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**DECISION ANALYSIS AND THE
DEVELOPMENT OF CONTAMINATED LAND**

by

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ABSTRACT

This thesis outlines a framework, that may be used by real estate developers, to systematically weigh the environmental risk associated with site contamination.

Successfully assuming environmental risk requires both technical sophistication and shrewd balancing of costs and benefits. Yet, many real estate developers and investors seem to approach this problem in an irrational manner. Properties are either bought with little or no environmental assessment, or companies refuse to purchase "suspected" property at any price. The framework presented provides an analytical decision model which can be applied to this problem.

To aid real estate developers with their generally limited knowledge of environmental issues, a brief survey of current technical information is provided. Along with two case studies, this information portrays the current thinking regarding environmental risk. Analysis of the case studies using the decision model, illustrates areas of potential risk miscalculation. Analysis indicates that risk associated with the uncertainty of an event happening is more volatile than that associated with uncertain costs. It is concluded that environmental risk is substantial, and should usually only be assumed when the contaminant is well-known and well-documented, when the polluter is known and well-capitalized, and when the market value of the remediated site is significant.

The decision model is general and may be applied to problems other than site contamination; it is hoped that its' use will result in better decision making.

Thesis Supervisor: Michael Wheeler
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CHAPTER I

INTRODUCTION TO SITE CONTAMINATION

1.1 Sources of Environmental Contamination.

Environmental contamination originates from either naturally occurring sources or as a result of society's activities. The primary difference between the two sources is that naturally occurring toxins are usually from a single source and anthropogenic toxins commonly have multiple origins. Many anthropogenic contaminants do not have natural source equivalents.

Nature is not benign.¹ Long before humans began polluting their environment at today's rate, sites were inappropriate for human habitation. Contamination of streams and lakes from natural source metals has been well documented.² Also, natural source radon has also been shown to be a major source of public exposure to ionizing radiation.³ While these natural source contaminants are hazardous to human health, regulations do not hold land owners responsible for them.

Most current concern and regulation regarding contamination of the environment is focused upon anthropogenic source toxics. As a nation, the United States uses more than 62,000 chemicals in industry, agriculture, and the home.⁴ The Environmental Protection Agency (EPA) estimates that 2,000 new chemical substances are introduced each year. Testing facilities world-wide are only capable of evaluating about 300 of these chemicals for toxicity, and as this is far less than the number introduced, the number of toxic substances is not known.

¹L. Lave and A. Upton, Toxic Chemicals, Health, and the Environment, (Baltimore: The Johns Hopkins University Press, 1987), p. 8.

²B. Freedman, Environmental Ecology, (Toronto: Academic Press, 1989), p. 57.

³Lave & Upton, p. 207.

⁴Lave & Upton, p. 207.

Even among those tested, there is disagreement as to the results.⁵ Therefore, without an estimate of how many toxic substances there are, there can be no clear picture as to the actual volume of toxic substances used annually.

In the U.S., more than six-billion tons of waste is generated annually, of which at least 250 million tons is hazardous.⁶ The EPA considers a substance to be hazardous waste if, when tested, it meets one of the following criteria: ignitability, corrosivity, reactivity or toxicity.⁷ The land is the final resting place for the majority of these wastes.⁸

With few exceptions, anthropogenic sources of toxic substances can be classified as originating from one or more of the following activities.⁹

- A. Mining or extraction of ores or biomass.
- B. Production and manufacturing of goods, products, and energy.
- C. Transportation of raw materials, goods, products, and wastes.
- D. Consumer uses of goods and products (includes farming).
- E. Disposal of wastes.

This classification of sources is useful for real estate developers because the human activity generating the toxic substance is tied to the site's former land use.

1.2 Land Use History and Site Contamination.

In an absolute sense, there is still a large amount of land that is unbuilt upon in the United States. While this land is not being used for human habitation, most of it is being used for human activities (e.g., agriculture, forestry, and resource extraction). All other things being equal, developers would prefer sites not previously used by any activity. However, these "clean" sites are relatively rare. Available sites have

⁵Lave & Upton, p. 282.

⁶N. Myers, Gaia, an Atlas of Planet Management, (Garden City, N.Y.: Anchor Books, 1984), p. 122.

⁷Resource Conservation and Recovery Act, 42 U. S. C. § 6921(a), (1982).

⁸Interview with Dr. J. Ehrenfeld, MIT, Cambridge, MA, June 1990.

⁹Lave & Upton, p. 11.

varying degrees of "contamination" or human impacts based upon their former or adjacent land use. Sites range in relative toxicity from fairly polluted former industrial plants to forestry lands mildly sprayed with pesticides. Today, due to a shortage of "clean" sites, these otherwise undesirable properties may begin to look attractive because of their proximity to transportation, labor supply, and markets, as well as their low cost. A brief overview of some of these sites follows.

Past industrial practices have had a considerable effect on land use within U.S. cities. Due to high transportation costs, the most valuable property for industry was located immediately adjacent to the city's waterfront (access to shipping) and/or central core (access to railway yards). These locations were desirable because they minimized the distance goods were transported from ship to factory or between markets. During the latter half of this century, transportation costs decreased while the value of urban land increased and assembly line production facilities (which require large parcels of land) became the norm. In response, most manufacturers relocated their factories out of downtown areas and closer to two increasingly more important factors of production: labor, and large tracts of inexpensive land.¹⁰

With the exodus of industry from the inner city, many manufacturers left behind a legacy of contaminated property - one that only now is beginning to be understood. Some of these properties occupy prominent urban locations; more may be found in the rapidly expanding suburban fringes. Hoboken, New Jersey, located on the Hudson River within a 20-minute commute of Midtown Manhattan, is an example of former industrial land that could be extremely valuable if it were less contaminated. Instead, this property is undervalued and primarily used for warehouses and storage facilities.¹¹ Planners recognize that if the downtowns of cities are to continue to be viable entities, these contaminated sites cannot be fenced off and left to fallow, they must be re-used. Developers are currently evaluating sites in the Hoboken area; for them the developed value of this land may be worth the clean-up costs and associated environmental risks.

Agriculture is actually one of the leading sources of hazardous waste generation in

¹⁰ W. Wheaton, class notes in "Real Estate Economics", MIT's Center for Real Estate Development, 1990.

¹¹ Interview with Gordon Duus, Margolis Chase, Verona, NJ, July 1990.

the U.S.¹² Since 1950, agricultural production has been increased through mechanization and the application of pesticides. As cities expand, agricultural land on the fringe of the city becomes very desirable for developers, since they can afford to pay prices that exceed the land's value when used for agricultural production. Today, an unwary developer can find extreme soil and/or ground water contamination on a site that on the surface looked "safe". An example is an apple orchard near Amherst, Massachusetts, that had soil concentrations of lead and arsenic equal to that found at sites of lead contaminating industries.¹³

Resource extraction activities are also a large source of hazardous waste. While most of these sites are located great distances from centers of commerce, and thus often less valuable for development, this is not always the case. Gravel, stone, and clay quarries, in particular, are commonly found within city boundaries. Also, many cities that were founded around mineral resource extraction have gone on to be viable cities once the extraction is complete. Forestry sites are also commonly desirable for expanding cities. While most of these resource extraction sites have been exposed to only low levels of pesticide application, there are exceptions.

Finally, there is a full range of legal disposal sites ranging from sanitary landfills to radioactive materials storage areas. Again, as cities expand, landfills often become valuable property. An example is North Waterfront Park in Berkeley, California. This 90-acre former sanitary landfill site is in the San Francisco Bay, and has sweeping views of the City of San Francisco and the Golden Gate Bridge. Many cities have large sections built upon "urban fill"; landfill of unknown source. This "urban soil" can be quite toxic itself, and may have been placed on top of former industrial or resource extraction land. All former landfills are a concern to developers because of the usually poor records of disposal activities. Also, landfill sites are easy targets for illegal dumping because of the difficulties involved in screening waste and controlling activities.

The problem of land contamination is not limited to those sites with a previous incriminating land use. Because of the ability of contamination to spread, all sites should be suspected. One study measured lead contamination in a high elevation

¹²Lave & Upton, p. 207.

¹³Freedman, p.63.

Vermont forest and found very high soil concentrations that were continuing to increase. The study hypothesized that direct cloud deposition of air contaminants from the industrialized New York area was causing the problem.¹⁴ Similarly, high lead, copper and zinc concentrations have been found in soils along highways.¹⁵ In these cases, the metals are emanating from the adjacent land use and are caused by automobile exhaust, tires and brakes.

Other sites without a questionable former land use may be contaminated by illegal or historical dumping. More "innocent" infringements include oil storage drums buried to circumvent World War II rations, as well as common household cleaners and paints that were thrown away in backyards. However, the extent of illegal dumping of hazardous waste by companies is still being discovered, and these sites number heavily on the Superfund list. They are particularly worrisome to the real estate developer because they are often difficult to detect and can have massive clean-up costs associated with them. An example is a developer in Virginia who wanted to buy a piece of property for a shopping mall. When the bank insisted on soil samples, the developer tested and found lead. Eventually, after searching records it was discovered that the property had once been the site of a Civil War ammunitions dump. The cost of clean-up was estimated at two million dollars and the developer abandoned the project.¹⁶

Finally, the sale and transportation of hazardous waste is a burgeoning business; it is also one that can contaminate land. An excellent current example is East Germany which has been importing five million tons of hazardous waste annually from West Germany in order to gain "hard currency".¹⁷ As regulations tighten in one area or region, the pressures on other regions are increased. In the United States, four billion tons of hazardous materials are transported annually; one-half of this on highways.¹⁸ Estimates of the number of spills vary: The National Academy of Sciences has estimated that approximately 16 thousand spills occur

¹⁴T. G. Siccama and W. H. Smith, "Lead accumulation in a northern hard wood forest," Environmental Science Technology, Vol. 12 (1978).

¹⁵Freedman, p. 79.

¹⁶J. Jaben, "Environmental Risk Problems and Liabilities Rising; Laws, Regulations Evolving to Deal with Situations," National Real Estate Investor, (September 1989), p. 74.

¹⁷H. French, "A Most Deadly Trade", World Watch, (July/August 1990), p. 11.

¹⁸Lave & Upton, p. 13.

annually; the EPA has estimated that approximately 38 gallons of every 200 fifty-five-gallon drum shipment is lost.¹⁹ For developers, the message is *caveat emptor*.

As illustrated, there are many possible sources and land uses that result in the contamination of property. The broad scope discussed was intended to illustrate the extent of the problem, and to show that real estate developers must be wary of many sites previously assumed to be benign. Of all the land uses, industrial sites are the most obvious sources of contamination. Perhaps for this reason, and also because in the past they have been the worst offenders, industrial sites have been the focus of the bulk of research and regulation concerning site contamination. This paper will focus on industrial sites for this reason. It should not be forgotten, however, that other former land uses can lead to equally contaminated sites.

1.3 Recycling Land.

The current practice of treating land as disposable - using it, and then moving on to "clean" land once it has been used - is unsustainable in the long run. Land is a non-renewable resource. Globally, the human population is expanding and therefore the demand for a shrinking quantity of "clean" land is increasing. An obvious solution is to recycle contaminated land.

European countries such as England, the Netherlands and West Germany are currently working on technologies and legislation to make possible and encourage the re-use of land. The small land mass available in these countries obviously fuels this approach, however, it is probably only a matter of time before the re-use of land becomes an important issue in North America. Here, the memories of Love Canal and the still growing public concern for a safe environment may further encourage the clean-up and responsible re-use of contaminated sites.

When recycling land, there is always another component to the development process - the site's previous land use. Determining the site's highest and best "recycled" use must take into account, and will in part be determined by, its previous use.

¹⁹Lave & Upton, p. 13.

CHAPTER II

RESEARCH METHOD

2.1 A Method for Making Decisions.

How do real estate developers and investors make decisions when contamination is encountered during the development process? What are the key variables used to decide whether or not to proceed with the venture once contamination is discovered? Is there a willingness to pay for additional information about the site contamination, and if so, how much? At what point do ventures proceed without additional information, and when are, or should, they be abandoned? Does the increased legal liability associated with developing tainted land preclude its re-use, or simply depress its value? The answers to these questions outline the territory to be explored in this paper.

There is a growing, although fragmented, body of law and experience on environmental liability and site remediation techniques. This information may be integrated with a method of decision analysis in order to provide an analytical model for real estate developers and investors to use when considering the development of contaminated land. A goal, therefore, is the outlining of this analytical model. The model should provide a framework to help real estate developers and investors systematically weigh environmental risks, and thus arrive at individual answers to the questions posed above. It is also hoped to encourage better decision making.

Although there are many useful tools available to help a real estate developer make decisions, very few of them are used on a consistent basis, if they are used at all. Those that are used, are generally financial in nature. These include a variety of sophisticated analytical tools which incorporate market and interest rate risk into the decision making process (e.g., discounted cash flow analysis, linear regression

models, and Monte Carlo simulations).²⁰ Many of these models represent a “catching-up” to more state of the art finance techniques used on Wall Street.

As the real estate industry moves towards professionalism, and as the market becomes ever more competitive, the use of sophisticated methods of analysis, including linear regression, may well increase. Insurance companies and pension funds (institutional investors), a growing segment of the real estate market, are generally not willing to make decisions based solely upon intuition. The sheer size of their investments, along with a fiduciary responsibility, make this so. For these groups, and possibly for all parties in the real estate industry, rigorous analysis will ultimately supplant the attitude of “flying by the seat of your pants”.

Like market and interest rate risk, environmental risk has a large cost associated with a poor decision. In addition, however, there is a potentially enormous legal risk. These two factors should undoubtedly suggest the necessity, and perhaps foretell of a future trend, towards a more sophisticated decision making process. Indeed, this is the justification for this thesis. It is hoped that it may serve as a resource to help developers, and other decision makers in the real estate industry, make better decisions when confronted with the issue of land contamination.

2.2 Outline of Chapters.

In the first Chapter, the relationship between land use and contamination was surveyed. This survey was broad based and general. It intended to paint a wide picture of the issues and give specific examples of them. The possible implications of land contamination on the future of our cities was also introduced. These issues potentially affect all aspects of development. However, in order to focus this paper, the following chapters will concentrate only on industrial land uses in the United States.

Chapter 3, which follows, outlines some of the more technical aspects of developing contaminated land and decision making. These are subjects that a

²⁰P. Byrne and D. Cadman, Risk, Uncertainty and Decision-making in Property Development, (New York: E. & F. N. Spon, 1984), p 27.

decision maker must be conversant with in order to be effective in this venture. They include: the legal ramifications of owning contaminated land; an outline of industries that are known to pollute; some common forms of contamination; methods engineers have developed to remediate contaminated sites; and, some basic concepts of decision analysis. There is an extensive literature available on all of these topics. The inclusion of this information is to help the reader who is unfamiliar with the subject matter; it is not intended to be a primer. A reader already familiar with these subjects should feel free to move forward.

Chapter 4 presents two case studies. Their inclusion is intended to provide instructive insights into how some people view the environmental risks associated with contaminated land. The first case study looks at a company that is underwriting environmental liability insurance. By analyzing how the company decides which sites are insurable, insight into the variables that determine environmental risk, as well as their magnitude, may be gained. The second case study is about a real estate developer who purchases a former gasoline station site which is contaminated. It was selected because an underground storage tank is one of the more common sources of site contamination. This case study also provides the example to test the analytical model developed in Chapter 5.

Chapter 5 integrates the technical material outlined in Chapter 3, some basic decision analysis concepts, and the results of interviews with professionals in the environmental field, in order to present a decision making methodology for dealing with contaminated land. Decision analysis is not a new technique for solving complex problems. However, the application of this technique should provide a framework for developers to rigorously assess this complex and risky problem. Finally, in Chapter 6, some generalizations about the decisions currently being made by developers when they encounter contaminated land, and speculations about future decisions, are presented.

CHAPTER III

TECHNICAL INFORMATION

3.1 The Legal Implications of Owning Hazardous Real Estate.

3.1.1 Environmental Law.

Public awareness of the health risks posed by hazardous waste has increased in part due to the publicity associated with Love Canal and Times Beach. To address these concerns, Congress, in 1980, enacted the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). This legislation was intended to handle emergencies arising from the release of hazardous substances, to provide long-term clean-up for a limited number of other sites, and to encourage more responsible disposal of hazardous substances in the future. The purpose of the Act was to establish a mechanism through which the government would have the authority and funds necessary to clean-up contaminated sites and then recover the costs from statutorily identified sources. CERCLA was initially authorized for a five year period and was financed by \$1.6 billion in taxes (a "Superfund") levied from petroleum and chemical manufacturers. In 1986, Congress passed the Superfund Amendments and Reauthorization Act (SARA) which provided a further \$8.5 billion dollars for clean-up through 1991.

Superfund provides for two types of site clean-up. Its emergency response component is for the immediate removal of spills or abandoned materials that pose an imminent threat to human health or the environment. Its remediation component provides for the long-term clean-up and restoration of abandoned toxic waste sites. Superfund uses a liability approach to finance clean-ups. If the Environmental Protection Agency (EPA) can identify potentially responsible parties (PRPs), it tries to persuade them to undertake the clean-up themselves. If this proves ineffective, EPA may then issue "106 orders"; once these are issued, the PRPs will be held

jointly and severally liable for cleaning-up the site, and may be assessed treble damages (up to three times the actual cost). If this action fails to initiate the site clean-up, EPA will pay for it from the Superfund trust fund, and then try to recover the costs by taking the responsible parties to court. If no potentially responsible parties can be identified (i.e., an orphan site), Superfund pays for the clean-up.²¹

In addition to CERCLA, there are numerous other statutes that have been used to impose liability associated with damage to the environment. These statutes include: the Resource Conservation and Recovery Act (RCRA), which governs the management, handling, transportation and disposal of hazardous waste; the Clean Water Act, which governs the discharge of pollutants into navigable waters; the Clean Air Act, which is designed to control and prevent air pollution; and, the Toxic Substances Control Act, which provides guidelines concerning the manufacturing, processing and distribution of chemicals.²²

RCRA deserves an additional comment since it is concerned with the current and future generation of waste, and provides for “cradle-to-grave” management of such wastes. A waste that RCRA classifies as hazardous, requires a manifest to trace it’s path from origin to ultimate deposition at a treatment, storage, or disposal site. This cradle-to-grave manifest system provides a mechanism for identifying parties accountable for the waste. Also, under RCRA, all hazardous waste treatment, storage and disposal facilities must obtain permits, which include information about the composition, quantities and concentrations of wastes managed. The Act additionally requires storage facilities to maintain extensive records on the quantities, composition and location of wastes.²³ In summary, RCRA deals with current and future generation, transportation and storage of wastes, while CERCLA deals with contaminated waste sites once they have been created.

Finally, there are state, and most recently local equivalents to many of the above mentioned laws. The most notable of these is New Jersey’s Spill Compensation

²¹J. P. Acton, “Understanding Superfund, A Progress Report,” (The Rand Institute for Civil Justice, 1989), p. v.

²²C. Davidson, “Corporate Ownership of Real Estate: The Impact of Environmental Legislation on Shareholder Liability,” Real Estate Law Journal, Vol. 17, (1989), p. 292.

²³Resource Conservation and Recovery Act, 42 U. S. C. § 6901, (1982).

and Control Act. This Act actually preceded CERCLA by three years and was its model. It's subsection, the Environmental Clean-up and Responsibility Act (ERCA), requires that before certain industrial facilities are transferred or closed, they be investigated and, if necessary, remediated.²⁴ ERCA establishes a mechanism to detect and inventory the State's contaminated properties. Until the State of New Jersey has approved the site investigation, and made provision for remedial activities, if required, the sale or transfer of a property may not occur - in fact, an otherwise valid transfer can be declared void.

Once the EPA discovers a potentially contaminated site, it evaluates the site with a series of investigations (both off and on-site) designed to determine the extent of any contamination and to provide data with which to fashion a remedial response. These investigations become the basis for a report which identifies the types of waste present, estimates their amounts, and describes how they are to be disposed of or stored. The scientific data gathered are then evaluated under the EPA's Hazard Ranking System, which produces a "score" by assessing possible exposure to the hazardous substances through three pathways: ground water, surface water, and air. Specific criteria taken into account include: possible risk to human population; potential hazardous substances at a given site; potential for contaminating drinking water supplies and other pathways that affect human health; and, potential for destruction of sensitive ecosystems.²⁵ EPA is specifically interested in the ability of wastes to migrate off-site. Any site which scores high enough is included on the National Priorities List (NPL), which is a list of sites designated for clean-up.

