this application is for commercial rather than residential property. The commercial results from South Carolina are generally consistent with CV studies from Ohio real estate professionals, although additional survey data, which are not described in detail here, indicate that Ohio professionals appear to have more experience and bid larger discounts due to having more experience and familiarity with selling contaminated property. An alternative explanation is that attitudes in Ohio are different from South Carolina. Among the commercial Ohio respondents, the top half and top quarter discounts of 35% and 27% compare closely to the revealed outcomes for commercial property (in the same study area of northeastern Ohio) of 28-42% (Simons, Bowen and Sementelli 1999).

Table 3 Results from Commercial CV Survey

	Number of Surveys	Number of Bidders	Percent Bidding	Average Discount	Top 1/2 Discount	Number of Observations in Top 1/2	Top 1/4 Discount	Number of Observations in Top ¼
Total								
Scenario A LUST	127	127	100%	-15%	-2%	64	0%	32
Scenario B LUST	127	109	86%	-41%	**-22%**	55	-15%	28
Scenario C LUST	127	94	74%	-59%	-42%	47	-34%	24
Ohio								
Scenario A LUST	48	48	100%	-14%	-4%	24	0%	12
Scenario B LUST	48	45	94%	-51%	**-35%**	23	-27%	12
Scenario C LUST	48	37	77%	-73%	-66%	19	-58%	10
South Carolina								
Scenario A LUST	79	79	100%	-16%	-2%	40	1%	20
Scenario B LUST	79	64	81%	-34%	**-17%**	32	-13%	16
Scenario C LUST	79	57	72%	-50%	-36%	29	-29%	15

Source: Authors

Top quarter is less than 1/2% premium not discount

6.3 Formulation of Decision Rules Based On the Literature and Commercial CV

The review of the literature and the implementation of a commercial CV survey lead to decision rules. The results from the literature and the commercial CV survey demonstrate the relative undesirability of commercial property polluted by LUSTs for seasoned commercial real estate investors.

For the commercial CV survey conducted in South Carolina, which uses Scenario A as a data point, there is no reduction in value for a property with close proximity, but no actual contamination. This provides a data point on the low end for the decision rules regarding the discounting of property values due to proximity. For a mid-range data point, Scenario B provides a reduced percentage of potential buyers (86% bid, but only 59% state that they could get bank financing). Thus, with a relatively smaller number of potential commercial buyers, and large number of potential properties available once the information about contamination becomes known, we have considered likely market-clearing bids in the top half of the market. The loss figures from the CV are 17% for South Carolina, and 35% in Ohio. Taking into account this factor, plus difficulty in obtaining financing, we have determined that the discount for a commercial property similar to Scenario B would be 25-30%. This assumes a mix of in-state and out-of-state potential buyers for contaminated property, and also accounts for difficulty in financing unremediated contaminated commercial property (Jackson 2001c). The 25-30% reduction figure for Scenario B is conservative, given that the average property from the peer-reviewed literature has a loss between 35-45%. For loss on the high end, Scenario C (former contaminated gas station site) and the peer-reviewed literature both indicate a loss percentage of about 42% for this type of situation.

Summarizing the loss figures from most severe to least and conservatively applying these loss figures to the cases, the highest loss applied is 40% if the property is affected by multiple sources and there is substantial and verified contamination. Multiple sources are defined as the presence of more than one plume or contamination by LUSTs from two different properties. However, this discount would only be applied in a small number of cases. The 25-30% loss figure pertains to the situation where there is documented environmental contamination based on the results of environmental testing on the off-site property. As the property is further downgradient from the pollution source, it becomes less clear that it is affected, although it may be affected in the future. These properties have been assigned a lower loss figure of 10-20%, depending on the distance from the source. Also, side gradient properties (where the plume runs parallel to the property along its border) and adjacent upgradient property, may experience the need for testing and prove that they are clean, at their own expense. These two categories of property have been assigned loss figures between 5-10%. Commercial property with test wells drilled on the

