Groundwater Contamination and Real Estate Investment Risk

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Abstract. The market for commercial and industrial real estate can be impacted by the risks and uncertainty associated with environmental contamination. This research addresses environmental risk perceptions through a national survey of commercial and industrial real estate investors, and compares the results to a similar survey of lenders. Key findings are: perceived risk declines as cleanup plans for contaminated properties are approved, cleanup begins and is completed; lenders perceive greater risk than investors before, during and after cleanup; prior experience with contaminated properties generally decreases perceived risk; and strong market conditions mitigate perceived risk while weak conditions tend to exacerbate these perceptions.

Introduction

This paper presents a survey of equity investors with respect to their perceptions of environmental risk from groundwater contamination. Environmental contamination can potentially impact real estate by increasing investment risk, and through risk premiums added to equity yield and capitalization rates, reduce property values. Accordingly, research focused on understanding how the market perceives contamination-related risks is essential to understanding how and under what conditions environmental contamination may affect the value and liquidity of equity interests in commercial and industrial real estate. Specifically, this research addresses the changes in perceived risk over the remediation cycle, as source site commercial and industrial properties are remediated to applicable regulatory standards.

This paper also compares the risk perceptions of real estate investors with those of lenders. Mortgage (lender) and equity (investor) interests in commercial and industrial real estate differ in the way they perceive risk, generally, and compensate for that risk in real property transactions. Indeed, many valuation frameworks, including formal mortgage-equity analysis, consider these interests separately and then combine them in an analysis of the overall real property. Similarly, modern financial analysis often addresses debt and equity in a weighted average cost of capital approach. While both sets of market participants are considered risk averse, investors are usually in a higher risk position with respect to real property than lenders. Thus, it is important to study both sets of interests.

Other research topics addressed herein involve the extent to which investor perceptions of environmental risk may be influenced by their prior experience in considering contaminated commercial or industrial properties for investment or acquisition and further experience in acquiring them. Greater experience should translate into a greater

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ability to understand the risks associated with contamination and therefore should reduce uncertainty and risk. Lastly, this research addresses the potential intervening effect of general market conditions on perceived environmental risk. While the underlying degree of risk is more a function of knowledge about the contamination and its cleanup, value is generally influenced by market conditions with strong conditions reducing capitalization rates and increasing value and weak conditions having the opposite effect. Environmental risk premiums added to lower rates (strong markets) may tend to have less absolute effect on value than those added to higher rates (weaker markets).

Literature Review

In 1996, Worzala and Kinnard (1997) conducted a survey on investor reactions toward alternative sources and types of contamination. A total of 76 responses were received out of 220 deliverable surveys mailed to a pre-selected, but not random, sample for an average response rate of 35%. The survey results indicated investors were least likely to acquire or invest in properties with groundwater contamination, followed by soil contamination and building contamination. Worzala and Kinnard also investigated investor perceptions concerning properties near (within 300 feet) of a groundwater contamination plume. Their survey indicated that 5.3% would invest, 7% would "probably" invest, 49.1% would "maybe" invest, 36.8% would "probably not" invest and 1.8% would not invest in such a property.

Subsequently, Bond, Kinnard, Worzala and Kapplin (1998) compare the results of the Worzala and Kinnard (1997) survey of investors in the United States with their survey of investors in New Zealand. In the N.Z. survey, 48 investor responses were received out of 209 for an overall response rate of 23%. As noted, Worzala and Kinnard achieved a 35% response rate among investors in their U.S. survey. Both the U.S. and N.Z. surveys also included lender respondents. In the N.Z. survey, some additional items are reported. One of these is the frequency with which respondents had invested in a contaminated property. In the 1996 U.S. sample, 65% of the investors had done so in the past. In the N.Z. sample, 37% of the investors had purchased a contaminated property. Comparing contamination conveyances, 42% of the U.S. sample would not invest in a property with groundwater contamination, while 25% would not invest with soil contamination. The N.Z. results show greater risk aversion, with 54% deterred from investing in a property with groundwater contamination and 38% deterred by soil contamination. In both samples, groundwater contamination was perceived as producing greater risk than soil contamination. Lastly, when asked about specific modifications to investment criteria to compensate for the greater perceived risks, the most frequently mentioned adjustments from both sets of respondents were higher yield, discount and capitalization rates. The U.S. investors had a slight preference for capitalization rate adjustments, while the N.Z. respondents preferred yield rate adjustments. These adjustments could be viewed as environmental risk premiums.