In contrast, sites which do not score high enough to be placed on the NPL, as well as sites suspected of contamination which have not yet been evaluated, may be placed on the CERLIS (CERCLA Information System) list. The CERLIS list is mainly an informational database developed by the EPA to aid in the management of the Superfund program. When a site is listed on the National Priorities List, an owner may have additional and heightened legal duties, including disclosure of the listing to potential purchasers. However, a CERLIS listing carries with it no

²⁴D. Salvesen, "Liability for Hazardous Waste Cleanups: *Caveat Emptor*," Urban Land, (April, 1988), p. 36..

²⁵EPA Federal Register, Vol. 53, No. 247, (Dec. 23, 1988), p. 51962-51965.

corresponding legal duties.²⁶ Nonetheless, a CERLIS listing should be a “red flag” to potential purchasers.

While the EPA’s focus is on those sites listed on the NPL, its authority is not limited to them. The Government may seek injunctive relief for clean-up at any site when a release or the threat of a hazardous substance release causes imminent and substantial danger.

3.1.2 Who is Liable under CERCLA?

Superfund liability has had a profound impact on real estate transactions. Though the parties to these transactions do not typically focus on Superfund liability, the failure to do so can be costly. The strict liability policy of CERCLA and its progeny requires caution on the part of sellers, purchasers, and even those parties financing these transactions. The enormous potential liability requires that the scope of contractual obligations be closely scrutinized.

Statutory liability under CERLCA extends to four categories of responsible parties:

- A. The current owner or the operator of the facility that produced the hazardous waste;
- B. Any person who owned or operated a facility at the time disposal of hazardous substances occurred at such facility;
- C. Any person who contracted or otherwise arranged for disposal of hazardous substances; and,
- D. Any person who accepted any hazardous substances for transportation or disposal.²⁷

These parties are known as Potentially Responsible Parties (PRP’s). CERCLA identifies site owners and operators, generators, and transporters of hazardous substances as those who are liable for Superfund clean-ups. This liability is strict, joint and several. This means that anyone listed above can be held liable without regard to fault (“strict liability”) for releases into the environment. Each party,

²⁶W. H. Frank and T. Atkeson, Superfund: Litigation and Cleanup, (BNA Special Report, 1985), p. 11-13.

²⁷CERCLA § 9607(a).

despite the total number involved, can be held liable for 100 percent of the site's remediation costs ("joint and several" liability). Furthermore, the time the disposal occurred has been interpreted to mean any time during which the site was/is contaminated. Even though an entity may not have actually dumped any hazardous waste, the fact that they owned the site while it continued to leak, is interpreted to mean that they have disposed of waste on the site. Among liable parties, the burden may be shared in accordance with relative contributions of wastes to the site, but the ultimate liability does not have to vary with the volume of waste contributed. Liability may be imposed at any time for past actions, even if they were legal at the time they were committed. Liability is also retroactive, reaching back to prior owners and operators.²⁸

3.1.3 Defenses Against Superfund Liability.

Defenses against liability under Superfund are limited. Besides the traditional "Act of God" and "Act of War" defenses, liability does not exist if it can be shown that a release was due to the actions of a third party. To invoke this third party defense, a PRP must show that the release was caused exclusively by an act or omission of a third party, and that the PRP was diligent in trying to prevent the release.²⁹

Superfund also allows for the innocent landowner defense if the owner acquired the property after the waste disposal occurred and can establish that acquisition was made without knowledge, or reason to know, of the disposal. Successful use of this defense requires establishing that the owner undertook, at the time of acquisition, an appropriate inquiry into the previous ownership and uses of the property consistent with good commercial customary practice in an effort to minimize liability.³⁰ The innocent landowner defense is one of the reasons for the popularity of Environmental Assessment Reports. Not only can they help screen potentially hazardous sites, but they also allow the new owner to invoke this defense if in the property is found to be contaminated after title is transferred.

²⁸A. P. Vollmann, "Double Jeopardy: Lender Liability Under Superfund," Real Estate Law Journal, Vol. 16: 3, (1987), p. 4.

²⁹W. H. Chapman, "Lenders Beware: CERCLA and Mortgagee Liability," Real Estate Finance, Vol. 3, No. 3, (Fall, 1986), p. 31.

³⁰G. McGregor, "Thorough Site Assessments Are Essential," Hazmat World, (March, 1989), p. 44.

Finally, there is the secured creditor exemption. This exemption defines the owner or operator of a hazardous site to exclude a person, who without participating in the management of a facility, holds *indicia* ownership primarily to protect his security interest in the facility. There are, however, a few cases where this exemption may be forfeited. This may occur when the secured creditor's involvement with the management of the facility is sufficiently broad to support the inference that it could effect hazardous waste disposal decisions if it so chose.³¹ The exemption may also be lost if the lender takes ownership of the property through foreclosure, as in United States v. Maryland Bank & Trust Co.³²

Lenders, in addition to running afoul of this exemption, must also worry about the existence of a superlien. This special lien has been created by the federal, and some state governments, as a cause of action to recover funds expended in the remediation process. Superliens are particularly severe because they take seniority over other liens, even if the Government does not record its lien until after other liens are recorded. While lenders are rarely fond of the creation of competing liens, even junior liens, the existence of a senior lien is often a compelling reason to refuse a loan.³³ Banks are thus leery of contaminated property. Writing off a loan is difficult enough; if a bank is also held responsible for the total clean-up costs of a property, it could be forced into bankruptcy.

To avoid confusion, only CERCLA requirements will be considered in the following text. It should be obvious, however, that a full scan of all applicable legislation should be made before purchasing a contaminated piece of property, or one that is suspected of being contaminated. In many cases State legislation may be more stringent than CERCLA. For example, most State environmental laws do not allow the innocent landowner defense.³⁴

³¹United States v. Fleet Factors Corporation, Op. N.89-8094 (11th Cir., 1990).

³²United States v. Maryland Bank & Trust Co, 632 F. Supp. 573 (D. Md., 1986).

³³H. J. Richman and T. J. Stukane, "Avoiding the Environmental Risks in Mortgage Transactions," Real Estate Finance Journal, (Winter, 1987), p. 15.

³⁴R. G. Todd, "Handling Environmental Law Concerns in Real Estate Transactions," Real Estate Review, (Spring, 1989), p. 78.

3.2 Potential Contaminants.

3.2.1 Contaminating Industries.

The environment naturally contains radioactive substances such as uranium and radon gas, organic chemicals such as benzene and toluene, and heavy metals such as lead and mercury. These naturally occurring toxic chemicals can be measured for background levels. The background level of a contaminant is the concentration in the environment assumed to be from natural sources and not harmful to human health or the environment (note that this is an assumption - background levels may still be harmful). Exposure to toxic substances is said to occur when concentrations have accumulated in individuals at levels above background. Human activities, particularly in industrial societies, have introduced countless new toxic chemicals. Most of these substances do not have natural counterparts against which to measure background levels; nevertheless, they have vastly increased the Publics' possible exposure.³⁵ Table 1, below, shows a list of these activities.

Table 1. List of "Contaminating" Industries.³⁶

Airfields	Oil refining and storage
Asbestos manufacture and use	Paints and graphics
Chemicals manufacturing	Pharmaceutical industries
Dockyards	Railway land
Explosives industry	Scrapyards
Gas works and similar sites	Sewage works and farms
Iron and steelworks	Tanning and associated trades
Metal smelting and refining	Waste disposal (Landfills)
Metal treatment and finishing	Wood preserving
Mining and extractive industries	

This list is not inclusive; all land with a history of industrial use should be suspect.

³⁵Lave & Upton, p. 1.

³⁶T. Cairney, Reclaiming Contaminated Land, (Glasgow, Scotland: Blackie and Sons Ltd, 1987), p. 3.

3.2.2 Common Industrial Contaminants.

A description of industrial source contaminants is a subject broad enough for a textbook. As a means of introduction, Appendix A describes a few of the most common groups of contaminants frequently associated with these sites. General characteristics of petroleum products are described below, however, as the second case study in Chapter 4 makes specific reference to this pollutant group.

Petroleum (crude oil) consists of a solution of hundreds of *hydrocarbons* - alkanes, alkenes and benzene derivatives (aromatics). Industrially, crude oil is separated by distillation into a variety of products. The distillation process requires boiling the crude oil over a range of temperatures, where each range gives a different product. Products include: solvents, gasoline, kerosene, lubricants, heavy oils, diesel fuel and vaseline. Of these, gasoline, and its carcinogenic derivative benzene, are two of the more common contaminants. Due to the toxic nature of benzene, in any gasoline spill, it should be the primary focus of the clean-up effort. Leaking storage tanks are a common source of hydrocarbon pollution, particularly in urban areas. EPA estimates that 25 percent or more of all underground tanks have corroded and are leaking gasoline, oil, and other hazardous substances into the ground water.³⁷

Pollutants do not respect property lines; nor do they necessarily remain chemically unaltered. It is these two characteristics that make the desired effective clean-up an uncertain event. Substances may volatilize into the air, move through the ground water to drinking water wells or streams and lakes, or fix themselves in soil or biomass. Contaminants are commonly described according to which of these four environmental "compartments" (air, water, soil, or biota) they are most likely to accumulate in. The contaminated site must also be viewed as a chemistry laboratory - one over which the experimenter has very little control over. Changing temperatures, atmospheric pressure, acidity of rainwater, etc., can chemically alter the hazardous substance, changing both its toxicity and motility.

The hydrocarbon contamination commonly encountered by the real estate industry is located in the soil and ground water compartments. The movement of hydrocarbons through soil to ground water is generally a function of the soil

³⁷G. Duus and A. Telsey, "Underground Storage Tank Update," Journal of Property Management, (March/April 1990), p. 54.

characteristics (e.g., porosity, moisture) and the physical characteristics of the compound. In general, lower molecular weight materials like gasoline move much more rapidly than do higher molecular weight materials such as motor oil. Both of these products tend to degrade slowly in soil and ground water, and migration from a leak will continue as long as there is a driving force (i.e., additional leakage, percolation of rain water from the surface, or the gradient of normal ground water movement). The actual pathway and distance of migration are difficult to predict, but increase in magnitude with time.³⁸ Therefore, the area of contamination will be difficult to delineate and thus remediate.

3.2.3 Remediation Methods

The need to clean-up a given hazardous waste site is based on several factors: the degree of contamination (extent, medium, the number of chemicals at the site, and the geographical area of coverage); the likelihood of spread; the likelihood or degree of human exposure; the intrinsic toxicity of chemicals at the site; and the overall health threat to potentially exposed populations.³⁹

When selecting remediation techniques, it is important to understand that the contamination is not going to go away. It may change its form or location, but it will not "disappear".⁴⁰ The term "clean-up" means that the contamination is chemically or physically altered to form a more benign substance, or the contamination is removed from the site, either physically carted away, or vaporized. When the contaminants are not "cleaned-up", remedial measures may be undertaken to contain the contaminants. Containment means to prevent or impede the contaminants from reaching the targets at risk. All remedial measures, either clean-up or containment, must be designed to be durable and robust. Durable, such that they continue to perform in the desired manner for the length of time required, and robust, to ensure that their effectiveness is not easily undermined by natural events such as flooding, subsidence and vegetation growth or unconscious intervention by man (e.g., excavating a foundation for a new building).⁴¹

³⁸J. Moskowitz, Environmental Liability and Real Property Transactions: Law and Practice, (New York: Wiley Law Publications, 1989), p. 21

³⁹Lave & Upton p. 208.

⁴⁰Interview with Dr. Michael Binford, Harvard University, Cambridge, MA, June 1990.

⁴¹Cairney, p. 121.

Again, because hydrocarbons are the contaminant of interest in the second case study of Chapter 4, only the remediation of soil and ground water is considered here. General remediation concepts for these two compartments are outlined. More specific information on soil venting and ground water pumping is also provided as these two methods are proposed in the case study. Some additional information about other soil remediation techniques may be found in Appendix B. It should be noted that new soil remediation methods are being developed constantly, and therefore, Appendix B should not be construed as a definitive list of all methods currently available.

There are two basic options available to remediate contaminated soil; either excavate it or leave it in place. If excavated, the contaminated material may be: deposited elsewhere (hazardous waste landfill); cleaned-up at facilities either on or off-site (primarily vaporized); or, treated to stabilize or fix the contamination (altered to a more benign form). If left in place the options are to: prevent access to the site and deal with any immediate environmental problem; contain or isolate the affected area by superimposing cover and providing ground barriers to contaminant migration, as necessary; stabilize or fixate the contaminants in-situ; or, clean-up the soil in-situ (i.e., bioremediation).⁴² Bioremediation techniques are currently gaining wide acceptance as the preferred treatment method for sites contaminated with hydrocarbon's.⁴³ Any treatment option where the contamination remains in place may require additional measures to control ground water movement, and to contain or treat leachate and contaminated ground water.⁴⁴

One of the most common remediation options for sites contaminated with hydrocarbons is to excavate the contaminated material, dispose of it, and replace it with clean fill. However, there may be problems associated with this approach, including: lack of an appropriate disposal facility; uncertainty as to extent of the contamination; and, inability to reach all of the contaminated area (e.g., the contamination may have moved under a building). In addition to these problems, under CERCLA, a person who owns a property from which contaminated waste

⁴²Cairney, p. 122.

⁴³Interview with Jim Leeman, DuPont, Willmington, DE, August, 1990.

⁴⁴Cairney, p. 122.

was removed, may be held responsible for that waste forever, even when disposed of properly.⁴⁵ Excavation is usually acceptable when the contamination is confined to a small area.

The current availability of appropriate hazardous substance disposal facilities is an interesting issue. Companies that frequently dispose of hazardous substances are now often purchasing disposal “cells” in landfills or buying capacity at incineration and solvent extraction facilities. The creation of “disposal futures” is due, primarily, to the problems of siting new facilities, and the limited capacity of existing ones. Companies that have a frequent need for these services appear to be willing to purchase this commodity to ensure that their required capacity is available at a fixed price.⁴⁶ These same disposal futures are likely to diminish the availability of these commodities to one-time or infrequent users, like real estate developers.

The treatment of soil to extract or destroy contaminants, or to stabilize or fixate them, is the preferred approach in many European countries like the Netherlands and is receiving increasing attention in the United States. This option is preferred because it offers a more complete solution to the problem, although there will still be a concentrated amount of associated waste to dispose of.⁴⁷ Such treatment process may take place either on-site using a mobile unit (a temporarily erected facility), or after transporting the soil to a permanent waste treatment facility. EPA has developed a mobile incineration system that was originally intended for the treatment of PCB containing media. This mobile system is preferable because removing the contaminated soil to a permanent facility poses the risk of transportation loss.⁴⁸ (This risk is also a factor when transporting it to a hazardous waste dump). For this reason, transportation of hazardous wastes to a central treatment or disposal facility may only make sense when the facility is close-by.

Soil venting is an on-site method of extracting contaminants from the soil. It is a process that can be used to remediate sites contaminated with volatile organics or hydrocarbons. The process evaporates the contaminants by drawing air through

⁴⁵W. Freedman, Hazardous Waste Liability, (Charlottesville, VA: The Michie Co., 1987), p. 165.

⁴⁶Leeman.

⁴⁷Cairney, p. 127.

⁴⁸Cairney, p. 130.

tubes which are embedded in the soil. The vaporized substance is then passed through activated carbon beds which absorb the contaminant. Finally, when the carbon beds reach their saturation point, they are steam cleaned, a process that produces pure contaminant. This greatly reduced contaminant can then be landfilled as a small concentrated volume. In addition, because this method draws oxygen through the soil, it increases the activity of micro-organisms which may help to further degrade any remaining contaminant. Soil venting is substantially cheaper than other methods such as soil excavation and removal, or water-based bioremediation, and has been proven effective for hydrocarbon clean-ups. Finally, this method is excellent because it is complete; the problem is largely resolved, not moved from one site to another (e.g., soil disposed of at a hazardous waste disposal landfill).⁴⁹

The cost of soil remediation can vary widely depending on the location and extent of the contamination. However, when the contaminant has migrated through the soil and into the ground water, clean-up becomes more complex and costly. Because ground water flow is a driving force, contaminants move easily in this compartment, particularly if they are water soluble. The cost of cleaning-up contaminated ground water has been estimated to be about ten times the cost of remediating contaminated soil⁵⁰.

Ground water pumping is a ground water treatment method that is usually applied to gasoline spills. Pumps are installed on-site in order to reduce the level of the ground water, thereby creating depressions, or cones, into which the gasoline (or any substance less dense than water, and therefore floating on the surface) can flow. The contaminant is then removed from the surface of the water in these depressions using skimming pumps. The remaining ground water is then passed through an air stripping tower which further removes contaminants, before being recharged into the ground.⁵¹

⁴⁹J. R. Connor, "Case study of soil venting," Pollution Engineering, (July, 1988), p. 75.

⁵⁰R. Ouellette and B. Maestri, "Conducting the Environmental Audit," Journal of Property Management, (March/April, 1990), p. 19.

⁵¹Connor, p. 77.

3.3 How Clean is Clean?

Recycling land means "cleaning it up" and finding a new use for it. Anyone positioning themselves to do this ultimately must decide how clean is clean enough for the new use. Once a site has been "contaminated", no matter how small the contamination, it will probably never be as "clean" as it was before the contamination. Determining "how clean is clean" has three components:

- A. Moral: Is it clean enough to reduce actual human and environmental toxicological risk? This is essentially how the scientists think about the problem.
- B. Market: Is it clean enough to meet the perceived societal risk? This can be quite different than the actual toxicological risk.
- C. Legal: Is it clean enough to satisfy the federal and/or state EPAs?

3.3.1 Moral.

The scientific investigation into the effects of environmental contaminants on people is the backbone to all three components of the "how clean is clean" question. For the moral component, it is the over-riding consideration. In order to protect people from contaminants that may not yet be legislated against, it is important to have a general understanding of how environmental exposure occurs.

Any chemical or substance can cause death if taken into the body in sufficiently large quantities, but the chemicals of primary concern in environmental health are those which, in small doses, can cause adverse effects. People come in contact with environmental chemicals in many ways, such as breathing them, touching them with their skin, and ingesting them via food and water. Exposure may occur as a single major dose of a single substance, as in the case of an accidental emission or chemical spill, or more typically, as an individual's cumulative exposure to a complex mixture of substances over a long period of time. Toxic chemicals vary widely in their potency. Some cause cancer or genetic damage, while others are simply irritants whose effects will end when the exposure ceases. People also vary widely in their susceptibility to health damage as a consequence of exposure. The elderly are more susceptible to lung infections than are the young, while younger people are more susceptible to early-stage carcinogens.

Children, and especially fetuses, are more susceptible than adults to most toxic chemicals.⁵²

When evaluating toxic substances, it is important to determine their bioavailability. Bioavailability determines whether a substance is present in a form that is potentially accessible to humans, animals, and plant material. In general, a toxic element that dissolves in water is relatively available to biota, and therefore even a seemingly dilute aqueous concentration can exert a powerful effect.⁵³ In contrast, toxic elements in soil and rock that are insoluble can have a high concentration and yet very little or no toxic effect (i.e., a crystal glass may be 24% lead, but does not endanger the person drinking from it). Note that it is the solubility, or chemical form of the substance, that is important; environmental factors that can alter the chemical form (e.g., sunlight, heat, acid rain) must also be considered.

The ability of a substance to move in the environment is another consideration in determining its potential risk to humans. Many substances, such as PCB's and heavy metals, have a high affinity for soil and bind to it. This is considered a desirable attribute since it isolates the contaminant to a particular compartment.⁵⁴ For example, when metals bind to the soil, they won't get into the ground water - they may, however, be consumed by children making mud pies. Primary movement corridors are water (both surface and ground water), and air. A moving substance is difficult to quantify and clean-up; it may also change form as a result this movement. If it moves off-site, receptors near the property must be considered.

How clean a site has to be to minimize human exposure is an open question. Because of varying susceptibility, a paucity of toxicological data, and difficulties determining causality, it may never be answered. Even the most recent data are unlikely to give a satisfactory answer to this question, although it is nevertheless worth examining for any major new breakthroughs. As a way to proceed, there are two evaluations the developer must make. The first is an evaluation of all the potential movement paths, chemical combinations and bioavailability of the substance(s). This should be conducted for both ordinary scenarios and weather conditions, as well as with exceptional events characteristic of the site location in

⁵²Lave & Upton, p. 7-8.

⁵³Freeman, p. 54.

⁵⁴Binford.

mind, such as drought, floods, excessive rains, landslides and earthquakes.⁵⁵

The second evaluation is an assessment of the potential ways in which humans could have contact with the substance. Both everyday and unusual human activities should also to be contemplated (e.g, planting a garden or excavating a new trench for a sewer system). Ultimately, the toxicity level one strives to achieve, or conversely, the land use proposed for the recycled site, should be determined not only with people of average health in mind, but also by those subgroups which are likely to be exposed. For example, a site that was previously contaminated with lead is probably a better site for a new parking lot than a daycare center.