property (even with no detectable results) have also been assigned a 10% loss for insurance and financing concerns, and nuisance value, since monitoring wells are visible. Also, a few larger properties may have just parking lots (shopping malls) affected, and splitting off parcels may be a viable alternative: a lower loss amount of 10-20% is typically assigned to these properties to ensure that reduction loss figures are not inflated. Continued presence of an operating gas station in the area is also factored into the loss estimates, up to 5%. All other property, further away from the plume, or upgradient, is assumed not to have suffered any property value loss for the LUST. This spectrum of losses is consistent with the CV results and the peer-reviewed literature, and provides a framework for benchmarking the likely reduction in property value in a logical way between data points. The loss numbers described above can be applied on a systematic, parcel-by-parcel basis to properties near a LUST case. These percentages are intended to apply to commercial property with structures; vacant land may have higher losses because (as per the land residual approach) the land would be expected to absorb losses if development is to be feasibly undertaken.

7. Examination of Environmental Maps

We obtained the environmental consultant's map from the files of South Carolina's environmental agency, Department of Health and Environmental Control (DHEC). The maps contain the monitoring of well locations and test results by date, groundwater gradient, and nearby structures. The consulting firm, IST, is the source of most of the maps used in this research. The maps typically contain a delineated benzene plume. We selected the map that demonstrated the largest extent of off-site contamination. This is typically, but not always the most recent map. The maps were transferred to digital format.

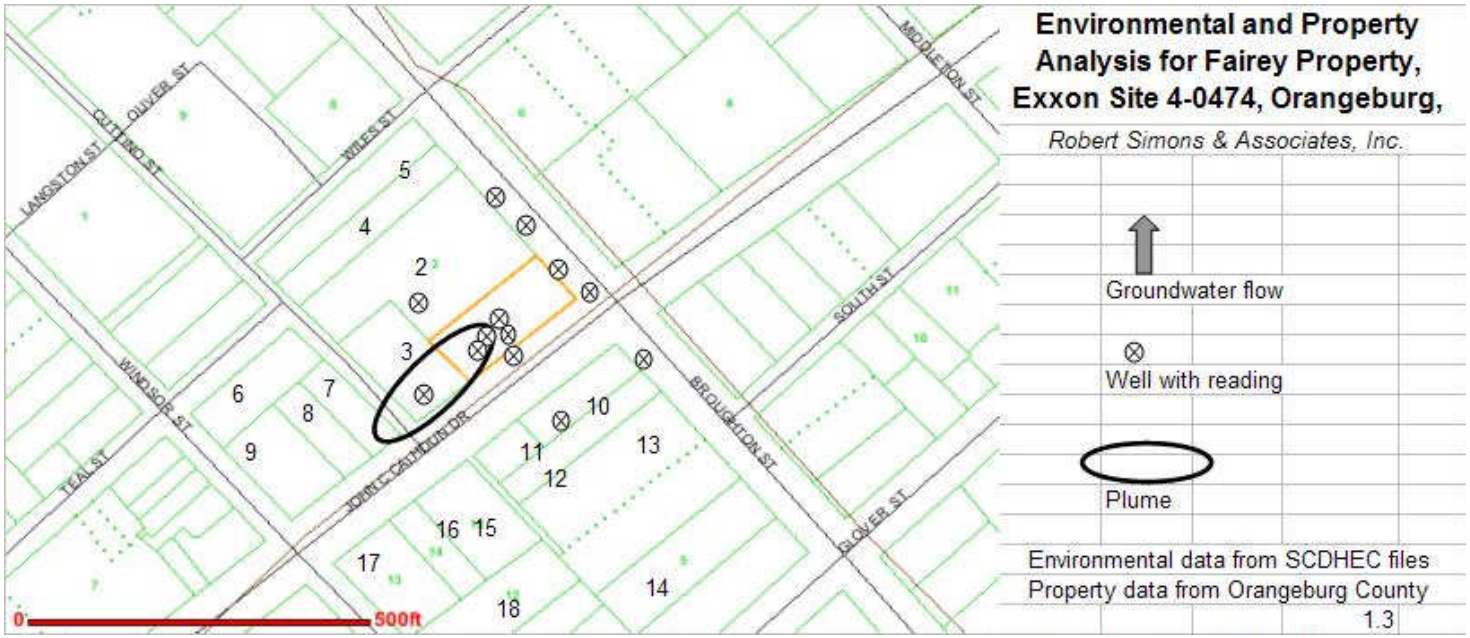
We then obtained property tax records from the county or city government. The records show parcel boundaries, property market values and assessed values, land use, owner names, size of lots, buildings, etc. This information was also transferred to digital format and the maps were superimposed upon one another. Due to a lack of data on recent comparable sales for surrounding and similar properties, as well as none of the sites had an appraised value that accounted for the contamination, the baseline values were obtained from assessor data. Baseline (uncontaminated) market values were adjusted upward by 30% to account for a lag in the assessment process and other systematic undervaluation of property (Harrison 2003) particular to South Carolina at this time. Following the methodology for map review set forth by Simons, Bowen and Sementelli (1999), we then identified which properties are contaminated by being on a plume or adjacent to a parcel that is affected. The discount factors from 0% to 40% described above are applied to each potentially affected property, depending on its location relative to the environmental data.

