A Suggested Remedy For Toxic Injury: Class Actions, Epidemiology, and Economic Efficiency

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As the number of reported injuries in communities bordering hazardous waste sites grows, courts and legislatures struggle to unravel the knotted problems of toxic waste disposal. Although the manufacture of chemicals produces most of the nation's hazardous waste, legislatures realize that the manufacture of chemicals nevertheless bolsters the nation's industry and economy. Johns-Manville's experience suggests the disastrous consequences for defendant corporations of present tort liability for hazardous waste injury. Plaintiffs fare no better because the machinery of traditional tort doctrine, long a deterrent against injury, breaks down in cases of toxic-waste damage. Statutes of limitations, when coupled

1. See, e.g., Garmon, Times Beach: The Long Road to Recovery, 123 SCIENCE NEWS 270 (1983) (Times Beach Dump); Its the Pits, TIME, May 2, 1983, at 62 (Stringfellow Acid Pits); McQuaig, The Legacy of Love Canal, MACLEANs, Oct. 3, 1983, at 10 (Love Canal waste site); Sounding The Tocsin for Toxins, TIME, July 25, 1983, at 61 (Silicon Valley Chemical pollution); Tafler, Industriplex-128: Woburn's Superfund Site, ENV'T, July-Aug. 1983, at 4 (Stauffer chemical site in Massachusetts).

2. SUPERFUND SECTION 301(E) STUDY GROUP, INJURIES AND DAMAGES FROM HAZARDOUS WASTES—ANALYSIS AND IMPROVEMENT OF LEGAL REMEDIES: REPORT TO CONGRESS IN COMPLIANCE WITH SECTION 301(E) OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OF 1980 (P.L. 96-510), S. Doc. No. 97-571, 97th Cong., 2d Sess. pt. 2, at 248 (1982) (referring to the manufacture of chemicals as "an industry whose international competitive position may be of great significance to the balance of trade and to the welfare of the country") [hereinafter cited as REPORT OF THE SUPERFUND STUDY GROUP].

with the long gestation periods of toxic injuries, bar claims from being heard. Conventional notions of causation prevent plaintiffs from linking toxins with injury. The few plaintiffs who overcome these obstacles are frustrated by high litigation costs, inability to discover evidence, and difficulty in determining the proper defendant.

The problem of hazardous waste litigation has triggered an outpouring of legal comment. Its authors, though, have confined their suggestions either to repairing the legal system or to statutorily circumventing it. The toxic-tort system, however, has become so ineffective that it requires replacement rather than repair. This Note suggests that courts allow compensation based on a statistical showing of injury, either present or future, to best remedy what otherwise promises to become a futile legal exercise.

In analyzing competing suggestions for reform, this Note adopts two standards. First, the solution must provide a reasonable response to the novel legal problems of toxic torts. Second, the solution should be economically optimal.


7. By using an economic standard to assess the quality of reform, this Note concedes that an acceptable level of accidents exists. That is, society will accept a certain number of accidents because it considers the production leading to such accidents sufficiently valuable.

A production system is at its optimal economic operation when the costs (including acci-
American industry needs chemicals. In response to that need, the chemical industry has developed and distributed over 63,000 different chemicals, most in the last twenty years.

Although society long ago recognized the benefits of using chemicals, it only recently realized the cost of that use. Producing helpful chemicals produces harmful waste. The chemical industry disposes of that waste either as air and water pollution or, more commonly, as deposited solids. Every year, the chemical industry generates, and then disposes of, millions of tons of hazardous waste. In 1980, the Environmental Protection Agency (EPA) esti...
mated that the industry generated fifty-six million metric tons of hazardous waste annually. 2 Often producers dispose of their waste in waste storage sites. In 1979, the EPA counted between 32,000 and 50,000 of these sites in the United States. 3 Between 1000 and 34,000 contain significant quantities of hazardous wastes. 4

While proper disposal of waste raises serious legal problems, its improper disposal has bred turmoil. The chemical industry has disposed of an estimated ninety percent of its wastes improperly, leading to "significant imminent hazards." 5 These wastes, for example, may seep into groundwater and migrate to residential communities. 6 The commotion promises to intensify as producers exhaust even the most inadequate waste sites. 7 Responding to the


14. Id. The EPA has admitted that these estimates are approximate ones. Hazardous and Toxic Waste Disposal: Joint Hearings on S. 1341 and S. 1480 Before the Subcomm. on Environmental Pollution and Resource Protection of the Senate Comm. on Environment and Public Works, 96th Cong., 1st Sess., pt. 4, at 12, 37 (1979) (statement of Thomas Jorling, Assistant Administrator for Water and Hazardous Materials, EPA) [hereinafter cited as Senate Environmental Comm. Hearings]. The chemical industry has charged that the estimates are exaggerated. Id. at 431-33 (statement of Jackson B. Browning, Chemical Manufacturers Association).


