Robert A. Simons, PhD, William M. Bowen, PhD, and Arthur J. Sementelli, PhD

The Price and Liquidity Effects of UST Leaks from Gas Stations on Adjacent Contaminated Property

This article reports on the effects of registered leaking underground storage tanks (LUSTs) from gas stations on neighboring residential and commercial property that is actually known to be contaminated. Addressing the effects on transaction rates, sales price, and ability to obtain financing, the research employs a variety of statistical methods appropriate when small numbers of properties are available for analysis. These include individual property prediction models in a hedonic regression framework, multiple analysis of variance (MANOVA), presale/postsale analysis, and difference of proportions analysis.

The effects of gas station leaking underground storage tanks (LUSTs) are a concern because petroleum compounds may potentially cause groundwater contamination (especially serious if drinking water is affected), soil contamination, and noxious deleterious fumes in confined areas such as basements. The main hypothesis of this article is that if nearby properties are contaminated by petroleum from LUSTs, their value would be reduced. We address the effects of LUSTs on various market outcomes, including transaction rate, sales price, and ability to obtain financing. The study area was Cuyahoga County, Ohio, with Cleveland as its central city. All analyses were based on public records.

The statistical technique used to analyze each of the different market outcomes depended largely on matching the requirements and capabilities of each of the alternative feasible techniques with the characteristics of the available data for the particular outcome of interest. The main constraint was the small number ($n < 10$) of contaminated properties sold in a property class in any given year. For each type of analysis, we used the technique providing the best match between technique and available data, including predictive regression models in a

Robert A. Simons, PhD, is an associate professor of real estate and urban planning in the Levin College of Urban Affairs at Cleveland State University in Ohio. He earned his graduate degrees from the University of North Carolina, Chapel Hill. Dr. Simons consults and conducts research on the effects of environmental contamination on real estate values. Other areas include brownfields, housing policy, and government real estate problems. Contact: roby@wolf.csuohio.edu.

William M. Bowen, PhD, is an associate professor of urban studies and public administration in the Levin College of Urban Affairs at Cleveland State University. He received his PhD in regional analysis and planning from Indiana University, Bloomington. His interests center on the use of empirical research methods and statistics as applied to decisions in environmental affairs, energy policy, and economic development.

Arthur J. Sementelli, PhD, is an assistant professor of political science and geography in the public administration program at Stephen F. Austin State University in Texas. He received his PhD from Cleveland State University, and conducts research on public administration and public policy. Other research areas include management science, environmental policy, and economic impacts of contamination

hedonic framework for individual properties, multivariate analysis of variance (MANOVA), presale/postsale analysis, and difference of proportions analysis. Throughout, we report only those results established at a 95% confidence level or better.

This research approach is complementary to direct surveys of market participants. Though direct surveys are often more detailed and specific about certain hypothetical situations or past experiences, they are often more difficult to employ. Moreover, they often fail to present an overall view of a situation in a real estate market, thereby limiting the ability to generalize any conclusions drawn from them.

The results we present here are consistent with our earlier findings of the effects of registered LUSTs on residential property, which concluded that there was a 17% reduction in sales price.[1] For residential properties in this study, results indicate a statistically significant reduction of up to 14%–16% for those properties sold after contamination becomes known. This is an observable effect from sales only, before consideration of effects on value from any delayed sale or reduced transaction rates. For commercial properties, we find a significant reduction in transaction rates (33% lower), a reduction in sales price of approximately 28%–42%, and more than twice the incidence of seller financing.

The rest of this article covers the literature pertaining to value loss of adjacent property, including a detailed description of the data collection and analysis used in this research, and reports results for residential and commercial property.

