Stigma: A Case Study Analysis of Long-Term Environmental Risk Effect

by Michael Tachovsky, PhD

Abstract

In real estate valuation, *stigma* is a term used to describe a negative perception associated with a property or group of properties. From a complex valuation perspective, stigma is considered to be synonymous with a risk effect. Appraisal literature discusses the development of stigma and risk, including some literature on temporary stigma, a situation where negative perceptions diminish and properties eventually return to full market value. For example, brownfield redevelopment sites are generally examples of temporary stigma situations. Yet, temporary stigma is not always the case. This article presents an environmental case study using multiple regression and paired sales that finds stigma can continue more than twenty years after the discovery of an environmental issue. The case study reports a risk effect ranging from –10% to –42% with lingering concerns about market disclosures, demolished homes that were never rebuilt, and so forth.

Stigma: Temporary versus Ongoing

A negative effect on market value based on adverse public perception is sometimes referred to as *stigma*.[1] *Environmental stigma* is "an adverse effect on property value produced by the market's perception of increased environmental risk due to contamination."[2] Additionally, as with other detrimental conditions, this can be derived from perceived risks and uncertainties surrounding a detrimental condition and may result in a diminution in value.[3] The term *stigma* emerged in *Appraisal Journal* literature with Peter Patchin's article "Valuation of Contaminated Properties."[4] In 1991, Patchin addressed the topic again with his *Appraisal Journal* article "Contaminated Properties—Stigma Revisited."[5] As additional articles emerged on stigma, discussion continued on the evolving topic of real estate damages, leading to numerous articles, textbooks, seminars, and advice such as Appraisal Institute Guide Note 6, "Consideration of Hazardous Substances in the Appraisal Process," Appraisal Institute Guide Note 10, "Developing an Opinion of Market Value in the Aftermath of a Disaster,"[6] and USPAP Advisory Opinion 9, "The Appraisal of Real Property That May Be Impacted by Environmental Contamination."[7]

Stigma has been referred to in many ways in the literature, incorporating terminology such as

1. Appraisal Institute, *The Dictionary of Real Estate Appraisal*, 7th ed. (Chicago: Appraisal Institute, 2020), s.v. "stigma."
2. Appraisal Standards Board, Advisory Opinion 9 (AO-9), "The Appraisal of Real Property That May Be Impacted by Environmental Contamination" in *USPAP Advisory Opinions*, 2020–2021 ed. (Washington, DC: The Appraisal Foundation, 2020), Lines 85–86.
3. Appraisal Institute, *The Appraisal of Real Estate*, 15th ed. (Appraisal Institute, 2021), 184.
4. Peter J. Patchin, "Valuation of Contaminated Properties," *The Appraisal Journal* (January 1988): 7–16.
5. Peter J. Patchin, "Contaminated Properties—Stigma Revisited," *The Appraisal Journal* (April 1991): 167–172.
6. *Guide Notes to the Standards of Professional Practice of the Appraisal Institute* are available at https://bit.ly/3xjFnFT.
7. Appraisal Standards Board, Advisory Opinion 9.

residual damages,[8] *uncertainty factor*, *project incentive*, *market resistance*,[9] and *risk*.[10] *Risk* tends to be the more formal reference, as it is one of the three components to consider when determining any effects on value from a detrimental condition—the three components being cost, use, and risk effects.[11] When considering any risk effects associated with a detrimental condition, the duration of the effects, if any, may either be temporary or ongoing.[12] Temporary stigma refers to a residual loss that eventually disappears; the appraisal literature has at times described certain temporary stigma issues under the model and phrase "diminishing diminution."[13]

While there are some studies that find temporary price effects that diminish after contamination is remediated, this is not always the case. For example, in 1999, Reichert reported that residential properties surrounding a Superfund landfill in Ohio experienced ongoing market value impacts as prices continued to react to the contamination even after announcement of a remediation plan.[14] Further examples of ongoing price effects include the Love Canal in New York, Uravan in Colorado, Hinkley in California, Picher in Oklahoma, Wittenoom in Australia, and Chernobyl in Ukraine.

Although real estate valuers may discuss temporary stigma, in a valuation assignment this can be a diversion from the current situation since an opinion of value (and any possible diminution thereof) is typically given as of a specific point in time.[15] This raises the question as to whether identifying if risk effects are temporary or ongoing is pertinent when providing a value or diminution in value opinion *as of a specific date*. For example, if a real estate valuation professional finds that a property incurred a risk effect as of the date of value, the fact of the matter is that the property incurred a loss and therefore was damaged; the converse applies in assignments where no risk effects are identified. Speculating whether a risk effect is temporary or ongoing does not negate a conclusion that a loss does or does not exist.