As part of a study of brownfield decision making in the United Kingdom, Syms (1999) conducted a survey of "people directly involved in the development of brownfield

land, or known to have an interest in the subject." These people included surveyors (appraisers), developers, town planners, lawyers and architects. Syms distributed 280 questionnaires and received 104 responses for a 37% response rate. The focus of the survey was on the relative priority of decision factors in the redevelopment of brownfields. Risk assessment, the main contamination-related factor, ranked above site-specific factors (site size, topography), community considerations (supply and demand), transportation and environmental factors (soil quality, air quality). The risk assessment factor included risks for human health, as well as risks due to changes in the regulatory acceptability of remediation methods and the financial strength of the entity financing the remediations due to the contamination.

Another study by Syms (1996) was based on surveys of the environmental risk perceptions of 130 members of various real estate professionals in the U.K. In the second phase of study conducted in 1994, twenty-one "leading real estate professionals," occupying "senior positions in national or regional firms, or were sole principals with many years of experience," were interviewed. Included in the interviews were questions concerning reductions in value before and after remediation. Since there were no actual properties being analyzed, the changes in property value would correspond to the interviewees' perceptions of reduced hazard or risk subsequent to cleanup. Five hazard classifications were presented. For properties in the "very high hazard" category, reduction in value before remediation was 90.4% and after remediation was 53.9%. For properties in the very low hazard category, the reduction in value was 3.7% before remediation and 1.9% after. Accordingly, if a very high hazard site could be remediated to a very low hazard site, the reduction in risk-related property value diminution would be from 90.4% to 1.9%. For properties in the medium hazard category, remediation would reduce value diminution from 22.4% to 9.9%.

Urban planners in the U.S. have also begun to research the decision making of the private sector in redeveloping contaminated properties. Meyer and Lyons (2000) conducted a survey of the preferences and requirements of specialist brownfield developers. Among the findings of a survey of 13 such developments was that minimum annual equity returns were 20% to 25% in 1996. Interviews in 1997 identified required rates of return of 15% to 20%. The important point, though, is in the 500 basis point decline in these "hurdle" rates from 1996 to 1997. As the market gains greater knowledge and experience in dealing with contamination-related issues, stigma-related risk premiums should decline. A similar pattern is hypothesized to occur over the remediation cycle, as greater knowledge and certainty are gained when the required remediation is completed. Meyer and Lyons also note that the brownfield developers prefer locations that have strong market demand, suggesting that strong general market demand may offset or mitigate some of the contamination-related financial risks.

Research Questions and Hypotheses

This research primarily addresses three questions as derived from the literature and other sources. The first involves changes in perceived investment risk due to

environmental contamination over the remediation cycle. As a contaminated property is remediated, the level of perceived risk is likely to change. This was found by Syms (1996), albeit for different sets of market participants, and was hypothesized by Meyer and Lyons (2000). This was also found by Jackson (2001) in a survey of commercial and industrial lenders. The three periods or stages of the remediation cycle to be presented in the survey instrument were: (1) before remediation or cleanup, and without an approved cleanup plan; (2) *during* cleanup, with cleanup proceeding under a plan that has been approved by applicable regulatory authorities; and (3) after cleanup to applicable regulatory standards. Thus, the first set research hypotheses are that investor perceptions of risk due to the environmental condition of a commercial or industrial property would vary over these three periods, and decline as the properties are remediated to appropriate regulatory standards. Further, comparing the risk perceptions of investors and lenders should indicate that lenders are more risk averse than investors across the stages of the remediation cycle. The corresponding null hypotheses are that risk perceptions are the same for each period, and for lenders and investors.

The second research question involves the effect of prior experience with acquiring or considering contaminated properties on perceived environmental risk. Since risk is directly related to uncertainties about remediation costs, timing, regulatory requirements and other factors (see Chalmers and Jackson, 1996), prior experience with these factors should reduce uncertainty and perceived risk. Thus, the research hypothesis is that investors with such prior experience will have lower perceived environmental risk over the remediation cycle than those without such experience. The third set of research questions deals with the potential intervening effects of market conditions on the risk perceptions of investors before, during and after cleanup. The research hypotheses are that market conditions affect these perceptions, with subhypotheses that strong market conditions mitigate investment risk while weak conditions exacerbate risk, and, again, that investor and lender perceptions differ with respect to these variables. The null hypothesis is that market conditions have no effect.

Data Collection

A national investor survey was conducted to address these research questions. The survey questionnaires distributed to potential investor respondents were designed with sets of question items that provided sufficient data to statistically test the research hypotheses. The reliability of the survey results is dependent on the scope and quality of the data collection process. Toward this end, a broad population of investors was targeted and randomly sampled. The sampling process as well as the target population and sampling frames was structured to produce results representative of the population of equity investors who would be likely to make or influence investment decisions concerning commercial and industrial properties. Accordingly, the target population would be investors who actively evaluate property acquisitions and investments, as well as those who evaluate commercial and industrial properties on the behalf of equity investors. The critical activity is the investment evaluation function and assessing the risks of ownership interests in such properties.

