Chapter 5:
A Meta-Analysis of the Effect of Environmental Contamination on Residential Real Estate Values

by Robert A. Simons and Jesse D. Saginor

I. Introduction

This chapter addresses the overall effects of proximity influence of environmental contamination on residential property values. Environmental sources that influence property values include Superfund sites, leaking underground storage tanks (LUSTs), landfills, air and water pollution, pipeline ruptures, nuclear power plants, overhead transmission lines, roads, and several other urban nuisance uses. The chapter first summarizes a literature review of 58 peer-reviewed journal articles and selected case studies. (See Appendix A.) Research findings are then distilled into a data set of 228 observations that contains information about each study's dollar property value loss (the dependent variable) compared with the independent variables of: distance from the source; type of contamination: urban or rural environment; local and national market conditions; information about the contaminative event; remediation; study type; and several other variables. Regression analysis is used to determine the effect of contamination variables on percentage change in value.

As discussed earlier, contamination affects property values through its impact on the real estate bundle of rights. These include the rights to possess, enjoy, control, and dispose of real property. A loss can occur in a variety of ways, such as a discounted sale, the inability to access capital or to finance or refinance, a delay of sale, and so on. [1] In this chapter, the loss being measured is the realized capitalized loss that occurs when the property is sold. This chapter will not look at the losses associated with a delayed sale or other is-

1. For a review of how losses can occur, see Chapter 3 of this book, or Robert A. Simons et al., *The Price and Liquidity Effects of UST Leaks From Gas Stations on Adjacent Contaminated Property*, Appraisal J., Apr. 1999, at 186-94, or Thomas Jackson, *The Effects of Environmental Contamination on Real Estate: A Literature Review*, 9 J. Real Est. Literature 93-116 (2001).

sues as they may affect the bundle of rights infringed through contamination. The sales prices studied in this research are just the net proceeds in the disposal part of the real estate bundle of rights (realized capital loss) and do not consider the timing of the sale.

II. Extant Literature

There has been one meta-analysis of similar scope for air pollution, and three comprehensive literature reviews on the effect of contamination on real estate values. These are covered below. In addition, Chapter 4 of this book conducted a literature review of about 80 peer-reviewed articles on proximity negative influence for residential and commercial property, which is the source of the data set for this residentially focused chapter.

Kerry V. Smith and Ju-Chin Huang conducted a meta-analysis of 37 air pollution studies providing 86 estimates of marginal willingness to pay (MWTP) for reduction of particulate matter measuring 10 microns in diameter or less (PM_{10}) per cubic meter during 1982 and 1984. [2] The hedonic meta-analysis provides an average of the marginal values estimated under specific circumstances across several U.S. cities. Ordinary least squares (OLS) regression and minimizing the absolute deviation (MAD) econometric models were employed. Using the MAD estimator, a one-unit reduction of PM_{10} per cubic meter resulted in an average MWTP (price increase) of $110 in 1992 dollars, or about 0.1% of property value for each unit reduction in air pollution. Their study was based on reconstructed data, and there were influential outliers that affected the results substantially. Their approach validates the use of OLS and related statistical techniques for this type of study.

Three other literature reviews on the broad subject of contamination and property values have recently been published in peer-reviewed journals. All three are thorough and logical. None of the studies, however, made an attempt to statistically compare results, opting instead for a descriptive approach within contamination types or land use categories.

Stephen Farber focused on the theory and empirical outcomes for about 50 articles mostly on landfills, solid waste, Superfund sites, and other large projects on residential property values. [3] He used studies dating back to the 1960s. His analytical framework was from the public benefit-cost perspective and covered the theory and methodology issues for both revealed preferences, e.g., for actual sales using hedonic regression analysis, and stated preferences, e.g., for actual sales using contingent valuation analysis. He

2. Kerry V. Smith & Ju-Chin Huang, *Can Markets Value Air Quality? A Meta-Analysis of Hedonic Models*, 103 J. Pol. Econ. 209-27 (1995).

3. Stephen Farber, *Undesirable Facilities and Property Values: A Summary of Empirical Studies*, 24 Ecological Econ. 1 (1998).

found considerable agreement in the gradient effects across three post-announcement studies (with good public information): sanitary landfills and coal-fired utilities had comparable gradients; chemical refineries and nuclear power plants had roughly comparable gradients; and the zonal effects of refineries and sanitary landfills were quite comparable and substantial. [4] The study found the factors affecting property value included: type of facility; distance; information (relative to an opening or closing date); thin markets; and the employment effects of the source. He also brought his results to a base year for analysis.

Rather than addressing theory, a study by Melissa Boyle and Katherine Kiel reviewed over 30 exclusively hedonic price studies. [5] Their study is organized into air pollution, water quality, undesirable land uses, multiple pollution sources, and which neighborhood variables (income, vacancy, etc.) are important. They focused on getting their results into a base year for comparison and looked to see if effects change over time and with new information. They found that air studies produce mixed results and posit that measurement factors are not generally known to homebuyers. The water quality studies consistently produced negative signs and statistical significance where theory would predict it, but with fluctuation in dollar amounts. Readily visible factors like water clarity and information announcements, and distance from water, are important factors. The studies on undesirable land uses also consistently produced negative signs and statistical significance where theory would predict it, but with considerable fluctuation in dollar amounts. Factors such as distance, information, neighborhood characteristics, and visibility are important factors.

Thomas Jackson considered about 45 articles that dealt with the effects of environmental contamination on real estate, covering real estate appraisal theory and sales price analysis. [6] The appraisal theory coverage includes: stigma; mortgage financing; marketability of frozen assets; risk premium adjustment to the discount rate; market demand; and timing of sale with respect to remediation. Other transaction-specific items, notably, the possibility of third-party lawsuits and indemnification of buyers by sellers, are also addressed. In terms of the quantitative review, Jackson reviewed about 20 articles that had empirical results for residential and commercial property affected by landfills, LUSTs, Superfund sites, and similar uses. His articles included hedonic regression analysis, case studies, and reported appraisal outcomes. The residential studies were published from 1982 on. He looks at ef-

4. *Id*. at 11-12.

5. Melissa Boyle & Katherine Kiel, *A Survey of House Price Hedonic Studies of the Impact of Environmental Externalities*, 9 J. Real Est. Literature 116-44 (2001).

6. Jackson, *supra* note 1.

fects over time, distance, different markets, sales price discounts (some found no effects), and others reported effects on transaction rates and seller financing. Jackson offers no final observations on the consistency of the findings other than that 15 studies showed negative effects and 4 showed no effects, and that intervening factors may play a role. He calls for a more systematic study and additional research for nonresidential property.