LITERATURE REVIEW

Residential Property Affected by Environmental Contamination (Including LUSTs)

The effects of environmental contamination on surrounding residential property are well documented, with important studies noted in the reference section of this article. Studies have been conducted on Superfund toxic waste sites, landfills, and existing hazardous waste sites, as well as high-voltage overhead electrical transmission power lines. Relevant work has also addressed the relationship between groundwater contamination and residential property values.[2] Results from these studies generally support the notion that a negative relationship exists between proximity to these objectionable sites and residential sale values. This relationship diminishes with increasing distance from the site. The type of toxic substance also affects the reduction in values. For example, one would expect to find a larger negative effect for hazardous waste than for nonhazardous environmentally harmful materials. Compared with other forms of contamination, LUSTs would be considered a moderately toxic environmental problem.[3]

Housing markets assimilate publicly available information (e.g., a discovery that contamination at a Superfund site is worse than expected) by capitalizing it into a lower sales price. Homeowners may also perceive separate diminution of value attributable to a nuisance associated with close proximity to a site and more general negative effects related to potential health hazards. Proximity to visually obvious hazardous sites may also deter potential buyers from making offers on homes, thus affecting sales price by reducing demand.

There is a small but growing body of empirical information on the effect of underground storage tank leaks on residential property. Our study finds a 17% reduction in sales price for residential property sold within one block or 300 feet of a registered LUST, where the site continued to have tanks onsite.[4] This result pertains to 1992, a year when recovery from the recession indicated generally soft market conditions. These results also include LUSTs associated with industrial sites that were not gas stations.

Nonresidential Property Affected by LUSTs

There is strong evidence in the literature to support the notion that nonresidential (income-producing) property could be nega-

1. Robert Simons, William Bowen, and Arthur Sementelli, "The Effect of Underground Storage Tanks on Residential Property Values in Cuyahoga County, Ohio," *The Journal of Real Estate Research*, v. 14, no.1/2 (1997): 29–42.

2. Mark Dotzour, "Groundwater Contamination and Residential Property Values," *The Appraisal Journal* (July 1997): 279–285; and G. William Page and H. Rabinowitz, "Groundwater Contamination: Its Effects on Property Values and Cities," *Journal of the American Planning Association* (Autumn 1993): 473–481.

3. Paul Syms, "Perceptions of Risk in the Valuation of Contaminated Land," *The Journal of Property, Valuation and Investment*, v.15, no. 1 (1997): 27–39.

4. Simons, et al., 1997.

A standard for establishing the magnitude of loss in real estate is the hedonic price model.

tively affected by proximity to environmental contamination (of which LUSTs are an important subgroup), even if no sale of the property occurs.[5] Because LUSTs are relatively common, they are often cited as a likely source of contamination appraisers should watch for, or are used as examples of contaminated property.[6] Further, a substantial portion of LUSTs have been found to have off-site groundwater contamination.[7] Much of the literature pertains directly to contaminated subjects, although the effects may also be applicable to some degree to proximate off-site properties if contamination becomes known, or if the sites are perceived to be contaminated.[8]

Regardless of how this potential value diminution comes to pass, the end result is that value diminution can occur without a sale. It is a form of unrealized capital loss due to a lessened income stream and loss of full use of the property. These losses in value can be attributed to reduced net income streams, delayed transactions, loss in the owner's ability to access equity in the property, higher discount rates to adjust for perceived risk, or reductions to property value due to stigma. Any combination of these factors can result in an overall reduction in value. Through discounted cash flow (DCF) analysis, an appraiser (or other real estate professional) can determine diminished future net income due to lost income, lower expected rents, lower occupancy rates, and higher environmental monitoring costs that depress the present value of income-producing property (including apartment buildings). The DCF approach has been generally accepted by many scholars and experts.[9]

MECHANISMS THROUGH WHICH LOSS OF PROPERTY VALUE MAY OCCUR

Delayed transactions. Contaminated properties are more difficult to sell, experience reduced marketability, or may never reach the market. Thus, lack of sale or a delayed sale is a loss.[10] There is evidence to support the proposition that LUSTs and other types of environmental contamination experience this problem.[11]

A standard for establishing the magnitude of loss in real estate is the hedonic price model. However, hedonic pricing models require a sale. Therefore, it can be argued that hedonic pricing models understate the actual loss because only the most desirable properties get sold, and also because the loss of value attributable to a delayed sale is not considered. A smaller number of sales and a higher percentage of failed transactions indicate that the present value of those properties that do sell would be lower because of the delay. Also, net sales price would be lower because of excess supply. The market clearing price may be harder to establish because buyers and sellers may have different perceptions of the cost to cure contamination.[12]