Reagan administration's policy of limited intervention in environmental disputes, producers increasingly abandon any pretext of safety and turn to the hazardous waste "black market" to cut costs.

No one knows how much harm hazardous waste has caused already. The gestation time for disease is long and scientific understanding of toxic disease is limited. Scientists estimate that ten to twenty percent of commercially produced chemical compounds represent an environmental threat. Environmental factors probably cause between seventy and ninety percent of all cancers. Although the exact number of injuries linked to waste sites is unknown, it must be considerable. Chemical hazards affect people

18. See Seltzer, supra note 5, at 807 ("President Reagan's stated emphasis is on limiting federal intervention into environmental disputes."); Trauberman, Superfund—A Legal Update, Env't, March 1981, at 25.


For a summary of health effects, see Senate Comm. on Env't. and Pub. Works, 96th Cong., 2d Sess., Health Effects of Toxic Pollution: A Report from the Surgeon General and a Brief Review of Selected Environmental Contamination Incidents With a Potential for Health Effects 8 (Comm. Print 1980) [hereinafter Health Effects of Pollution]; Environmental Sciences Laboratory, Disability Compensation for Asbestos-As-
of all backgrounds and ages. They cause both acute and chronic illnesses. In short, as the number of waste sites increases and the incidence of spills and improper disposals escalates, injuries in areas surrounding these incidents have become the nation’s “single most important environmental health issue.”

Although the health issue understandably has received the greatest public attention, toxic waste threatens the entire environment. Absent quick control, waste disposal soon may threaten...
Although they may debate its degree, commentators unanimously recognize that health and environmental problems exist. The problem doubtless will remain until the courts or the legislature effectively control hazardous waste disposal.

**THE FAILURE OF REGULATORY REFORM**

**Federal Regulation**

The federal government first attempted to control toxic pollution by creating an elaborate regulatory scheme. The programs, however, were flawed both in concept and in execution. As a result, the regulations have had only minimal effect.

At best, the regulatory response operates inefficiently. The programs focus upon prevention rather than upon compensation. Congress has been unwilling to pass legislation providing for a private compensatory cause of action. The lack of any compensation

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30. See, e.g., Institute of Medicine, supra note 21, at 14.
31. Health Effects of Pollution, supra note 24, at 8.
clause in federal statutes prevents private recovery in federal courts of damages resulting from statutory violations. A private citizen has standing only to sue for enforcement of the regulations. The closest Congress has come to providing private compensation is the provision for recovery of "response" costs in the Superfund legislation. Even this provision, however, specifically precludes recovery for medical expenses and for property loss.

Centralized regulation is inherently inefficient. Unable to assess the intricacies of market forces, agencies must deal in generalities. After time-consuming studies are conducted, regulations either totally ban chemicals or leave them unrestricted. EPA action, therefore, is an inefficient, albeit enforced, response. Regula-


37. Id.


Such inefficiency results despite federal government organizations having access to several data bases that are not commercially available. See ENVIRONMENTAL INFORMATION CENTER, TOXIC SUBSTANCES SOURCEBOOK 140-41 (1978) (Series 1).


40. See Ward, Criminal Enforcement: Is There Any? Where Is It Going?, ENVTL. FORUM, Oct. 1983, at 6 (EPA's criminal enforcement is effective, although its civil enforcement is not).
tions inevitably permit many harmful activities to continue while prohibiting harmless ones.\textsuperscript{41} Regulations neither internalize costs nor optimize efficiency.

Even if the federal government could estimate the optimal level of waste, other problems inherent in the system would prevent an adequate federal response. First, the legislative procedure is so time-consuming that Congress would need over one hundred years just to regulate presently known chemicals.\textsuperscript{42} Second, regulations emerge from a highly politicized process.\textsuperscript{43} Based on recent actions, few can expect the Reagan administration to improve the regulatory scheme.\textsuperscript{44} Third, special interests often influence regulation.\textsuperscript{45} Offers of industry employment often translate into regulatory laxity.\textsuperscript{46} Fourth, federal agencies lack the money and staff to enforce regulatory provisions fully.\textsuperscript{47} Finally, the regulations provide no incentive for private sector research into unknown environmental harms. For the most part, the chemical industry need meet only a static set of agency regulations.\textsuperscript{48} Alternatively, a private compen-