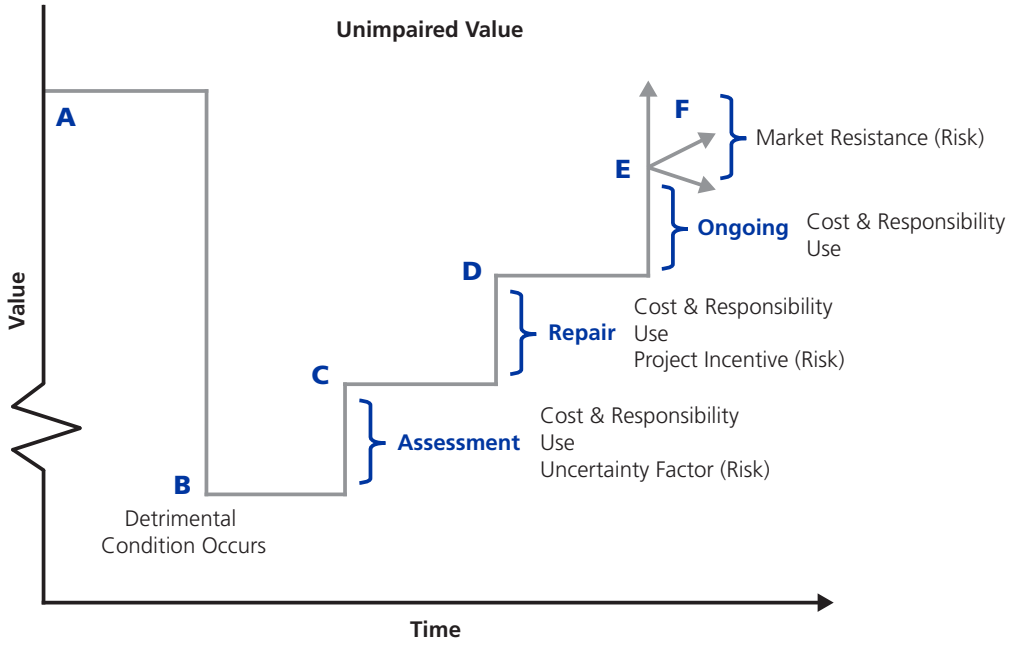
The text *Real Estate Damages*, third edition, presents numerous detrimental condition models that describe the relationship between a property's unimpaired market value and impaired market values at different stages of a detrimental condition lifecycle.[16] While there are numerous models that can be used to describe the relationship, that does not mean every model is relevant to an assignment. Rather, the numerous detrimental condition models serve as a visual aid to describe possible market value relationships overtime. *Real Estate Damages* offers a general detrimental condition model that indicates stigma (or risk) may diminish or increase in the ongoing stage of the remediation lifecycle (Exhibit 1).

Temporary and Ongoing Use Effects

As previously mentioned, three considerations have been identified as potentially impacting value of contaminated real estate: cost, use, and risk effects.[17] Similar to developing an unimpaired opinion of market value where the sales, income, and cost approaches are considered, the consideration of cost, use, and risk effects may be applicable to any assignment involving properties that are or may be impacted by a detrimental

8. Phillip S. Mitchell, "Estimating Economic Damages to Real Property Due to Loss of Marketability, Rentability and Stigma," *The Appraisal Journal* (April 2000): 169.
9. Randall Bell, *Real Estate Damages*, 3rd ed. (Appraisal Institute, 2016), 27.
10. Appraisal Standards Board, Advisory Opinion 9, Lines 77–96.
11. Randall Bell, "The Impact of Detrimental Conditions on Property Values," *The Appraisal Journal* (October 1998): 380–391; Appraisal Standards Board, Advisory Opinion 9, Lines 161–171.
12. An ongoing stigma may be referred to as "long-term" or "permanent" stigma in some texts. A temporary stigma may be referred to as "short-term." See discussion in *The Appraisal of Real Estate*, 15th ed., 184.
13. Richard A. Neustein and Randall Bell, "Diminishing Diminution: A Trend in Environmental Stigma," *Environmental Claims Journal* (Autumn 1998).
14. Alan Reichert, "The Persistence of Contamination Effects: A Superfund Site Revisited," *The Appraisal Journal* (April 1999): 126–135.
15. Michael V. Sanders, "Post-Repair Diminution in Value from Geotechnical Problems," *The Appraisal Journal* (January 1996): 64.
16. Bell, *Real Estate Damages*, 3rd ed., 29.
17. Appraisal Standards Board, Advisory Opinion 9, Lines 142–171.

Exhibit 1 General Detrimental Condition Model



Source: Adapted from Randall Bell, *Real Estate Damages*, 3rd ed. (Chicago: Appraisal Institute, 2016), 29.

condition.[18] Like risk effects, use effects may be temporary or ongoing.

An impairment to the conventional use and enjoyment of a property or its rights is typically reflected as a temporary use effect, and highest and best use issues typically reflect ongoing use effects. USPAP Advisory Opinion 9 describes *use effects* as follows:

> *Use effects* reflect impacts on the utility of the site as a result of the contamination. If the contamination and/or its cleanup rendered a portion of the site unusable, or limited the future highest and best use of the property, then there could be a use effect on value.[19]

When calculating a temporary use effect, questions may arise regarding what a property owner or renter does at the property during the time of impairment; however, from a real estate valuation perspective, the pertinent question is in regard to the effects on real estate and property rights. In other words, it is not a real estate valuation professional's duty to value people—it is their duty to value real estate. For example, if a property owner is on vacation and their house becomes the site of an environmental spill, that does not automatically mean that they did not incur a real estate damage because they were absent at the time of the spill. In a situation where a sudden disaster strikes and property owners remain bunkered down in their home, this is not necessarily evidence that there was no loss of use. Although the homeowners remained in their home, a use effect can still exist as this does not constitute conventional use and enjoyment of a property or its rights. Ultimately it comes down to if a property or its rights are impacted, not necessarily how the property owner reacts.

The bundle of rights concept further illustrates this perspective. In real estate, property rights are referred to as the "bundle of rights," because ownership of a parcel of real estate may embrace a great many rights, such as the right to its occupancy and use; the right to sell it in whole or in

18. Michael Tachovsky, "Environmental Dead Zones: The Evaluation of Contaminated Properties," *The Appraisal Journal* (Spring 2021): 115.

19. Appraisal Standards Board, Advisory Opinion 9, Lines 165–167.

part; the right to bequeath; the right to transfer, by contract, for specified periods of time; and the benefit to be derived by occupancy and use of the real estate.[20] *The Appraisal of Real Estate*, fifteenth edition, presents some of the many property rights, such as the right to use the real estate, sell it, lease it, enter it, and give it away.[21] The bundle of rights is the right to do any of these, whether or not they have been exercised. For example, "'the right to refuse to exercise any property rights,' as the absence of compulsion to use any right merely rounds out and makes complete the freedom of will in the enjoyment of property ownership."[22] Moreover, "it is also generally recognized that property encompasses the entire bundle of rights inherent in the ownership of the real estate and that the taking or infringement on these rights often constitutes a taking, even if no part of the physical real estate is taken."[23] Accordingly, use issues may not always be visible or apparent.