To summarize, the three literature reviews and consideration of the theory concerning the effects of contamination on property values reveal that the effect of contamination or other amenity on property value is based on several factors including: land use type; distance from the source; passage of time; existence of the condition; information; urban or rural environment; and market conditions. In some cases, indemnification or the presence of litigation may also play a role. Finally, study type, e.g., regression, case study, or survey, should be controlled for because different methodologies may also generate different results.

III. Model and Data

The review of the literature on this topic has revealed a number of factors that can affect the price of residential real estate from environmental contamination, other neighborhood factors, or off-site amenities. The dependent variable is the real change in property value in 2003 dollars. The regression model for this study is expressed as:

$$REALDIM = \beta o + \beta_1 REALVAL + \beta_2 GEO + \beta_3 CONTCOND + \beta_4 LOGDIST + \beta_5 CONTTYPE + \beta_6 LITIG + \beta_7 INFO + \beta_8 URB + \beta_9 UNEMP + \beta_{10} CONV30RT + \beta_{11} LOGN + \beta_{12} STUDY + e$$

Where these factors are variables or vectors as follows:

REALDIM = Property value diminution in 2003 dollars (dependent variable). An alternative specification is DIMPERC—the realized loss expressed as a percentage.

REALVAL = Unimpaired property value in 2003 dollars.

GEO = U.S. economic geographic locations based on those created by Salomon Brothers Company for the purpose of real estate portfolio diversification analysis. They use the following designations: Farmbelt, Industrial Midwest, Mid-Atlantic Corridor, South, Mineral Extraction, New England, Northern California, and Southern California.

CONTCOND = Influence condition is either in remediation or ongoing (ongoing), is the result of a sudden event (sudden), or is in no further action post-remediation (NFA Postrem).

LOGDIST = Log of distance from the property to the source of contamination.

CONTTYPE = Type or source of contamination including: nuclear power plant or manufacturing facility (Nukemanuf); a landfill, hazardous waste site, or Superfund site (Superfill); linear sources such as roads, power lines, railroad tracks, and pipelines (linear); groundwater contamination from LUSTs and other sources (groundwater); air pollution including that from concentrated animal feeding operations (CAFOs); or urban disamenities such as airport noise, sex offenders, and rental property (urban disamenity).

LITIG = The study was conducted for or the sale was part of litigation.

INFO = Information was disclosed based on the announcement of contamination (announcement of bad), the announcement of closing (announcement of closing), or common knowledge (common knowledge) at time of sale.

UNEMP = Unemployment rate in the county of sale in 1999.

CONV30RT = Conventional 30-year mortgage rate for the sale year.

URB = Intra-urban market location was an urban (urban), suburban (suburban), rural (rural), or mixed (mix) market where sale was recorded.

LOGN = Log of number of impacted properties from study (log of sample).

STUDY = Study methodology such as hedonic regression (regression), survey (survey), or case study (case).

e = Error term.

A. Data Set

The data set for this study is based on a detailed literature derived from Chapter 4 of this book. The 58 articles reviewed were published after 1980 and covered the empirical effects of contamination on residential and commercial property. These 58 articles represent the vast majority of residential empirical articles in the United States reviewed in the three literature reviews discussed above.

This literature review is organized based on type of contamination or influence. Each study generated between 1 to 12 usable observations. Each ob-

servation contains about 40 variables about the property, including sale location and year, contamination, sale amount, unimpaired value of similar property in the area, and location from the influence or source. In some cases, other economic data are also available. This literature review on negatively impacted residential properties generated a total of 228 observations (shown below in parentheses), in the following groups:

- LINEAR: 45 observations
- SUPERFILL: 75 observations
- NUKEMANUF: 34 observations
- URBAN DISAMENITY: 15 observations
- AIR: 35 observations
- GROUNDWATER: 24 observations

All of the observations are either residential or land zoned for residential use. Hedonic regression dominated the methodology typology, consisting of 72% (164) of all observations. Surveys accounted for 31 observations, and case studies provided an additional 26 observations. The "other" study category, consisting of sale-resale analysis, conjoint analysis, and similar techniques not in the previous categories added another seven observations.

There were six general types of contamination based on the overall sample. These categories of negative amenity were needed because of the relatively small sample size. The groups were created because the expected effects of each type were of a similar magnitude and from the same general pathway. The large operating plant category (NUKEMANUF) includes manufacturing plants, airports, and nuclear plants that have a large tax base. This category is of particular interest because it has positive location effects (access to jobs, large positive tax base impacts, and sometimes large amounts of open space), which may offset negative effects of potential explosions or other hard-to-predict events that have a high degree of uncertainty. The SUPERFILL variable contains landfills, hazardous waste sites, and Superfund sites. These sites had a relatively small overall tax base and limited jobs. Linear sources of negative proximity influence (LINEAR) are classified as power lines, railroads, roads, and pipelines. Groundwater (GROUNDWATER) focused on the type of contamination and included general water pollution studies, effects from LUSTs, water-bound polychlorinated biphenyls, and other sources. Air pollution (AIR) comprised sources such as PM without a known source, mold, asbestos, or similar forms of airborne contamination, including CAFOs. Urban disamenities (URBAN) included a wide range of urban phenomena, including proximity to sex offenders, traffic density from shopping centers, proximity to concentrations of rental property, and airport noise.

The change in property value (REALDIM) is the dependent variable in this research, although a model was also run with percent diminution (DIMPERC, calculated as REALDIM/REALVAL). In important independ-

ent variable is unimpaired property value price (REALVAL). In cases where either one or the other was missing, the median home value for the sale locality from the most time-proximate decennial census was used. This figure was then inflated or deflated based on the overall U.S. consumer price index for that year to get the estimated home value in 2003 dollars. If the change in property value was given in dollars rather than percent and no median sales price existed in the study, unimpaired property value was derived by dividing the dollar loss by the reported percentage reduction in value. In cases where a study covers multiple years, the average year was used. In studies using multiple periods, each period became a single observation in the data and the average year was used to determine property value.

The geographic variable (GEO) comes from the economic region definitions set forth by David Hartzell and others from Salomon Brothers for the purpose of real estate portfolio diversification analysis in the late 1980s, highlighted in an article by Emil Malizia and Robert A. Simons. [7] The Salomon Brothers' Economic Geography of the United States has eight distinct geographic regions. [8] A map of these regions is included in Appendix B.

Condition (CONTCOND) focuses on the environmental condition of the affected property at the time the study was conducted. In some cases, as in an explosion or chemical spill, it happened suddenly at a single point in time with a definite date corresponding to it. In other cases, such as noise from a railroad or airport, the effect is ongoing. The effect is also ongoing if the source of contamination is presently in remediation. For some studies, the property was in post-remediation and/or had received NFA status. [9] A dummy variable was created for each of these situations.

7. Emil Malizia & Robert A. Simons, *Comparing Regional Classifications for Real Estate Portfolio Diversification*, 6 J. Real Est. Res. 53-77 (1991).