---

5. James A. Chalmers and Scott A. Roeher, "Issues in the Valuation of Contaminated Property," *The Appraisal Journal* (January 1993): 28–41.
6. Daniel F. Ryan, "Lender's View of Hazardous Substances and Appraiser Responsibility,"*The Real Estate Appraiser and Analyst* (Fall 1989):10–12; Richard Roddewig, "Stigma, Environmental Risk, and Property Value: 10 Critical Inquiries," *The Appraisal Journal* (October 1996): 375–387; Albert Wilson, "The Environmental Opinion: Basis for an Impaired Value Opinion," *The Appraisal Journal* (July 1994): 410–423 and "Emerging Approaches to Impaired Property Valuation," *The Appraisal Journal* (April 1996): 155–170.
7. Simons, et al., 1997; Arthur Sementelli and Robert Simons, "Regulation of Leaking Underground Storage Tanks: Policy Enforcement and Unintended Consequences," *Economic Development Quarterly* (August 1997): 236–238.
8. Bill Mundy, "Stigma and Values," *The Appraisal Journal* (January 1992a): 7–13; Peter J. Patchin, "Valuation of Contaminated Properties and the Sales Comparison Approach," *The Appraisal Journal* (January 1988): 7–16 and "Contaminated Properties—Stigma Revisited," *The Appraisal Journal* (April 1991): 167–172.
9. Richard A. Neustein, "Estimating Value Diminution by the Income Approach," *The Appraisal Journal* (April 1992): 283–287; Chalmers and Roeher, 1993; Mundy, 1992a; Bill Mundy, "The Impact of Hazardous Materials on Property Value: Revisited," *The Appraisal Journal* (October 1992b): 463–471; Anthony J. Rinaldi, "Contaminated Properties—Valuation Solutions," *The Appraisal Journal* (July 1991): 377–381; Wilson, 1994 and 1996.
10. Michael V. Sanders, "Post-Repair Diminution in Value from Geotechnical Problems," *The Appraisal Journal* (January 1996): 63–65; Patchin, 1991; B. Christensen, "Can Pollution Contaminate Value?," *The Real Estate Appraiser and Analyst* (Fall/Winter 1987): 53–55; and John D. Dorchester, Jr., "Environmental Pollution: Valuation in a Changing World," *The Appraisal Journal* (July 1991): 289–302.
11. Simons, et al., 1997; Alan K. Reichert, Michael Small, and Sunil Mohanty, "The Impact of Landfills on Residential Property Values," *The Journal of Real Estate Research*, v. 7, no. 3 (1992): 297–314; and William N. Kinnard, Jr., "Tools and Techniques for Measuring the Effects of Proximity to Radioactive Contamination on Single-Family Residential Sales Prices," working paper, Real Estate Counseling Group of Connecticut, Inc., Storrs, 1991.
12. Wilson, 1996.

Reduced net income stream. According to prevailing theory, income can be reduced even if tenants do not move out, because future tenants may pay less rent to compensate for the environmental risk. There could also be a higher vacancy rate, where tenants avoid the building[13] or there is downtime for mitigation to occur. These conditions would apply to an income property affected by offsite contamination from a LUST. Also, any unreimbursed environmental monitoring costs could drive down net revenues for the building by increasing operating costs.[14]

Loss in Accessing Owner Equity. A contaminated property owner may lose the ability to obtain mortgage financing. There is evidence that lenders refuse to provide mortgage loans on contaminated properties, including those with USTs.[15] Such a situation may prevent the owner from obtaining financing and could cause cash flow problems for the business because the structure may not be used as collateral. Hence, the liquidity of the property (i.e., the owner's ability to convert the asset to cash relatively quickly) could be substantially impaired. In certain severe cases, a firm could undergo financial stress severe enough to cause bankruptcy. These issues related to liquidity loss indicate that the owner may have lost the ability to fully use the property or that the asset has been frozen. This liquidity loss includes the inability to refinance and loss of full income potential. Restrictions on future use are also a concern, and may affect both property owners and lenders worried about the value of the real estate as collateral.[16]