Temporary use effects are generally calculated using a loss of use technique where *market rent* × *time* = *use effect*. *Market rent* can be derived from different sources, including but not limited to standard monthly rates or short-term rates. *Time* is the period in which conventional use and enjoyment of a property (or its rights) is impaired, whether in part or in whole.

Measuring temporary use effects generally centers upon market rents, but it is not centered upon whether there has been an impact to market rental rates. Rather the issue is whether there is an impact to the conventional use and enjoyment of the property or whether the bundle of rights has been infringed. In this context, "conventional" relates to a customary or traditional usage or custom.[24] There may be situations such as displacement during and after an event, periods of trespass, periods of assessment, periods of repair, environmental assessment and remediation, delays, periods of nuisance, or as a result of many other situations that may impact the temporary conventional use or enjoyment of a property.

The definition of *diminution in value* in USPAP Advisory Opinion 9 references risk and/or costs; Advisory Opinion 9 defines *diminution in value* as follows:

> The difference between the unimpaired and impaired values of the property being appraised. This difference can be due to the increased risk and/or costs attributable to the property's environmental condition.[25]

This definition indirectly addresses a flawed perspective that may come up—that is, that use effects are always related to cost and risk effects. However, a use effect may be present even though a cost or risk effect is absent. Accordingly, an impaired property may not sell at a discount, yet it may still have incurred a use effect. An example would be properties surrounding the Three Mile Island nuclear facility during the 1979 partial meltdown incident, where a spectrum of risk effects was observed, from losses to no impact to even a positive impact;[26] nevertheless, there were evacuations in the surrounding areas.[27]

Diminution in Value

Typically, a real estate damage assignment involves computing the diminution in value of a property or group of properties. *The Dictionary of Real Estate Appraisal*, seventh edition, incorporates the USPAP Advisory Opinion 9 definition of *diminution in value*, referencing "the difference between the unimpaired and impaired values of the property being appraised"; however, a real estate damage assignment does not require both

20. JD Eaton, *Real Estate Valuation in Litigation*, 2nd ed. (Chicago: Appraisal Institute, 1995), 45.

21. Appraisal Institute, *The Appraisal of Real Estate*, 15th ed., 4.

22. Leonard C. Smith, "The Bundle of Property Rights," *The Appraisal Journal* (October 1956): 487.

23. JD Eaton, *Real Estate Valuation in Litigation*, 2nd ed., 16.

24. *Black's Law Dictionary*, 11th ed., s.v. "conventional."

25. Appraisal Standards Board, Advisory Opinion 9, Lines 71–73. See also *The Dictionary of Real Estate Appraisal*, seventh ed., s.v. "diminution in value."

26. Bell, *Real Estate Damages*, 3rd ed., 389–390

27. Susan Cutter and Kent Barnes, "Evacuation Behavior and Three Mile Island," *Disasters* 6, no. 2 (June 1982): 116–124.

an unimpaired and impaired value, let alone either of them. In fact, the Appraisal Institute's Guide Note 6, "Consideration of Hazardous Substances in the Appraisal Process," specifies that property value diminution is the sum of cost effects, use effects, and risk effects,[28] without regard to an unimpaired and impaired value. For example, a real estate valuation professional may opine that there is no diminution in value, which is an opinion of value, and an unimpaired and impaired valuation may not be necessary. Likewise, using pricing to draw a conclusion about how market behavior is reacting to a detrimental condition is also an opinion of value, though an unimpaired or impaired value is not developed. Pricing behavior is used to measure if property values have been diminished.[29] Simply stating that prices were studied (or opined upon) and not value does not void adherence to professional standards and guidance.

Real estate damage can also be computed on a percentage basis that is applied to an unimpaired value, similar to adjustments in the sales comparison approach.[30] Then, dollar damages or an impaired value can be deduced. In these scenarios, multiple sets of data may be analyzed, presenting a range of data. A real estate valuation professional can reconcile these data sets to estimate a single or straight-line opinion of value for a property or across a group of properties. In any of these valuation scenarios, a real estate valuation professional considers USPAP Standards 1 and 2, or Standards 5 and 6 if involving a mass appraisal assignment.[31]

The definition of *diminution in value* set forth by *The Dictionary of Real Estate Appraisal*, seventh edition, and USPAP Advisory Opinion 9 premises that it is a result of "increased risk and/or cost," whereas Guide Note 6 considers cost, use, and risk effects. The different definitions may create confusion as to what constitutes a diminution in value, like discussions regarding the definition of *market value*.[32] The definition of *diminution in value* set forth in *The Dictionary of Real Estate Appraisal*, seventh edition, and USPAP Advisory Opinion 9 does not mention use effects, nor does it mandate both cost and risk effects. One way to address this potential confusion is to set forth which of the three effects—cost, use, and risk—are developed in an assignment. Accordingly, this article examines how the environmental issues from a former oil production site in Hobbs, New Mexico, led to long-term risk effects for properties in a residential subdivision.

Permian Basin Case Study

Hobbs, New Mexico, lies within the Permian Basin, part of the southwest portion of the United States that is recognized for its oil and gas production. The Permian Basin "is one of the largest structural basins in North America," comprising approximately 86,000 square miles between West Texas and southeast New Mexico.[33] Hobbs was founded in 1907, and an oil boom in the 1920s began drawing many newcomers to Hobbs.[34] Since then, Hobbs has continued as a location for oil and gas exploration.

The contamination in this case study derives from the former site known as the Grimes Tank Battery (Grimes) site. The site operated from 1946 to 1993, with further oil production dating back to the initial boom in the 1920s. In the 1970s, the land adjacent to the Grimes site was developed into a single-family residential subdivision, known as Westgate. The homes in Westgate were typically three-bedroom, two-bathroom residences with attached garages. The composition and style of homes generally conforms with

28. Appraisal Institute, Guide Note 6: "Consideration of Hazardous Substances in the Appraisal Process" (Appraisal Institute, July 26, 2013, rev. 2020), 7, https://bit.ly/2RLm8mN.