7.1 Illustrative Case Study

The illustrative case study presented here is to display the methodology, data available and judgments of this research. The case study from Orangeburg, South Carolina is included because it is the most studied of all sites, due to being the named plaintiff in the litigation discussed in the introduction. The subject is a former gas station that had the tanks removed in 1989. However, the property was found to be contaminated in the early 1990s, and another previously undetected set of tanks was removed in 2003. The plume extended generally west of the subject by about 300 feet, and slightly north. Other properties in the area were contaminated from at least one other LUST on the same intersection. The former bank building (now selling propane) was worth about $150,000. According to a local realtor, it sold for $60,000 in 1994, less than half of its worth (losses for this property were calculated from actual contemporaneous sales records). We normally would have assigned this property a damage figure of 30%, so for this property, our methodology is conservative in that it does not overstate losses. The property taxes and tax value dropped by just over half after the sale in 1994. An appraisal report by a local appraiser shows contaminated sales, including the bank sale, well below par. The former bank property sold for a value that made it comparable to a land-only sale. The adjacent truck rental building, and the two properties west of it have also had their property values affected by contamination emanating from this property. Other property on the south side of the street also has contamination on site. Overall, five or more properties have been affected by the gas station's contamination. Offsite property losses total $85,228 in 2002 dollars. Table 4 shows a map of the Orangeburg site's contamination and its effect on nearby property.[2]

[2] There are also other gas stations in the area, and these affect other property, but these effects are not shown on this map for the sake of clarity and brevity.

Table 4 Orangeburg, South Carolina Case Study



Map ID	Land Use	Acres	Sale Date	Sale Price	Mkt Value	Adj Mkt Value	% loss	$$ Loss
1	Automotive Center	0.4	8/31/1998	$ 2,200	$ 86,300			
2	Office	1.01	5/1/1994	$ 5	$ 66,500	$ 86,450	40%	$ 34,580*
3	Storage Warehouse	0.39	1/1/1972	$ -	$ 50,200	$ 65,260	40%	$ 26,104
4	Office	0.36	5/1/1994	$ 90,000	$ 87,800	$ 114,140		
5	Office	0.36	1/17/2001	$ 5	$ 171,200	$ 222,560		
6	Comm Vacant	0.33	7/1/1987	$ 17,000	$ 14,400	$ 18,720		
7	Comm Out-buildings	0.19	12/1/1997	$ -	$ 21,100	$ 27,430	30%	$ 8,229
8	Comm Vacant	0.18	4/1/1997	$ 85,000	$ 15,700	$ 20,410	20%	$ 4,082
9	Retail Store	0.35	2/1/1985	$ 90,000	$ 94,100	$ 122,330	10%	$ 12,233
10	Comm Vacant	0.35	1/18/2000	$ -	$ 35,100	$ 45,630	**	
11	Service Repair Garage	0	1/18/2000	$ -	$ 15,900	$ 20,670		
12	Comm Vacant	0.27	1/18/2000	$ -	$ 27,100	$ 35,230		
13	Fast Food Restaurant	1.11	9/1/1991	$ 5	$ 367,600	$ 477,880		
14	Office	0.52	10/1/1978	$ 30,500	$ 86,500	$ 112,450		
15	Comm Vacant	0.38	8/13/2001	$ 66,000	$ 33,100	$ 43,030		
16	Comm Vacant	0.17	1/1/1975	$ 5	$ 14,800	$ 19,240		
17	Retail Store	0.37	7/13/1999	$ 5	$ 122,300	$ 158,990		
18	Exempt – Church	0.5	1/1/1955	$ -	$ 107,600	$ 139,880		
						Total Loss		**$ 85,228**