Higher discount rate to adjust for actual or perceived risk. A higher discount rate drives down the present value of the property, even if debt structure and revenue do not change. In some cases, upward adjustment in the risk premium component of the discount rate can be substantial. A two-percentage-point increase, or about 20%, was reported in one survey.[17]

Stigma. This term is generally accepted to mean the residual value loss outside of the cost to cure the actual contamination. One important component of stigma is fear or uncertainty about a future recurrence, and another is a chilling effect.[18] The stigma would be greater before remediation, and even after a successful cleanup, the affected property may never regain its full unimpaired value. Failed transactions may be a form of stigma. In addition, the stigma of a bad address should be controlled for by using either regression or matched pairs analysis. Courts have accepted the notion of permanent post-cleanup stigma. Also, courts have considered stigma damages in cases of incomplete repair, where the property has not been totally remediated back to clean standards.[19] This may become more common in the future, given the emergence of risk-based corrective action cleanup strategies.

Overall reduction in value. In summary, the combination of all the mechanisms mentioned here clearly supports the notion that unsold income-producing property can experience substantial diminished value. Both contaminated subjects and nearby property, whether perceived or actually contaminated, could be affected. Limited quantitative evidence exists of this value diminution for subjects and offsite properties.[20] Based on this evidence, the value diminution effects should be larger for offsite nonresidential properties than for offsite residential properties. The amount of loss can also depend on whether it was determined before or after remediation, the timing of market cycles, the severity of contamination, and other factors.[21]

13. Neustein, 1992; Joseph A. Campanella, "Valuing Partial Losses in Contamination Cases," *The Appraisal Journal* (April 1984): 301–304 and "Commercial Property Values and Toxic Sites," *The California Lawyer* (May 1990); Gerald E. Smolen, Gary Moore, and Lawrence V. Conway, "Hazardous Waste Landfill Impacts on Local Property Values," *The Real Estate Appraiser* (April 1992): 4–11.
14. Smolen, et al., 1992; and Rinaldi, 1991.
15. Mundy, 1992b; Patchin, 1991; Patricia R. Healy and John J. Healy, Jr., "Lenders' Perspectives on Environmental Issues," *The Appraisal Journal* (July 1992): 394–398; Mundy, 1992a; and Simons et al., 1997.
16. Smolen et al., 1992; Mundy, 1992a; and Sanders, 1996.
17. Neustein, 1992; Smolen et al., 1992; Mundy, 1992b; and Fisher et al., 1993, reported the 20% change.
18. Patchin, 1988; Sanders, 1996; Mundy, 1992b; Patchin, 1991; and Campanella, 1992.
19. Syms, 1996; Patchin, 1994; M. Elliot-Jones, "Stigma Damages and the Bad Address," unpublished paper (1996); B. Hogin, "Post-Cleanup Stigma Claims: The Latest from the War Over Hazardous Waste," *Toxics Law Reporter* (February 1995): 918; and Muldowney and Harrison, "Stigma Damages: Property Damage and the Fear of Risk," *Defense Counsel Journal* (October 1995): 525–538.
20. Page and Rabinowitz, 1993; Patchin, 1994; and Karl Guntermann, "Sanitary Landfills, Stigma and Industrial Land Values," *Journal of Real Estate Research*, v. 10, no. 5 (1995): 531–542.
21. Syms, 1996; Patchin, 1994; Sanders, 1996; and Kinnard, 1991.