29. Thomas O. Jackson, "Methods and Techniques for Contaminated Property Valuation," *The Appraisal Journal* (October 2003): 317.

30. Appraisal Institute, *The Appraisal of Real Estate*, 15th ed., 342.

31. Appraisal Standards Board, Standard 1, "Real Property Appraisal, Development," Standard 2, "Real Property Appraisal, Reporting," Standards 5 and 6, "Mass Appraisals, Development and Reporting" in *Uniform Standards of Professional Appraisal Practice* (USPAP), 2020–2021 ed. (Washington, DC: The Appraisal Foundation, 2020).

32. For more discussion on the definitions of *market value*, see Michael V. Sanders, "Market Value: What Does It Really Mean?" *The Appraisal Journal* (Summer 2018): 206–218.

33. Mahlon M. Ball, "Permian Basin Province (044)," USGS, 1, https://bit.ly/3zs5I66.

34. "Hobbs Comprehensive Community Development Plan," 2-2, last modified June 16, 2004, https://bit.ly/3xs7Uco.

competing residential developments built in Hobbs around that time.

The shutdown of the Grimes site in 1993 was part of a Stage 1 Abatement Plan. Approximately four years after the shutdown, in 1997, soils were excavated at the former Grimes site and removed.[35] Later that same year, residents of the Westgate subdivision filed complaints related to illness with the New Mexico Department of Health. The complaints led to investigations and discovery of crude oil sludge layers near residents' homes.[36] Further testing revealed elevated levels of benzene, methylene chloride, and phenols.[37] After the discovery, a Notice to Prospective Purchasers was drafted in June 1998 and a lawsuit was filed in 1999 by residents of Westgate.

Following the discovery, Shell Oil Company was identified as a responsible party. Shell performed several phases of remedial activities, including a Stage 2 Abatement Plan and the demolition of four residences within the subdivision, which have not been rebuilt.[38] After initial remediation and demolition, additional environmental testing was performed, revealing the presence of aromatic hydrocarbons, including benzene, toluene, ethylbenzene, xylene, pristane, and phytane in soil and air.[39]

The oil company later attempted to donate a portion of the former Grimes site to the City of Hobbs. In 2007, a scientist with Cordilleran Compliance Services wrote a letter to the City of Hobbs' attorney, recommending that the city not move forward with the proposed donation. The letter cited risks associated with the soil and groundwater contamination from the former Grimes site, including potential human exposure issues. The City of Hobbs turned down the donation offer. From a real estate valuation perspective, the environmental contamination issues associated with the former Grimes site present an opportunity to evaluate any effects on market value in the neighboring Westgate subdivision.

Analysis of Ongoing Risk Effects

Analyses of single-family residential homes in the Westgate subdivision of Hobbs were conducted to study long-term risk effects associated with environmental contamination issues. In the analysis, the homes in Westgate are considered "non-source"[40] properties and the former Grimes site is considered the "source"[41] property. Remediation efforts were conducted, indicating that the Westgate homes are in the "ongoing" stage of the remediation lifecycle. Although the Westgate homes are in the ongoing stage as of this analysis, if future assessment or remediation is required, the remediation lifecycle stage may change.

For this assignment, like any involving environmental contamination, USPAP Advisory Opinion 9 should be consulted. USPAP Advisory Opinion 9 sets forth guidelines for analyzing properties that may be impacted by environmental contamination, specifically the consideration of cost, use, and risk effects. Although USPAP Advisory Opinion 9 expressly addresses environmental contamination, cost, use, and risk effects are applicable to other detrimental condition assignments.

To assist in identifying and analyzing the stages and issues of a detrimental condition assignment, real estate valuation professionals can use the Detrimental Condition (DC) Matrix (Exhibit 2). Using a DC Matrix helps minimize potential confusion regarding the stages and issues of an analysis. As different characteristics of the valuation problem are identified, a DC Matrix[42] may

35. Phillip Services Corp., "Westgate Subdivision, Grimes Battery and Tasker Road Stage 1 Abatement Plan, Prepared for Shell Exploration and Production Technology Company" (May 1998).

36. James Dahlgren, Harpreet Takhar, Pamela Anderson-Mahoney, Jenny Kotleman, Jim Tarr, and Raphael Warshaw, "Cluster of Systemic Lupus Erythematosus (SLE) Associated with an Oil Field Waste Site: A Cross Sectional Study," *Environmental Health* 6, no. 8 (February 2007).

37. Dahlgren et al., "Cluster of Systemic Lupus Erythematosus (SLE) Associated with an Oil Field Waste Site."

38. Shell Exploration and Production Company, News Release, "Shell Enters Final Phase of Westgate Abatement Project" (February 21, 2002).

39. Dahlgren et al., "Cluster of Systemic Lupus Erythematosus (SLE) Associated with an Oil Field Waste Site."

40. USPAP Advisory Opinion 9 states, "Non-source sites are sites onto which contamination, generated from a source site, has migrated," Line 98.

41. USPAP Advisory Opinion 9 states, "Source sites are the sites on which contamination is, or has been, generated," Lines 97–98.

42. Orell C. Anderson, "Environmental Contamination: An Analysis in the Context of the DC Matrix," *The Appraisal Journal* (July 2001): 322–332.

Exhibit 2 DC Matrix

Detrimental Conditions Issues	Detrimental Condition Stages: Assessment	Repair	Ongoing
Cost	Cost to assess and responsibility Engineering Phase I, II, III studies	Repair costs and responsibility Repairs Remediation Contingencies	Ongoing costs and responsibility Operations and maintenance monitoring
Use	All loss of utility while assessed Disruptions Safety concerns Use restrictions	All loss of utility while repaired Income loss Expense increase Use restrictions	Ongoing use disruptions Alterations to highest and best use
Risk	Uncertainty factor Discount, if any, where extent of damage is unknown	Project incentive Financial incentive, if any, to complete repairs	**Market resistance** **Residual resistance, if any, due to situation**

provide a useful visual aid throughout the process. In the current case study, the focus of the analysis is on the quadrant reflecting the ongoing stage and risk effect issues. In some instances, more than one quadrant of the detrimental condition matrix might be applicable.