8. New England consists of all states east of New York. The Industrial Midwest stretches from New York to Pennsylvania, West Virginia, Ohio, southern Michigan, central and northern Illinois and Indiana, and southeastern Wisconsin, including Milwaukee. The Farmbelt includes: Iowa, Kansas, Minnesota, Missouri, North Dakota, South Dakota, northern Michigan and Wisconsin, and extreme southern Illinois and Indiana. The Mid-Atlantic Corridor covers Delaware, Maryland, and New Jersey. The South runs from Virginia and Kentucky south to the Gulf States of Alabama, Florida, and Mississippi. It also includes Arkansas but not Louisiana. Based on Louisiana's oil industry, it is part of the Mineral Extraction region, which also includes New Mexico, Oklahoma, and Texas, then moving northwest across Colorado, and west to east central Nevada, with Idaho and Montana as its northern border. Alaska is also included in the Mineral Extraction region. The Southern California region includes southern California, southern Nevada, and Arizona. The Northern California region includes northern California north of Los Angeles, northwestern Nevada, Oregon, Washington, and Hawaii.

9. NFA status means that the cleanup of the site has been completed as deemed by the U.S. Environmental Protection Agency or state agency.

The natural log of distance (LOGDIST) was used to convert miles from the source location. There was a wide range of variation in the distance variable, from 25 miles for a nuclear power plant to zero in cases of mold, asbestos, groundwater, and similar on-site forms of contamination. [10]

Many of the peer-reviewed articles were prepared by researchers with purely academic interests in determining the property effects from an environmental source. Several studies were also involved in litigation, such as a class action suit in response to contamination. In the case of CAFOs, the lawsuit may only include one adjacent property due to their relatively remote locations. Other litigation includes cases against governmental entities with tax assessment authority. Hence, a litigation dummy (LITIG) was included to determine if these sales were more likely to sustain larger losses.

The information variable (INFO) captures the amount of media or other public exposure received regarding the source of contamination. This dummy had three classifications: common knowledge; announcement of a bad thing; and announcement of closing. Common knowledge refers to the obvious; most people can see a nuclear power plant or large industrial plant or understand the source of noise from an airport or a railroad in their backyard. Additionally, an explosion or similar sudden event is also considered common knowledge. Announcement of a bad thing is the discovery of the contamination, such as a study that revealed groundwater contamination or the announcement that a radioactive cloud was released. An announcement of closing occurs when the source is closed, e.g., a landfill that has reached capacity.

Two other variables were inserted to control for variation in economic market conditions. The unemployment variable (UNEMP2K) used the 1999 unemployment rate in the county of sale (from the 2000 Census) and served as a proxy variable for local economic conditions on the demand side of the housing market. Originally, the 1989 unemployment rate was used as well as the change in the unemployment rate between 1989 and 1999. The only variable to exhibit any significance in any of the models was the 1999 unemployment rate and so it was retained for modeling. To control for the national economy and interest rates for the year of sale, the annual average rate of the conventional 30-year mortgage (CONV30RT) was also included.

The urban variable (URB) addresses intra-urban location of the sales area as a proxy for market depth. This variable was specified as either urban, suburban, rural, or mixed. Some studies mixed either urban and suburban or suburban and rural depending on the location of the contamination.

The study methodology (STUDY) and log of the number of impacted properties (LOGN) were also included to control for the type of research conducted. The study methodology dummy is one of four categories: (1) re-

10. Since logging a distance of zero is not possible, 0.00001 replaced zero to enable the model to run without rejecting this variable.

gression; (2) case; (3) survey; and (4) other. There were several studies that did not fit in any of the first three, such as pre- and post-analysis research. The number of impacted properties ranged from several thousand for a hedonic regression to only one for a case study.

B. Regression Diagnostics

The data were checked for normal regression-related problems, including multicollinearity [11] between independent variables and report the variance inflation factor (VIF) and tolerance (TOL) indicators along with the model results. No variables had multicollinearity problems, since all scored well below the VIF cutoff of 10.0. The data set was also screened for outliers, [12] and a model was run with some outliers excluded. To test for heteroscedasticity, [13] scatterplots were run of the residuals of the dependent variable. No fanning or cone-shaped pattern was evident. However, several outliers with large losses were present below the trend line. As a result, the outlier run was performed with these additional observations excluded.

We are interested to know if the model contains enough variation and internal consistency to derive significant parameter estimates for distance, contamination type, information, remediation, litigation, and the other variables, and the most appropriate functional form, e.g., linear versus logarithm. Also of interest is the detectable presence of intra-urban and interregional differences in contamination effects.

Table 5-1 contains descriptive statistics for the data set. The average loss was $15,055, or 9.5%, for a home with an unimpaired value of $157,818. The typical distance was slightly less than two miles from the source. Dummy variables also were important, and Table 5-1 reflects their presence in the data set, e.g., 77 sales from the industrial Midwest, 154 sales with common knowledge, 57 with litigation.

11. Multicollinearity is a statistical problem where independent variables are related to one another.

12. Outliers are observations that have unusual values, and they may heavily influence statistical results.

13. Heteroscedasticity is a statistical problem where the error terms of variables are related.

Table 5-1: Descriptive Statistics					
	Range	Minimum	Maximum	Mean	Std. Deviation
Diminished Property Value	$473,623	-$438,198	$35,425	-$15,055	$45,038
Property Value	$1,158,722	$25,278	$1,184,000	$157,878	$143,848
Year of Sale	29	1973	2002	1989	6.50
Log of Distance	14.73	-11.51	3.22	-4.36	5.76
Unemployment Rate 2000	9.23	2.01	11.24	6.13	2.17
Conventional 30-Year Mortgage Rate	10.09	6.54	16.63	9.97	2.17
Log of Sample Size	5.30	0	5.30	2.48	1.11
Geographic Regions					
Northeast	27				
Industrial Midwest	77				
Mid-Atlantic	25				
South	28				
Farmbelt	9				
Mineral Extraction	17				
Southern California	16				
Northern California	22				
USA	7				
Contamination Condition					
Ongoing	207				
Sudden	15				
NFA Post-remediation	6				
Source of Contamination					
Nuclear Power Plant, Manufacturing	34				
Landfill, Hazardous Waste, Superfund	75				
Linear	45				
Groundwater	24				
Air, CAFO	35				
Urban disamenity	15				
Litigation	57				
Information					
Common knowledge	154				
Announcement of a bad thing	53				
Announcement of a closing	9				
Location					
Urban	186				
Suburban	8				
Rural	14				
Mix	20				
Study Methodology					
Regression	164				
Case	26				
Survey	31				
Other	7				
Valid N = 228					

IV. Results

A number of models were run. The overall model contains the entire set of 228 observations. This model was later run without outliers. To avoid a meta-analysis pitfall, called a filebox effect, a smaller data set using no more than five observations per study was also used. Of the 228 observations, 34 were associated with zero property value loss. These observations were included in all of the models to minimize bias in the effects of contamination on property value.