Several alternative sampling frames were considered relative to the characteristics of the target population. The alternative chosen was a group selected from the membership of the Commercial Investment Real Estate Institute (CIREI). The CIREI confers the CCIM designation and is affiliated with the National Association of REALTORS[®]. The CCIM designation is granted subsequent to the completion of graduate-level education and work experience requirements. Education requirements include financial, market, lease and investment analysis. Thus, the individuals with this designation should have experience and training in the analysis of commercial and industrial real estate investments from the perspective of the equity investor. To target even more specifically, individuals with CCIMs with certain investment-oriented specializations and job functions were selected from the general CCIM membership. The selection criteria included: acquisitions, corporate investments, real estate investment trusts, pension fund investments and investment analysis for insurance companies.

CIREI staff selected a total of 1,103 individuals based on these criteria as of September 27, 1999. The data was provided in computer readable format. Upon further examination of the data, five individuals were eliminated due to missing address information, three were eliminated because no name was shown and 44 were removed because their address was outside the U.S. These eliminations left a total of 1,051 units of analysis, or elements, in the selected sampling frame. These individuals were sorted by last name and every third was chosen in a simple random sampling procedure. Babbie (1990) refers to this as a probability sample, with each element given an equal probability of selection. The sample size and corresponding sampling interval were based on the minimum size for estimating means of 50% (\pm 6%) at a 95% confidence interval. The sample size also assumed a 50% response rate. This process produced a sample of 349 potential respondents. Of this total, 19 surveys were undeliverable due to bad addresses and other reasons, leaving a net sample size of 330 individuals. Many of the undeliverable addresses were not identified until after the first survey mailing.

The implementation of the investor survey involved three mailings and several followup activities. After removing nine individuals from the initial sample of 349 due to undeliverable addresses, as determined by a commercial mailing service, the first mailing was sent to 340 potential respondents on October 5, 1999. Reminder cards were sent to these individuals on October 18, 1999. A second mailing was sent to 264 individuals who had not responded. The second mailing went out on November 12, 1999. Follow-up reminder cards were sent on November 20, 1999. A third and final mailing was sent on December 6, 1999, with a letter asking the potential respondents to participate. During this process, some of the questionnaires were returned uncompleted. These were not counted as usable responses. Subsequently, the still unresponsive individuals were contacted by telephone and asked to complete and return their questionnaires.

Due to these efforts, there were 184 usable questionnaires returned out of a net sample of 330, excluding those that were undeliverable. This results in an overall response

rate of 55.8% for the survey. All but four questionnaires were returned before December 31, 1999. Of the 184 total usable questionnaires returned, 99 (53.8%) were from the first mailing, 49 (26.6%) were from the second mailing and 36 (19.6%) were generated by the final mailing. Response rates for each of the three mailings cannot be computed since 10 of the 19 undeliverable questionnaires were not identified until after the mailing had begun. The overall response rate of 55.8%, though, exceeded the goal of 50%. As noted by Babbie (1990), a response rate of at least 50% is generally considered adequate for analysis and reporting of scientific survey research.

Background of Survey Respondents

Descriptive information on the investor survey respondents is presented in Exhibit 1. As can be seen, these respondents have over 20 years of real estate investing experience and their firms made an average of 9.1 investments in commercial and industrial real estate in the 12 months preceding the survey. Thus, these are experienced investors in commercial and industrial properties and represent the intended target population for the survey. The survey questionnaire and cover letter requested that an individual who was responsible for evaluating commercial and industrial properties complete the survey. If the addressee was not so qualified, then the questionnaire was to be given to an individual in the firm who was responsible for these evaluations.

	n	Percentage
Limited/general partnership	37	20.1
Individual/private real estate investor	36	19.6
Pension fund/pension fund advisor	2	1.1
Investment advisory firm	4	2.2
Real estate investment trust	9	4.9
Commercial brokerage firm	104	56.5
Insurance company	7	3.8
Other	25	13.6
Years of real estate investing experience	21.0	
Number of acquisitions/investments in last 12 months by firm of respondent	9.1	
Considered investing/acquiring a commercial or industrial property with environmental problems	123	67.2
Invested/acquired the property	59	48.0

Exhibit 1 Investor Survey Respondents' Background Information

Note: Some respondents indicated more than one type of firm, so the total exceeds the 184 respondents to the investor survey. Percentages are based on 184 respondents, and total to more than 100%.

The background data in Exhibit 1 also shows the specific experience of the investor respondents with contaminated commercial and industrial properties. Of the 184 randomly selected respondents, 123 (67.2%) had previously considered an investment or acquisition of a commercial or industrial property with environmental problems. Further, of those that had considered these properties, 48% had proceeded with the investment or acquisition. For comparison, Jackson (2001) found that 73.9% of commercial and industrial real estate lenders had been involved with a loan on a property with environmental problems.