\textsuperscript{41} Regulations deal in generalizations. They forbid entire groups of chemicals if a substantial number are shown to be carcinogenic. Further, regulations lag behind industrial chemical usage. Therefore, harmful chemicals are not immediately regulated. See Bardach \& Kagan, Postscript, in \textsc{Social Regulation: Strategies For Reform} 367-68 (E. Bardach \& R. Kagan eds. 1982). To allow harmful activities to proceed is not necessarily undesirable. Logic argues against prohibiting harmful conduct, regardless of the cost of its avoidance. At a certain level of accidents, society cannot afford to expend further resources to prevent harm. \textsc{See G. Calabresi, The Costs of Accidents} 17-18 (1970); \textsc{V. Fuchs, Who Shall Live} 17-19 (1974).


\textsuperscript{43} \textsc{See S. Epstein, supra} note 23, at 419-28.

\textsuperscript{44} The Reagan administration has cut regulations governing the disposal of hazardous wastes. \textsc{See Justice's Special Waste Litigator Resigns, citing 'Disastrous' EPA Enforcement Policy, 12 Env't Rep. (BNA) 1027} (Dec. 25, 1981); \textsc{Poison of the EPA, New Republic, March 24, 1982, at 7}; Shabecoff, \textsc{Ecology Charges Fall Off Sharply Under Reagan, N.Y. Times, Oct. 15, 1981, at A16, col. 1}. In sum, EPA's response to hazardous waste problems is "slowing" and the agency "can't maintain current levels of activities." \textsc{Custody Relationship Recommended for Hazardous Materials Management 12 Env't Rep. (BNA) 97} (May 15, 1981) (quoting Andrew Mank, Special Assistant to the EPA Assistant Administrator for Water and Waste Management).

\textsuperscript{45} \textsc{See} \textsc{3 Study on Federal Regulations, 1977: Hearings Before the House Comm. on Gov't Affairs, 95th Cong., 1st Sess. 1-11} (1977).

\textsuperscript{46} \textsc{See id. at} 95-160.


\textsuperscript{48} Some statutes attempt to include "technology forcing" provisions. \textsc{See Goldsmith &
sation system would compel the industry to conduct basic research in an effort to discover more cost-effective methods of pollution abatement. 49

Federal statutes generally have provided inadequate coverage of the hazardous waste problem. The Clean Water Act and the Clean Air Act do not address releases of unusually hazardous substances. 50 Before Superfund, section 311 of the Clean Water Act was the only statutory provision dealing with emergency spills. 51 Section 311, however, deals only with oil 52 and a few substances especially harmful in water. 53 The provisions further restrict coverage to discharges into navigable waters. 54 The Resource Conservation and Recovery Act of 1976 (RCRA) requires disposal site operators to treat and contain waste properly. 55 Although RCRA applies to a greater number of substances than does the Clean Water Act, 56 RCRA only operates prospectively to prevent further improper disposal of hazardous wastes and does not eliminate the threat posed by existing sites. 57

The recent Superfund legislation 58 represents the government's best effort at solving the toxic waste problem. The main Superfund

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52. See id.

53. The Clean Air Act requires publication of a list of these toxic pollutants and provides for revision of that list. The present list is published at 40 C.F.R. § 116.4 (1983).


56. EPA has identified four main characteristics of hazardous substances: ignitability, corrosiveness, reactivity, and toxicity. See 40 C.F.R. §§ 261.20-261.24 (1980). Wastes meeting these criteria are subject to RCRA regulations even if they have not been specifically listed by the EPA. See 40 C.F.R. § 261.1(b) (1983).


program provides a $1.6 billion fund to clean up hazardous spills if the EPA cannot locate the party responsible for the spill. If the government later finds the responsible party, the EPA may bring an action to recover the cleanup costs. Again, no incentive exists for the waste disposer to adopt methods of waste abatement. If the EPA finds a producer responsible for the waste, the producer merely must pay for the waste’s cleanup, not for the environmental damage that the waste has created. Even that minor sanction is rare.