The base model included all residential sales affected by negative proximity influences. Table 5-2 contains results for this full model consisting of all 228 observations. The F statistic [14] was 23.9, and the adjusted R squared [15] was 0.75. This means the variables in the model explain 75% of the variation in the decrease in property values.

14. F statistic is a statistical test of the goodness of fit (explanatory power) of the overall model.

15. R squared is the percent of variation in the dependent variable explained by all the independent variables in the model.

Table 5-2: Full Model

	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
(Constant)	24057.984	16272.584		1.478	0.141		
Real 2003$ value	***-0.232***	0.016	-0.741	-14.882	***0.000***	0.453	2.206
Northeast	10001.824	7450.501	0.072	1.342	0.181	0.391	2.556
Industrial Midwest	***-11745.621***	6577.420	-0.124	-1.786	***0.076***	0.234	4.267
South	***-21074.724***	7913.008	-0.154	-2.663	***0.008***	0.336	2.975
Farmland	-2986.366	11019.416	-0.013	-0.271	0.787	0.493	2.030
Mineral Extraction	12321.428	8983.833	0.072	1.372	0.172	0.407	2.456
Southern California	24.081	10117.610	0.000	0.002	0.998	0.339	2.946
Northern California	***20172.658***	8209.452	0.133	2.457	***0.015***	0.386	2.591
USA	***22769.792***	12773.813	0.087	1.783	***0.076***	0.467	2.141
Sudden	9666.305	7362.430	0.070	1.313	0.191	0.401	2.495
NFA Postrem	***60833.211***	25636.382	0.089	2.373	***0.019***	0.790	1.266
Log of distance	***873.157***	426.798	0.112	2.046	***0.042***	0.377	2.656
Nukemanuf	***-25885.182***	7013.232	-0.205	-3.691	***0.000***	0.363	2.752
Superfill	1531.336	6384.856	0.016	0.240	0.811	0.254	3.941
Groundwater	**-16610.194**	9710.841	-0.115	-1.710	***0.089***	0.246	4.060
AirCAFO	**-19303.986**	7069.330	-0.155	-2.731	***0.007***	0.349	2.864
Urban disamenity	-12018.997	10410.890	-0.066	-1.154	0.250	0.340	2.938
Litigation dummy	***-9002.766***	5201.625	-0.087	-1.731	***0.085***	0.447	2.237
Announcement of bad thing	-1452.143	6809.926	-0.015	-0.213	0.831	0.238	4.206
Announcement of closing	***52377.579***	14067.737	0.227	3.723	***0.000***	0.302	3.309
Suburban	-8508.088	10232.289	-0.035	-0.831	0.407	0.640	1.563
Rural	11095.010	9027.876	0.059	1.229	0.221	0.483	2.071
Mix	-1198.789	6887.093	-0.008	-0.174	0.862	0.597	1.674
2000 unemployment rate	***1878.386***	1070.011	0.091	1.755	***0.081***	0.421	2.378
30-year rate	342.978	978.125	0.017	0.351	0.726	0.500	2.000
Log of sample size	1212.765	2635.505	0.030	0.460	0.646	0.258	3.874
Case	***-45612.525***	10514.199	-0.328	-4.338	***0.000***	0.196	5.089
Survey	***-10561.260***	6151.500	-0.081	-1.717	***0.088***	0.510	1.960
Other	2054.510	10991.003	0.008	0.187	0.852	0.631	1.585

Dependent Variable: real 2003$ dim
Reference categories: Mid-Atlantic, ongoing, linear, common knowledge, urban, regression
N = 228, df = 198, adjusted R square = .75, R square = .78, F stat = 23.9

The reference categories for all the models were as follows: Mid-Atlantic region; common knowledge of contamination; ongoing site condition; linear contamination sources (the one with the smallest and most localized losses); and regression analysis methodology. A positive parameter estimate means losses from contamination are smaller, a negative number means losses increase. The following variables had statistically significant results:

- REALVAL: Property losses due to proximity to environmental contamination were $0.23 higher for every additional dollar over $157,818 in real unimpaired value, and were statistically significant at a 99% level of confidence, holding all else constant.

- GEO: In terms of economic geography variables, compared with the Mid-Atlantic region (the reference category), the Northern California region and the United States overall had lower losses of approximately $21,000, significant at 90% or better confidence intervals. This is likely related to more rapid overall property appreciation. The southern region had larger losses of approximately $21,000, significant at 95%, and the industrial Midwest region had losses that were $11,700 deeper at a 90% level of confidence. Other regions were not significantly different than the Mid-Atlantic region.

- CONTCOND: The condition of the contamination variables was compared to the reference category where the environmental condition was ongoing. Contaminated properties that were either in post-remediation or received an NFA letter had a large reduction in losses (over $60,000) and was significant at a 95% level of confidence. The plausibility of this parameter estimate's magnitude is limited. It may be unduly influenced by a few observations. Sales proximate to properties with sudden events, e.g., explosions, had losses that were smaller by approximately $6,000, but results were only significant at an 80% level of confidence. This is beyond normally accepted scientific standards.

- LOGDIST: The logarithm of distance is positive (873) and significant at the 95% level. As a property is located away from the source, the effect on price is positive and losses get smaller.

- CONTTYPE: Type of contamination compared with a property sold proximate to linear sources of nuisance, such as railroad tracks, roads, power lines, and pipelines:

  NUKEMANUF: Nuclear power plants and manufacturing facilities with substantial ongoing employment had the expected negative sign (despite one earlier study that found otherwise), and were significant at a 95% level. The parameter estimate of -$25,900 was quite large.
  SUPERFILL: Superfund sites and landfills, incinerators, and hazardous waste sites were not significantly different from linear effects. Several of these observations had little or no effect.
  GROUNDWATER: Groundwater contamination including water quality as well as contamination without a known source had a significant, negative effect, resulting in losses that were $16,600 larger than the reference property, significant at a 90% confidence level.
  AIR: Air pollution including CAFOs also had a significant, negative effect, with losses that were $19,300 larger, significant at a 99% confidence level.
  URBAN: Urban disamenities had the expected negative sign, but it was not statistically significant.

- LITIG: Litigation has a significant, negative effect on property value. Properties involved in litigation had losses that were $9,000 larger, at a 90% level of confidence, holding all else constant.

- INFO: The announcement of a bad thing was negative but not significantly different from an ongoing source or a source in remediation. The announcement of a closing was significant and positive ($52,300, with a 99% level of confidence), supporting the theory that property values increase with news of the source's closing. However, the magnitude of the positive effects is almost too large to be plausible.