When determining risk effects, if any, there are numerous potential methodologies to consider. Potential methodologies include, but are not limited to, regression analysis, paired sales analysis, sale/resale analysis, literature review, surveys, case study analysis, market trends, and many more.[43] While there are numerous techniques available to real estate valuation professionals, it is not necessary to use them all; some or even one technique can produce credible opinions in an assignment.[44] In this case study, a multiple regression analysis and paired sales analysis were conducted to evaluate any risk effects as of 2018.

In developing the studies, a search was conducted for improved single-family residential arm's-length transactions in Hobbs, New Mexico, since 2015[45] using the local multiple listing service (MLS). These areas were generally similar in property type and other characteristics. Once the data were identified, they were downloaded and geocoded to identify properties that sold within the Westgate subdivision (test properties) versus properties that sold outside of the Westgate subdivision (control properties). If the market value of properties in Westgate had been reduced by stigma related to the risk of the environmental issues, this would be reflected in a reduction of prices in the test area relative to prices of otherwise similar properties in control areas.

Market awareness was also analyzed to verify whether market participants were knowledgeable of the environmental issues in the subdivision.

43. Appraisal Institute, *The Appraisal of Real Estate*, 15th ed., 188; and Bell, *Real Estate Damages*, 3rd ed.

44. Tachovsky, "Environmental Dead Zones," 114.

45. The Federal Reserve Economic Data (FRED) for housing prices in New Mexico note growth in housing market prices for the period in which transactions were collected and analyzed.

Investigation into the matter revealed that buyers were provided a Notice to Prospective Purchasers, which summarized the detrimental environmental issue.[46] The notice also mentioned the neighboring subdivision, Dale Bellemah; because of the mention, sales within Dale Bellemah were not used in the analysis. Rather, Dale Bellemah was considered a buffer zone between the test property sales within Westgate and the control property sales outside of Westgate.

Regression Analysis

Three regression models are generally used in an analysis of environmental stigma. They are (1) property-level models (before/during/after an event), (2) proximity analyses (distance from a location), and (3) control area analyses (test/impaired versus control/unimpaired).[47] A control area analysis was conducted in this case study using a hedonic pricing ordinary least-squares model. Identifying the control area(s) is one of the initial steps in this type of analysis; the test and control areas do not need to be identical.[48]

In this study, the dependent variable is *Sale Price*. A log transformation is applied to *Sale Price*, so that the coefficients in the summary output table are presented as percentages, whereas an unlogged regression would present the summary output coefficients as dollar amounts. If the coefficients in a logged regression are being used to estimate property values or market rents, they can be unlogged after running the analysis to convert any indicated values to dollar amounts. In this regression, logarithmic transformations are useful to the overall case study because the regression risk effect coefficient is then presented on a percentage basis, allowing for a simpler comparison and reconciliation with any percent risk effect in the paired sales analysis. Moreover, a log transformation is sometimes used to control for statistical issues that may occur, such as heteroskedasticity.[49]

The general specification of the multiple regression model equation takes the following form:

$$\ln(SP) = \alpha + \beta_1\, SALE\ DATE + \beta_2 \ln LIVING\ AREA + \beta_3\, BATHROOMS + \beta_4\, GARAGE + \beta_5\, FIREPLACES + \beta_6\, AGE + \beta_7\, WESTGATE + \varepsilon$$

where:

$\ln(SP)$ = natural logarithm of the sale price,

$SALE\ DATE$ = a discrete variable for the year of the sale,[50]

$\ln\ LIVING\ AREA$ = natural logarithm of square feet of living area,

$BATHROOMS$ = number of bathrooms,

$GARAGE$ = number of garage spaces,

$FIREPLACES$ = number of fireplaces,

AGE = age of improvements,

$WESTGATE$ = location in or outside of Westgate (test or control),

β = coefficient to be estimated,

α = a constant term, and

ε = the random error term.

These independent variables (Exhibit 3) are designed to capture any influences and marginal effects they may have on the value of real estate. The variable for *Living Area* was logged, like the

46. "Notice to Prospective Purchasers," drafted in June 1998. The notice is used as a disclosure by sellers and local real estate agents to inform potential buyers of the contamination concerns, potential exposure to environmental hazards, and potential health concerns such as cancer and immune disorders associated with purchasing a property in the subdivision or nearby. Accordingly, the notice also mentioned the neighboring subdivision, Dale Bellemah.

47. Thomas O. Jackson, "Evaluating Environmental Stigma with Multiple Regression Analysis," *The Appraisal Journal* (Fall 2005): 366–367.

48. Jackson, "Evaluating Environmental Stigma with Multiple Regression Analysis," 367.

49. Appendix B, "Regression Analysis and Statistical Applications," in *The Appraisal of Real Estate*, 15th ed. (Appraisal Institute: 2021), available at https://bit.ly/3wxsZll.

50. In this study, using a discrete variable for the year of sale helped to capture effects due to market conditions that vary by year and to control for any heterogeneity that may have been in the data.

logarithmic transformation used for *Sale Price*, resulting in a log-log model. An independent variable that was considered but not ultimately used was lot size because MLS data did not report lot size for numerous properties. Jackson (2005) addresses this issue in a discussion on omitted variable bias:

> For example, lot size is frequently missing from multiple listing service (MLS) information and other property records. The influence of lot size on price could be picked up and indirectly accounted for by house size since they tend to be correlated. The model's overall prediction of sale price would still be unbiased.[51]

Some control area analyses may include a variable for an event, such as the release of a contaminant or remediation.[52] However, the purpose of this analysis is to measure any ongoing risk effects more than twenty years after the discovery of the environmental issues; therefore, an event variable was not used.[53] Ultimately, the independent variable of interest is the *Westgate* variable, as it is designed to measure any risk effect from the environmental issues. Thus, a binary variable was used; the properties in Westgate (test area) were coded with a "1" and the properties in the control areas were coded with a "0." Using the binary variable in the same regression allows for the measurement of any marginal effect on sale price that a certain attribute may have on market value.