DATA COLLECTION AND METHODS

Identification of Contaminated UST Sites

The first step in the empirical part of this research was to identify properties actually or very likely to be contaminated. In Ohio this was accomplished at the Bureau of Underground Storage Tank Regulations (BUSTR), the state UST regulating agency. BUSTR has a reasonably complete set of files on corrective action sites in Ohio, including well test results, gradient maps, and other materials for more than 200 UST events in Cuyahoga County. The operational definition of contamination refers to the documented presence of the carcinogen benzene and other volatile petroleum compounds in excess of 5 parts per billion (ppb). Due largely to measurement limitations faced by BUSTR engineers responsible for site characterization (most consultant reports stop at the property boundary), a degree of judgment is required in determining whether and to what extent an adjacent site meets this definition. Accordingly, upon review of each file, this research employed a ranking system (1 being the highest, 3 the lowest) based on the degree of confidence we could place in whether that property was actually contaminated. The highest was a "1", where direct evidence (well test results) showed that contamination was present. A property classified as a "2" was adjacent and down-gradient from a contaminated site, or refused to be tested. A "3" was adjacent to a 1 or 2 and also down-gradient, within 50 feet to 100 feet of the edge of contamination. A total of 60 sites were identified as having offsite contamination at level 3 or above. Care was taken to avoid classifying properties as contaminated if they were on the margin of these criteria.

The next step was to verify the parcel numbers of offsite contaminated properties. This was accomplished in Cuyahoga County at the county property tax map room by examining the LUST maps from BUSTR and comparing them to tax maps. Accordingly, 133 contaminated residential properties were identified in Cuyahoga County. Of these, about 100 were existing residential homes. The balance of the residential properties were new construction, all in one new residential subdivision. We similarly identified a total of 154 actually contaminated commercial properties.

Property data. Sales activity and sales price data are available through the county's property tax records. We obtained these records from the Amerestate Corporation (a data vendor) for sales data since 1986 and characteristics on all properties (sold or not) through the first quarter of 1997. This data set was combined with the contaminated property information, thus enabling comparison of the contaminated and uncontaminated properties.

This study focused on a subset of the data from July 1994 through December 1996, after the Ohio residential real estate disclosure form became required but during a relatively stable period in the regulation of and requirements concerning USTs. This time period provides some of the best available data on environmental contamination and property characteristics.[22]

Methods. Subject to the sorts of considerations mentioned previously, the best available analytical techniques were employed. These techniques were driven by quality and availability of property data, number of contaminated properties, if sold, market segmentation, distribution of variables and error terms in statistical models, degree of site remediation, and comparability of commercial property. The overall database permitted construction of hedonic multiple regression models for existing residential properties. Limitations existed due to cross-year pooling and a small number of sales in each year (fewer than 10). These limitations rendered it infeasible to follow a more traditional approach using hedonic models. Instead, depending on the number of available cases, this research used hedonic models to predict individual property values, MANOVA (multivariate analysis of variance), and sale/resale analysis, as appropriate. (The variables and predictive regression computer models that underlie this research are available from the authors on request.)

RESULTS FOR RESIDENTIAL PROPERTIES

Existing Residential Properties

Given the available data, the best analytical technique for existing residential sales is individual prediction using hedonic multiple regression analysis, with data transformed using the Box-Cox technique. One model

22. See Sementelli and Simons, 1997, for more details on the regulatory environment.

was created for each year of sale. Expressing the sales prices in log form helps to correct for lack of normality in their distribution. This technique enables comparison of the predicted sales price with the actual sales price. The difference can be attributed to contamination, holding all other information constant. Table 1 contains the results. The most important information includes the percentage reduction in value between the predicted and observed sales prices.

Eleven existing residential properties were sold after contamination became known, and before remediation was known to be initiated. Comparing the actual sales price with its predicted (market) price among this group, nine have a statistically significant reduction in price, one has a reduction that is not significant, and one has a significant increase in sales price. Aggregating these sales together reveals a 14%–15% reduction in sales price that can be attributed to the LUST contamination, without accounting for delay or other impacts on value.[23] Typically, these properties were under remediation at the time of sale.

Higher-Priced New Residential Units

Higher-priced new construction in one new upper-end subdivision in a desirable neighborhood forms one subset of the sales. The contamination in this subdivision resulted from a leak with a well-documented, extensive LUST plume. The event was discovered in mid to late 1994, and partially documented in 1995. By late 1995 and early 1996, residential disclosure forms were known to be in use in marketing these units. Some nicely located and otherwise attractive residential building lots currently remain undeveloped.