Effects of Remediation Status

As presented verbatim to the survey respondents, the three stages of the remediation cycle, and as presented to the respondents to the investor survey [and consistent with the Jackson (2001) lender survey], are: "(1) before cleanup, and without an approved remediation plan; (2) during cleanup, and with cleanup proceeding under an approved plan (cleanup plan has been approved by regulatory authorities); and (3) after cleanup to applicable regulatory standards." Assumptions, or pre-conditions, to be made about the reference (subject) property were: (1) "an income generating, improved commercial or industrial property;" and (2)"the property, if uncontaminated, would meet your investment objectives." The environmental condition of the reference property was described as: "a contaminated commercial or industrial property with groundwater contamination that originated on site (property is source site)." As previously noted, the specific contamination constituent, such as petroleum hydrocarbons or chlorinated solvents, was not specified. An earlier version of the survey having these as alternatives was not used because of its length and complexity, as determined through pre-testing.

The three risk levels and their operational definitions, as presented to the investor survey respondents, were: (1) "**normal level of investment risk**—typical pricing and investment criteria (rate of return, etc.) for this property/market would be applied without adjustment;" (2) **higher than normal investment risk**—price would be discounted and/or investment criteria would be adjusted (*i.e.*, increase required rate of return);" and (3) "**very high investment risk**—the property would not be acquired due to excessive contamination risk." This parallels the risk levels used by Jackson (2001) in the referenced lender survey. As presented to the lenders, the three risk levels were operationalized as: "(1) **normal level of lending risk**—mortgage loan provided but with adjustments to amount, rate, amortization, term, conditions;" (2) "**higher than normal lending risk**—mortgage loan provided but with adjustments to amount, rate, amortization, term or conditions;" and (3) "**very high lending risk**—mortgage loan would not be provided due to excessive environmental risk."

Investor Risk Perceptions

As can be seen in Exhibit 2, in the first stage of the remediation cycle, before cleanup, only 5.6% of the investor respondents indicated that the reference property would have a normal level of investment risk. The modal category was very high risk, with

	Before Cleanup, and Without an Approved Remediation Plan	During Cleanup, with Cleanup Proceeding under an Approved Plan	After Cleanup to Applicable Regulatory Standards
Normal level of investment risk (typical pricing and investment criteria)	5.6% (±3.4%)	20.1% (±5.9%)	62.4% (±7.1%)
Higher than normal investment risk (price would be discounted and/ or investment criteria adjusted)	35.2% (±7.0%)	69.3% (±6.8%)	37.1% (±7.1%)
Very high investment risk (property would not be acquired due to excessive risk)	59.2% (±7.2%)	10.6% (±4.5%)	0.6% (±1.1%)
Total Percentage	100%	100%	100%
Total Responses	<i>n</i> = 179	<i>n</i> = 179	<i>n</i> = 178

Exhibit 2 Effects of Remediation Status on Investor Risk Perceptions

Notes: 95% Confidence interval shown below each parameter estimate. Kruskal-Wallis Test using Wilcoxon Scores:

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Analysis of Variance:	Among Mean Square (Cleanup Status):	59.643
	Within Mean Square (Error):	0.304
	F-value:	196.194
	<i>p</i> -value:	0.001
Kendall = $s tau_b correla$	tion coefficient = -0.60 (<i>p</i> -value = .001)	

59.2% of the before cleanup responses. However, there were a large number (35.2%) of the respondents who would invest at this stage, but with adjustments. In the second stage of the remediation cycle, the pattern shifts, with generally lower perceived risk. A majority (69.3%) of the investors perceived environmental-related investment risk as higher than normal, but at a level that could be compensated by price discounts and/or additional risk premiums in return requirements. Over one-fifth of the respondents perceived investment risks due the groundwater contamination to have returned to normal at this stage. Thus, with an approved remediation plan underway, investor concerns subside. The regulatory threshold is an important determinant of the level of investment risk for contaminated properties. Unknown remediation requirements and/or an unapproved plan in the before stage would deter many, but not all, investors from proceeding with an acquisition that would otherwise meet their requirements.

In the third, or after, stage of the remediation cycle, the reduction in risk is again evident in the findings presented in Exhibit 2. Over 60% of the respondents consider risk levels to be at normal levels for properties in this condition. Less than 1% views the reference property as having a very high level of investment risk at this stage. Thus, the majority (62.4%) of the investors indicated that a commercial or industrial property that was the source site for groundwater contamination would generally have a normal level of perceived investment risk subsequent to its remediation to regulatory standards. However, perceived risk has not diminished for all investors, but the central tendency is that it has. A number of respondents (37.1%) view the reference property as having higher than normal risk, but risk that can be compensated for by adjustments to investment criteria. These adjustments will be discussed in a later section of this paper.