The regression analysis indicates a long-term risk effect from the environmental contamination of approximately −28% for properties in the Westgate subdivision, which is indicated by the *Westgate* coefficient (Exhibit 4). The standardized residuals of this model appeared to have a generally random pattern, with 95% of the data between ±2 standard deviations and 99% between ±3 standard deviations.[54] The overall statistical indicators of this model were generally good, with the independent variable coefficients for *Sale Date*, *Bathrooms*, and *Fireplaces* indicating less confidence and significance.[55] Nevertheless, the *Westgate* variable used to measure any risk effect was statistically and economically significant.

Multiple regression has been used by real estate valuation professionals to estimate the effects of environmental contamination issues (or other detrimental condition issues) on property values,[56] as it has been conducted for this case study. In addition, regression can also be used to estimate unimpaired values, impaired values, and market rents.[57] As the Appraisal Institute course *Quantitative Analysis* states, "a regression analysis

Exhibit 3 Descriptive Statistics

Variable	Minimum	Maximum	Mean	Standard Deviation
Sale Price	$78,000	$235,000	$168,313	$34,552
Sale Date (Year)	2015	2018	2017	407
Living Area (SqFt)	923	2,197	1,740	277
Bathrooms	1	3	2	0
Garage Capacity	0	4	2	1
Fireplaces	0	2	1	1
Age (Years)	31	48	38	4
Westgate	0	1	0.06	0.23

51. Jackson, "Evaluating Environmental Stigma with Multiple Regression Analysis," 366.

52. Jackson, "Evaluating Environmental Stigma with Multiple Regression Analysis," 367.

53. An analysis of risk effects does not require an event; an analysis of data with and without a detrimental condition (test and control analysis) can be developed, regardless of a specific event. An example includes the study design in Jackson, "Evaluating Environmental Stigma with Multiple Regression Analysis," 368.

54. Appraisal Institute, *Quantitative Analysis* coursebook, Part 8–227.

55. *t* Stats >2 or <–2 and *P*-values >0.1 or 0.05.

56. See discussions in Appraisal Institute, *The Appraisal of Real Estate*, 15th ed., 188; Bell, *Real Estate Damages*, 3rd ed.; Jackson, "Evaluating Environmental Stigma with Multiple Regression Analysis," 363–369; Alan Reichert, "The Impact of a Toxic Waste Superfund Site on Property Values," *The Appraisal Journal* (October 1997): 381–392; Alan Reichert, "The Persistence of Contamination Effects," 126–135; Jackson and Yost-Bremm, "Environmental Risk Premiums and Price Effects in Commercial Real Estate Transactions," *The Appraisal Journal* (Winter 20018): 48–67; Mark Dotzour, "Groundwater Contamination and Residential Property Values," *The Appraisal Journal* (July 1997): 279–285.

57. Marvin Wolverton, *An Introduction to Statistics for Appraisers* (Chicago: Appraisal Institute, 2009), 345; Appendix B, "Regression Analysis and Statistical Applications" in *The Appraisal of Real Estate*, 15th ed., 8; and Appraisal Institute, *Quantitative Analysis* coursebook, Exercise 3.2 Question 1, Practice Test 6 and 7 Question 11, and Part 12 Question 6.

Exhibit 4 Summary Output Table

Regression Statistics	
Multiple *R*	0.840644353
R Square	0.706682928
Adjusted *R* Square	0.694461383
Standard Error	0.124094832
Observations	176

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	7	6.233097668	0.890442524	57.82271764	0.00000000
Residual	168	2.587120602	0.015399527		
Total	175	8.82021827			

	Coefficients	Standard Error	*t* Stat	*P*-value	Lower 95%	Upper 95%
Intercept	6.002374574	0.445600346	13.470309488	0.000000000	5.122676969	6.882072180
Sale Date (Year)	0.017577597	0.009229802	1.904439301	0.058561967	–0.000643741	0.035798935
Living Area (SqFt – Log)	0.845074246	0.064161586	13.171031158	0.000000000	0.718407393	0.971741099
Bathrooms	–0.016675790	0.045339251	–0.367800299	0.713485110	–0.106183869	0.072832288
Garage Capacity	0.051919923	0.018061114	2.874680046	0.004567750	0.016263940	0.087575906
Fireplaces	–0.000434555	0.011763425	–0.036941160	0.970575780	–0.023657734	0.022788624
Age (Years)	–0.009467577	0.002359533	–4.012479102	0.000090310	–0.014125732	–0.004809422
Westgate (Risk Effect)	**–0.283552424**	0.041566467	–6.821662860	0.000000000	–0.365612327	–0.201492520

can be used to form the basis for an opinion of value by direct sales comparison. If the data are representative, the resulting regression equation can be seen as a means of estimating market value that is fully consistent with the principle of contribution."[58] To further analyze any ongoing risk effects, a paired sales analysis was also conducted.

Paired Sales Analysis

A paired sales analysis compares the sale price of a property with a feature of interest, here environmental contamination risk, to the sale price of a similar property sold without the feature. Paired sales analyses can be conducted as a before-and-after analysis or as a test-and-control analysis. A before-and-after paired sales analysis looks at sales before a period of time or event and compares them to otherwise similar sales after a period of time or event. The period of time may be determined as the single date of an event or a date range. A test-and-control paired sales analysis compares test properties with a detrimental condition to otherwise similar control properties without a detrimental condition. Like the regression analysis, a test-and-control analysis was conducted through a search of single-family residential properties in Hobbs, New Mexico, that were developed around the same time as residences in the Westgate subdivision.[59] The table in Exhibit 5 summarizes the paired sales study.