Consistent with the notion of price segmentation, these homes were modeled separately from the lower- and middle-priced homes. For these higher-priced sales, MANOVA was used. This technique enables comparison of the sales prices of properties classified as contaminated with those classified as uncontaminated, without violating regression assumptions. Statistical significance tests on bivariate relationships can be used to indicate the marginal difference in sales price attributable to contaminated and otherwise similar uncontaminated properties.

The results, shown in table 2 and figure 1, indicate that before contamination became known, the properties in this subdivision were selling at a 5% premium over houses in similar neighborhoods. By 1995, the contaminated sales had experienced a reduction of 2% over the other properties. By 1996, the price reduction was 16% for those contaminated units that sold. These results are statistically significant at a level of 0.05.

TABLE 1 Existing Residential Properties Sold After 1994 with Disclosure in Effect

Year Sold	Parcel	Degree of Contamination	Actual Price	Predicted Price	Price Difference	Price Change Predicted
1994	821-18	3	$72,000	$98,280	-$26,280	-26.7%*
1994	312-05	3	$102,000	$131,453	-$29,453	-22.4%*
1995	363-15	2	$103,000	$85,440	$17,560	20.6%*
1995	134-23	2	$20,000	$32,169	-$12,169	-37.8%*
1995	018-04	2	$61,000	$64,467	-$3,467	-5.4%*
1995	018-04	2	$60,000	$60,699	-$699	-1.2%
1995	022-14	2	$53,000	$60,118	-$7,118	-11.8%*
1996	684-01	2	$63,500	$91,780	-$28,280	-30.8%*
1996	131-19	1	$15,000	$21,077	-$6,077	-28.8%*
1996	018-04	1	$48,000	$51,058	-$3,058	-6.0%*
1996	314-21	3	$129,000	$145,129	-$16,129	-11.1%*
Totals			$726,500	$841,670	-$115,170	
					Total Loss:	-13.7%
					Average Loss:	-14.7%

*Significant at 0.05

23. A 95% confidence interval around these data would indicate the change to be between –3.6% and –25.8%. If the one positive value is omitted, a 95% confidence interval would be –9.1% to –27.3%. Either way, the confidence interval excludes zero, indicating that the value is negative and the loss is statistically significant.

TABLE 2 Higher-Priced New Residential MANOVA Results

Year of Sale	Number of Contaminated Sales	Total Number of Sales	Price Range	Model *F*-statistic	Price Uncontaminated	Price Contaminated	Average Change in Price	Annual Difference
1994	4	117	$300–$450	15.18	$333,830	$352,191	$18,361	5.5%
1995	8	325	$300–$450	14.29	$345,511	$336,990	-$8,521	-2.5%
1996	8	287	$300–$450	15.32	$360,572	$303,983	-$56,589	-15.7%

Notes: Average prices of contaminated properties when compared with uncontaminated properties are statistically different at 0.01. This table is based on 20 contaminated sales over a three-year period.

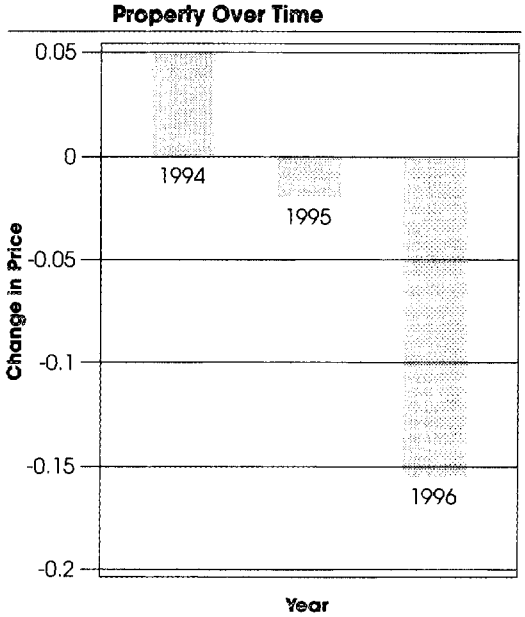
COMMERCIAL PROPERTY RESULTS

Three types of analysis can be conducted to determine the effect of LUSTs on contaminated commercial property: transaction rates once contamination becomes known, the likelihood of seller financing on sale, and difference in sales price upon sale.