The information in Exhibit 2 also presents the results of formal statistical tests that can be used to accept or reject the null hypothesis that the stage of the remediation cycle has no effect on perceived risks. The non-parametric Kruskal-Wallis test, with Wilcoxon rank sum scores, producing a chi-square test statistic of 225.27, indicates that the null hypothesis can be rejected at the .001 level. Further, an analysis of variance resulted in an *F*-Statistic of 196.19, which is also significant at the .001 level. Thus, the null hypothesis can be rejected in favor of the research hypothesis that the remediation stage does effect investor risk perceptions due to environmental groundwater contamination. Finally, the direction of the relationship between perceived risk and the remediation life cycle can be statistically tested with Kendall's tau_k correlation coefficient. The tau_k coefficient of -0.60, with a *p*-value of .001, indicates a statistically significant relationship between risk and cleanup status, with risk significantly decreasing over the three-stage lifecycle. The negative coefficient corresponds to the higher percentage of responses along the main diagonal from lower left to upper right in Exhibit 2. Therefore, the first set of research hypotheses are supported by these findings.

Comparisons to Lender Risk Perceptions

As noted, Jackson (2001) conducted a survey of commercial and industrial lenders that paralleled the investor survey presented herein. The lender survey also focused on groundwater contamination at source site commercial and industrial properties. Exhibit 3 compares the findings from the two surveys with respect to changes in perceptions of environmental risk over the remediation cycle. In the comparisons in Exhibit 3, investors are shown to generally perceive less risk than the lenders. In the before cleanup condition, 93.2% of the lenders perceive very high risk and would not make a loan, while a significantly lower 59.2% of investors perceive very high risk during this period. Further, 35.2% of investors compared to only 5.5% of lenders perceive higher than normal risk, where a loan or an acquisition would be made, but with some adjustments to the lending or investment criteria, in the before condition. In the during cleanup period, over 20% of the investors perceive normal level of risk, compared to only 6.4% of the lenders. On the other hand, 39.4% of the lenders perceived very high risk during this period, compared with only 10.6% of the investors. In the after cleanup period, the differences in the perceptions of the two sets of market participants are less pronounced. The differences between the percentages of lenders and investors perceiving normal or high risk is within the margin of error of the two surveys. Overall, risk perceptions for both lenders and

	Investors (%)	Lenders (%)	t-Statistic ^a
Before Cleanup			
Normal level of investment or lending risk	5.6	1.3	-2.31
Higher than normal investment or lending risk	35.2	5.5	-7.66
Very high level of investment or lending risk	59.2	93.2	8.43
During Cleanup			
Normal level of investment or lending risk	20.1	6.4	-4.05
Higher than normal investment or lending risk	69.3	54.2	-3.17
Very high level of investment or lending risk	10.6	39.4	7.32
After Cleanup			
Normal level of investment or lending risk	62.4	65.3	0.61
Higher than normal investment or lending risk	37.1	30.5	-1.40
Very high level of investment or lending risk	0.6	4.2	2.57

Exhibit 3 A Comparison of Lender and Investor Perceptions of Environmental Risk by Remediation Status

Notes: All differences between lender and investor risk perceptions in the before and during cleanup condition are statistically significant. In the after cleanup condition, the only significant difference is in the very high risk category. Source for the lender survey data is Jackson (2001). ^a *t*-Statistic for difference between investor and lender perceptions.

investors significantly decline during this stage, with 95.8% of the lenders and 99.5% of the investors indicating a normal or high level of risk, suggesting that a previously contaminated property would be marketable and capable of obtaining debt and equity financing at this stage.

Exhibit 3 also shows *t*-Statistics calculated for the differences between the two sets of survey results. These *t*-Statistics use an approximate *t*-test for independent samples with unequal variances as originally described by Welch (1938). The results indicate that all of the differences between the environmental risk perceptions of the lenders and investors in the before cleanup and during cleanup conditions are statistically significant. In the after cleanup condition, only the differences in the very high risk category were significant.

Effects of Prior Experience

Exhibit 4 presents an analysis of the effect of previous experience in considering a contaminated property on the investor risk perceptions. This analysis is based upon the survey question asking respondents whether they had "ever considered investing in or acquiring a commercial or industrial property with environmental problems." If the research hypothesis that this prior experience reduced perceived environmental risk were true, then the group that answered yes to this question would perceive less risk across the remediation cycle. The analysis in Exhibit 4 generally supports this hypothesis. In all three of the stages, those with prior experience perceived less risk in the "very high" risk category than those without such experience. Similarly, those