The paired sales analysis indicated a risk effect ranging from −10% to −42%, whereas the regres-

58. Appraisal Institute, *Quantitative Analysis* coursebook (Chicago: Appraisal Institute), Part 3-46.

59. This is one consideration that may be made when developing paired sales.

Exhibit 5 Westgate Analysis Summary

Westgate – Hobbs, New Mexico, Paired Sales Summary

Test (Impaired)						Control (Unimpaired)						
No.	Sale Date	FRED Index	Sale Price ($)	SqFt	Price per SqFt ($)	No.	Sale Date	FRED Index	Sale Price ($)	SqFt	Time Adj. Price per SqFt ($)	Risk Effect
1	May-16	299.63	103,000	1,437	72	1A	Jun-18	320.55	152,000	1,426	100	–28%
						1B	Sep-15	293.89	158,000	1,608	100	–28%
						1C	Jun-18	320.55	165,500	1,540	100	–29%
						1D	Jun-18	320.55	175,000	1,581	103	–31%
						1E	Sep-16	301.56	187,000	1,588	117	–39%
						1F	Dec-15	292.83	171,000	1,680	104	–31%
						1G	May-17	307.45	155,000	1,484	102	–30%
						1H	Jun-17	307.45	158,000	1,532	101	-29%
						1I	Jul-16	301.56	162,000	1,680	96	–25%
						1J	Jun-16	299.63	165,000	1,621	102	–30%
						1K	Apr-18	320.55	180,000	1,627	103	–31%
2	Jun-18	320.55	135,000	1,819	74	2A	Feb-16	294.96	167,900	1,706	107	–31%
						2B	Apr-18	320.55	153,000	1,756	87	–15%
						2C	Apr-16	299.63	175,000	1,798	104	–29%
						2D	Jun-18	320.55	175,000	1,999	88	–15%
						2E	May-17	307.45	185,000	1,722	112	–34%
						2F	Jun-15	290.87	190,000	1,961	107	–30%
						2G	Feb-18	315.78	197,000	1,954	102	–27%
						2H	Aug-16	301.56	200,000	1,900	112	–34%
						2I	Sep-17	313.42	206,000	1,936	109	–32%
						2J	Aug-15	293.89	210,000	1,786	128	–42%
3	Nov-16	305.76	117,000	1,629	72	3A	Mar-18	315.78	145,000	1,426	98	–27%
						3B	Sep-15	293.89	165,000	1,590	108	–33%
						3C	Apr-18	320.55	149,500	1,600	89	–19%
						3D	Jul-18	324.01	186,000	1,699	103	–30%
4	Aug-15	293.89	129,000	1,800	72	4A	Apr-18	320.55	153,000	1,756	80	–10%
						4B	Feb-16	294.96	167,900	1,706	98	–27%
						4C	Apr-16	299.63	175,000	1,798	95	–25%
						4D	May-17	307.45	185,000	1,722	103	–30%
						4E	Jun-15	290.87	190,000	1,961	98	–27%
						4F	Feb-18	315.78	197,000	1,954	94	–24%
						4G	Aug-16	301.56	200,000	1,900	103	–30%
						4H	Sep-17	313.42	206,000	1,936	100	–28%
						4I	Aug-15	293.89	210,000	1,786	118	–39%
5	Feb-17	304.48	122,000	1,760	69	5A	Apr-18	320.55	153,000	1,756	83	–16%
						5B	Feb-16	294.96	167,900	1,706	102	–32%
						5C	Apr-16	299.63	175,000	1,798	99	–30%
						5D	Jun-18	320.55	175,000	1,999	83	–17%
						5E	Mar-18	315.78	180,000	1,718	101	–31%
						5F	May-17	307.45	185,000	1,722	106	–35%
						5G	Feb-18	315.78	197,000	1,954	97	–29%
						5H	Aug-16	301.56	200,000	1,900	106	–35%
						5I	Sep-17	313.42	206,000	1,936	103	–33%

sion indicated a risk effect of approximately −28%. The findings among the two analyses generally reconciled. In real estate economic and valuation analyses, a single percentage or numerical risk effect, a range, and a not less than or not greater than opinion[60] can be derived from a set of data for application to a property or properties impacted by a detrimental condition. Case study findings across different geographies and times can be considered in real estate economic and valuation studies.[61] Furthermore, both the regression and paired sales methods used in this case study are property-by-property and mass appraisal techniques. Accordingly, in class action lawsuits, mass appraisal techniques can be used to evaluate real estate damages on individual and aggregate bases. As Jackson states, "with reasonable similarities in property, market, and environmental characteristics, property interests defined in a class action can be meaningfully analyzed."[62]

When any risk effect techniques in mass appraisal assignments, such as the regression and paired sales in this case study, are conducted on a percentage basis (e.g., −20% for view impairment), the findings can be then be applied to unimpaired values generated by regressions or other techniques on both an individual and aggregate basis.[63] Likewise, with use effect calculations, market rents can be determined using regression or other techniques, and the time period of impact can be applied to the results on both an individual and aggregate basis.[64]

The paired sales analysis made market (or time) adjustments using the Federal Reserve Economic Data (FRED) for housing prices in New Mexico. While real estate valuation professionals may consider trending prices in a neighborhood(s), using the FRED index is an appropriate approach. The Federal Reserve Bank of St. Louis is a leading, respected resource for economic and financial information.[65] FRED market data includes a house price index for numerous markets across the country, including housing price indices on a national, regional, statewide, metropolitan, and citywide basis. Sometimes there is not a citywide FRED index for an area of study; therefore, it may be appropriate to consider the statewide index when developing market or time adjustments.