Transaction Rates of Contaminated Versus Uncontaminated Commercial Properties

This study identified 154 nonresidential properties known to be contaminated. This number was reduced to 122 properties to account for government-owned lands and double counts of properties with multiple parcels. Next, commercial properties sold in the same year or after information about LUST contamination became known were considered. This indicates that commercial properties contaminated by LUSTs transact at a rate of 2.7% per year, compared with 4.0% per year (based on activity of over 32,000 properties) for uncontaminated properties. This is a reduction of 33% in the rate of sales activity. A simple difference of proportions analysis (comparing the average annual sales ratios for contaminated and uncontaminated properties) indicates that the difference between the two groups is statistically significant. This provides evidence that contamination is associated with a significant delay in sales activity.

FIGURE 1 Higher-Priced New Residential: Average Change in Contaminated Property Over Time



Financing of Contaminated Commercial Properties

Twenty commercial properties sold in the same year or after the BUSTR file date was initiated. Of these, 30% obtained seller financing registered with the county auditor at time of sale, compared with only 13% for all commercial properties sold since 1988. Differences in these proportions are statistically significant, and this substantiates the notion that owners of contaminated properties have difficulty accessing their equity in the property, and suffer from a type of liquidity loss that further compounds property value loss. These results are shown in table 3.

Pre- and Post-Remediation Sales Price Analysis

Because of the variety of commercial properties (e.g., retail, office, freestanding stores) and the small number of sales in each type, regression analyses of these data are not feasible. In addition, in our case resource limitations preclude the possibility of conducting appraisals of each property and comparable sales. Therefore, the best available technique is a presale/postsale comparison. This technique is a form of matched pairs, where each sale serves as its own control. That is, a commercial property is sold, found to be contaminated by a LUST, then resold, with no change to the parcel or substantial alteration to the physical structure.

Six properties were eligible for the presale/postsale analysis. Lack of physical changes were confirmed at the county auditor's office. Table 4 shows these results.

TABLE 3 Commercial Properties that Sold After Contamination was Known to Polluters

	Contaminated		All Commercial			
	After File Date		1988–1997		1994–1997	
Received Financing	Number	Percentage	Number	Percentage	Number	Percentage
None	9	45.0	6,687	59.6	2,663	57.9
Seller	6	30.0	1,452	13.0	521	11.3
Bank	4	20.0	3,057	27.3	1,396	30.4
Other	1	5.0	16	0.1	16	0.3
Total	20	100.0	11,212	100.0	4,596	100*

Note: Contaminated properties had a significantly higher proportion of seller financing ($p = 0.0044$) than all commercial properties between 1994 and 1997 and also a significantly higher proportion of seller financing ($p = 0.0234$) than all commercial properties between 1988 and 1997.

* Totals may not add to 100% due to rounding error.

Before adjusting for commercial property appreciation trends, five properties experienced a value loss when sold after contamination became known, and one property had a small increase. The average diminution of value was 28%–31% (depending on how the results are weighted). An even more realistic measure would also include the effects of property appreciation trends. Commercial property in Cuyahoga County (as proxied by the value of the property tax duplicate) increased by an annual rate of well over 4% over the study period. Assuming the contaminated properties appreciated at only 2% (less than half the county average), all six properties (as well as the vacant parcel) decreased in real value, and the average reduction was 42%. These results are statistically significant.

CONCLUSION

Table 5 summarizes the results of this research on the effect of LUSTs from gas stations on nearby properties that were actually contaminated. For residential properties, we found a statistically significant reduction of up to 14%–16% in observed sales price for those properties sold after contamination became known. This does not consider any effects due to reduced transaction rates or delayed sale. These results are consistent with the earlier figure of a 17% reduction in price for residential sales located in close proximity to LUSTs with ongoing nuisance and the potential for future releases.