3.3.2 Market.

Whether or not a site is clean enough for its intended market is a completely different question from whether or not it poses a risk to human health. The overriding component in determining "how clean is clean" enough for the marketplace is the human perception of risk - not the actual risk.

People think about risk in a simple way. They are more comfortable with familiar risks and consequences than with unfamiliar ones; they are more comfortable when they believe they have individual control than when they feel they do not; and they are more comfortable when they see a direct benefit from taking the risk. This cognitive structure leads some people to reject situations that experts believe pose minute risks (e.g., living near a nuclear power plant or toxic waste dump) and to accept situations that have verified large risks (e.g., highway travel or occupational exposure to toxic chemicals).⁵⁶ Generally, the Public perceives the risk posed by reusing contaminated land to be greater than the experts do.⁵⁷

Though there may not be any actual scientific or legal reason for cleaning a site to standards exceeding those required by the EPA, the developer who ignores the market perception of risk takes a risk. A Los Angeles, CA developer who recycles oil fields into single family residential subdivisions cleans the soil hydrocarbons to

⁵⁵Moskowitz, p. 33.

⁵⁶Lave & Upton, p. 287.

⁵⁷W. D. Ruckelshaus, "Science, Risk, and Public Policy," Science, Vol. 221, p. 1028.

250 parts per billion (ppb), even though the state regulatory body only requires 500 ppb. The slight remaining odor at the higher concentration is believed to affect the marketability of these properties.⁵⁸ Another example is a science laboratory outside of Boston, MA. The property is well-located and the building an excellent facility, but the Owner is unable to sell. The market perception of the risk associated with this site appears to be higher than the legal clean-up limit.⁵⁹

3.3.3 Legal.

One of society's tasks is to protect humans and the environment from excessive exposure to hazardous materials. Science can describe the risks associated with exposure to hazardous material at certain levels, but it is social policy and regulation that ultimately determines whether the costs to diminish risk are worth the benefits. Therefore, the legal component of the question "how clean is clean" should, in an idealistic sense, depend upon the outcome of the two previous Sections: scientific risk and societies perception of that risk.⁶⁰

Another influence on the legal definition of a "clean" site, however, is changing technology. A few years ago, the presence of a chemical below a few hundred parts per million was indeterminable. The recent development and dissemination of sophisticated analytical equipment such as gas chromatographs, coupled with flame ionization and electron capture detectors, has allowed detection of chemicals with unheard of precision and accuracy.⁶¹ New precision testing procedures detect smaller and smaller amounts of contaminants. This precision, coupled with the tendency for society to want sites to be as clean as is detectable, often results in a legal definition of "cleanliness" that moves with technology. Similar to precision testing is the evolving remediation technologies. Here again, new clean-up techniques influence the legal definition of cleanliness, such that standards are tightened to correspond with the newest "best available technology". The question is whether new contamination standards are the result of a substantiated change in

⁵⁸Interview with John Allum, Sand Dollar Developments, Los Angeles, CA, June, 1990.

⁵⁹Interview with Dr. Donald Chappenelli, Harvard University, Cambridge, MA, July, 1990.

⁶⁰C. C. Travis and H. A. Hattemer-Frey, "Determining an acceptable level of risk," Environmental Science Technology, Vol. 22, No. 8 (1988), p. 873.

⁶¹Moskowitz, p. 12.

the accepted exposure level to a substance, or the availability of increasingly more sensitive instruments and remediation technologies⁶²?

The current legislation which defines how clean a site must be, as well as which parties are responsible for this condition, was outlined in Section 3.1.

3.4 Minimizing the Risk Associated with Contaminated Land.

3.4.1 The Environmental Assessment.

Performing an Environmental Assessment during the due diligence process is a good way to identify a site's potential environmental liabilities. An Environmental Assessment is an objective review of a specific property or business to determine the sources - actual and potential - of environmental contamination and to assess the potential for human exposure. It also examines risks and liabilities involved and recommends future courses of action.⁶³ The Environmental Assessment is distinct from the Environmental Audit; the later is typically limited to evaluating whether a facility is in compliance with applicable laws or regulations.⁶⁴ There are no regulations governing the contents of Environmental Assessment Reports, nor who may prepare them⁶⁵; what follows is considered "common practice".

The Environmental Assessment is typically divided into three Phases; each phase culminates with a Report of findings. The first phase, Phase 1, is primarily a paper exercise which examines available historical records (from government and other sources). Typical data sources include maps, ground and aerial photographs, reports, drawings, geological and hydrological records, permits, and other written documents on the history and use of the site. However, Phase 1 is not complete with just a paper survey; a physical inspection of the site should also be included. Site inspection involves limited sampling and analysis of suspect situations. The

⁶²Ouellette and Maestri, p. 20.

⁶³Ouellette and Maestri, p. 16.

⁶⁴R. W. Kane, "Environmental Audits and Risk Assessments: Essential Underwriting Tools," Real Estate Finance, Vol. 2, No. 3 (Fall 1987), p. 32.

⁶⁵J. C. Becker, W. A. Butler and H. S. Jatlow, "The Role of Environmental Assessments in Real Estate Transactions," Real Estate Law Journal, Vol. 18: 379 (1990), p. 383.

major objective of Phase 1 is to obtain semi-quantitative evidence for the probability of there being hazardous substances at the site.⁶⁶

If the Phase 1 Report indicates a reasonable chance of site contamination, it is usually prudent to enter Phase 2. The objective of Phase 2 is to obtain quantitative evidence of hazardous substances and to delineate the scope of the contamination. This involves intrusive sampling (e.g., drilling wells) to quantify the magnitude and extent of contamination.⁶⁷ (Note that data collected from soil is much more reliable than data collected from water, since ground water contamination may be from off-site sources.⁶⁸) If contamination is determined to be present, the Phase 2 Report should delineate the extent of the problem and the risks involved, as well as a “ball park” estimate of the cost to remediate. It should also analyze alternatives and rank them in terms of risk and liability. This information about risk and liability is crucial to the decision making process.

One environmental consultant estimates that with a Phase 1 Report, qualified environmental consultants can determine with a 60-90% confidence level whether or not the site is contaminated (this level increases to 98-99% confidence with Phase 2).⁶⁹ Unfortunately, attorneys and developers interviewed did not report a similar level of confidence. In general, they felt about half as confident as the engineers. Although not a comprehensive survey, this information may indicate that either engineers believe they are doing a better job than they really are, or, that developers are over-estimating environmental risk. The latter would imply a potentially untapped area of opportunity for developers where the difference between actual risk and perceived risk could be arbitrated. The ability to trust an environmental consultant’s judgment is critical.

The distinction between where the Phase 1 Report stops and where Phase 2 begins is nebulous.⁷⁰ It may therefore be useful to request and review a complete

⁶⁶R. P. Newman, “Strict regulations make environmental assessments essential for transactions,” Hazmat World, (March, 1989), p. 31.

⁶⁷Ouellette and Maestri, p. 17.

⁶⁸Interview, Peter Twining, Copley Real Estate Advisors, Boston, August, 1990.

⁶⁹G. Pilko, and F. Geer, “Avoiding Hazardous Waste Pitfalls in Real Estate Transactions,” Industrial Development, (Nov/Dec, 1987), p. 8.

⁷⁰J. Bishop, “Marketing site assessments,” Hazmat World, (March, 1989), p. 36.

list of procedures the environmental consultant will undertake, prior to commissioning either report. Hopefully this will eliminate any ambiguity about the services being purchased, and save time in the process. It should also help make certain that the developer, environmental consultant, lender, and insurance company (if used) are all speaking the same language when referring these Reports. Lenders and insurance companies may have requirements that will partially determine which procedures are necessary.

If the Phase 2 Report indicates contamination on the site, the EPA probably must be notified (note that each state law will have strict and individual reporting requirements). Then a consultant, or remediation contractor, may be asked to prepare a solution to the problem; this signals the beginning of Phase 3. This Report will outline extensively the remediation solution for the site and delineate all the necessary steps and working details for the clean-up.⁷¹ However, with known site contamination, the owner assumes responsibilities. Before, during, and after the Phase 3 assessment and subsequent decision making, the owner and manager must monitor hazardous substances to ensure legal compliance.⁷²

There is no assurance that the Environmental Assessment Reports will detect hazardous conditions, regardless of the care, time, and money spent on the investigations. However, if used appropriately, this process can significantly reduce a developer's, investor's, or creditor's exposure to environmental risk. The assessment should not be treated as a commodity, something that is required just to obtain a loan. If price is the only concern in selecting a consultant, the level of service may decrease to the point where the quality of the product is suspect. Enough information must be supplied in the Reports to support a sound decision and to document the "innocent party" liability exclusion (refer to Section 3.1.3).

One final note on Environmental Assessment Reports. In order to perform some of the work necessary for the Report's, the seller's permission will be required. If permission is not granted, this may indicate the owner is hiding a problem. However, from an owners perspective, these Reports actually increase exposure to liability (e.g., a seller may be held liable for newly detected contamination).

⁷¹Ouellette and Maestri, p. 17.

⁷²Ouellette and Maestri, p. 17.

Therefore, the lack of permission to perform an assessment should not be construed as evidence that the site is in fact contaminated, only that caution should be taken.⁷³

3.4.2. Other Risk Minimization Techniques.

In addition to Environmental Assessment Reports, there are a number of other techniques that may be utilized to minimize environmental liability. Some options include:

Representations and warranties. This common contractual technique forces the party making the representations to formally commit to a state of knowledge or facts about the property (i.e., past uses, materials known to be on the property, past governmental actions, etc.). Requiring this statement in the contract may induce greater candor on the part of the seller; the refusal to make this representation may be just as revealing. This warranty may also act as a form of indemnification if certain representations made by the seller are found to be false at a later date.⁷⁴

Indemnification agreements. An indemnification agreement is a contractual relationship between two or more parties that assigns responsibilities for a particular act, such as the past or future contamination of a site. Although widely sought after, and seldom received, these contracts can eliminate a great deal of uncertainty about future liability. It is critical, however, to look at credit worthiness of the indemnitor; an indemnification agreement from an insolvent party has little value. It should also be realized that the Government can, and probably will, still look to the current owner (as a PRP) for any remediation costs. However, with this agreement, one can look contractually to the indemnitor (if solvent) for reimbursement of these costs.⁷⁵

Agreements to remediate. This agreement provides an option on the part of the indemnitor to perform the remediation as an alternative to reimbursing the indemnitee. For the indemnitor, taking physical control of the remediation eliminates the concern that the indemnitee will adopt an exorbitant or ineffective

⁷³Twining.

⁷⁴Moskowitz, p. 264-265.

⁷⁵Moskowitz, p. 265-267.

remedy. For the indemnitee, the negative cash flow and inevitable drain on time and energy associated with the remediation is eliminated.⁷⁶

Escrow accounts. If a site is known to be contaminated, and a buyer still wishes to purchase it, an escrow account may be created for the cost of remediating the property. Although new to the area of Environmental remediation, escrow accounts can be quite effective in insuring the completion of the remediation process. The amount deposited in the account can range from an actual estimate of the clean-up cost, to an amount two or three times that size - enough to cover any large contingencies. For example, assume a site that is worth \$100 “clean”, but because it is contaminated it requires \$20 to remediate. The buyer may pay \$80 for the property and have the seller place \$40 in an escrow account. If the buyer’s remediation costs exceed \$20, the funds in the escrow account can be used to offset this overage. When the EPA notifies the buyer that the site remediation is complete, or the site meets the specifications set forth in the escrow instructions, any excess funds left in the account are then remitted to the seller.⁷⁷

Insurance. Insurance is a traditional means of risk allocation, where an innocent party, for a fee, agrees to assume a defined risk. Although insurance is the preferred method of risk avoidance for most developers, environmental impairment insurance is difficult to obtain and very costly. A large developer, with a moderate appetite for risk, can probably self-insure; the consequences for a small developer, however, may be severe.⁷⁸ The subject of the first case study in Chapter 4 is an insurance company that offers environmental impairment policies.

Incorporation. Although traditionally used to limit liability, this well-known sidestep of taking and holding property in a “shell” corporation to avoid liability will probably not help to avoid environmental obligations for either the seller or the purchaser. Individual officers, directors, and shareholders of such corporations can be and have been held liable for clean-ups.⁷⁹

⁷⁶Moskowitz, p. 268.

⁷⁷K. Silvera, “Investors Gamble on Sick Properties,” Commercial Property News, (June 1, 1990), p. 19.

⁷⁸Moskowitz, p. 271-272.

⁷⁹Moskowitz, p. 93-105.

Deed restrictions. This can be an effective mechanism for a seller to prevent future unsuitable uses of the site (e.g., allowing an former industrial site to be used for a school). These may be hard to enforce, indeed, a drawback to this strategy is that the restrictions will have to be monitored in perpetuity, or until the seller is removed from liability statutorily (an unlikely event)⁸⁰. By controlling the future use of the site, the seller reduces the likelihood of being held liable for damages to persons who are injured by inappropriate redevelopment.

These techniques have been presented to outline a range of ideas which can be used to structure transactions.⁸¹ Although they may not seem overly protective of the developer, many of the most successful redevelopment projects have utilized some combination of them. The indemnification agreement, in particular, is very attractive, especially if the polluter is well capitalized. A good example is the 1985 redevelopment of a semi-conductor plant into a highly successful shopping mall in California. The single most important factor in the redevelopment was an indemnification agreement that the developer received from a well capitalized corporate owner. This agreement protected the developer from all future liability and clean-up costs associated with the site.⁸² An excellent reference for more information on this subject is Moskowitz (see footnote 81).

3.5 Decision Analysis.

3.5.1 Uncertainty.

Virtually all important business decisions are made under uncertainty, and the real estate industry is not an exception. Will the demand for office space still be strong

⁸⁰Leeman.

⁸¹The appendix in Moskowitz contains a set of legal forms useful for structuring these transactions. See also, B. W. Hyman, T. D. Trapp, and K. S. Mitchell, "The Environmental Legal Opinion: Guidelines for Real Estate Attorneys," Real Property, Probate and Trust Journal, (Summer, 1989), p. 186-190, for a Disclosure statement form. For investor protection, see: D. A. Smith, "Investor Protection Against Environmental Risks," Journal of Property Management, (March/April, 1990). For lender remedies see: H. J. Richman and T. J. Stukane, "Avoiding the Environmental Risks in Mortgage Transactions," Real Estate Finance Journal, (Winter, 1987).

⁸²W. Benson, "Redeveloping Toxic Sites: A case study," Development Magazine, (July/August, 1988), p. 22.

when the new building is ready? Will the contractor who submitted the lowest bid perform as well as another known contractor? Will interest rates remain stable?

Not all developers handle uncertainty in the same way. Some will do everything possible to reduce exposure to risk, aiming for that elusive, completely risk free deal. Other developers may, upon the reduction of one form of risk, immediately assume additional risk in another form; they simply substitute one risk for another. These different views can be explained by risk preferences. On one extreme are risk seekers, people who don't mind being exposed to risk. At the other end of the spectrum are people who are risk adverse; they are willing to purchase insurance, forego opportunities and reduce their required returns just to minimize their risk. People who fall in the middle can be described as risk neutral.⁸³

No decision maker can perfectly predict the future. However, even just a simple accounting of the risk being assumed can ensure that uncertainties are taken into consideration, and an individual's risk preferences are respected. In addition, careful analysis of risk can reveal areas where the market has exaggerated the actual risk, thus making an investment in a "high risk venture" entirely prudent.

3.5.2 Decision Models: The Decision Tree.

There are models available (although not commonly used by developers) to help analyze decision problems.⁸⁴ The objective of modeling is to enable a problem to be studied, analyzed, and adjusted, in order to arrive at the best solution. It should direct the focus of the decision maker to the key variables of the problem. These formal and systematic structures also allow for the application of sets of fairly rigorous criteria. This is particularly useful when attempting to assess or measure uncertainty or risk; the result is that the intuitive decision is enhanced by more precise and objective statements about outcomes under conditions of uncertainty. Several distinct advantages of decision analysis models are:

⁸³R. Behn and J Vaupel, Quick Analysis for Busy Decision Makers, (New York: Basic Books, 1982), p. 206.

⁸⁴For more information on this subject, see: H. Raiffa, Decision Analysis, (Reading, MA: Addison-Wesley, 1968); R. G. Moore and H. Thomas, The Anatomy of Decisions, (Harmondsworth, England: Penguin Books, 1976); and, R. Behn and J Vaupel, Quick Analysis for Busy Decision Makers, (New York: Basic Books, 1982)

- A. They force the decision to be made in a logical and consistent fashion, usually with a much more extensive analysis of the problem.
- B. The formal approach reveals the decision maker's attitude towards risk inherent in the decisions being made. This is particularly useful in the real estate industry where intuitive decisions are prevalent. Formal methods force the decision maker to be much more specific about the criteria on which a decision is to be based, and to be consistent in the application of those criteria to successive decisions.
- C. Finally, such an approach enables errors to be traced, even if this is only with hindsight, thereby improving similar decisions in the future.⁸⁵

Examples of decision analysis models include: pay-off tables, linear programming, the Monte Carlo method and decision trees. Whatever the problem's complexity, the model used should be efficient in terms of the time, cost and effort taken to develop; it should also be widely interpretable and, if necessary, easy to adjust.

An excellent model for making decisions about problems that are complex, have considerable uncertainty, and little numerical data available, is the decision tree. A decision tree is a road map for a decision problem. It lays out, in schematic form, the decision alternatives, uncertain events, possible outcomes of such events, and consequences of each outcome, all in the order that the decision maker will face them. A decision tree allows a large or complex problem to be broken down into smaller sub-problems which can be solved separately and then re-combined.⁸⁶

Decision trees are advantageous because they require the dissection of problems into smaller more manageable parts, the determination of the relevant variables to the decision, the specification of beliefs about uncertainty and preference for outcomes, and, the presentation of these factors in their proper relationship. It should be remembered, however, that the solutions a decision tree provides are only worthwhile if the tree truly represents the problem structure. Also, there is no reason to suppose that a decision based upon a full, orderly and objective analysis is always better than decision made entirely upon intuition. In a particular case, the results may be identical, or, it may be that the intuitive decision will prove to be

⁸⁵Behn and Vaupel, p. 29.

⁸⁶Behn and Vaupel, p. 28-29.

better. However, for most people, most of the time, this method will offer real assistance in making better decisions. This technique will assist, not replace, the quality judgment of the decision maker.⁸⁷

A decision problem is not characterized by only one “correct” decision tree. Rather, there exist a variety of different diagrams that describe the various factors influencing the decision. Some trees are quite simple; some complex. Different trees will emphasize different factors. The key to resolving a decision dilemma lies not in discovering the decision tree - for it does not exist - but in developing the one that best helps analyze the problem. Designing an appropriate decision tree depends upon which factors are believed to be most important, and the detail that is needed for the decision maker to be convinced that the resolution of the dilemma is satisfactory.⁸⁸

It is usually best to begin an analysis with a simplified definition of the problem, one that focuses attention on the essence of the dilemma. Then, if a first-cut analysis proves unsatisfactory, a second may be undertaken, incorporating those additional factors whose exclusion made the first inadequate.⁸⁹

3.5.3 Expected and Certain Outcomes.

Suppose there is an opportunity to gamble on a coin toss. Heads is worth \$100, and tails, nothing. Further, suppose there is an option to accept a guaranteed payment of \$40, in lieu of the 50-50 coin toss proposition. Which choice is preferable? If the gamble were for the average of a coin flipped an infinite number of times, a rational gambler would take the coin toss. With a 50-50 chance of winning, the expected gain of this gamble is \$50 per toss. In decision analysis, this \$50 is considered the expected monetary value, or EMV, of the gamble. The EMV is the sum of the various outcomes, multiplied by their probability of occurrence (e.g., $\$100 \times 50\% + \$0 \times 50\% = \$50$).⁹⁰ This is also known as Bayes Theorem.

⁸⁷Behn and Vaupel. p. 29.