	Previously Considered Investing in Contaminated Property (%)	Had Not Previously Considered Investing in Contaminated Property (%)	Effect of Previous Experience on Perceived Risk
Before Cleanup			
Normal level of investment risk	5.8	5.3	Decrease
Higher than normal investment risk	38.3	28.1	Increase
Very high level of investment risk	55.8	66.7	Decrease
During Cleanup			
Normal level of investment risk	20.0	17.5	Decrease
Higher than normal investment risk	70.0	70.2	Slight Decrease
Very high level of investment risk	10.0	12.3	Decrease
After Cleanup			
Normal level of investment risk	63.3	58.9	Decrease
Higher than normal investment risk	36.7	39.3	Decrease
Very high level of investment risk	0.0	1.8	Decrease

Exhibit 4 Effect of Previous Experience in Considering a Contaminated Property Investment on Investor Risk Perceptions by Remediation Status

Notes: All differences are in the hypothesized direction (previous experience with contaminated properties decreases perceived risk) except for those perceiving higher than normal risk in the before cleanup condition. Based on 120 investor respondents who indicated they had "considered investing in or acquiring a commercial or industrial property with environmental problems" and 57 respondents who indicated that they had not, or 177 total respondents.

with prior experience perceived greater "normal" risk in all three stages. The pattern is less clear in the middle category, "higher than normal" risk, but the percentages in this category are a function of the changes in the other two categories. In the before cleanup stage, 38.3% of the prior experience group perceived higher than normal risk while 28.1% of those without this experience perceived higher than normal risk. In the during cleanup and after cleanup stages, a lower percentage of the group with prior experience perceived higher than normal risk, supporting the hypothesis that prior experience tends to reduce perceived risk.

Exhibit 5 presents a further analysis of the effect of prior experience on investor risk perceptions. This analysis is based on the subset of investors who had previously considered a commercial or industrial property with environmental problems and who had actually proceeded with the acquisition. The survey question was a follow on, asking: "Did you invest in or acquire the property?" As can be seen in Exhibit 5, the perceived risk reducing effect of this prior experience is more pronounced than is the type of experience in Exhibit 4. In all of the remediation categories except one, the investors who had acquired a contaminated property perceived less risk than those who had considered such an acquisition but had not proceeded with it. The one category that did not show this pattern was "very high" investment risk for

	Previously Invested in Contaminated	Had Not Previously Invested in Contaminated	Effect of Previous Experience on
	Property (%)	Property (%)	Perceived Risk
Before Cleanup			
Normal level of investment risk	5.4	3.4	Decrease
Higher than normal investment risk*	33.9	44.1	Decrease
Very high level of investment risk	60.7	52.5	Increase
During Cleanup			
Normal level of investment risk	23.2	17.0	Decrease
Higher than normal investment risk*	67.9	71.2	Decrease
Very high level of investment risk	8.9	11.9	Decrease
After Cleanup			
Normal level of investment risk *	67.9	57.6	Decrease
Higher than normal investment risk	32.1	42.4	Decrease
Very high level of investment risk	0.0	0.0	

Exhibit 5 Effect of Previous Experience in Acquiring a Contaminated Property on Investor Risk Perceptions by Remediation Status

Notes: All differences are in the hypothesized direction (previous experience with contaminated properties decreases perceived risk), except those perceiving very high risk in the before cleanup condition. Based on 56 investor respondents who indicated they had "considered investing in or acquiring a commercial or industrial property with environmental problems" and further that they had "invested in or acquired the property" and 59 respondents who indicated that they had not acquired the property, or 115 total respondents.

*Indicates responses from the two largest national investors who specialize in contaminated properties.

contaminated properties before cleanup. Perhaps the prior experience of these investors indicated that before cleanup (and without an approved cleanup plan) these properties have a very high risk, and as suggested in the data, a higher risk than that perceived by those without actual experience owning or acquiring such properties.

As noted, the respondents to the investor survey were selected from a pool of individuals with general commercial investment experience and duties. In recent years, a group of investors specializing in contaminated properties has emerged (see Jackson, 1997). These specialists acquire contaminated property prior to cleanup, finance the remediation, hold it during cleanup and sell it in the after cleanup stage. The properties are acquired at very high capitalization rates in the before cleanup stage and sold with capitalization rates at or near market levels in the after cleanup stage (see Jackson, Dobroski and Phillips, 1997). To compare the perceptions of these specialist investors with the more general pool of commercial real estate investors from the survey, representatives of the two largest contaminated property/brownfield firms were contacted and asked the questions about perceived risk before, during and after cleanup. Again, the questions were predicated on the assumptions that the property was an income-producing commercial or industrial property that was the source site

for groundwater contamination. The responses of the two specialist investors are noted in Exhibit 5 by the asterisks. As can be seen, these investors perceived higher than normal risk before and during cleanup and normal risk in the after cleanup stage. Compared to the non-specialist investors, the specialists perceived less risk before cleanup but otherwise their responses were consistent with the general pattern of the non-specialist investors. Of course, in the before cleanup stage, a "very high" level of perceived risk corresponded to a level so high that the property would not be acquired, and the business of these specialist investors is to acquire such properties.