For commercial properties, we identified several results. There is a significant reduction in transaction rates (33% lower) com-

TABLE 4 Commercial Building Sale/Resale Analysis

PPN, Land Usage, and Contamination Date	Resale Date	Resale Value	Sale Date	Sale Value	Original Price Change	Original Change	Adjusted Change (2% inflation)	Adjusted Change at Market Rate
013-01 Bowling alley 5/90	4/96	$270,000	11/77	$477,000	-$207,000	-43%	-61%	-82%
449-25 Office building 4/91	12/91	$530,000	2/86	$510,000	+$20,000	+4%	-6%	-36%
396-07 Car wash 4/96	5/96	$200,000	4/78	$225,000	-$25,000	-11%	-38%	-69%
372-18 Bank 7/90	1/95	$1,110,150	10/85	$1,800,000	-$689,850	-38%	-49%	-66%
005-18 Commercial 10/90	11/93	$96,550	1/90	$190,000	-$93,450	-49%	-52%	-58%
140-05 Retail 3/90	3/96	$91,000	5/84	$128,600	-$37,600	-29%	-44%	-64%
Total		$2,297,700		$3,330,600	-$1,032,900	Average	Average	Average
						-28%	-42%	-63%
						Weighted average:		-31%

TABLE 5 Summary of Results

Property Type	Probability of Transaction	Reduction in Sales Price	Incidence of Seller Financing
Existing residential	N/A	-14% to -15%*	N/A
New higher priced residential	N/A	-16%*	N/A
Commercial	Annual rate for contamininated is 33% lower* (2.7% versus 4.0%)	-28% to -42%*	Contaminated more than twice as likely to be seller financed* (30% versus 11%–13%)

* Statistically significant at a 95% level of confidence.

pared with uncontaminated properties. Further, there is a significant increase (more than double) in the incidence of seller financing. This increase indicates a further loss in value to the owner of contaminated property. For those properties that did sell, a 30%–40% reduction in sales price occurs. These results are consistent with expected relationships evident in the literature.

The overall pattern of these results consistently shows evidence of reduction in price, and (among commercial properties) reduced market transaction rates as a result of delay or other problems as well as difficulty in obtaining financing among properties that are very likely to be actually contaminated. These results and methods can be generalized to Cuyahoga County and potentially to other areas. In the context of other studies, these results provide evidence that properties actually contaminated by LUSTs experience a reduction in value from reduced sales prices and other market effects.

These results confirm that environmental contamination attributable to LUSTs should be a consideration when appraising both contaminated residential and commercial properties. We show that proximity to and actual LUST contamination have a more pronounced effect on commercial than on residential property. This is probably due to the lack of substitutability (and thinner markets) among relatively unique commercial property, whereas residential units are more interchangeable. In addition to reductions in sales price, value reductions for contaminated commercial property should also consider the present value of the loss to the seller from a delayed transaction or longer marketing period, and any favorable seller financing terms beyond normal market conditions.

REFERENCES

Colwell, Peter and K. Foley. "Electric Transmission Lines and the Selling Price of Residential Property," *The Appraisal Journal* (October 1979): 490–499.

Colwell, Peter. "Power Lines and Lane Value," *Journal of Real Estate Research* (Spring 1990): 117–127.

Delaney, C. and D. Timmons. "High Voltage Power Lines: Do They Affect Residential Property Value?," *Journal of Real Estate Research* (Summer 1992): 315–330.

Kiel, Katherine. "Measuring the Impact of the Discovery and Cleaning of Identified Hazardous Waste Sites on House Values," *Land Economics*, 71 (1995): 428–435.

Kohlhase, J. "The Impact of Toxic Waste Site on Housing Values," *Journal of Urban Economics* (1991): 30, 1–26.

Michaels, R., and V. Smith. "Market Segmentation and Valuing Amenities with Hedonic Models: The Case of Hazardous Waste Sites," *Journal of Urban Economics* (1990): 28, 223–242.

Nelson, A. Chris, J. Genereux, and M. Genereux. "Price Effects of Landfills on House Values," *Land Economics* (November 1992): 359–365.

Thayer, M., H. Albers, and M. Rahmatian. "The Benefits of Reducing Exposure to Waste Disposal Sites: A Hedonic Housing Value Approach," *Journal of Real Estate Research* (Summer 1992): 265–282.