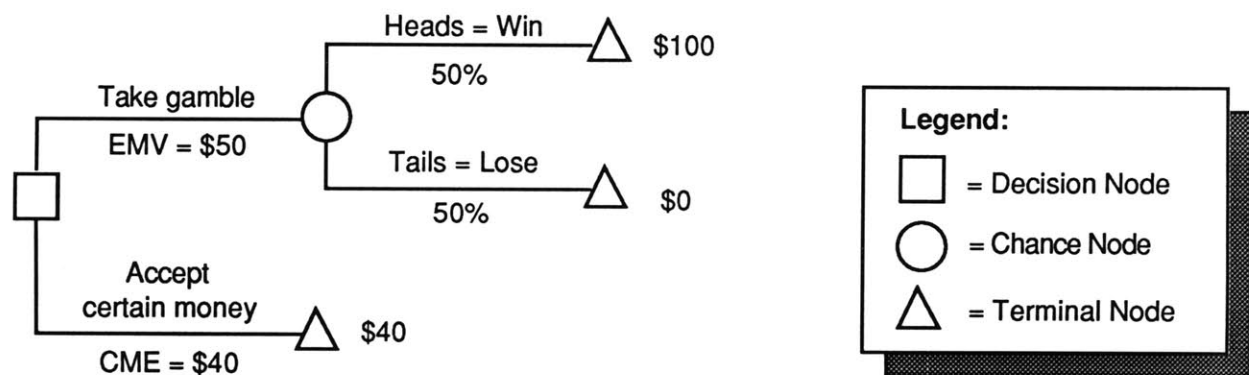
⁸⁸Behn and Vaupel, p. 266.

⁸⁹Behn and Vaupel, p. 40.

⁹⁰H. Raiffa, Decision Analysis: Introductory Lectures on Choices under Uncertainty, (Reading, Massachusetts: Addison-Wesley, 1968), p. 9.

A decision maker's indifference point in a gamble, or any other uncertain event, is often called the certain monetary equivalent, or CME. The CME is the amount of certain money the decision maker feels is equivalent to taking the gamble.⁹¹ Because everyone has a different set of risk preferences, CME's vary from person to person. For example, a given individual might be indifferent between a certain \$30 and a 50-50 gamble for \$100. Someone with more money, or a different outlook on risk, might not accept anything less than \$50 in lieu of the gamble. In the gamble described above, with a guaranteed payment of \$40 offered, the first person (CME \$30) would take the certain money and not risk the coin coming up tails. The decision tree, Figure 1 below, describes these different risk preferences.

Figure 1. Decision Tree of Coin Toss Gamble.⁹²



Insurance is an excellent example of EMV and CME.⁹³ If an uninsured house burns down, the cost to replace it may be \$200,000. However, if the fire does not occur, nothing is lost. Not insuring the house is equivalent to taking the gamble described above. Leaving bank lending requirements out of the argument, most people are willing to pay an insurance premium (a known sum of money) instead of assuming the risk of fire. Even if the CME (insurance premium) exceeds the EMV (the collective odds that a house will burn down), a homeowner will pay the premium simply because a possible loss of \$200,000 is too great a risk. The value difference between the EMV and the CME is where the insurance company makes

⁹¹Raiffa, p. 9.

⁹²Modified from similar trees in Behn and Vaupel, p. 196-197.

⁹³Raiffa, p. 91.

its money; because they insure many homeowners, the odds for the insurance company approach those of the person who flips the coin an infinite number of times (the EMV). It follows that well-capitalized companies tend to assume greater risk of loss and self-insure against catastrophes. Like a casino in Las Vegas, they can afford many “small” losses, because in the end the odds are on their side.

CHAPTER IV

CASE STUDIES

This Chapter presents two case studies chosen to illustrate current thinking with respect to the environmental risk associated with contaminated land. In the first, the risks are weighed before a site, or client in this case, is located. By contrast, the second, presents a situation where the contamination was not anticipated. In each example, the decision making process reflects the individuals' risk preferences and future expectations. Together the two cases suggest the complexity of calculating the financial dimensions of environmental risk.

4.1 The Insurance Company - Case #1.

In 1979, Environmental Compliance Services, Inc. (ESCI) was formed to provide insurance for a newly emerging market; the hazardous waste industry. The company was formed to participate in a market being rapidly abandoned by other insurance companies. These other companies were becoming aware of the potential liability associated with issuing environmental coverage to firms that dealt with hazardous waste. Meanwhile, the federal EPA created RCRA which required companies in the hazardous waste business to provide assurances of financial responsibility. One way to meet this requirement was to purchase liability insurance.

Seeing an opportunity in the requirements of RCRA , the owners of ESCI sought to provide a needed service and at the same time make a profit. Even though there was not any actuarial data on potential losses, they understood that the key to success would be underwriting the policies correctly. Underwriters would have to work hand in hand with environmental engineers, as the engineers were in a better position to understand the risks inherent in the industry. In 1979, ESCI formed

ECS Underwriting (ECS) and signed a managing general agency agreement with a major U.S. insurance company. This agreement gave ECS responsibility for underwriting and administering a program of insurance for companies facing environmental exposure.

By 1985, liability coverage for environmental clean-up was removed from most insurance companies' comprehensive general liability (CGL) policies. In particular, the clause relating to "sudden and accidental" pollution was removed, due to a series of claims, and subsequent lawsuits, that PRP's filed against their insurance carriers.⁹⁴ Since that time the availability of pollution coverage has dropped substantially and now ECS and one other firm, American International Group, are the only insurance companies offering environmental impairment liability insurance in the United States. ECS's insurance program has evolved since 1979, and now includes seven different types of specialized environmental risk policies in addition to general liability insurance. These policies are listed in Table 2.

Table 2. Environmental Risk Insurance Policies.

<u>Policy Name</u>	<u>Entities Covered</u>
Pollution Liability	Treatment, storage and disposal facilities, or any firm with environmental exposure.
First Party Pollution Clean-up	Developers, owners, bankers, etc.
Transporters Pollution Liability	Transporters of hazardous waste materials.
Contractors Pollution Liability	Clean-up/remedial action contractors.
Professional Liability Coverage	Environmental consultants.
Products Liability	Chemical distributors and pollution equipment manufacturers.
Automobile Liability	Chemical distributors, remedial action contractors, hazardous waste transporters and treatment, storage and disposal facilities.
General Liability	All of the above.

⁹⁴K. Roy, "Shell, Insurers and Attorneys Take on Liability - and Each Other," Hazmat World, (March, 1989), p. 49.

As part of the application process for insurance coverage, ECS required the applicant to submit a compliance audit and/or an Environmental Assessment. Some companies had difficulty providing these reports and it soon became apparent that there was an additional need for a company which could help applicants comply with ECS's underwriting criteria. In 1984, to meet this need, ECSI formed Consulting Services, Inc (CSI). CSI is an environmental consulting firm which offers a range of services including: underwriting technical assistance to ECS, Environmental Assessments, management consulting, compliance audits, and the development of emergency response procedures.

As the hazardous waste industry evolves, so do the policies that ECS offers. Their most recent policy, "First Party Pollution Clean-up", is a first for the industry. Designed primarily for real estate developers, property owners, and lenders who have a security interest in a property, the policy reimburses the insured for the remediation costs associated with a mandated clean-up. Before a binder is issued, the property must undergo the traditional Phase 1 Environmental Assessment Report (historical search and site walk through). In addition to the Phase 1 Report, ECS has a comprehensive application/checklist their environmental engineers use to determine the acceptability of the applicant.

The complete application for ECS's Pollution Clean-up Coverage is attached as Appendix C. This application requires the following information about the company requesting insurance: financial statements; past history of compliance with environmental laws; employee training classes; interaction with local, state and federal authorities; and, safety programs in place. The site is also evaluated for: its location relative to protected environments; nearby water sources; security measures at the facility; emergency procedures in place; storage and disposal practices; discharge points for waste and storm water; known chemicals on the site; monitoring results for effluent discharges and air emissions; and, a schedule of all storage tanks including age, capacity, contents, and construction material.

The policy is written if, based upon the Phase 1 Report, a review of the application, and a site visit, the property and/or company are deemed a reasonable risk. Factors considered by ECS not to be good risks include: a poor past record of compliance with environmental laws; a site near sensitive target populations; and,

excessive prior insurance claims. Because of their lack of experience in this area, ECS is currently limiting the maximum amount of coverage to \$1,000,000. Premiums range from \$15,000 to \$200,000, depending on the site and company insured. The deductible is usually \$25,000. Of those companies seeking coverage, only about 20 percent are actually insured.

Although in concept this policy should appeal to risk averse developers and bankers, David Rosenberg, the vice-president of ECS, comments that "business has not been as good as expected". The policy has been offered since September, 1989, and during the first 10 months only 20 policies have been written, for a total of about \$1 million in premiums. A profile of the insured includes the owner of a vacant piece of land, an industrial property owner, lenders who wish to be named as additional insured parties, and the owner of a property that was previously contaminated.

While the number of First Party Pollution Clean-up policies written is relatively small, the more mature products that ECS offers are selling very well. At the end of 1984, ECSI had fewer than 20 employees and \$6 million in annual premiums. As of 1990, the firm has 70 employees and annual premiums of over \$70 million with that number expected to increase to \$100 million by the end of this year.

Why is ECS's First Party Pollution Clean-up policy not more popular? Are their underwriting criteria so stringent that only people who do not need the coverage are offered it? What does this say about their ability to assess risk? Are they being too careful? Have developers perhaps decided to insure themselves by using some of the techniques outlined in Chapter 3 (e.g., an indemnification agreement)?

4.2 The Gasoline Station - Case #2.

Robert Young founded Prometheus Development Corporation (PDC) in 1984. After ten years in the real estate industry, three as an asset manager with a real estate investment trust, and seven as the vice-president of a real estate company, he was ready to start his own firm. His development experience was diverse and included work with industrial and commercial properties, as well as multi-family housing. In addition to this experience in real estate industry, Young holds

degrees in chemical engineering, law, and a Harvard M.B.A. He felt comfortable taking on a variety of projects and looked forward to the challenge that this new venture offered.

In 1985, Young successfully developed and sold an 8,300 square-foot office building in Quincy, Massachusetts. Encouraged by this success, he bought an option on a former gas station site just down the street where he hoped to build a similar building. The option on the half-acre site was valid for a six-month period, enough time to obtain the necessary buildings permits and approvals. Because the site did not have access to a sewer hookup, he obtained permission from the owner to dig percolation test pits, which would determine if the soil could support the proposed building's septic tank. During the excavation of the pits, the site crew detected a strong gasoline odor.

When Young first saw the site, he suspected that there might be some contamination due to its past use as a gas station. Now, with fumes rising from the test pits, his suspicions were confirmed. He reasoned, however, that if the extent and amount of contamination could be determined, and if the cost of remediating the site was not too prohibitive, the deal could still go through. Although a chemical engineer by training, Young had no previous experience in the remediation of contaminated sites, so he hired an environmental consulting firm to analyze the extent of the contamination. Soil samples were taken and analyzed. The lab results confirmed the site was contaminated with hydrocarbons.

Once the contamination was found, it was reported to the State's Department of Environmental Protection (DEP), as required by law. Upon notification, the DEP required that the tanks be removed immediately to prevent any further contamination of the soil and surrounding ground water. The history of the gas station was researched in order to locate all the potential tanks. This search revealed that the property had been used as a gasoline station from the mid-1930's until its closure in 1976. It was also noted that three underground storage tanks (UST's) had been replaced in 1957, and that there were still approximately four more tanks on site.

Because PDC's previous building had been very profitable, Young determined that even if the clean-up costs exceeded his consultants' conservative projections, the

site would still be profitable. With the required building approvals in hand, and confident that the real estate market would remain strong, Young committed himself to purchasing the site.⁹⁵ Although he still had not exercised his purchase option, in the fall of 1985 he hired a hazardous waste contractor to remove the tanks. A total of eight tanks were removed from the site: five 4,000-gallon gasoline storage tanks; two 500-gallon waste oil tanks; and, one 275-gallon heating oil tank (Figure 2, Site Plan for Gasoline Station Case Study). While a strong odor of gasoline was observed in the soil at the time of tank removal, there was only a thin film of gasoline on the surface of the ground water. The next step was to install monitoring devices to determine the amount and extent of contamination.

Eight ground water monitoring wells and numerous soil vapor monitoring pipes were installed and the plume of gasoline was established as covering about one-third of the site. Water table levels in the monitoring wells showed about a 2 percent water table gradient (slope) from the front of the site, where the tanks were located, towards the rear where a wetland area exists (Figure 3, Water Table Gradient for Gasoline Station Case Study). The water table varied in depth from about 4-feet below ground during the winter and spring to about 6-feet in the summer.

Further laboratory analysis of ground water samples showed volatile hydrocarbon concentrations of up to 12,000 ppb; these concentrations consisted primarily of gasoline. Due to the small size of the spill and the tightness of the soil, the main plume of gasoline was found to exist no more than 70 feet down gradient from the source. While trace amounts of gasoline were found beyond this distance, it was believed that bacterial action in the soil had reduced the gasoline to relatively harmless levels.

⁹⁵When evaluating this decision, the reader should remember that the detection and remediation technology was not as sophisticated in 1985 as it is today. In addition, the publicity associated with owning contaminated land was not as great, therefore the business community (e.g., bankers, appraisers, governmental officials, etc.) did not evaluate these sites with the same level of scrutiny used today.

Figure 2. Site Plan for Gasoline Case Study.

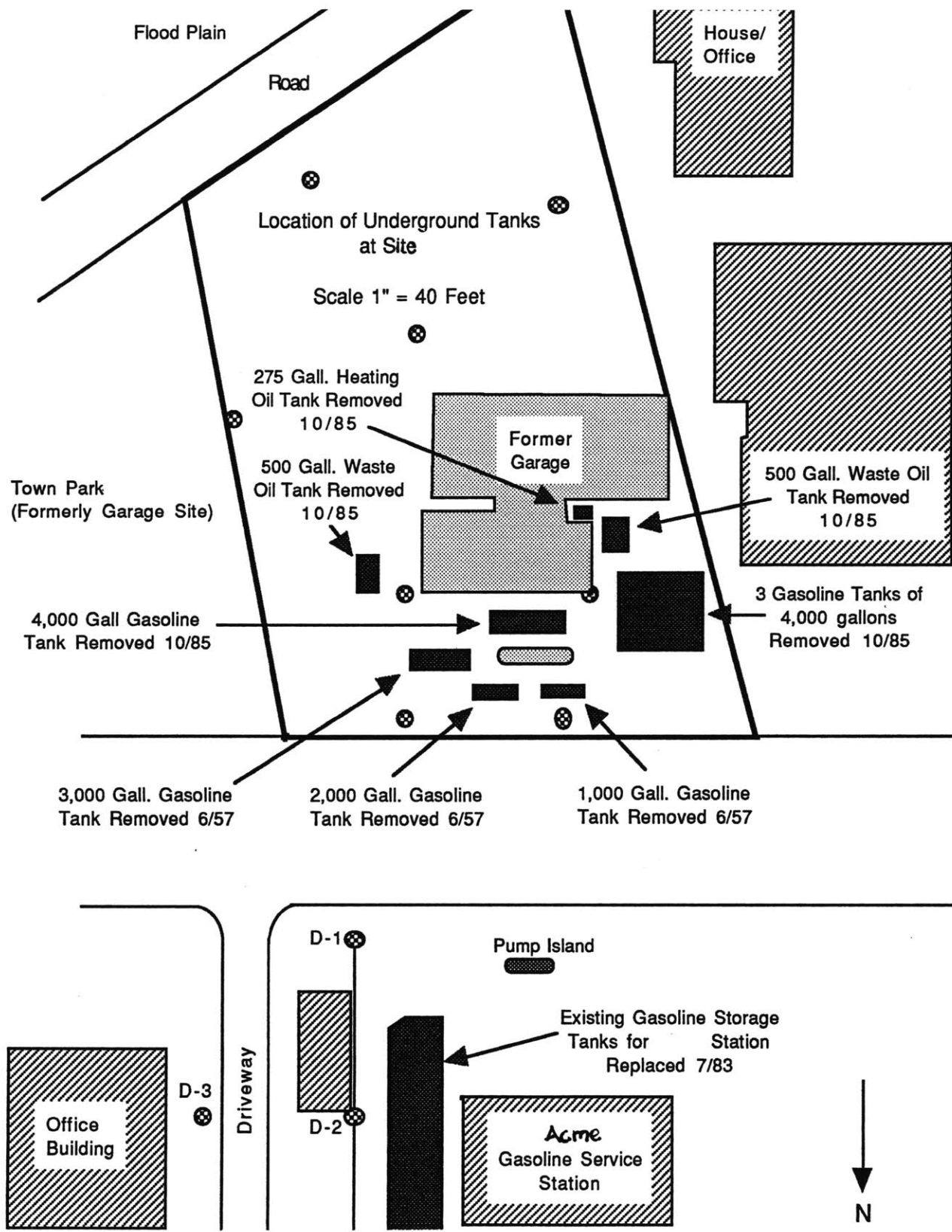
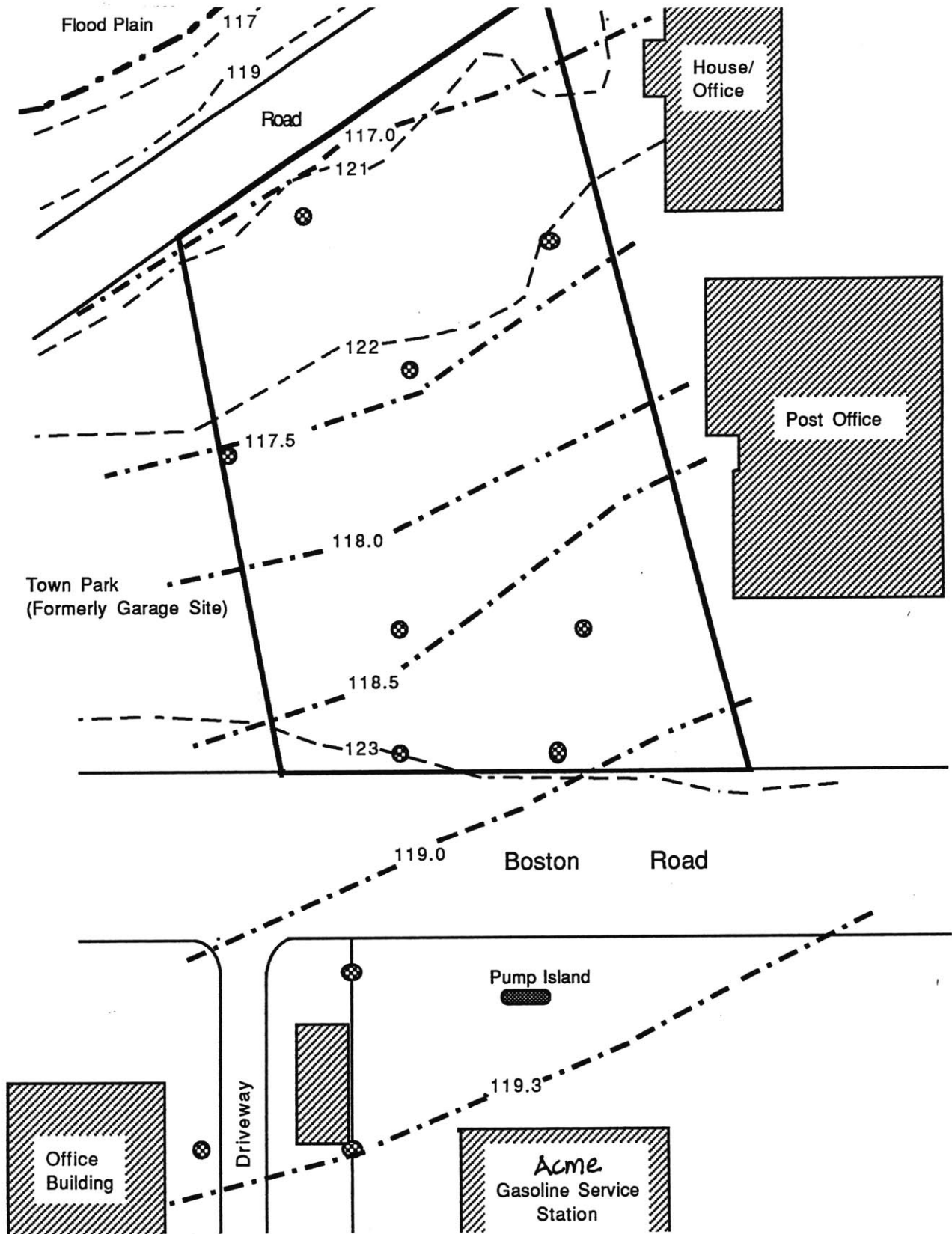


Figure 3. Water Table Gradient for Gasoline Case Study.



Only a thin film of gasoline had been observed on the surface of the ground water during the removal of the tanks, and it was therefore concluded that very little gasoline could be removed by depressing the water table and skimming off free product (i.e., ground water pumping, refer to 3.2.3). Two remediation options were considered. The first was excavation and removal of all of the contaminated soil on the site (1,000 cubic yards). This was estimated to cost approximately \$200,000. The second option was the less expensive soil venting method (3.2.3), which was estimated to cost \$150,000, including a \$30,000 contingency for cost overruns. Mr. Young renegotiated with the seller a reduction in purchase price from \$145,000 to \$115,000. This new price reflected both an increase in the site's value due to a general appreciation in the real estate market during the initial option period, and the substantial cost of remediating the site.