Effects of Market Conditions

The effect of strong market demand on investor risk perceptions for contaminated commercial and industrial property over the remediation cycle is analyzed in Exhibit 6. Statistical tests of the effect of market conditions on investor risk perceptions before cleanup in Exhibit 6 utilize a mean scale score and a *t*-test of its difference from zero, or no effect. The mean scale score in the before condition with strong market demand is slightly less than zero at -0.09, but since this is significant at the .05 level, the null hypothesis of no effect can be rejected at this level. In the during and after remediation stages, the *t*-Statistics for strong market demand are significant at the .001 level and also indicate that the null hypotheses can be rejected in favor of the research hypothesis that strong market conditions effect the risk perceptions of investors relative to contaminated commercial and industrial property. The direction of the effect, as shown in Exhibit 6, is a reduction in perceived risk, with greater percentages of respondents indicating a reduction in risk rather than an increase. Interestingly, the reduction in risk due to strong market conditions increases over the remediation cycle, with a greater relative effect in the later stages of the lifecycle, as the property's

	Before Cleanup	During Cleanup	After Cleanup
Reduce the risks of investing in or acquiring the property, Scale $= -1$	25.6% (<i>n</i> = 46)	41.7% (<i>n</i> = 75)	60.3% (<i>n</i> = 108)
Not effect the risks of investing in or acquiring the property, $Scale = 0$	58.3% (<i>n</i> = 105)	48.9% (<i>n</i> = 88)	35.2% (<i>n</i> = 63)
Increase the risks of investing in or acquiring the property, Scale = 1	16.1% (<i>n</i> = 29)	9.4% (<i>n</i> = 17)	4.5% (<i>n</i> = 8)
Total Percentage	100%	100%	100%
Total Responses	(<i>n</i> = 180)	(<i>n</i> = 180)	(<i>n</i> = 179)
Mean Scale Score	-0.09	-0.32	-0.56
<i>t</i> -Statistic for effect of market conditions $(H_0: Mean Scale Score = 0)$	-1.98	-6.79	-12.86
<i>p</i> -value	0.049	0.001	0.001

Exhibit 6 Effects of Strong Market Demand on Investor Risk Perceptions

Note: Strong market demand for similar properties in the general market area.

remediation is approved and completed. There is, though, a statistically significant effect on risk from strong market conditions in each of the three stages, supporting the hypotheses that market conditions have a significant intervening effect on perceived risk and that strong market conditions reduce or mitigate these risks.

The research hypothesis is also supported by the results in Exhibit 7, which depicts the increase in risk due to contamination across the remediation cycle due to weak market conditions. The adverse effects of weak market conditions are most pronounced in the before cleanup stage, where 77% of the investors indicated that they increase risk due to groundwater contamination. This was also the stage with the greatest general risk, as was shown in Exhibit 2. The adverse intervening effect of weak market conditions on perceived risk is less strong in the later stages of the cleanup cycle. As explained, strong market conditions had an increasingly positive intervening effect over the remediation cycle. For weak market conditions, the *t*-Statistics of 19.9, 14.2 and 8.8 for the three stages, respectively, indicate that the effect remains significant, though, across the lifecycle. Thus, the null hypothesis can be rejected at the .001 level, with strong statistical support for the research hypothesis that these market conditions have a significant impact on investment risk due to groundwater contamination.

Adjustments to Investment Criteria

In Exhibit 2, the middle risk category, higher than normal level of investment risk, corresponded to an acquisition or investment in a contaminated commercial or industrial property in which (the price would be discounted and/or investment criteria adjusted.@ Exhibit 8 presents a list of potential investment adjustments ranked by frequency of selection by the investor survey respondents.

	Before Cleanup	During Cleanup	After Cleanup
Reduce the risks of investing in or acquiring the property, Scale $= -1$	2.8% (<i>n</i> = 5)	5.6% (<i>n</i> = 10)	10.1% (<i>n</i> = 18)
Not effect the risks of investing in or acquiring the property, $Scale = 0$	20.1% (<i>n</i> = 36)	26.3% (<i>n</i> = 47)	35.4% (<i>n</i> = 63)
Increase the risks of investing in or acquiring the property, $Scale = 1$	77.1% (<i>n</i> = 138)	68.2% (<i>n</i> = 122)	54.5% (<i>n</i> = 97)
Total Percentage	100%	100%	100%
Total Responses	(<i>n</i> = 179)	(<i>n</i> = 179)	(<i>n</i> = 178)
Mean Scale Score	0.74	0.59	0.44
<i>t</i> -Statistic for effect of market conditions $(H_o: Mean Scale Score = 0)$	19.95	14.19	8.81
<i>p</i> -value	0.001	0.001	0.001

Exhibit 7 Effects of Weak Market Demand on Investor Risk Perceptions

Note: Weak market demand for similar properties in the general market area.