Notes:
* Property sold at a 50% discount 8 years before analysis
** Loss of @10-15% not valued: attributable to other LUST

8. Conclusions and Future Research

This research has presented a methodology for determining property value losses due to LUSTs for commercial property. Several methods (including literature review, CV analysis, review of public property taxes and environmental records, and application of survey results to specific properties) are combined to produce a depiction of the losses that is legally acceptable and plausible. These factors are combined using decision rules to estimate property damages from LUSTs. This research also presents the first known application of CV to estimate damages from environmental contamination to commercial property. These loss figures in their current form may not be generalizable beyond this case study, but the methodology should be applicable where the data (or close substitutes) are publicly available.

References

Boyle, M. and K. Kiel. (2001). A Survey of House Price Hedonic Studies of the Impact of Environmental Externalities, *Journal of Real Estate Literature*, **9**, 2, 116-144.

Carson, R., N. Flores, K. Martin, and J. Wright. (1996). Contingent Valuation and Revealed Preference Methodologies: Comparing the Estimates for Quasi-public Goods, *Land Economics,* **72**, 1, 80-99.

Dotzour, M. (1997). Groundwater Contamination and Residential Property Values. *The Appraisal Journal,* **65,** 3, 279-285.

Federal Register (January 7, 1994). **59**, 5, Proposed Rules: 1142.

Farber, S. (1998). Undesirable Facilities and Property Values: A Summary Of Empirical Studies, *Ecological Economics,* **24**, 1-14.

Flower, P. and W. Ragas. (1994). The Effects of Refineries on Neighborhood Property Values, *Journal of Real Estate Research,* **9,** 3, 319-338.

Guntermann, K. (1995). Sanitary Landfills, Stigma and Industrial Land Values, *Journal of Real Estate Research,* **10**, 5, 531-542.

Harrison, Glenn, Ph.D. (March 2003). Email communication.

Jackson, T. (2001a). Environmental Risk Perceptions of Commercial and Industrial Real Estate Lenders, *Journal of Real Estate Research*, **22**, 3, 271-288.

Jackson, T. (2001b). The Effects of Environmental Contamination on Real Estate: A Literature Review, *Journal of Real Estate Literature*, **9**, 2, 93-116.

Jackson, T. (2001c). The Effects of Previous Environmental Contamination on Industrial Real Estate Prices, *The Appraisal Journal*, **69,** 2, 200-210.

Kiel, K. (1995). Measuring the Effect of the Discovery and Cleaning of Identified Hazardous Waste Sites on House Values, *Land Economics*, **71**, 4, 428-435.

Kohlhase, J. (1991). The Impact of Toxic Waste Sites on Housing Values, *Journal of Urban Economics*, **30**, 1-26.

Jenkins-Smith, H., C. Silva, R. Berrens, and A. Bohara. (2002). Information Disclosure Requirements and the Effect of Soil Contamination on Property Values, *Journal of Environmental Planning and Management*, **45**, 3, 323-339.