Before taking title to the site (a point where PDC would become a PRP under the State's Superfund legislation), Young had an appraisal of the property prepared. The appraiser determined the value of the site to be \$430,000, assuming that the property was "clean" and zoned for commercial office use. Young also contacted the bank and informed them of the plans for the site. Also explained was the approval needed from DEP before site clean-up could begin and that once begun, the whole process was expected to take 6-12 months. The following calculation was presented to the banker:

Appraised Site Value Once Clean	\$430,000
Less: Cost of Land	(115,000)
Cost of Remediation (Soil Venting)	<u>(150,000)</u>
Value Created	<u>165,000</u>

The bank approved an 18-month, \$250,000 loan for the purchase and remediation of the site, a decision unlikely in today's more stringent lending climate. PDC purchased the site and turned its attention towards the clean-up.

Young decided to utilize the soil venting remediation method because excavation was considered too expensive, primarily because of disposal costs. Operation of the venting system began in early June, 1987. By the end of September, approximately 150-gallons of gasoline had been recovered from the ground. Gasoline recovery averaged 1.5 gallons/day, although on some occasions as

much as 5 gallons/day were recovered. Monitoring well results were considered encouraging because no treatment of the ground water had occurred and yet ground water concentrations were reduced - presumably by evaporation from the ground water surface.

After four months of soil venting, there still appeared to be an ample amount of contamination on the front part of the site. It was suspected that another source was leaking gasoline. Young spoke with the owner of the Acme station directly across the street. It was then disclosed that in 1983, the Acme station's storage tanks had been replaced due to a leak and 60-cubic yards of gasoline contaminated soil had been removed from the site. DEP had supervised and sanctioned the clean-up, and the Acme owner was convinced the site was not currently leaking. This could not be substantiated however, because in 1983, DEP did not require the installation of monitoring wells to detect future leaks. Today this is common practice.

Young has since found that regulations can be a moving target. For instance, the Massachusetts DEP does not have set standards for allowable contamination concentration in soil. Each site is evaluated on a case by case basis by means of a risk assessment. This is accomplished by evaluating: the location of the site; proximity to wetlands, drinking water supplies, and surface water; local hydrology and geology; etc.⁹⁶ (Refer also to 3.1.1). In addition to a lack of specific levels that determine when a site is clean (e.g., x ppb = clean), it has become obvious to Young that DEP's requirements have become more stringent during the time he has owned the site. Because of these two factors, Young believes that achieving DEP approval will be a tenuous process.

By 1987, Young had become quite an expert on the subject of leaking UST's and soil venting. In an effort to reduce expenses, the remediation consultant was dismissed and Young took charge of the remediation efforts. To determine if the Acme station was leaking gasoline, three monitoring wells were installed on the property line that abutted the station (up gradient from the location of the tanks removed earlier). UST's can leak not only from holes that have either rusted

⁹⁶Interview with Amy Ferguson, Massachusetts Department of Environmental Protection, Woburn, MA, July, 1990.

through or are punctured in the tank, but also from leaking connector fittings (the hose from the tank to the pump) and most commonly, by overfilling the tank.⁹⁷ The results of this monitoring were inconclusive. DEP was notified of these suspicions, but has not felt them sufficiently convincing to respond.

Today, PDC has owned the site for four years. All of the contamination in the first four feet of soil has been removed. The four-foot level is the high water mark on the fluctuating ground water table, and the venting system cannot access the contaminated soil below the water table. The ground water can be treated, but since the soil in the 4-6 foot range is still contaminated, it will just recontaminate any clean water that it has contact with. For soil venting to remediate the 4-6 foot layer, the water table will have to fall. This happens naturally during the summer months, although, reaching the six-foot level may require a mild drought. In the absence of a drought, a pumping system can be used to lower the ground water an additional 6-inches from the dry summer low level, however this is expensive. In addition, Young is still uncertain about whether gasoline is coming on to the site from the adjacent Acme station.

During the four years that PDC has been trying to clean-up the site, the real estate market has gone from “red-hot” to “stone cold”. Fortunately, the site is centrally located between four hospitals. Young believes that the local medical community has been unable to locate suitable office space in the area, and so there may still be a market for his proposed building.

PDC has several options, none of which are quick or inexpensive:

- A. Wait for a dry summer so that the water table lowers, thus allowing the venting system to access the contaminated soil in the 4-6 feet below grade range. This is completely *in-situ*.
- B. Strip the first four feet of remediated soil and stockpile it on site. The remaining contaminated soil in the 4-6 foot layer can then be excavated,

⁹⁷Today, new tanks are made of materials that do not rust (e.g., fiberglass). They may also contain two liners, each equipped with a sensor that alerts the owner to a perforation in the tank. In addition, sensors are available that sound an alarm when a tank is 90% full, thus preventing tank overflow during the refilling process.

placed in a pile, and vented. After most of the gasoline evaporates, this soil, and that previously stockpiled, is replaced (the 4-6 layer is the amount of soil that is displaced by the new "engineered fill" required for the septic system).

- C. Same as option #2, except the 4-6 foot layer could be immediately removed to a hazardous waste disposal site. This is more expensive than venting it and then disposing of it at the local landfill, but it takes less time. Sanitary landfills will only accept soil that is mildly contaminated.
- D. Another option, although it doesn't involve clean-up, is to sell the site "as is". This may be difficult due to the site's past history.

No matter what option is selected, Young still faces two major dilemmas. First, is there gasoline still coming on to the site from the Acme station across the street, and if so, will DEP order the owner to fix the leak? Second, what is the probability that DEP will come back to Young after the site remediation and construction of the building are complete, and require further remediation in order to meet new, more stringent, standards? DEP will not give any assurances that they will certify the site as clean even after it has been remediated as far as technically possible by today's standards. As the case history indicates, standards may continue to get tighter the longer the final clean-up is delayed.

CHAPTER V

ANALYSIS

5.1 Characteristics of Environmental Risk.

Real estate is an inherently risky business. There are ways, however, that a developer can minimize this exposure. Pre-leasing or pre-selling a building is an example of a method used to reduce market risk. Interest rate “lock-in’s” can be purchased which fix the interest rate on a loan for a set period of time; a form of insurance to reduce financing risk. Purchase options can be used to “control” the property until the required development approvals have been granted, or other contingencies met. Market data can be purchased which may help identify relationships between certain variables and the demand for a product (e.g., employment growth and demand for office space), thus reducing sales risk.

This increased certainty has a price, however, and the question therefore is, “how much should be spent for this information or certainty?” Land that has the necessary approvals is more expensive, builders quote higher prices for fixed price construction contracts, and a pre-leased building may mean agreeing to a lower rent in a rising market. Each developer must calculate the advantage to be gained from this increased certainty and balance it against greater risk but higher potential gain. The way this is done will be a function of the developer’s risk preferences.

How do the environmental risks associated with developing real estate compare with these more traditional risks? One large difference is the volatility of environmental regulations. This variable makes determining the amount of risk a developer assumes when purchasing a contaminated site a constantly moving target. As outlined in the Gasoline Station Case Study, in Massachusetts, the DEP will not commit to clean-up criteria (e.g., x ppb = clean). Instead, standards for cleanliness are assessed on a site by site basis (refer to 4.1). Environmental

regulations may be subject to change because of increased public pressure for a cleaner environment, the evolution of contamination detection equipment, or increased knowledge about contaminants and their effects. Changing regulations are an unknown future risk that is extremely difficult to quantify. In general, however, they tend to become more stringent as time passes.

A second distinguishing characteristic of environmental risk is that the clean-up is never “complete”. Subsequent to site remediation, the DEP states only that the remediation process has been taken as far as is possible with today’s technology. This gives DEP the ability to order a new clean-up in the future, if additional risks to life are discovered. An example of this is found in the Gasoline Station Case Study. When the Acme station had its tanks replaced in 1983, there was not a requirement to install leak detection devices. Today this is a standard requirement, and it is not impossible that new tanks could be mandated again in the future.⁹⁸ In addition, unlike other forms of risk, environmental risk can not be disposed of. Once the site is purchased, the owner becomes a PRP and may be held liable for the clean-up of the site in perpetuity. Neither of these risks are easily assessed.

Another area where environmental risk is different from traditional development risk is the effect of neighboring properties. Although there is an element of this in traditional risk (e.g., the neighborhood surrounding a property may deteriorate, thus lowering its value), at least today, this risk is much greater for environmental issues. Again, recall the Gasoline Station Case Study where there is uncertainty about whether the Acme station is leaking gasoline on to the property. Conversely, if a property’s contamination migrates off-site, all PRP’s may be held liable for the clean-up of the neighboring properties, and any affected water supply or protected habitat. Unless this variable can be controlled (e.g., using a barrier wall to immobilize the contaminant or purchasing an insurance policy) the risk associated with it will have to be assumed by the developer.

Environmental risk carries a potentially much higher price tag than traditional development risk. Until recently, nonrecourse financing typically limited a developer’s exposure to the value of the property. If the market became soft or the

⁹⁸EPA wants to upgrade all existing UST’s and piping on a phased schedule so that by 1998, all UST’s will have leak-detection devices installed.

project ran into problems, the developer always had the option of returning the property to the lender. In contrast, with the enactment of Superliens, State EPA's can place a lien not only on the contaminated property, but also on any other property in the developer's portfolio. The severe consequences of CERCLA and most state environmental statutes can bankrupt even the wealthiest developer or corporation.

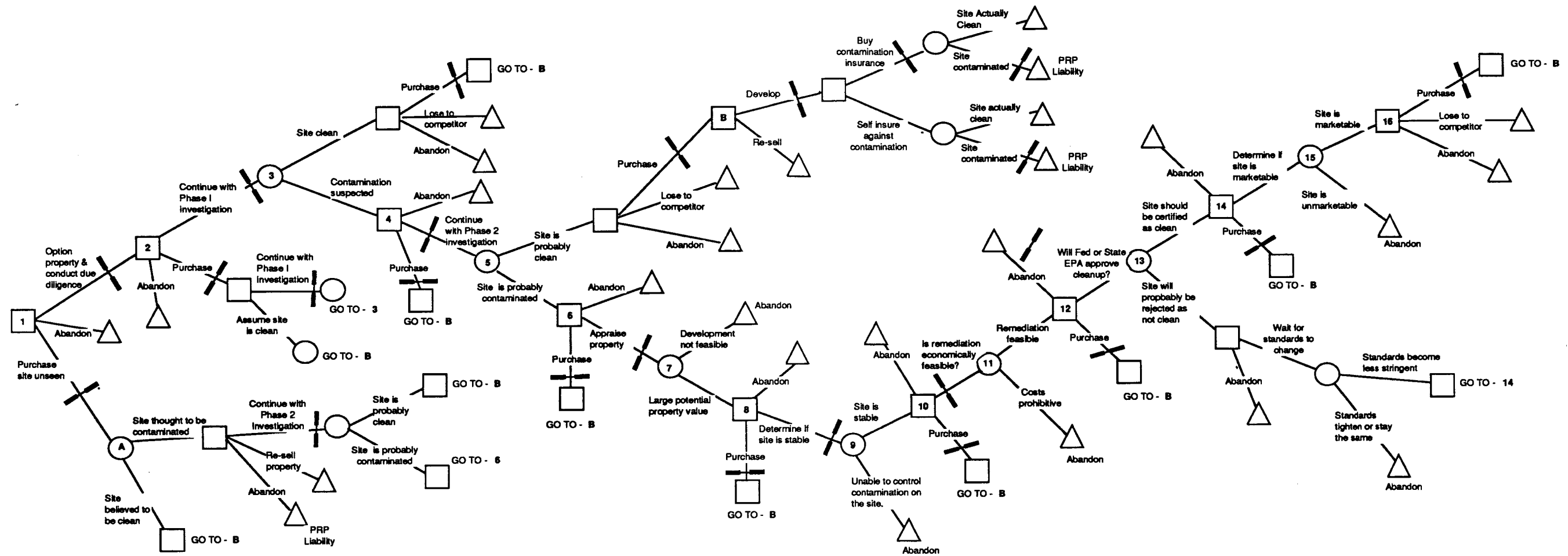
Finally, for the developer who proceeds with a contaminated site, the time delays can be crippling. While time delays are inherent with all regulatory procedures and public approvals, with environmental risk, the wait can bankrupt a developer. In the Gasoline Station Case Study, Young has waited for: information on the extent of contamination, appropriate weather conditions for his remediation method, DEP to react to his proposals and letters, and testing to determine if the Acme station is leaking. For Young, these delays have taken five years.

5.2 A Methodology for Approaching Environmental Risk.

Figure 4, illustrates a generic decision tree that may be used to help think systematically about the consequences of developing contaminated land. It is included to demonstrate the usefulness of decision trees to environmental development; mainly their ability to help the decision maker strategically map out this complex problem. Mapping out a strategy means anticipating all possible outcomes at the various chance nodes. This requires the decision maker to delineate the relationship between decision and chance nodes and potential outcomes. In doing so, new alternatives (or previously discarded solutions) to the problem may be discovered.

In Figure 4, the nodes numbered in sequence illustrate the path a risk adverse developer would follow. Two nodes are lettered; this is so that they may be referred to, thus avoiding duplication at the ends of branches. "Tolls" illustrate locations where a cost is assumed. Obviously, the risk adverse path contains many tolls for additional information (premiums for increased certainty). This generic tree is described in detail below, by tracing the numbered steps taken by a risk adverse developer. It should be recognized that a decision tree of a complex problem would most likely be much more intricate than Figure 4.

Figure 5. Generic Decision Tree for Evaluating Environmental Risk.



Legend:

- = Decision Node
- = Chance Node
- △ = Terminal Node
- = Toll (Cost)

The first thing a risk adverse developer should do before purchasing a site is determine the probability that the site is contaminated, or the likelihood that it will be in the future. This is not the only choice, however, as described by Decision Node #1. A potential buyer may purchase the property, decide that it is not worth pursuing, or proceed with the traditional strategy of conducting due diligence. Note that both the purchase and due diligence options have costs associated with them. These costs, or tolls, are represented by a black barbell. After the due diligence period, which includes a title search, review of the property's "as of right" zoning, and an architect's design feasibility study, the decision maker is presented with Decision Node #2. At this Node, as with all subsequent decision nodes, the developer may either proceed with the information gathering process (Phase 1 Environmental Assessment Report), abandon the venture, or decide that enough information has been gathered and purchase the site.

If the decision is made to proceed with the Phase 1 Report (now commonly considered part of the due diligence process), the decision maker will arrive at Chance Node #3. As described in 3.4.1, the Phase 1 Report estimates the probability that a site is contaminated. Even if the seller has had a Phase 1 Report prepared recently, it is probably a good idea to hire one's own environmental consultant, particularly if the site is in a high risk area. The information this Report provides is critical to the decision-making process. It can also have implications for future sales price negotiations. However, due to the lack of regulation in the environmental consulting profession, anyone can prepare these Reports, and therefore, by and large, they lack the rigor necessary to make informed business decisions.⁹⁹ Regardless of the confidence levels associated with the Phase 1 Report, the results are out of the developer's hand, and thus indicated by Chance Node #3 in the decision tree.

If the Phase 1 Report indicates that the probability of site contamination is great, the decision maker is moved to Decision Node #4. At this Node, the decision maker must once again decide to either buy the site, abandon the effort, or pay for more information (i.e., a Phase 2 Report). This is a Node where it is a good idea to re-assess risk preferences. Even if the Phase 2 Report indicates a "clean" site, the

⁹⁹T. C. Homburger and R. B. Selman, "Pervasive Pollutants: Learning to Evaluate the Risks," Journal of Property Management, (March/April, 1990), p. 13.

fact that the site did not receive a “clean” Phase 1 Report should alert the developer to the possibility of encountering contamination at some future date. It is prudent to remember that these Reports are only educated guesses and probabilities; one can never be absolutely sure of a site's condition. Also, at Node #4, financial position should be reviewed. Is the additional expense of a Phase 2 Report something the developer can afford? If the results of Phase 2 positively indicate site contamination, would the project be abandoned or continued? If the project were abandoned, is the cost of the Phase 2 Report an acceptable loss? Is there adequate cash flow to cover the extended approvals and development period that is anticipated if the development proceeds? If after considering individual risk preferences and financial position, purchasing the site is still an acceptable option, it is probably wise to have a Phase 2 Report commissioned.

The decision to commission a Phase 2 Report leads the developer to Chance Node #5. This Node's results will suggest with greater certainty whether the site is contaminated or clean. If it confirms the Phase 1 finding that the site is probably contaminated, it will be important to know the type of contamination, and its extent. The answers to both these questions should be provided in the Phase 2 Report, so that a sound next decision at the next node is possible. At Node #6, the developer must again decide to either purchase the property “as is”, abandon the effort, or move forward and determine if the development is still viable.

One way to determine if the project is still feasible is to commission an appraisal of the property. If the contamination is extensive, the future potential of the site should be scrutinized carefully. The amount of contamination a developer can assume is directly related to the value of the land. For example, contaminated land across the river from New York City is worth a considerable amount of money if clean, and is possibly worth pursuing. In contrast, land in rural Iowa probably does not have this potential for value creation. In the event of a cost over-run during remediation, it is helpful to have a substantial profit margin. This margin will also provide a lender or equity partner with some assurance that their investment is secure.

Although site contamination is still a new issue for appraisers, techniques for

valuing contaminated property have been, and will continue to be, developed.¹⁰⁰ As with other real estate transactions, the appraised value of the completed development will determine the financial feasibility of the project. When dealing with contaminated land, this point can not be over emphasized! The potential risks involved in redeveloping contaminated land are not worth assuming unless the value created is significant. If the site has enough potential value, (Chance Node #7), the decision maker moves forward to Node #8.

Once again, at Node #8, the decision maker is confronted with continue, buy, or abandon options. If the development is pursued, the information that determines which branch of Chance Node #9 the process follows will be provided by the environmental consultant. Leaking chemicals do not respect property boundaries. Even after properly cleaning-up the property, and obtaining the Environmental Agency's blessing, there is still the possibility of pollutants migrating on to, or off of the site and recontaminating it or its neighbors. This is of particular concern if the site is in an industrially zoned area where new contaminating industries may locate. To minimize the risk of recontamination, careful attention should be paid to the existing and future use of surrounding property. Also consider proposed tenants and/or developments in the area and evaluate their potential to contaminate the property under consideration. A new dry cleaning plant 1-mile up-gradient may have implications for the future condition of the site. This is an issue not only during for the redevelopment of a contaminated site, but also in the on-going area of asset management (for more detail on this topic refer to Section 6.3).

If the clean-up is considered stable (i.e., the site will stay clean once remediated), the decision to either proceed with determining the economic feasibility of the remediation procedure, or to fall back to the options of purchasing the site, or abandoning the effort must be made (Decision Node #10). If the site is confirmed as contaminated, most environmental consultants will provide an estimate of the remediation cost in their Phase 2 Report. As mentioned in 3.4.1, the standards for these Reports are nebulous, so clarification is a must. The clean-up cost will depend on many factors: the remediation technique used, the availability of proper disposal facilities, and, the clean-up standards required by the governing body. By

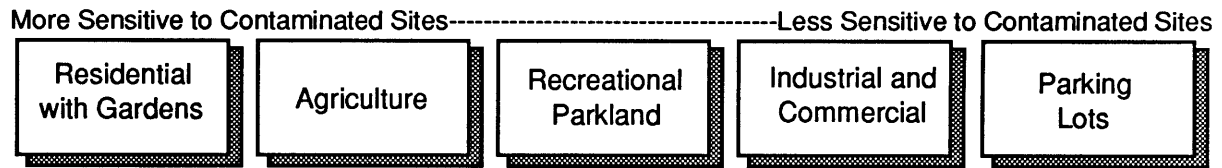
¹⁰⁰For more information about this topic refer to P. Patchin, "Valuation of Contaminated Properties", The Appraisal Journal, (January, 1988), p. 7-16.

consulting with both an experienced environmental engineer and remediation contractor, an assessment of the likely remediation cost may be made.

If Chance Node #11 shows the clean-up to be financially feasible, the decision maker moves to Decision Node #12. At this point, an assessment of the regulatory atmosphere needs to be made. What are the chances that the clean-up will be sanctioned by the Authorities? The key variable here is time. State EPAs are usually inundated with work and may take months to respond to a letter or request. A discussion with a representative should reveal the procedure for certification (if any), and how long this process may be expected to take. An environmental consultant may be helpful; if this is the case, a toll must be inserted. A developer who has been through the "learning curve" associated with remedial developments, may know the system, and thus slightly improve the odds of receiving approval. Although State Environmental Agencies will most likely be reluctant to give firm numbers, any information about the probability of getting the site certified given the contaminants involved, the detected quantities, the proposed method of remediation, and the anticipated contractor, will be very useful at this point in the decision process.