- UNEMP: The local unemployment rate variable was significant and positive. This result was unexpected, given that the theory that increased unemployment has a positive affect on property values is counterintuitive.
- STUDY: Case study (-$45,600) and survey methods (-$10,600) were both statistically significant at 90% or better. Unlike the reference category of hedonic regression models that use a large data sample, case methods often have larger losses because they focus on one or a few properties more likely to show a definite change. Survey methods are also negative because respondents are likely to have better and more complete information than actual sales, where information may not be complete. It is interesting to note that log of sample size was not statistically significant.

A. Outlier Analysis

Table 5-3 contains the results of the residential model without outliers. The dependent variable was the percentage reduction in property value. [16] There were several observations that were located far from the source of contamination (greater than 10 miles), some results showed a positive effect in response to contamination (indicating some mis-specification in the statistical models), and other observations had an unusually high prevailing mortgage rate (over 15%). We also removed observations with unimpaired property values in excess of $500,000. [17] Running the same model as that shown in Table 5-2 without these outliers resulted in a data set of 184 observations. The outliers included two case studies that dealt with vacant residential land and multifamily structures.

The F statistic dropped substantially from the original model to 4.9, with a parallel decrease in the adjusted R squared to 0.38. Despite the loss in overall goodness of fit, this outlier-free model makes good economic sense. Many of the variables significant in the first model became slightly more significant in the model without the outliers. In some cases, parameter estimates also changed substantially, and these are reflected in percentages because the dependent variable is the percentage of diminution–not real diminution—in property value. The Northern California region (4.1%) and the United States as a whole (0.7%) maintained their expected positive signs but were no longer significant at a 90% level of confidence. Farmland remained negative (-10.1%) and was significant at a 95% level. Properties in post-remediation or with an NFA letter had a reduction in value of 11.5%, but

16. A model with these observations that was also run was one in which the dependent variable was real diminution in property value. The R squared was 0.32—substantially lower than the other models.

17. Many of these were influential outliers with respect to large losses and large residuals.

was not significant. Two variables not significant in the previous model but significant here are the rural location variable and the 30-year conventional mortgage rate. The rural variable had a larger loss of 10.2% at the 90% level. The 30-year conventional mortgage rate (1.4% at the 95% level) is significant. This suggests that the expected rate of real estate appreciation was not due to a reduction in potential buyers from higher interest rates. Overall, the model presented in Table 5-3 had the most plausible parameter estimates of any of the models, e.g., none appeared excessively high or low.

Table 5-3: Outlier Model

	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
(Constant)	-0.043	0.103		-0.415	0.679		
Real 2003$ value	***0.000***	0.000	-0.137	-1.493	***0.137***	0.402	2.487
Northeast	-0.041	0.042	-0.101	-0.956	0.340	0.305	3.275
Industrial Midwest	***-0.087***	0.038	-0.323	-2.266	***0.025***	0.166	6.027
South	***-0.074***	0.045	-0.168	-1.658	***0.099***	0.330	3.034
Farmland	***-0.101***	0.053	-0.171	-1.897	***0.060***	0.417	2.395
Mineral Extraction	0.021	0.044	0.046	0.475	0.636	0.366	2.736
Southern California	0.023	0.059	0.048	0.394	0.694	0.225	4.438
Northern California	0.041	0.042	0.094	0.968	0.335	0.358	2.791
USA	0.007	0.068	0.008	0.107	0.915	0.571	1.750
Sudden	***0.064***	0.040	0.156	1.605	***0.111***	0.356	2.811
NFA Postrem	0.115	0.084	0.113	1.374	0.172	0.495	2.019
Log of distance	***0.006***	0.003	0.256	2.212	***0.028***	0.252	3.961
Nukemanuf	***-0.097***	0.040	-0.240	-2.412	***0.017***	0.340	2.938
Superfill	-0.048	0.041	-0.180	-1.195	0.234	0.148	6.738
Groundwater	***-0.085***	0.052	-0.219	-1.627	***0.106***	0.187	5.348
AirCAFO	***-0.091***	0.038	-0.266	-2.428	***0.016***	0.281	3.561
Urban disamenity	-0.043	0.059	-0.089	-0.724	0.470	0.224	4.460
Litigation dummy	***-0.061***	0.030	-0.207	-2.049	***0.042***	0.331	3.025
Announcement of bad thing	0.012	0.041	0.043	0.290	0.772	0.154	6.484
Announcement of closing	***0.128***	0.074	0.203	1.715	***0.088***	0.241	4.148
Suburban	0.001	0.052	0.001	0.013	0.990	0.640	1.563
Rural	***-0.102***	0.053	-0.196	-1.921	***0.057***	0.325	3.075
Mix	-0.013	0.034	-0.030	-0.367	0.714	0.493	2.030
2000 unemployment rate	0.004	0.006	0.070	0.669	0.504	0.307	3.261
30-year rate	***0.014***	0.005	0.227	2.491	***0.014***	0.408	2.450
Log of sample size	-0.003	0.016	-0.026	-0.195	0.846	0.194	5.151
Case	***-0.116***	0.057	-0.294	-2.028	***0.044***	0.160	6.242
Survey	***-0.063***	0.031	-0.170	-2.033	***0.044***	0.482	2.077
Other	***0.083***	0.053	0.124	1.576	***0.117***	0.549	1.820

Dependent Variable: DIMPERC (Property diminution in percent)
Reference categories: Mid-Atlantic, ongoing, linear, common knowledge, urban, regression
N=184, df = 154, adjusted R square = .38, R square = .48, F stat = 4.9.

B. Common Validity Threats to Meta-Analysis

Unlike conventional regression analysis where the unit of observation is individual sales, meta-analysis poses certain additional validity threats due to the nature of data collection. Fredric Wolf has identified a number of potential validity threats to meta-analysis, many of which were avoided here by selecting only peer-reviewed studies. [18] These problems include having an

18. Fredric M. Wolf, Meta-Analysis Quantitative Methods for Research Synthesis, Newbury Park, CA 9 (Sage Publications Quantitative Applications in the Social Sciences No. 59, 1986).

identical dependent variable (percent loss in value) for all studies, reporting instead of interpreting the results from each article, having rigorous oversight on data input procedures, and having a strong theoretical basis for finding results.

However, there are a few threats that must be addressed specifically. One of the more important threats is the "file drawer effect," where studies with no significant findings get buried in a file drawer and are never published, thereby resulting in a bias toward studies with significant findings. The other threats are sensitivity of the results where multiple observations are derived from one study, [19] and using weighting schemes where studies had a different sample size. [20] The first two issues are addressed below.