McClelland, G., W. Schultze, and B. Hurd. (1990). The Effect Of Risk Beliefs On Property Values: A Case Study Of A Hazardous Waste Site, *Risk Analysis*, **10**, 4, 485-497.

McLean, D. and B. Mundy. (1998). Adding Contingent Valuation and Conjoint Analysis to the Required Body of Knowledge for the Estimation of Environmental Damages to Real Property, *Journal of Real Estate Practice and Education*, **1,** 1, 1-19.

Mundy, B. and D. McLean. (1998). Using the Contingent Value Approach for Natural Resource and Environmental Damage Applications, *The Appraisal Journal*, **66,** 3, 290-297.

Nelson, A., J. Genereux and M. Genereux. (1992). House Price Effects of Landfills, *Land Economics*, **68**, 4, 359-65.

Patchin, P. (1994). Contaminated Properties and the Sales Comparison Approach. *The Appraisal Journal.* **July**: 402-409.

Reichert, A. (1999). The Persistence of Contamination Effects: A Superfund Site Revisited, *The Appraisal Journal*, **67**, 2, 126-35.

Roddewig, R. (1999). Classifying the Level of Risk and Stigma Affecting Contaminated Property, *The Appraisal Journal*, **67,** 1, 98-102.

Sementelli, A. and R. A. Simons. (1997). Regulation of Leaking Underground Storage Tanks, *Economic Development Quarterly*, **11**, 3, 236-248.

Simons, R. A. (1998). *Turning Brownfields into Greenbacks*. Urban Land Institute: Washington DC.

Simons, R. A. (1999). The Effects of Oil Pipeline Ruptures on Non-Contaminated Easement-Holding Property, *The Appraisal Journal*, **67,** 3, 255-263.

Simons, R. A. (2002). Estimating Proximate Property Damage from PCBs in A Rural Market: A Multiple Techniques Approach, *The Appraisal Journal*, **70,** 4, 388-400.

Simons, R. A., W. Bowen and A. Sementelli. (1997). The Effect of Underground Storage Tanks on Residential Property Values in Cuyahoga County, Ohio, *Journal of Real Estate Research*, **14**, 1/2, 29-42.

Simons, R. A., W. Bowen and A. Sementelli. (1999). The Price and Liquidity Effects of UST Leaks from Gas Stations on Adjacent Contaminated Property, *The Appraisal Journal*, **67,** 2, 186-194.

Simons, R. A., J. Saginor, A. Karam, and H. Baloyi. (2008). Use of Contingent Valuation Analysis in A Developing Country: Market Perceptions of Contamination on Johannesburg's Mine Dumps, *International Real Estate Review*, **11,** 2, 75-104.

Simons, R. A., J. Saginor and R. Throupe. (2005). A Meta Analysis of the Effect of Environmental Contamination Commercial Property Values, working paper.

Simons, R. A., and J. Saginor. (2005). A Meta Analysis of the Effect Of Environmental Contamination and Positive Amenities on Residential Property Values, *Journal of Real Estate Research*, **28**, 1, 71-104.

Simons, R. A. and A. Sementelli. (1997). Liquidity and Delayed Transactions with Leaking Underground Storage Tanks: Some Evidence from Cleveland, Ohio, *The Appraisal Journal***, 65**, 3, 255-260.

Simons, R. A. and R. Throupe. (2005). Toxic Mold Issues and Effects on Property Values: A Preliminary Analysis, *The Appraisal Journal*, **73,** 2, 156-166.

Simons, R. A. and K. Winson-Geideman. (2005). Determining Market Perceptions On Contamination Of Residential Property Buyers Using Contingent Valuation Surveys, *Journal of Real Estate Research*, **27**, 2, 193-219.

Simons, R. A., K. Winson-Geideman and B. A. Mikelbank. (2001). The Effects of an Oil Pipeline Rupture on Single Family House Prices, *The Appraisal Journal*, **69,** 4, 410-418.

Syms, P. (1996). Perceptions of Risk in the Valuation of Contaminated Land, *Journal of Property, Valuation and Investment,* **15**, 1, 27-39.