If, the developer determines that the chance of receiving Agency approval is favorable, the next step taken is determining the probability that the Public (e.g., potential buyers and tenants) will believe the site is truly clean (Node #14). The marketability of the site will depend largely on the the end use of the property. The stigma of past site contamination may prevent the sale of luxury homes on the site, but not discourage the potential tenants of a storage facility, parking lot, or industrial building. Likewise, redeveloping a gas station site as a "Jiffy Lube" which is held for income production, certainty reduces marketing risk. Recall the example of the developer who is cleaning-up oil fields and building single family residential homes on the reclaimed land. In his case, the market requirement for cleanliness is the determining factor in the remediation process. In that case, the remediation standards used exceeded those set by the State Environmental Agency in order to insure that gasoline fumes were not noticeable by residents. Marketability will also vary with product demand and whether potential tenants have other choices available. The diagram below represents the current relationship between the end use of the site and the degree of current contamination.

Figure 5. Relationship Between End Use and Contamination.¹⁰¹



The ownership strategy for the property will also play a role in the decision maker's assessment of market risk. If the site is cleaned-up and sold without building on it, development risk is eliminated, and perhaps more environmental risk is appropriate. Alternatively, the site could be cleaned-up, redeveloped, and rented or sold, or, cleaned-up, developed and held for long-term income production. What the Public considers, or perceives, as clean should weigh heavily. If the plan is to develop and hold the property, can a desirable tenant mix be achieved (i.e., can an anchor tenant for the shopping center be found)?

If the site's marketability is considered adequate, the risk averse developer has reached the last numbered node and thus thoroughly tested the environmental risk of the proposed project. Node #16 is where the final decision to purchase the property is made. If it is purchased, Decision Node B illustrates the two ownership options outlined above (to develop, or to re-sell). Finally, the last decision the developer makes is whether or not to purchase insurance (assuming insurance is available). Insurance is discussed in detail in Section 5.3. The tree concludes with a chance node. Either the site is actually clean and will stay clean, or it is recontaminated, does not receive Agency approvals, or requires future clean-up.

A final note about tolls. Most decision nodes required a toll to be paid for additional information. This toll may be an out of pocket expense (e.g., purchase options, Environmental Assessment Reports, etc.), or possibly the value of the developer's time and money, and the opportunity cost of doing other things with it. The information purchased at each stage is used to aid the decision about whether the proposed development should proceed forward unmodified, or, be adjusted or abandoned. The costs associated with any additional work should be weighed against the potential value created. At any point in the tree, it may be decided that

¹⁰¹Cairney, p. 70.

the information is becoming too costly and enough has been gathered to make a rational decision. An economist will advise that no matter where one is in the tree, anything spent up to that point is a sunk cost. Therefore, if at some point the project no longer looks attractive, the venture can always be abandoned. Obviously, this is easier said than done. However, if the decision maker is rigorous about looking at alternative investments, an attractive option may make the sunk cost “pill” of abandoning the project easier to swallow. It is important to note that, although there are costs involved at most decision nodes, a decision maker can move all the way through the tree for a modest price. Also, recognize that the entire tree can be traversed without taking title to the property, and thus incurring liability.

In conclusion, the following questions should be carefully considered prior to developing a contaminated site. Is there a sufficient contingency for additional remediation costs and time? Is the financial return enough to compensate for the additional risk and uncertainty being assumed? If not, can the deal be restructured to make it more attractive (e.g., indemnifications, a reduction in the purchase price, etc.). In the final analysis, it is this economic pay-off that makes the deal profitable. Is the deal profitable?

5.3 Analysis of the Insurance Case Study.

There is increasing empirical evidence that one reason the insurance industry has been reluctant to cover a number of risks is the ambiguity associated with either the probability of specific events occurring and/or the magnitude of the potential consequences.¹⁰² Why then, would ECS want to provide insurance in the highly uncertain area of environmental pollution? They are providing the coverage because there is a market for the product. This market could be the result of differences in risk perception. ECS is optimistic about the potential of losses, while the customer is pessimistic. ECS's perception is certainly affected by its ability to pool risk; by contrast, most customers are only insuring one asset (i.e., they do not have the ability to flip the coin an infinite number of times).

¹⁰²H. Kunreuther and R. Hogarth, “How Does Ambiguity Affect Insurance Decisions,” in: G. Doinnie, ed., Contributions to Insurance Economics, (Boston: Kluwer, In Press), p. 13.

Selling insurance is entirely a matter of pricing. If the price is too high, it will not sell. Conversely, if it is too low, many policies will be sold, but the insurance company may go out of business. People buy insurance to reduce the loss associated with an uncertain event. What they are willing to pay for coverage relates directly to their risk preferences. Similarly, the coverage that a company is willing to offer is also dictated by risk preferences. How does ECS view the risks of insuring against pollution clean-up? Essentially, the premiums collected, plus any income earned, less the pay-out of claims to insured clients, has to be positive over a period of time for the Company to be profitable and survive.

Determining the appropriate premium is, then, the essence of the insurance business. The variance associated with all potential losses is important when deciding where to set the insurance premium, because as the variance gets larger, the probability of the insurer going bankrupt increases. Because of the potentially large claims associated with cleaning-up contaminated sites, ECS has decided to restrict the right tail of the potential loss distribution by limiting the amount of coverage to \$1,000,000. This reduces the magnitude of potential claims.

If the pooled risks being insured are correlated (e.g., with earthquake insurance there are either no claims, or a deluge), or the probabilities of losses are uncertain, the insurer will also want a higher premium. This would indicate that ECS is probably not insuring too many properties in the same geographical area. If the ground water table for that whole area were to become contaminated, the number of actual claims could exceed the amount anticipated. Also, ECS probably would avoid insuring too many of the same type of sites. In this case a change in regulations could trigger the worrisome torrent of claims.

To better understand the premium setting behavior of insurers when risks are ambiguous, Hogarth and Kunreuther conducted a survey of 190 insurance companies throughout the United States. Two hundred and twenty-two completed questionnaires were received from 47 companies. In order to determine whether specific risk contexts influenced the premium setting process, each underwriter was given one of two possible scenarios and asked to set a premium for the coverage. The first scenario required insuring a commercial building against earthquake damage, while the second provided coverage against pollution damage from a leaking underground storage tank.

The results showed that the potential hazardous waste loss induced underwriters to charge a higher premium than for the earthquake scenario. It also established that ambiguity in the probability of an event occurring had more impact on raising premiums than ambiguity in the magnitude of the loss.¹⁰³ This makes sense, since underwriters can reasonably estimate the cost of repairing a damaged building, but are less likely to predict the probability of the earthquake occurring.

If uncertainty about the probability of an event occurring is one of the more sensitive variables for insurance underwriters, these results would imply that ECS should be very concerned about any variable that would affect the probability of a claim occurring, instead of the magnitude of the claim (which has been limited by the policy maximum of \$1,000,000). In the context of environmental risk, one such variable would be the potential of off-site contamination leaking on to the insured property (e.g., a dry cleaning plant up-gradient that is leaking TCE). This also suggests that ECS should be doubly concerned about changing environmental regulations. Not only are claims arising from a change in regulations correlated but they are also uncertain events.

This assessment of risk may also have implications for traditional development. In traditional development scenarios, the variables that most affect the probability of a loss are related to market risk. For example, if a speculative building is built and no one leases the space, the loss is great. Market risk is a volatile variable because it relates to the probability of an event occurring. By contrast, a change in interest rates from 10% to 13% will reduce the profitability of the project, but because this variable is less volatile, the magnitude of the loss is small. If the uncertainty about the probability of an event occurring can be extrapolated to environmental risk, then the decision maker should be most concerned about: a change in regulatory milieu or the ability to get Agency sanctions; migrating pollutants; and the Public's perception of "cleanliness" (i.e., any variable that would change the status of the site from "clean" to "contaminated"); not, the cost of the clean-up.

Other variables that may be potentially volatile are revealed by reviewing ECS's Application for Pollution Clean-up Coverage (Appendix C). The following variables

¹⁰³Hogarth and Kunreuther, p. 13.

are considered: financial solvency; history of environmental affairs management; location of potentially sensitive receptors to the site; company safety programs and emergency procedures in place; and, any previous claims related to environmental liability.

5.4 Analysis of the Gasoline Station Case Study.

The Gasoline Station Case Study concluded with a list of four alternative “next steps” that Young believed were available. Three of these options were different site remediation remedies, the fourth was to sell the site (refer to 4.2). These alternatives, however, did not take into account two rather large uncertainties. The first is the probability that DEP will endorse the site clean-up. What is the possibility that the regulatory standards become more stringent during the remediation process, subsequent to completion of the clean-up, or, after the site is sold? The second sizable uncertainty is whether the Acme gasoline station is, or in the future will become, a source of contamination for Young’s property (i.e., will Young’s site stay clean once it has been remediated?).

Both uncertainties represent potentially large losses. Also, based upon the conclusions drawn from the Insurance Company Case Study, because these variables are ambiguous in the probability of an event occurring, they are the variables that Robert Young should be most concerned with. In contrast, the variables Young is primarily concerned with are parameters that are ambiguous with respect to probable cost. These variables are unlikely to approach in magnitude the potential loss associated with regulatory and off-site recontamination risk.

To help highlight the key issues and decision options available to Robert Young, a decision tree of his choices was prepared (Figure 6).

5.4.1 Modeling the Problem.

The decision tree in Figure 6 maps out three initial options available to Robert Young: wait for a dry summer, excavate the hazardous material, and sell the property. (Young’s fourth option was really a variation on the excavate scenario

and is allowed for by the second decision node on the “Excavate 4 Feet” branch.) If Young is unable to sell the site, or the summer turns out to be wet, these two branches present alternative options (i.e., if Young cannot sell the site, he can wait for a dry summer or excavate the hazardous material). One of the advantages of this model is that it forces the decision maker to assess the probability of certain events occurring. For example, what is the probability of selling the site? When forced to assign this probability, the decision maker may contact a local real estate broker for more information. (Refer to 3.5.2, for information on tree construction.)

In order to craft the decision tree in Figure 6, assumptions were made about the costs associated with each decision, as well as the probability of the decision maker achieving the desired outcome. The assumptions made, and illustrated in the tree, are not set in stone. Another decision maker, with different risk preferences, might make different assumptions, or initial values. These values are only a starting point for modeling the problem. Once the model is constructed, the decision maker may try alternative futures (i.e., varying probabilities and costs). This allows one to see the effect of different values have on the problem’s outcome.

Not incorporated into the tree are market variables. This analysis assumes that the market demand and the interest rate for the proposed office building will remain stable. These assumptions were left out of the model in order to keep the tree manageable. They could certainly be added, however. Market risk, for example, could be modeled by adding a chance node at the end of each terminal node in the tree. The new branches from this node would describe various potential outcomes based upon different market conditions (e.g., “market stays the same”, “market improves”, and “market declines”).

Also implicit in the model is the assumption that Young is a PRP no matter what decision is made. It can be argued that if the site is sold, there will be another PRP to help absorb any future potential losses. However, this new owner may do something with the site that increases Young’s potential liability as a PRP (e.g., redevelop the site inappropriately). This assumption could be modeled by increasing the losses associated with undesirable terminal nodes. A list of the initial values used to generate Figure 6 are outlined in Table 3.

Figure 6. Decision Tree for Gasoline Station Case Study.

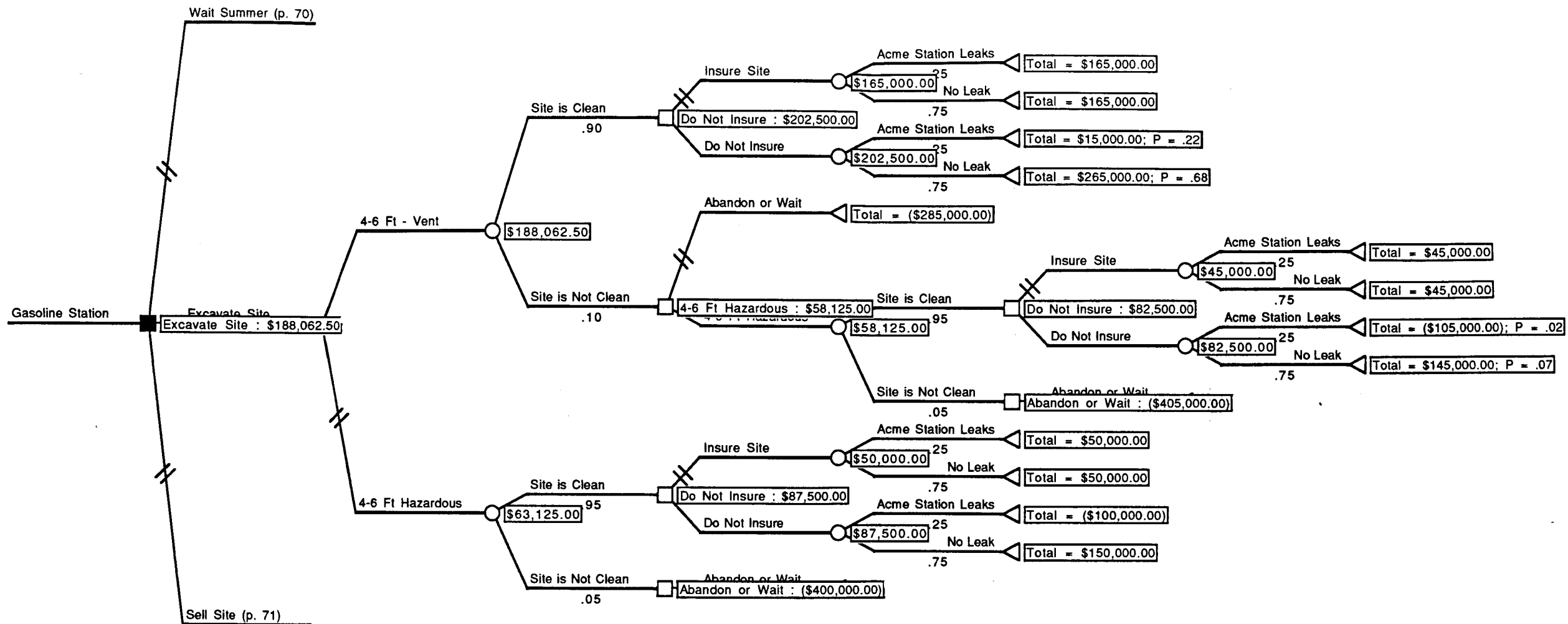


Figure 6. (continued).

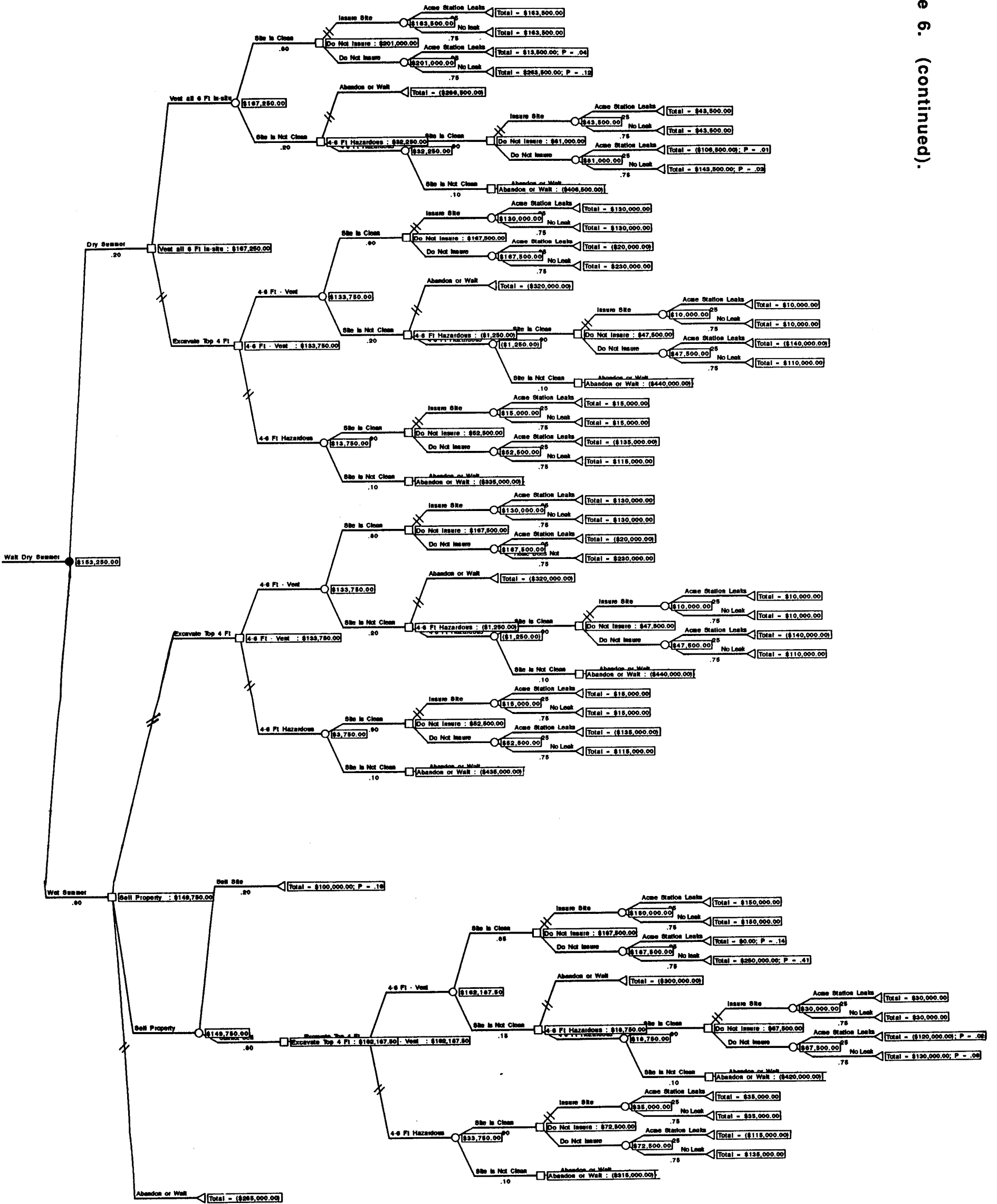


Figure 6. (continued).

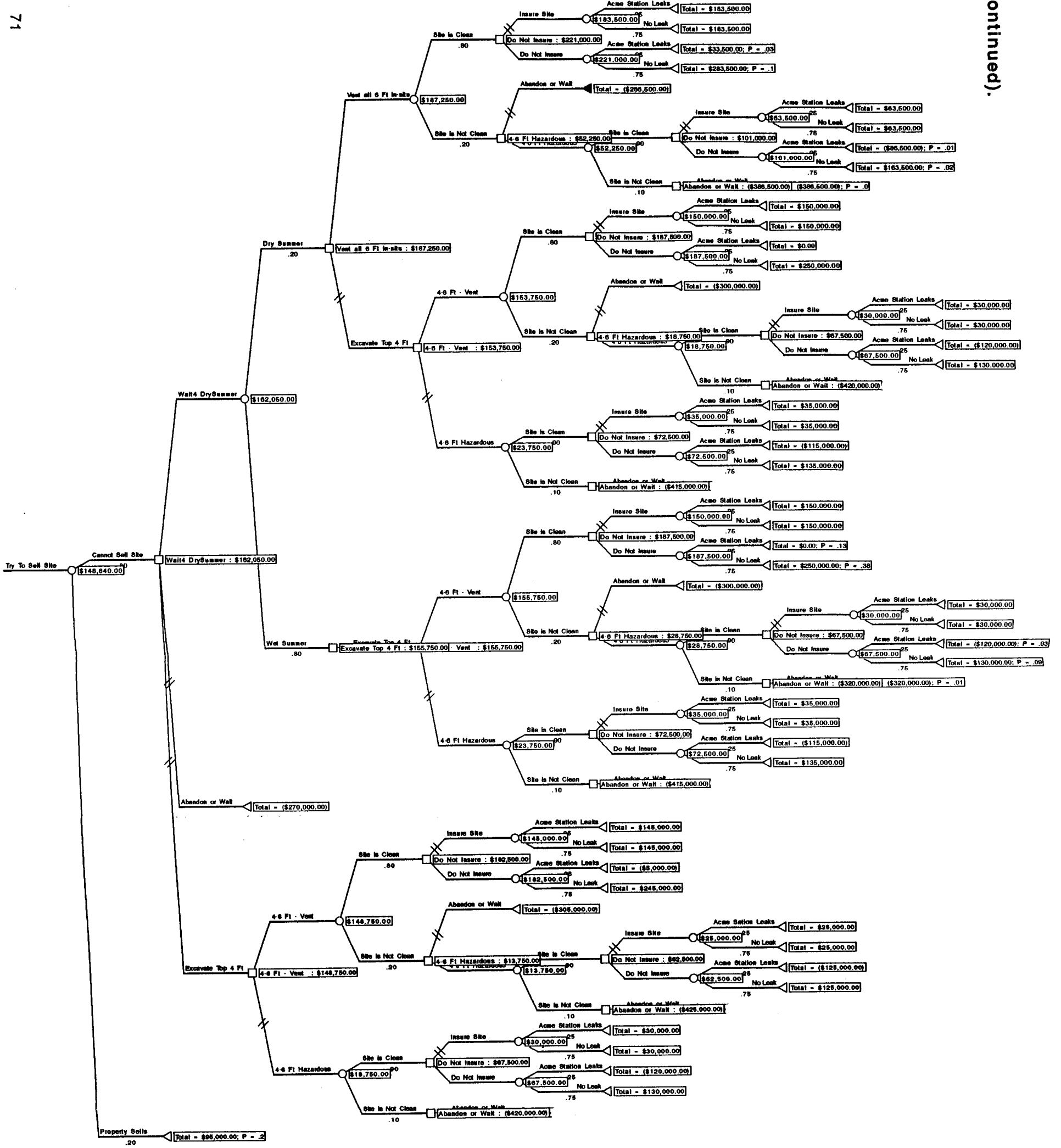


Table 3. Initial Value and Probability Table for Figure 6.