The file drawer effect looks at the potential bias of peer-reviewed journals to accept research that only has findings supporting a theory. While the study for this chapter used several studies accounting for 34 observations in the overall model that show no effect, most indeed have some significant negative results, as predicted by theory. The test for this problem is to determine the "fail safe N," the number of studies that would be required to "overturn" the findings of statistical significance. Following Wolf, the formula to determine the fail safe at a 95% level of significance, (N_{fs}) where p (probability) = 0.05 is:

$$N_{fs.05} = (SZ/1.645)^2 - N$$

where SZ = the sum of individual Z scores (another test for statistical significance) and N = the number of studies. [21] Solving for $N_{fs.05}$, the number of studies (not observations) must invalidate the statement that contamination negatively affects property values. The sum of the Z scores was 8.11. We had 58 studies, and assuming the absolute value of the equation, it would take 34 studies with a positive finding to overturn the results.

In order to test for study bias issues due to using the maximum number of observations from any study, the model was rerun with a maximum of only five observations from any one peer-reviewed study. Studies with more than five observations were input into a statistics processing computer program and five observations were then randomly selected based on the program. The remaining observations were taken out of the model. This diminished the degrees of freedom available (N = 160). (This number was reached by

19. *Id*. at 24-45.

20. It is not believed this is a problem because the log of study size variable is not statistically significant. Additionally, study type was controlled for and the results were reported. The related problem of oversampling from any study was also dealt with. Although it may be possible to rerun the data set with artificial weights that reflect the source of the study, this was deemed to be unnecessary.

21. WOLF, *supra* note 18, at 38-39.

counting the remaining observations left in the model.) The F statistic for the five observations maximum model was 21.2 and the adjusted R squared was 0.785. Unlike the previous models, the constant is significant and positive. In general, similar signs and results are expected, but statistical significance will likely drop. Therefore, the threshold of statistical significance was dropped to a confidence level of 85%.

Table 5-4: Five Observations Max Model

	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
(Constant)	***37559.92***	16215.22		2.316	***0.022***		
Real 2003$ value	***-0.18***	0.01	-0.709	-12.230	***0.000***	0.399	2.505
Northeast	11268.32	7577.76	0.081	1.487	0.139	0.454	2.203
Industrial Midwest	***-12390.90***	6410.21	-0.140	-1.933	***0.055***	0.256	3.905
South	-11084.33	8164.75	-0.097	-1.358	0.177	0.260	3.840
Farmland	4004.47	10501.94	0.021	0.381	0.704	0.423	2.365
Mineral Extraction	9007.70	8717.44	0.065	1.033	0.303	0.343	2.916
Southern California	1031.53	10234.09	0.006	0.101	0.920	0.361	2.771
Northern California	9368.38	8093.56	0.065	1.158	0.249	0.423	2.362
USA	-13367.36	11954.14	-0.067	-1.118	0.266	0.371	2.699
Sudden	10828.01	7251.98	0.090	1.493	0.138	0.369	2.709
NFA Postrem	***46378.98***	22401.25	0.090	2.070	***0.040***	0.711	1.407
Log of distance	617.23	420.82	0.090	1.467	0.145	0.360	2.778
Nukemanuf	***-17485.90***	7052.61	-0.154	-2.479	***0.014***	0.349	2.865
Superfill	-1316.68	6317.99	-0.015	-0.208	0.835	0.243	4.112
Groundwater	-13506.52	9939.17	-0.100	-1.359	0.177	0.249	4.015
AirCAFO	***-13617.72***	7018.98	-0.126	-1.940	***0.055***	0.320	3.123
Urban disamenity	-9851.90	10217.23	-0.059	-0.964	0.337	0.362	2.762
Litigation dummy	-4061.32	4820.70	-0.045	-0.842	0.401	0.471	2.125
Announcement of bad thing	-1728.19	6580.44	-0.020	-0.263	0.793	0.240	4.164
Announcement of closing	***50878.33***	21168.88	0.218	2.403	***0.018***	0.163	6.124
Suburban	***-15173.23***	9061.23	-0.081	-1.675	***0.096***	0.568	1.761
Rural	59.89	11185.56	0.000	0.005	0.996	0.255	3.920
Mix	1223.33	6522.79	0.009	0.188	0.852	0.578	1.729
2000 unemployment rate	827.62	1077.82	0.043	0.768	0.444	0.432	2.314
30-year rate	-97.11	1018.98	-0.005	-0.095	0.924	0.462	2.163
Log of sample size	-3385.06	2833.48	-0.094	-1.195	0.234	0.219	4.570
Case	***-51944.43***	13584.26	-0.414	-3.824	***0.000***	0.115	8.723
Survey	***-16105.96***	6263.07	-0.134	-2.572	***0.011***	0.495	2.021
Other	1276.32	9990.70	0.006	0.128	0.899	0.530	1.885

Dependent Variable: real 2003$ dim
Reference categories: Mid-Atlantic, ongoing, linear, common knowledge, urban, regression
N=160, df = 130, adjusted R square = .79, R square = .82, F stat = 21.2

For this five-observation maximum model, the key variables are unimpaired value and distance. The results in Table 5-4 were essentially the same as in the basic model displayed in Table 5-2. However, the model had several different variables that were now statistically significant when compared to the base model. The Northeast region was positive, showing a reduction of $11,268 from the Mid-Atlantic reference category, and was significant at an 85% level. The South, Northern California, and U.S. regions were found to be statistically insignificant. The SUDDEN variable was also positive at $10,828 and at the 85% level, indicating that properties affected by a sudden contaminative event sell for a higher amount. Among the intra-urban variables, the suburban variable shows larger losses of $15,173 at a rate 10% higher than urban properties. This could be attributed to greater market

depth, but it may also reflect higher initial sales prices. In model 4, unlike the base model, groundwater, litigation, and the unemployment rate have all become insignificant. The case and survey method variables continue to be negative, but their significance increases in both cases compared to earlier models.

V. Conclusions

This chapter has addressed the overall effects of proximity influence of environmental contamination on residential real estate property values. Empirical research from peer-reviewed studies were distilled into a data set that contains information about each study's loss (the dependent variable), with the independent variables being geographic location; distance from the source; condition of the contaminated site; urban, suburban, rural, or mixed environment; market conditions; and a few others. Regression analysis was used to determine the effect of contamination variables on the real change in value.

In all three models (overall, outlier, and five-observation maximum), the following variables were significant and had the expected signs: the unimpaired value (positive effects on value), the Industrial Midwest region (negative effects on value), a site in post-remediation or that had received its NFA (positive), NUKEMANUF (negative), air pollution (negative), announcement of a closing (positive), case method (negative), and survey method (negative). The first two models (overall and outlier) had the following additional significant variables: the South and Northern California regions (positive); the log of distance (positive); groundwater contamination (negative); litigation (negative); and the unemployment rate (positive and contrary to theory). Any two models indicated the following variables were significant: post-remediation/NFA (positive); distance (positive); and groundwater pollution (negative). Last, the regression studies systematically show a lower level of losses compared with other methodologies.