The adjustment process in a paired sales is similar to making an adjustment in the sales comparison approach, where a comparable sale is adjusted in comparison to the subject property. Likewise, the test property is analogous to the subject property, and the control property is like the comparable sale. To calculate the market-adjusted price per square foot in the paired sales, the change in the FRED index was calculated and applied to the control sale price.[66]

Furthermore, when measuring any impacts of a detrimental condition, entire local markets may also be impacted—for example, after a widespread wildfire or flooding. In such instances, local market trends may not serve as the best indicator for a market adjustment. In these instances, the statewide housing index may serve as an appropriate measurement, and at times as an indicator of unimpaired market trends. Housing trend indices may also be used to estimate prospective market values, by projecting future market trends.

60. Appraisal Standards Board, *Uniform Standards of Professional Appraisal Practice*, 2020–2021 ed., Lines 64–66. "Comment: An appraisal is numerically expressed as a specific amount, as a range of numbers, or as a relationship (e.g., not more than, not less than) to a previous value opinion or numerical benchmark (e.g., assessed value, collateral value)."

61. Tachovsky, "Environmental Dead Zones," 112; and Sanders, "Post-Repair Diminution in Value from Geotechnical Problems," 61.

62. Jackson, "Real Property Valuation Issues in Environmental Class Actions," 149.

63. Wolverton, *An Introduction to Statistics for Appraisers* , 345; Appraisal Institute, *Quantitative Analysis* coursebook, Part 3-46; and Exercise 3.2 Question 1, Practice Test 6 and 7 Question 11, and Part 12 Question 6 in *Quantitative Analysis* coursebook.

64. Appendix B, "Regression Analysis and Statistical Applications" in *The Appraisal of Real Estate*, 15th ed., 8.

65. Dan L. Swango, "Economic Research Resources," *The Appraisal Journal* (Spring 2017): 148.

66. The following formula illustrates a general calculation that may be used: [(Test Sale Index/Control Sale Index) × Control Sale Price]; there are other calculations that can also be considered. Excel was used in this case study and numbers rounded to the nearest whole number; any noted discrepancies are a result of rounding.

Conclusion

Early real estate valuation literature on contaminated properties introduced the term *environmental stigma* in reference to an adverse effect on property value produced by the market's perception of increased environmental risk due to contamination.[67] As the research literature further addressed evaluation of contaminated properties, discussions arose regarding temporary versus permanent stigma. However, the issue of stigma endurance may not be important where an opinion of value or diminution in value is given as of a specific point in time. If a real estate valuation professional finds that a property incurred or did not incur a risk effect as of a date of value, that is what is relevant. Speculating whether that risk effect is temporary or permanent does not negate that a measured loss (or no loss) occurred as of that date of value.

Like risk effects, use effects may be temporary or ongoing. With use effects, an impairment to the use and enjoyment of a property (or its rights) is typically reflected as a temporary use effect, and highest and best use issues typically reflect ongoing use effects. Measurement of temporary use effects generally centers on market rents. It is not centered on whether there has been an impact to market rental rates or whether a property is used, but rather on whether there is an impact to the conventional use and enjoyment of the property or its rights or whether the bundle of rights has been impaired.

In this article, a case study with ongoing stigma was analyzed. In Hobbs, New Mexico, past oil production and storage activities at the former Grimes Tank Battery site led to contamination issues in the neighboring Westgate subdivision. A multiple regression analysis and paired sales analysis were conducted, which indicated that ongoing stigma (or risk effects) persist more than twenty years after the discovery of the environmental issues in Westgate. The analyses found a risk effect ranging from −10% to −42%.[68] The findings also demonstrate that stigma is not always temporary and in cases may be ongoing.[69]

About the Author

Michael Tachovsky, PhD, is a principal partner and expert witness at Landmark Research Group LLC. Tachovsky is a certified general real estate appraiser who specializes in real estate damage economics and complex valuation. This includes valuation issues related to a variety of conditions, such as environmental contamination, natural disasters, eminent domain, crime scenes, construction defects, neighborhood nuisances, geotechnical issues, location premiums, and other conditions involving a wide variety of property types. His professional experience includes complex valuation and diminution-in-value studies involving issues for government agencies, major corporations, oil and utility companies, developers, and property owners. Tachovsky has researched disasters such as the Sandy Hook shooting, Hurricane Harvey flooding, Uravan Colorado radioactive Superfund site, Chernobyl nuclear meltdown, the Porter Ranch gas leak, and the Love Canal Superfund site. He has been featured in *Forbes* and has taught seminars on valuing properties impacted by detrimental conditions, real estate valuation methodologies, and complex valuation issues for Appraisal Institute chapters, the American Society of Appraisers, the National Association of Independent Fee Appraisers, the Society of Certified Appraisers, the Urban Land Institute, and assessors. **Contact: MichaelT@LandmarkResearch.com**

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67. Appraisal Standards Board, Advisory Opinion 9, Lines 85–86.

68. In real estate economic and valuation analyses, a single percentage or numerical risk effect, a range, and a not less than or not greater than opinion can be derived from a set of data for application to a property or properties impacted by a detrimental condition.

69. Locations that suggest ongoing stigma include Love Canal in New York, Uravan in Colorado, Hinkley in California, Picher in Oklahoma, Wittenoom in Australia, and Chernobyl in Ukraine.

Additional Resources

Suggested by the Y. T. and Louise Lee Lum Library

Appraisal Institute

Lum Library [Login required]

- Knowledge Base Information Files—Real estate damages
- *Diminution Valuation Assignments: Enhance the Importance of Highest and Best Use* (Conference presentation, 2019)

US Environmental Protection Agency

- **Chemicals and Toxics Topics**
  https://www.epa.gov/environmental-topics/chemicals-and-toxics-topics
- **Cleanups at Federal Facilities: Land Use Controls**
  https://www.epa.gov/fedfac/land-use-controls-lucs
- **Laws and Regulations**
  https://www.epa.gov/laws-regulations
- **Report on the Environment: Land Use**
  https://www.epa.gov/report-environment/land-use
- **Superfund: Institutional Controls**
  https://www.epa.gov/superfund/superfund-institutional-controls