Initial Values for Annual Costs:

In-situ venting (equipment is paid for; utilities only)	\$1,500
Pile venting	\$5,000
Excavation of contaminated soil	\$30,000
Hazardous waste dumping fee	\$120,000
Sales price of land "as is"	\$115,000
Carrying costs on the property	\$30,000
Insurance against future contamination (slurry wall construction)	\$100,000
Total cost of Acme station leak, if uninsured	\$250,000
Profit from completed building	\$300,000

Initial Values for the Probability of Outcomes:

Chances That Initial Choices Will Come to Fruition:

Probability of a dry summer (water table lowers for soil venting)	10%
Probability that excavation remediation can begin	100%
Probability that site will sell (\$115,000)	20%

Chances that Clean-up is Successful and Receives Agency Approval:

(probabilities reflect effectiveness of technique as well as time to complete - i.e., tightened regulations)

Probability for in-situ soil venting	80%
Probability for excavating hazardous soil and pile venting	90%
Probability for above after first trying to sell or achieve a dry summer	85%
Probability for excavating hazardous soil and dumping	95%
Probability for above after first trying to sell or achieve a dry summer	90%

Other:

Probability the Acme station will recontaminate Young's site in the future	25%
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Time Factors:

(assumes initial decisions are made in September of 1990)

To determine outcome of "Wait for Dry Summer" option	14 months
To determine outcome of "Try to Sell" option	6 months

5.4.2 Description of Gas Station Decision Tree - Figure 6.

The decision tree in Figure 6 outlines the options available to remediate the gasoline station site.¹⁰⁴ At the first decision node (Gas Station Problem), Young must decide whether to wait for a dry summer so that the drop in the water table will allow *in-situ* venting, proceed immediately with remediation, or sell the property and minimize any further losses. Note that both the “Wait For Dry Summer” and “Try to Sell” options have two diagonal slashes through them. This indicates that these decisions are not on the optimal Expected Monetary Value (EMV) pathway. This convention is followed throughout the rest of the tree.

The optimal EMV decision from the initial decision node is the “Excavate Top 4 Feet” option. The rectangular box directly to the right of the first decision node contains the EMV of that pathway, in this case \$188,062. Remember, the EMV will not be the actual outcome if that pathway is chosen, it is just the probabilistic weighted average of all possible outcomes (this assumes that the optimal path is selected at each decision node in the tree).

If the decision maker is risk neutral, the optimal decision will be that with the highest EMV, in this case, the “Excavate” option. However, because developers are not necessarily risk neutral, the option with the highest EMV may not be optimal. Because the EMV represents an average outcome, the distribution of all potential outcomes needs to be examined. One measure of this variability is the range of potential outcomes. The boxes on the far right of the report containing the word “Total”, represent the outcome for each path if followed to its terminal node. By observing the value associated with each terminal node, the range of potential outcomes for each decision can be evaluated. The “Excavate Top 4 Feet” option, for example, produces outcomes that range from (\$405,000) to \$265,000. EMV decision paths that have potentially catastrophic losses should always be evaluated carefully. Depending on the risk preferences of the decision maker, the potential loss of \$405,000 may or may not be acceptable.

While the range of outcomes is interesting, the actual distribution of all outcomes is

¹⁰⁴The software used to produce this decision tree was Decision Analysis by Tree Age Software, Boston, MA. This version was written for the Apple Macintosh™; an IBM compatible version should be available in late 1990.

much more informative. Figure 7, illustrates the probability distribution of all outcomes for each of the three initial decisions (“Wait for Dry Summer”; “Excavate Top 4 Feet”, and “Sell Site”). A review of these charts reveals a few common characteristics. All three options have a small probability (1-2%) of producing a \$400,000 - \$450,000 loss. In addition, all have a large probability of producing a reasonable return (i.e., approximately \$300,000). Although it is hard to extrapolate a smooth distribution for each of these scenarios due to the small number of potential outcomes, they all appear to have similar distributions. The primary reason for creating these charts is to isolate an option that might have extremely variable outcomes. Due to the similarity of the three distributions, the decision as to which option to select, is not, in this situation, influenced by this information. If the reader does not have the capability to produce probability distribution charts, the standard deviation of the outcomes may also be used as a measure of variability.

5.4.3 Sensitivity Analysis.

In order to further distinguish between the options available, it is useful to know how the decision maker’s choice might differ in reaction to a movement in one of the initial values. For example, how might Young modify his decision, if upon reviewing a meteorological forecast, it is determined that the upcoming summer will be wet? Sensitivity analysis can be used to identify those parameters or variables to which the decision is sensitive. It is performed by varying the magnitude of more uncertain variables either singularly or in combination and examining the results. When using this type of analysis, it is important to identify variables that are uncontrollable and have a significant impact on the outcome of the model. In this way, sensitive variables can be monitored by the decision maker for any changes that might affect the viability of the project. These variables may also be the focus of attention when purchasing information to increase certainty.

The mechanics of sensitivity analysis require increasing or decreasing each of the selected variables by a constant amount (e.g., 50%). By standardizing the change, any unusually large variation in the model’s output (in this case the EMV) can be detected and thus attributed to a particular variable. Table 4 is a sensitivity matrix of the three chance node variables in the Gasoline Station decision tree. Each variable was increased and decreased by 50%, to model “best” and “worst” case scenarios; the effect of these movements on the EMV was recorded.

Figure 7. Probability Distribution of Outcomes.

The charts depict the distribution of all potential outcomes for a particular decision node. These outcomes assume that the optimal EMV choice is made at each decision node. On the vertical axis is the probability of a certain outcome occurring. The horizontal axis represents the EMV of each potential outcome. The first chart, (7A), only has five vertical bars, which represent EMV's. If more than one outcome falls in the same EMV range, the cumulative probability is represented in that range, not each individual outcome (e.g., a 10% chance of \$105,000 and a 5% chance of a \$115,000 would be represented as a 15% probability of the EMV falling in the \$100,000 - \$125,000 range):

A. Decision to Wait for Dry Summer

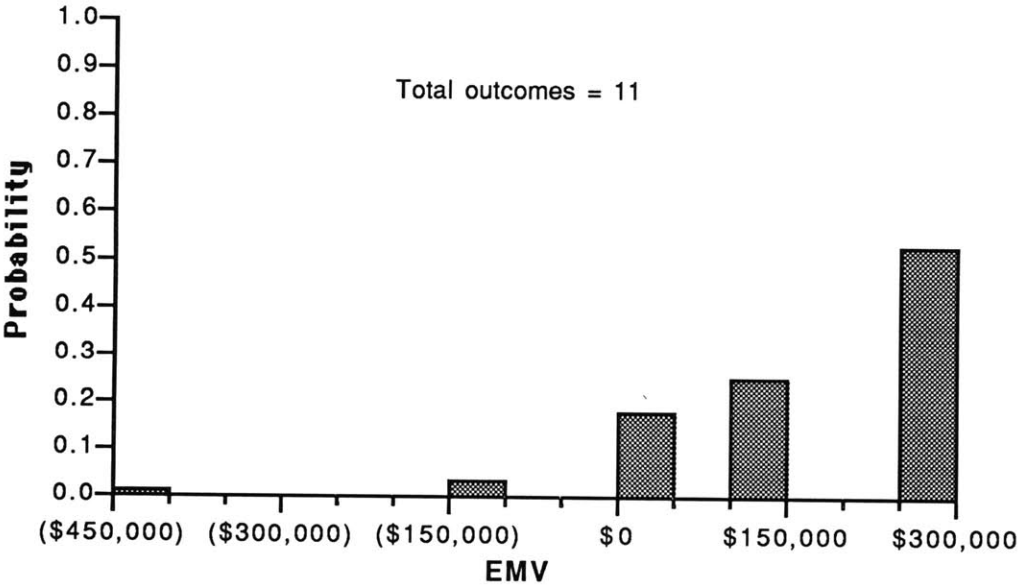
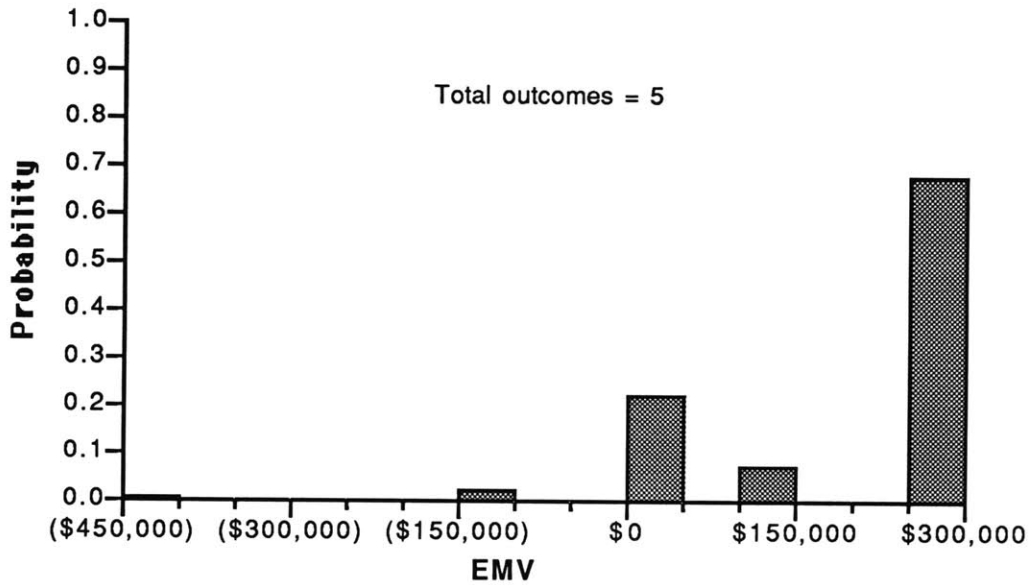


Figure 7. (continued)

B. Decision to Excavate and Proceed with Clean-up Immediately.



C. Decision to Try to Sell Property.

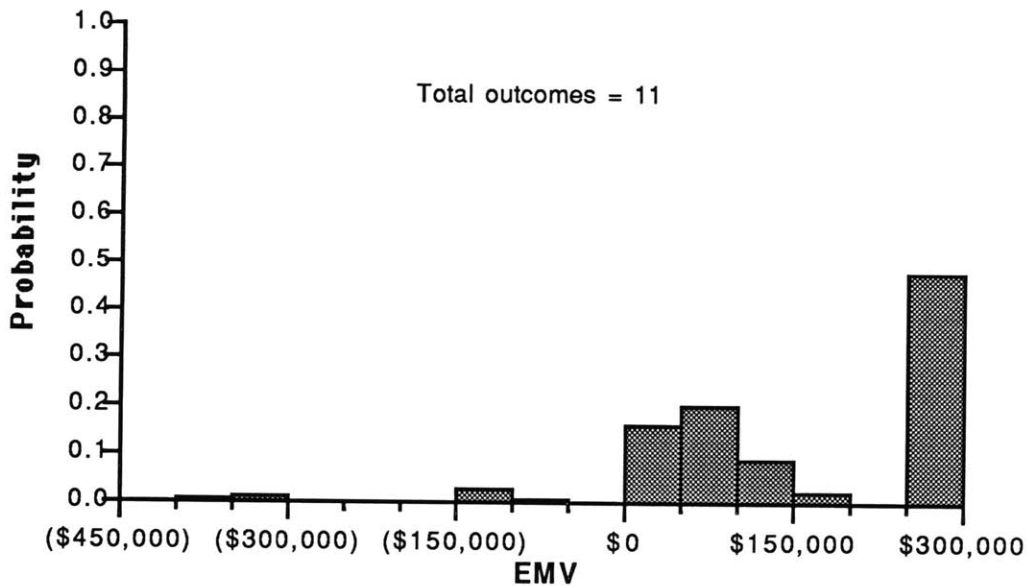


Table 4. Sensitivity Analysis Table for Figure 6.

WORSE CASE SCENARIO - PROBABILITIES WORSEN 50%									
PROBABILITIES	Base Scenario	Dry Summer		Selling Site		Acme Site Leaks		Site Not Approved	Clean
Initial Values		20.00%		20.00%		25.00%		5% - 20%	
Alternative Values		10.00%		10.00%		37.50%		7.5% - 30%	
EMV'S AND % CHANGE									
Wait for Dry Summer	\$153,250	\$151,500	-1.1%	\$158,225	3.2%	\$127,425	-16.9%	\$140,029	-8.6%
Excavate Top 4 Feet	\$188,062	\$188,062	0.0%	\$188,062	0.0%	\$157,062	-16.5%	\$180,141	-4.2%
Sell Site	\$148,640	\$146,120	-1.7%	\$155,345	4.5%	\$124,140	-16.5%	\$134,270	-9.7%
BEST CASE SCENARIO - PROBABILITIES IMPROVE 50%									
PROBABILITIES	Base Scenario	Dry Summer		Selling Site		Acme Site Leaks		Site Not Approved	Clean
Initial Values		20.00%		20.00%		25.00%		5% - 20%	
Alternative Values		30.00%		30.00%		12.50%		2.5% - 10%	
EMV'S AND % CHANGE									
Wait for Dry Summer	\$153,250	\$155,000	1.1%	\$148,275	-3.2%	\$179,075	16.9%	\$166,382	8.6%
Excavate Top 4 Feet	\$188,062	\$188,062	0.0%	\$188,062	0.0%	\$219,156	16.5%	\$195,891	4.2%
Sell Site	\$148,640	\$151,160	1.7%	\$141,935	-4.5%	\$173,140	16.5%	\$163,130	9.7%

The results of this analysis indicate that adjusting both the probability of a dry summer, and the chance of selling the site, have little impact on the EMV's of the available options. The variables that did produce a significant change in the EMV's of the options were the likelihood of the Acme site recontaminating Young's property, and the possibility of regulations becoming more stringent, thus affecting the completion of the clean-up. It is interesting to note the last two variables were highlighted in the generic decision tree as being potential problems due to the lack of certainty associated with their occurrence (refer to Figure 4).

The probability of the Acme site leaking is a variable that is inherent in all three options. A 50% increase in the probability of a leak, decreased the EMV of each option by approximately 16%. All options were equally sensitive to this change. The "Site is Clean" variable (includes moral, regulatory, and market perceptions of "how clean is clean" - refer to 3.3), on the other hand, is more pronounced in the "Waiting" and "Selling" scenarios. This is due to the additional time required before remediation efforts begin, thereby creating additional exposure to the risk of regulatory and market perception change. A 50% decrease in the probability of the site being clean, produced a 10% decrease in both the Wait and Sell options, but only a 4% decrease in the "Excavate" option.

5.4.4 Making a Decision.

Of all the scenarios tested, the "Excavate" option consistently produced the largest EMV. At first blush, the decision maker might consider this to be the optimal route. Other information must be taken into account, however. The EMV must be evaluated in light of the model's assumptions (e.g., the market is constant, the opportunity cost of the decision maker's time, etc.). For example, although the "Wait" option may not have the largest EMV, the decision maker may feel that the market will significantly improve during the waiting period. In addition, risk preferences also have to be considered.

Assume that a buyer for the property is found. If there is 100% certainty that the buyer will purchase the site, what sales price will make the decision maker indifferent between accepting the money offered (i.e., a certain monetary equivalent (CME) - refer to 3.5.3.), and gambling with the "Excavate" option? Remember, the outcomes for the "Excavate" option range from a loss of \$405,000

to a gain of \$265,000. In this situation, certainly any price in excess of \$188,062 (the optimal EMV) should be accepted. However, the greater Young's aversion to risk, the the smaller the acceptable CME. The risk preference curve will be affected by the the magnitude of the potential losses and by the asset base of the decision maker. Knowing one's CME is an important step in understanding when a guaranteed option is worth pursuing.

While this modeling system does not produce a single optimal solution, it does allow an individual to choose from all the possible outcomes, thereby enabling the decision maker to factor in individual preferences. It is a simulation model, not an optimization model. In the end, the decision maker makes the final judgement, not the model.

5.5. A Final Comment on Decision Trees.

The benefit of sensitivity analysis is that the impact of changes in the factors that create the dilemma can be modeled. In this way, new insights into beliefs about uncertainty and preferences for outcomes may be revealed to the decision maker¹⁰⁵. This an essential part of analytical thinking. Although the outcomes associated with each decision are still unknown, by modeling the problem, future alternatives are uncovered.

While it has been advocated that the use of decision analysis techniques may help developers make better decisions under uncertainty, it does not follow that a decision that is the product of this process is always better than a decision made entirely on intuition. In a particular case, the results may be identical or the intuitive decision might prove better. However, for most people, most of the time, the methods described are of real assistance. These techniques assist, but do not replace, the quality of judgment of the decision maker. They are useful tools, no more and no less.

¹⁰⁵Behn and Vaupel, p. 256-7

CHAPTER VI

CONCLUSIONS

6.1. Environmental Risk Management

The presence of pollution in the environment is a phenomenon that, unfortunately, is here to stay. Dealing with contamination is becoming a normal part of life. The volume of chemicals utilized by society, and the extent of the resulting contamination is such that no land should be above suspicion. Environmental Assessment Reports are evidence of this; they have become as fundamental to the developer's due diligence process as title insurance and land surveys.

As our understanding of pollutants and their effects on the environment grows, so does public pressure for reform. As a result, environmental regulation has become more stringent and the number of sites considered contaminated is increasing. The real estate industry today is very concerned about exposure to environmental risk and is generally trying to avoid these properties. At some point, however, developers must accept these hazards as just one more risk to be managed, along with market , regulatory , construction, and interest rate fluctuation risk.

Development is a risky business. The "down" market of 1990 has forced many developers to return buildings to the bank, or close their doors. Many of these companies were overextended and caught in a cycle of overbuilding. These developers and their bankers assumed a large business risk when building, or financing, speculative office buildings. These same developers and bankers, however, would probably balk at buying property suspected of contamination. On the surface, these decisions do not appear rational. From a *pro forma* financial statement perspective, the total loss associated with a poorly conceived building on a "clean" site (interest expense, additional marketing costs, etc.), can far exceed the

costs associated with a high demand shopping center that is built on land requiring some remediation.

However, the *pro forma* financial statement is not an adequate measure of environmental risk (as the Gasoline Station Case Study illustrated, refer to 4.2 and 5.4.2). To begin with, environmental remediation technology is new, without certain costs, and without set standards to determine when it is complete. This makes remediation efforts particularly prone to cost overruns and time delays; thus, almost impossible to quantify in the *pro forma*. Also missing from the financial statement is the volatile variable that the site may need to be remediated again in the future when new regulations are issued, or environmental conditions change. Finally, the fact that environmental risk is being assumed in perpetuity, is not easily illustrated in a *pro forma*. Other kinds of risk can be walked away from, sold or abandoned; not so with environmental risk.

This uneasy state should be looked at in context - any new risk is not easily quantifiable. In fact, the ability to manage a given risk increases as it becomes better understood and the regulations, procedures, consultants, costs, liabilities, etc., better defined. The management of asbestos risk is an example. When it was first disclosed that asbestos might cause workers to develop asbestoses and/or lung cancer, many building owners experienced an immediate drop in the marketability of their properties. There was a stigma associated with asbestos and owners had a difficult time locating buyers willing to accept the environmental risks. Most of the real estate industry reacted in the same manner; banks stopped lending on properties known to contain the substance, tenants looked for other buildings to lease, and contractors refused work due to the potential hazards of exposing their employees.