Appendix A: References Used in the Meta-Analysis

Jeff Anistine, *Property Values in a Low Populated Area When Dual Noxious Facilities Are Present*, 34 GROWTH & CHANGE 345-58 (2003).

Paul K. Asabere, *The Value of a Neighborhood Street With Reference to the Cul de Sac*, 3 J. REAL EST. FIN. & ECON. 185-93 (1990).

Randall Bell, *The Impact of Airport Noise on Residential Real Estate*, APPRAISAL J., July 2001, at 312.

Donald Bleich et al., *An Evaluation of the Impact of a Well-Designed Landfill on Surrounding Property Values*, APPRAISAL J., Apr. 1991, at 247.

DAVID E. CLARK, THE EFFECTS OF IGNORING WHISTLE BANS AND RESIDENTIAL PROPERTY VALUES: AN HEDONIC HOUSING PRICE ANALYSIS (Marquette University, Dep't of Economics, Working Paper No. 0504, 2005), *available at* http://www.busadm.mu.edu/mrq/workingpapers/wpaper0504.pdf.

David E. Clark & Tim Allison, *Spent Nuclear Fuel and Residential Property Values: The Influence of Proximity, Visual Cues, and Public Information*, 78 PAPERS REGIONAL SCI. 403-21 (1997).

David E. Clark et al., *Nuclear Power Plants and Residential Housing Prices*, 28 GROWTH & CHANGE 496-519 (1997).

Peter Colwell, *Power Lines and Land Value*, 1 J. REAL EST. RES. 117-27 (1990).

Bruce M. Cosser, *Fuel-Oil Contamination of a Residence: A Case Study in Stigma*, APPRAISAL J., July 2001, at 307.

Charles J. Delaney & Douglas Timmons, *High Voltage Power Lines: Do They Affect Residential Property Value?*, 3 J. REAL EST. RES. 315-29 (1992).

Francois Des Rosiers, *Power Lines, Visual Encumbrance, and House Values: A Microspatial Approach to Impact Measurement*, 23 J. REAL EST. RES. 275-302 (2002).

Francois Des Rosiers et al., *Shopping Centers and House Values: An Empirical Investigation*, 14 J. PROP., VALUATION & INVESTMENT 21 (1996).

Patrick Flower & Wade Ragas, *The Effects of Refineries on Neighborhood Property Values*, 9 J. REAL EST. RES. 319-38 (1994).

Sherman Folland & Robbin Hough, *Externalities of Nuclear Power Plants: Further Evidence*, 40 J. REGIONAL SCI. 735-53 (2000).

Marvin Frankel, *Aircraft Noise and Residential Property Values: Results of a Survey Study*, APPRAISAL J., Jan. 1991, at 96.

Hays Gamble & Roger Downing, *Effects of Nuclear Power Plants on Residential Property Values*, 22 J. REGIONAL SCI. 457-78 (1982).

Kishore Gawande & Hank Jenkins-Smith, *Nuclear Waste Transport and Residential Property Values: Estimating the Effects of Perceived Risks*, 42 J. ENVTL. ECON. & MGMT. 207-33 (2001).

Michael Greenberg & James Hughes, *Impact of Hazardous Waste Sites on Property Value and Land Use: Tax Assessors' Appraisal*, APPRAISAL J., Jan. 1993, at 42.

S.W. Hamilton & G.M. Schwann, *Do High Voltage Electric Transmission Lines Affect Property Value?*, 71 LAND ECON. 436-44 (1995).

HELMUTH, OBATA & KASSABAUM, INC., & RAYTHEON INFRASTRUCTURE SERVICES, SEA-TAC INTERNATIONAL AIRPORT MITIGATION STUDY (Washington State Dep't of Trade & Econ. Dev. 1997), *available at* http://www.rcaanews.org/hoksum.htm.

Diane Hite et al., *Property-Value Impacts of an Environmental Disamenity: The Case of Landfills*, 22 J. REAL EST. FIN. & ECON. 185-202 (2001).

William T. Hughes & C.F. Sirmans, *Adjusting House Prices for Intra-Neighborhood Traffic Differences*, APPRAISAL J., Oct. 1993, at 533.

William T. Hughes & C.F. Sirmans, *Traffic Externalities and Single-Family House Prices*, 32 J. REGIONAL SCI. 487-500 (1992).

Hank Jenkins-Smith et al., *Information Disclosure Requirements and the Effect of Soil Contamination on Property Values*, 45 J. ENVTL. PLAN. & MGMT. 323-39 (2002).

Marion Johnson et al., *Case Study: The House of Mold*, ASSESSMENT J., Nov./Dec. 2001.

K. Ketkar, *Hazardous Waste Sites and Property Values in the State of New Jersey*, 24 APPLIED ECON. 647-59 (1992).

Katherine Kiel, *Measuring the Effect of the Discovery and Cleaning of Identified Hazardous Waste Sites on House Values*, 71 LAND ECON. 428-35 (1995).

Katherine Kiel & Katherine McClain, *The Effect of an Incinerator Siting on Housing Appreciation Rates*, 37 J. URB. ECON. 311-23 (1995).

Katherine Kiel & Katherine McClain, *House Prices During Siting Decision States: The Case of an Incinerator From Rumor Through Operations*, 28 J. ENVTL. ECON. & MGMT. 241-55 (1995).

John A. Kilpatrick, *Concentrated Animal Feeding Operations and Proximate Property Values*, APPRAISAL J., July 2001, at 301-06.

William N. Kinnard et al., *Market Reactions to an Announced Release of Radioactive Materials: The Impact on Assessable Value*, 10 PROPERTY TAX J. 283-97 (1991).

Janet Kohlhase, *The Impact of Toxic Waste Sites on Housing Values*, 30 J. URB. ECON. 1-26 (1991).

Hsiang-te Kung & Charles F. Seagle, *Impact of Power Transmission Lines on Property Value: A Case Study*, APPRAISAL J., July 1992, at 413.

Christopher G. Leggett & Nancy E. Bockstael, *Evidence of the Effects of Water Quality on Residential Land Prices*, 39 J. ENVTL. ECON. & MGMT. 121-44 (2000).

Gary McClelland et al., *The Effect of Risk Beliefs on Property Values: A Case Study of a Hazardous Waste Site*, 10 RISK ANALYSIS 485-97 (1990).

Jill McCluskey et al., *Neighborhood Effects and Compensation for Property Value Diminution*, 24 LAW & POL'Y 37-50 (2002).

Gregory R. Michaels & Kerry V. Smith, *Market Segmentation and Valuing Amenities With Hedonic Models: The Case of Hazardous Waste Sites*, 28 J. URB. ECON. 223-42 (1990).