	Percentage	n
Discount/reduce the acquisition price	84.2	155
Require indemnifications from a financially responsible third party against all future costs of remediation	66.3	122
Increase the overall rate of return	52.7	97
Seek environmental insurance to cover unforeseen increases in estimated remediation costs	48.9	90
Increase the overall discount (property IRR) rate	41.8	77
Increase the cash on cash (equity dividend) rate	36.4	67
Increase the equity (leveraged) discount (yield) rate	21.7	40
Would either invest/acquire the property or not without any adjustments	3.8	7

Exhibit 8 Adjustments for Increased Investment Risks Due to Environmental Contamination

Note: Percentages do not sum to 100% since more than one adjustment was selected in many cases. The responses are from 184 investors.

As can be seen in Exhibit 8, most, or 84.2%, of the investors would discount the acquisition price of the property. This is generally equivalent to increasing the required overall rate of return, which was selected by 52.7% of the respondents. Indemnifications ranked second and were selected by about two-thirds of the respondents. Environmental insurance was selected by nearly one-half (48.9%). Adjustments to the property internal rate of return (IRR) and the equity dividend and yield rates were also selected by many respondents as appropriate adjustments for environmental risk. As previously explained, property value impacts can result from adjustments to investor criteria through environmental risk premiums added to income capitalization rates and/or discount or yield capitalization rates. These at higher rates reflect greater perceived risks. Investors will require a risk premium and a corresponding higher rate of return for investing in contaminated properties, where such properties are perceived to have greater risk. Without any corresponding changes in property income, these rates of return adjustments would also reduce the acquisition price. The particular rate-property IRR, equity yield, equity dividend, or overall rate—probably reflects the individual investor's preferences for investment analysis.

Summary of Findings

Effects of Remediation Status

Investor risk perceptions were shown to decline as contaminated commercial and industrial properties attain an approved cleanup plan and then are remediated to appropriate regulatory standards. As was shown in Exhibit 2, the majority (59.2%) of the investors would not acquire a contaminated commercial or industrial property before cleanup even though the property otherwise met their investment criteria. During cleanup, 69.3% would acquire the property but at a discounted price. After

cleanup, 62.4% would acquire the property without any adjustment. The statistical significance of these results was tested with a Kruskal–Wallis test and an analysis of variance and with *t*-tests for differences in means within risk bands from one period to the next. All of the tests were significant at acceptable levels, and the null hypothesis was rejected in favor of the research hypothesis that investor risk perceptions vary with remediation status. The investor survey results are similar in direction and pattern to those of Syms (1996) concerning the perceptions of market participants in the U.K. with respect to environmental risk and property value impacts before and after cleanup.

Comparing lenders and investors, as was shown in Exhibit 3, investors perceived less risk than lenders before and during cleanup, and these differences were statistically significant. In the after cleanup period, the risk perceptions of lenders and investors were generally the same, except that the small percentage of lenders still perceiving very high risk (4.2%) was significantly higher than investors (0.6%). The equity investor is typically in a higher risk position than the mortgage lender since the lender has a prior claim and lien against the property. For this higher level of risk, the investor will seek a higher compensating return. It is this return requirement that would also increase by a risk premium corresponding to the perceived risks due to contamination.

Effects of Prior Experience

The analysis of prior experience in considering a contaminated commercial or industrial property for acquisition and in acquiring it found that in general this experience tends to reduce perceived environmental risk. As such experience is acquired, greater knowledge of and about contaminated properties and their remediation is gained and this knowledge translates into less uncertainty and risk for these investors. Having gone through the due diligence required to consider such an acquisition, these investors can better understand and perhaps quantify the true levels of risk involved with a contaminated property investment. Further, the results of the investor survey were compared to the perceptions of two investors who specialize in the acquisition and remediation of contaminated properties. These specialist investors perceived less risk in the before cleanup stage than the non-specialists but otherwise their perceived risk levels were consistent with the general pattern of the nonspecialists. The majority of the non-specialists and both of the specialist investors perceived a normal level of investment risk subsequent to cleanup.

Effects of Market Conditions

The findings on market conditions indicate that strong general market conditions tend to mitigate perceived environmental risk while weak conditions exacerbate these risks. These effects were addressed through a series of scenarios in the survey questionnaires in which the investor respondents indicated whether strong and weak market demand in the general market area would increase, decrease or not affect investment risk for contaminated commercial and industrial properties before, during and after cleanup. The effects of strong market conditions in reducing investment risk for contaminated properties before cleanup was significant at the .049 level, with a *t*-Statistic of -1.98.

For the other five scenarios the risk reducing effect of strong market conditions and the risk increasing effect of weak market conditions were significant at the .001 level. The null hypothesis was rejected in all six scenarios in favor of the research hypothesis that market conditions have a significant effect.

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