The resulting drop in property values created a niche market for a few companies who now specialize in buildings known to contain asbestos. After the property is purchased (at a reasonable discount from its market value) an asbestos management program is implemented. As tenants move out or renovate, the substance is removed. Finally the building is sold, or held for its income production (with rents no longer discounted due to the existence of asbestos).¹⁰⁶

¹⁰⁶For more information see: K. Silvera, "Investors Gamble on Sick Properties,"

Although there is not a direct analogy between asbestos and contaminated land (i.e., the asbestos problem rarely gets worse and is unlikely to cross property boundaries), some of the same patterns will undoubtedly evolve in the contaminated land sector. This evolution in the management of risk may be seen as comprising four stages. Since the enactment of CERCLA and SARA, developers have moved through three of these stages.¹⁰⁷

The first stage in the evolution of environmental risk management was resistance. Initially, developers saw site assessments as an additional cost, not worth incurring. When government enforcement officials struck, and a few developers were held at least partially responsible for cleaning contaminated sites, they moved to stage two - panic - and avoided all questionable properties. However, the fact that many prime parcels are contamination risk sites, encouraged some developers to migrate from the second to third stage. This third stage is risk management; these developers learned that site contamination was a risk that could be assessed and handled. Now a few companies are beginning to enter a fourth stage called risk exploitation. These developers are negotiating very good prices for properties that require remediation because no one else wants them. If they properly assess and manage the clean-up and associated liabilities, the profit is theirs.¹⁰⁸

An example of risk exploitation, the mature stage of this cycle, is the developer in Southern California who is buying former oil fields in residential in-fill areas. The land is acquired at a substantial discount because it is saturated with hydrocarbons. The land is cleaned-up, and single family residential housing built. This developer's profits have been substantial. To date, nineteen such transactions have been completed.¹⁰⁹ Beyond the liability issues, a sound economic investment opportunity has been found and exploited.

Determining when the risk of developing a contaminated site is acceptable is a complex process involving many factors. However, when analyzing the cases

Commercial Property News, (June 1, 1990), p. 1.

¹⁰⁷K. P. Kelley, "Developers Weigh Property Value With Potential Liability," Hazmat World, (March, 1989), p. 33.

¹⁰⁸T. C. Homburger and R. B. Selman, p. 12.

¹⁰⁹Allum.

researched for this paper, three variables seemed to reoccur. First, developers who remediate sites seemed to prefer sites that were contaminated with a substance that was well-known, had been in the marketplace a long time, had a number of proven treatment technologies, and could be readily characterized as to extent and effects. Such a contaminant is advantageous because remediation costs can be more effectively calculated (reduced remediation cost risk). In addition, a well-known contaminant is less likely to have market risk; people, in general, prefer a risk they are familiar with. Finally, a substance that has been around for a while will have less risk associated with changing regulations. While there are outstanding exceptions, in general, legal precedent is established and health effects broadly tested for common contaminants.

A second variable that reoccurred when analyzing successful remediation cases, was a property that, when “clean”, had a very high value. Developers are always interested in profit, however, in order to accept the potentially severe consequences of environmental liability, successful remedial developers required exceptional returns. In some cases, environmental risk was assumed when market risk was negligible. For example, the Southern California developer of abandoned oil fields, only remediated sites that had excellent location, an established residential neighborhood, and a market where the homes were in demand.

Finally, the third variable was a seller who was well known and financially solvent. Usually the seller was willing to structure the transaction such that the developer's risk was minimized. Indemnification agreements were sought after, and sometimes required as a condition for proceeding with the venture. A well-known and financially solvent seller was considered to greatly diminish the future liability associated with becoming a PRP, especially with a secure indemnification agreement in hand.

Obviously, not all successful redevelopment cases met each of these three conditions. In one example, where extremely high returns were expected and the market risk was considered negligible, the indemnification agreement was forgone. Another developer refused to consider a venture without this agreement. Individual risk preferences will dictate different combinations. However, it is concluded that when these three conditions are met, there may well be opportunities to exploit the difference in risk perception between that of the general real estate industry, and

that which actually exists. Conversely, when these conditions are not met, environmental risk is of a magnitude to be treated with extreme caution, and probably avoided.

6.2 Risk Preferences.

Successful remedial developers are also unique. Re-occurring in the cases examined, were developers who exaggerated the hazard during negotiation in order to achieve a huge price reduction, and had their own in-house staff to manage the hazards and make the properties marketable.¹¹⁰

These developers are also unique in that there are few of them. To date, most companies do not have an appetite for risk that allows them to undertake these projects. This may be because few companies are set-up with environmentally savvy in-house staff or the necessary experience to exploit this opportunity. As with asbestos, until developers are savvy with the risks of contaminated properties, they will avoid them.

Another reason for a company to avoid environmental risk is the entity's inherent risk preferences. While most investors acknowledge the need for caution when dealing with contaminated properties, different sectors of the real estate industry undoubtedly perceive the associated risk in different ways. Pension funds, for example, one of the leading forces in institutional real estate today, are very serious about avoiding exposure to environmental liability. This view reflects a fiduciary responsibility to their clients; their clients have very little tolerance for risk.

It is possible that institutional investors would be willing to accept small amounts of environmental risk if the project has very little business risk. In today's environment, a prominent, well-located regional shopping center with excellent sales, that has a hydrocarbon storage tank (or other minor common contaminant, refer to 6.1), might be considered. However, an office building known to contain asbestos in a market that is severely overbuilt, would be avoided. In this scenario, there is both market and environmental risk; tenants with many choices probably

¹¹⁰Homburger and Selman, p. 12.

would not choose a building with asbestos. While institutional investors may not be willing to accept environmental risk themselves, they might joint-venture with a developer on a site after clean-up¹¹¹. Unfortunately, this requires the developer to bring in other funds to remediate the site; funding that may not be available.

In contrast, local or regional developers typically don't have fiduciary responsibilities, and may, if they choose, assume more risk when making development or acquisition decisions. An example is the developer in the Gasoline Station Case Study. Because Young owns the company, his individual risk preferences may be exerted, and a contaminated site purchased.

Undoubtedly, the opportunity to exploit environmental risk will appeal to only a certain type of developer. Those who wish to be successful, should be very well capitalized (equity financing), have the most knowledgeable consultants available, be prepared to spend a long time working on the venture, and have a large appetite for risk. Joint ventures with remediation consultants may make sense. A "dream team" would have a good source of capital, and might include a well-versed environmental attorney, environmental consultant, remediation contractor, and, a developer with vision.

6.3 Implications For Asset Management.

There are implications for the field of asset management in environmental risk. As the focus of many real estate firms in the 1990's turns from new development to the management of existing properties, a mandate to "create value" in these existing properties is emerging. Because the potential for acquiring contaminated property is increasing, one way to create value is to document a property's compliance with any applicable environmental regulations. A company that is able to adequately document compliance with environmental regulations, and implement a policy to proactively screen for potential accidents, will probably be able to receive a "cleanliness" premium upon disposition of the asset. At the very least, it should increase the marketability of the asset, thereby improving the chances of a quick sale. A program of proactive monitoring and documentation may also diminish the

¹¹¹Twining.

current trend towards longer escrow periods, and thus be an effective way to reduce liquidity risk.

A proactive monitoring policy might include: screening “high risk” tenants known to have inadequate safety procedures or a record of environmental regulation violation (e.g., manufacturers - refer to Table 1); observing tenant improvements for any inappropriate use of hazardous materials; monitoring new and old developments in the area for non-compliance with environmental statutes; and, monitoring the site’s septic and sewer systems for signs of illegal dumping. Many of these policies can be incorporated into the asset’s standard lease. To be effective, monitoring must constantly evolve to incorporate new regulations that may affect a property. It may be appropriate to retain an environmental consultant to conduct annual compliance audits and inform the property manager of new regulations.

6.4 Final Thoughts and Future Projections.

Environmental risk is a difficult and complex problem, of a magnitude and type that has probably not been seen before in the real estate industry. Because of this complexity, developers may find decision analysis techniques useful. The decision tree presented in this paper is an excellent technique to help simplify and resolve these dilemmas. However, it is realized that creating a decision tree to adequately describe a problem is not easy. For this reason, while modeling techniques are useful and therefore encouraged, it is probable that intuitive decisions will continue to be the norm in the industry.

There appears to be a niche market for certain development organizations to exploit the risks inherent in redeveloping contaminated land. This is not an endeavor that should be approached lightly, however. If the developer has both the financial resources and qualified staff necessary, there may be significant opportunities to create value with these properties. Therefore, development or consulting companies may begin to position themselves to exploit the risk inherent in owning and developing contaminated land.

As the number of sites deemed “contaminated” increases, many “high profile“

properties will be “fenced off”. From a city planner’s perspective, this is not desirable. At some point, in order to reverse this trend of “moth balling” sites, governmental agencies (especially State EPAs) may begin to offer developers immunity from environmental liability in exchange for redeveloping abandoned sites. These agreements probably would be negotiated on a case by case basis, or be sanctioned by new legislation. In addition to the negotiated agreements that may begin to appear at the state and federal levels, local governments may begin to address the issue of environmental regulation by incorporating legislation into their city by-laws.

Finally, as environmental regulations become more restrictive, it should become harder for industrial companies to open “greenfield facilities” (i.e., facilities built on clean or virgin land). Therefore, fewer corporate owners of real estate may sell their unused contaminated property in the future. This lack of new space for manufacturing facilities, combined with the potential liability associated with selling contaminated, or remediated land to developers for redevelopment (i.e., future end users may sue the corporation because of problems with the site) may curtail the amount of industrial land that is sold. If the company that owns the contaminated land has the financial strength to do so, it may hold on to the property until it is needed again in the future. This may become a preferred strategy for large companies that pollute.

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APPENDIX A

COMMON GROUPS OF CONTAMINANTS¹¹²

Pesticides. Although the Public is familiar with pesticides such as DDT and DDE, others like Methoxychlor, Chlordane and Toxaphene can also be extremely hazardous. Concentrations of pesticides in ground water is one of the tougher problems to isolate and remediate. Look for evidence of pesticide contamination not only on crops and in the fields, but also in storage areas where improper handling can lead to ground water and soil contamination.

Heavy Metals. Since heavy metals (e.g., lead, mercury and cadmium) are common and occur naturally in the environment, concentrations need to be compared with background levels to determine if contamination exists. The ability of these contaminants to move is a function of the environment that they are found in. In acidic conditions, these materials are mobile and soluble. In neutral and alkaline conditions, they are more stable. Common sources include discarded automobile batteries and metal treatment facilities.

Chlorinated Hydrocarbons. Aromatic hydrocarbons are widely used in manufacturing dyes, synthetic drugs, dry cleaning material, paint solvents, explosives, and plastics. The chemical names of some of these compounds (also called halogenated organic compounds) include dicholormethane, chloroform, carbon tetrachloride, trichloroethane, etc. These materials are extremely stable in the environment. Once in the ground water, they vaporize to the surface very slowly. Chlorinated hydrocarbons usually have a specific gravity greater than water (they sink), and they may be quite soluble in water. Since even very low levels require clean-up, halogenated solvent spills are deceptive; a very small loss (e.g., a few gallons) can create a major problem.

¹¹²Moskowitz, p. 13-23, and Cairney, p. 39-60.

Polychlorinated Biphenyls (PCB's). PCB's are commonly found as insulating and cooling liquids in electrical equipment, usually transformers and capacitors. During the their period of use (over 40-years), the best quality electrical equipment contained PCB's. One of the biggest risks associated with the presence of PCB's is fire. Although always toxic, if PCB's burn, they give off dioxin, a highly toxic substance, as a by-product of combustion. PCB's are the only chemical substance specifically regulated by the Toxic Substances Control Act (TSCA). There has been a substantial amount of publicity about this chemical and any spill can readily turn into a clean-up and public relations nightmare; however, PCB's are rarely bioavailable to humans.

APPENDIX B

SOIL REMEDIATION TECHNIQUES¹¹³

Thermal treatment. There are two heat treatment methods which may remove contaminants: removal by evaporation - either by direct heat transfer (convection or radiation) from heated air, or open flame (incineration); and, removal of the contaminants by direct or indirect heating of the soil to an appropriate temperature. The gas leaving the heating appliance must be treated to remove any contaminants or unwanted by-products of combustion. A related process is steam-stripping in which steam is injected into soil to aid the evaporation of relatively volatile contaminants which may, or may not, be water soluble. The contaminants are thus vaporized and enter the air compartment in small quantities; the physical by-product of this process is hazardous ash, which must still be landfilled.

Chemical treatment. This method usually involves the suspension of the soil in a suitable liquid. Intimate contact between the soil and chemicals is essential, contact times are frequently long, and treatment chemicals (which may themselves be contaminating) must be applied in excess amounts to ensure complete detoxification. Usually the soil is first forced through a screen to take out the "clumps"; this ensures uniform exposure to the chemicals. The goal is to combine the contaminant with another chemical (a catalyst) in order to invoke a reaction which creates a less problematic substance.

Microbial treatment. Also known as bioremediation, this method involves the use of bacteria which digest and decompose the contaminants. The clean-up may be accomplished by micro-organisms that currently reside at the site or, by strains of organisms that are genetically "engineered" to metabolize particular chemicals or

¹¹³Cairney p. 114-140; for additional information on this subject, refer to U. S. Environmental Protection Agency, "A Compendium of Technologies Used in the Treatment of Hazardous Wastes," EPA/625/8-87/014, (September, 1987).

compounds. This process is usually accomplished by excavating the soil prior to treatment and placing thin layers of the micro-organism between layers of the contaminated soil. The micro-organisms metabolize the chemicals leaving only their excrement, which is usually benign. Standard agriculture techniques such as fertilization and ploughing are often used to encourage the remediation process. This process may take a much longer period of time to accomplish, but the clean-up does not render the soil inert, and no hazardous by-products are produced. (Inert soil requires amendment with organic mulches etc., to enable vegetation to grow.) Unfortunately, not all forms of contamination have a corresponding microbe that will consume them.

Stabilization and solidification. These processes do not remove the contamination, instead they physically or chemically eliminate, or at least reduce, the hazardous nature of the soil so that it can be safely handled, stored or disposed of in some way. The reduction in mobility or leachability of contaminants can be achieved by: inducing a chemical reaction which forms a practically insoluble compound; vitrification (convert into a glass or a glassy substance by heat); or, mixing with portland cement, lime, slags and other cementing systems. Although this is one of the more commercially available processes, its' main limitation is that the contaminants are not removed and the treated soil may remain a source of future contamination. In addition, there are long-term performance concerns about some of these processes (e.g., certain chemicals have the ability to decompose cement).

Macro-encapsulation/isolation. This method essentially puts a box around the area of contamination. When using this method, it must be recognized that no containment system can be fully effective and that its effectiveness is likely to decrease with time. As mentioned previously, there may be reactions between the material being contained and the barrier system used that could increase the permeability of the barrier. This technique is used to keep contaminants from spreading while they are being treated in-situ, and to contain contaminants for which good treatment methods have not yet been devised.

APPENDIX C

**ECS's APPLICATION FOR
POLLUTION CLEAN-UP COVERAGE**

This is an application for a CLAIMS MADE Policy

1) NAMED INSURED: (Include All Subsidiary Companies to be Covered) _____

EPA IDENTIFICATION NUMBER(S): _____

POST OFFICE ADDRESS: _____

LOCATIONS TO BE COVERED: _____

2) NAMED INSURED IS:

_____ Partnership _____ Corporation _____ Joint Venture _____ Other _____

3) HOW LONG HAS THE NAMED INSURED BEEN IN BUSINESS? _____

4) SALES:

A) ESTIMATED (Ensuing Year): _____

B) LAST 5 YEARS: 19____ 19____ 19____ 19____ 19____

5) COMPANY PROFILE AND ENVIRONMENTAL AFFAIRS MANAGEMENT

A) Outline the site history including any previous uses of the site and by whom: _____

B) Briefly describe the operations conducted at the facility, including raw materials and by-products: _____

C) Give details on any claims or lawsuits against the company, including outcome when applicable: _____

D) Describe the Management Organization and identify those managers with environmental responsibility (attach organization chart if available): _____

E) Briefly describe any employee training classes held: _____

F) Describe the company's interaction with local, state, and federal authorities: _____

6) OVERALL FACILITY OPERATIONS

A) Provide a description of the site, including adjacent properties and target populations (attach site plan) _____

B) Identify nearby water sources, both surface and groundwater: _____

C) Are there any protected environments in the area (parks, wildlife preserves, etc.)? ___ yes ___ no

If yes, please describe: _____

D) Briefly describe the geology and hydrogeology of the area: _____

E) Identify any surface or groundwater uses in the area (drinking wells, etc.):

F) Is public water and sewer available? ____ yes ____ no

G) Outline the security measures at the facility, describe the facility access points, security system, posted areas: _____

H) List the safety programs presently in place: _____

I) Describe the fire safety systems in place: _____

J) Outline the emergency procedures used at the facility: _____

7) SOLID AND HAZARDOUS WASTE MANAGEMENT

A) Outline the sources of solid and hazardous waste: _____

B) Describe the storage practices used: _____

C) Describe the disposal methods used: _____

D) Is there a manifest system in place (include a recent copy)? yes no

E) Identify any past storage or disposal practices at the site, including any inactive disposal areas: _____

F) Is there a wastewater treatment unit on site? yes no

If yes, identify:

1) What type of treatment? _____

2) Quantity per year _____

3) Discharge points for treated wastewater _____

G) Identify discharge points for wastewater and stormwater: _____

H) Describe any lagoons, impoundments, or landfills on site: _____

I) Is incineration done on site? ___ yes ___ no

If yes, identify:

1) Emission Controls: _____

2) Air Monitoring procedures: _____

3) List permits and attach copies: _____

8) SPILL CONTAINMENT AND CONTINGENCY PLANNING

A) Are materials stored in drums? ___ yes ___ no

If yes, identify:

1) Type of materials: _____

2) Quantity of materials: _____

3) Description of storage area: _____

4) Inventory control (permitted amount): _____

B) Tank Storage:

<u>Tank No.</u>	<u>Material</u>	<u>Capacity</u>	<u>Age</u>	<u>A/G or U/G</u>	<u>Diked</u>
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

C) Have any underground tanks or underground piping ever been present at the site? ___ yes ___ no

If yes, please explain: _____

D) Is a spill plan approved and on file (attach copy)? ___ yes ___ no

9) OTHER CONCERNS

A) Is there any asbestos located anywhere on the site? ___ yes ___ no

If yes, identify: _____

B) Is there any PCB contaminated material anywhere on the site? ___ yes ___ no

If yes, identify: _____

10) ADDITIONAL INFORMATION

A) Please attach the latest monitoring results for facility effluent discharges, air emissions, landfills, or surface impoundments, including any groundwater data available.

B) Please attach a schedule of all storage tanks including the following information: capacity, age, above or below ground, spill containment methods, contents, steel or fiberglass, type of inventory control, testing methods.

11) RECORD

- A) Have you during the last 5 years been prosecuted for contravention of any standard or law relating to the release from the location of a substance into sewers, rivers, air or onto land? yes no

If yes, give details: _____

- B) Please describe any pollution claims during the last 5 years (if none, please so state): _____

- C) At the time of signing this application, are you aware of any circumstances which may reasonably be expected to give rise to a claim under the policy?

yes no

If yes, give details: _____

THE APPLICANT REPRESENTS THAT THE ABOVE STATEMENTS AND FACTS ARE TRUE AND THAT NO MATERIAL FACTS HAVE BEEN SUPPRESSED OR MISSTATED.

* NOTICE TO NY APPLICANTS:

Any person who knowingly and with intent to defraud any Insurance Company or other person files an application for insurance containing any false information, or conceals for the purpose of misleading, information concerning any false material thereto, commits a fraudulent insurance act, which is a crime.

COMPLETION OF THIS FORM DOES NOT BIND COVERAGE. APPLICANT'S ACCEPTANCE OF COMPANY'S QUOTATION IS REQUIRED PRIOR TO BINDING COVERAGE AND POLICY ISSUANCE. IT IS AGREED THAT THIS FORM SHALL BE THE BASIS OF THE CONTRACT SHOULD A POLICY BE ISSUED, AND IT WILL BE ATTACHED TO THE POLICY.

Applicant: _____

By: _____ (Title) Date: _____

Agent/Broker: _____

Address: _____

If an order is received, the application is attached to the policy so it is necessary that all questions be answered in full.