Bill Mundy & David McLean, *Using the Contingent Value Approach for Natural Resources and Environmental Damage Applications*, APPRAISAL J., July 1998, at 290-97.

Arthur J. Nelson et al., *House Price Effects of Landfills*, 68 LAND ECON. 359-65 (1992).

G. William Page & Harvey Rabinowitz, *Groundwater Contamination: Its Effects on Property Values and Cities*, 59 J. AM. PLAN. ASS'N 471-79 (1993).

Peter J. Patchin, *Contaminated Properties and the Sales Comparison Approach*, Appraisal J., July 1994, at 402-09.

Alan K. Reichert, *Impact of a Toxic Waste Superfund Site on Property Values*, Appraisal J., Oct. 1997, at 381.

Alan K. Reichert, *The Persistence of Contamination Effects: A Superfund Site Revisited*, Appraisal J., Apr. 1999, at 126-35.

Alan K. Reichert et al., *The Impacts of Landfills on Residential Property Values*, 7 J. Real Est. Res. 297-314 (1992).

Jack Schoppa, *Mold, Moisture, Stigma, and Value*, Appraiser E-Gram, Oct. 2002.

Arthur Sementelli & Robert A. Simons, *Regulation of Leaking Underground Storage Tanks*, 11 Econ. Dev. Q. 236-48 (1997).

Robert A. Simons, *The Effects of Oil Pipeline Ruptures on Non-Contaminated Easement-Holding Property in Fairfax County*, Appraisal J., July 1999, at 255.

Robert A. Simons, *Estimating Proximate Property Damage From PCB Contamination in a Rural Market: A Multiple Techniques Approach*, Appraisal J., Oct. 2002, at 388.

Robert A. Simons & Abdellaziz el Jaouhari, *The Effect of Freight Railroad Tracks and Train Activity on Residential Property Values*, Appraisal J., Summer 2004, at 223-33.

Robert A. Simons & Ron Throupe, *An Explanatory Review of the Effects of Toxic Mold on Real Estate Values*, Appraisal J., Spring 2005, at 156.

Robert A. Simons et al., *The Effect of Underground Storage Tanks on Residential Property Values in Cuyahoga County, Ohio*, 14 J. Real Est. Res. 29-42 (1997).

Robert A. Simons et al., *The Effects of an Oil Pipeline Rupture on Single-Family House Prices*, Appraisal J., Oct. 2001, at 410-18.

Robert A. Simons et al., *The Price and Liquidity Effects of UST Leaks From Gas Stations on Adjacent Contaminated Property*, Appraisal J., Apr. 1999, at 186-94.

Andrejs Skaburskis, *Impact Attenuation in Nonconflict Situations: The Price Effects of a Nuisance Land Use*, 21 Env't & Plan. A. 375-83 (1989).

Gerald E. Smolen et al., *Economic Effects of Hazardous Chemical and Proposed Radioactive Waste Landfills on Surrounding Real Estate Values*, 7 J. Real Est. Res. 283-96 (1992).

Donald Steinnes, *Measuring the Economic Value of Water Quality: The Case of Lakeshore Land*, 26 Ann. Regional Sci. 171-76 (1992).

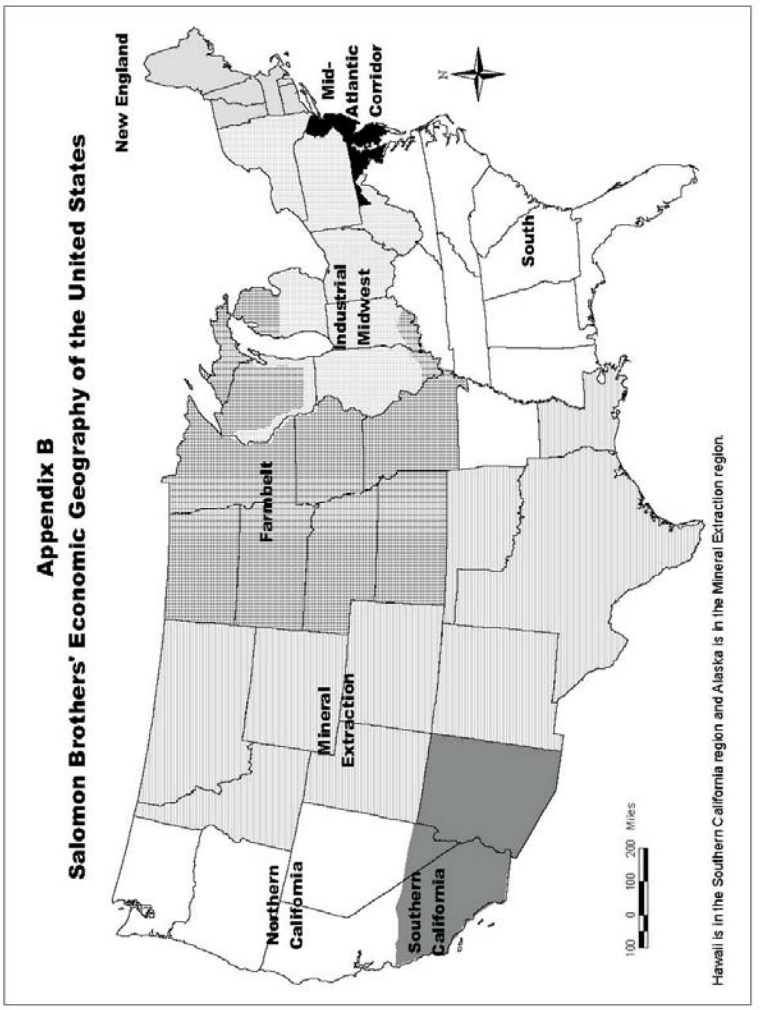
Mark Thayer et al., *The Benefits of Reducing Exposure to Waste Disposal Sites: A Hedonic Housing Value Approach*, 7 J. Real Est. Res. 265-82 (1992).

Ko Wang et al., *The Impact of Rental Properties on the Value of Single-Family Residences*, 30 J. Urb. Econ. 152-66 (1991).

James R. Webb, *Nuclear Power Plants: Effects on Property Values*, Appraisal J., July 1980, at 230-35.

Kenneth Wise & Johannes Pfeifenberger, *The Enigma of Stigma: The Case of the Industrial Excess Landfill*, 9 Toxics L. Rep. (BNA) 1435-42 (May 18, 1994).

Chris Zeiss & James Atwater, *Waste Facility Impacts on Residential Property*, 115 J. Urb. Plan. & Dev. 64-80 (1989).


Appendix B
Salomon Brothers' Economic Geography of the United States
New England
Mid-Atlantic Corridor
Industrial Midwest
South
Farmbelt
Mineral Extraction
Northern California
Southern California
N
100 0 100 200 Miles
Hawaii is in the Southern California region and Alaska is in the Mineral Extraction region.