Finally, the very number of programs that address hazardous substances prevents an adequate treatment of the problem. This regulatory fragmentation leads to confusion, to inefficiency, and ultimately, to inadequate regulation. Thus crippled, federal regula-


61. See 42 U.S.C. § 9607 (1982). The Superfund concept certainly does not guarantee economic optimality. Cleanup costs bear no necessary relation to the harm the toxin causes, and therefore, to the “true cost” of that toxin. An easily cleaned up, extremely hazardous toxin thwarts Superfund’s intention. Imagine a company, Glossop Indus., that dumps a hazardous waste, named Wooster. Filtering Wooster out of its effluence would cost Glossop $100 a day. Rather than paying that sum, Glossop deposits Wooster in a nearby river. Remarkably, on contact with water, Wooster coagulates to form a floating foam rubber. Glossop can clean up the Wooster by a process jeeves for $10 a day. Unfortunately, another of Wooster’s vagaries is its less admirable quality of coagulating mamillar blood on its way to the brain. As a result, the nearby hamlet of Finknottle experiences a 40% increase in strokes. Health costs, as a result of Wooster, run $1000 a day. The Superfund concept reaches the wrong result. It internalizes only $10 of the cost, rather than the full $1010. As a result, Glossop keeps polluting the river even though it could easily filter Wooster out of its system.

Alternatively, the cost of filtering out, or cleaning up a waste may greatly exceed the true cost of the product. Society might prefer to absorb $100 a day in health costs rather than $1000 in cleanup costs. Instead, Superfund forces the industry either to charge an excessive price or to shut down altogether.

62. See Novick, What is Wrong with Superfund? Envtl. Forum, Nov. 1983, at 6 (Superfund geared too much towards catastrophic sites); Ward, supra note 40, at 6.

63. Trauberman, supra note 6, at 203-06.

64. See, e.g., 5 Senate Comm. on Govt. Affairs, 95th Congress, Ist Sess., Study on Fed-
tions hold no realistic hope for remedying the problem of hazardous waste disposal.

State Regulation

With the possible exceptions of California and New Jersey, state statutory provisions are as ineffective as their federal counterparts. The vast majority of state statutes fail to provide a right of action for hazardous waste injuries. Those few states that do provide compensation for injuries are hindered by inadequate funding and an incomplete coverage of hazardous substances. Furthermore, Superfund legislation apparently preempts state authority to create clean-up programs. Similarly, causes of action under Superfund and state programs are mutually exclusive—a plaintiff cannot bring a state claim for compensation if the federal government has acted under Superfund.

Policy fragmentation thwarts state efforts to control hazardous waste. The effects of improper disposal often cross state lines into areas not amenable to regulation by a single authority. Many state programs fail simply because the offending industries move...
to states with inadequate programs.\textsuperscript{73}

Without broad reforms in present law, any successful program of waste control must work through market mechanisms.\textsuperscript{74} The program, in addition, must be national in scope. Although regulations occasionally succeed in decreasing pollution, they founder in their effort to control waste disposal.

The Failure of Conventional Tort Law

This Note maintains that the only optimal solution to the problem of improper waste disposal must come through the tort system. Unfortunately, common law tort doctrines now make recovery for injuries caused by exposure to hazardous waste impossible. We must completely restructure the tort system for compensating hazardous waste injuries.

Judges must make efforts to adjust the law to social change. Technological innovation occurs so quickly today that the common law cannot rely upon its inherently slow evolution of solutions to technological problems. The law needs a change with at least the same vigor as that which accompanied the expansion of the railroads.\textsuperscript{75} Three areas, in particular, bar recovery for waste related injuries and thus deter economic efficiency. These areas are statutes of limitations, legal rules based upon the reasonability of the defendant's activity, and proof of causation.

Statutes of Limitations

Traditionally, statutes of limitations have protected defendants

\begin{footnotes}
\item 73. Report of the Superfund Study Group, \textit{supra} note 2, at 31.
\item 74. See supra note 7.
\end{footnotes}
This traditional function is poorly suited to injuries that manifest themselves only after long latency periods. Restrictive statutes of limitations, therefore, present unreasonable obstacles for prospective hazardous-waste litigants. These litigants often remain unaware of their injuries for decades before seeking redress in the courts. By that time, discovery is difficult, defendants cannot be found, and the statute of limitations may bar the suit. Some states have recognized the problems associated with cases stemming from latent disease by exempting them from general statutes of limitations. Many states, however, address latency problems under their general limitations provisions.

A few states adhere to the traditional “date-of-exposure” rule. In these jurisdictions, a personal injury claim accrues at the date of the first exposure to the causative agent. Neither ignorance of the injury nor of the existence of a cause of action will toll the statute. The United States Supreme Court, in Urier v. Thompson, recognized the unfairness of this approach when it refused to adopt the “date-of-exposure” rule for federal claims. The Court pointed out that a plaintiff’s “failure to diagnose within the applicable statute of limitations a disease whose symptoms have not yet obtruded on his consciousness would constitute waiver of his right to compensation at the ultimate day of discovery and disability.” This rule effectively precludes all claims for latent diseases. Its underlying flaw is its assumption that an “injury” cannot occur without some attendant symptoms to alert the victim.

Modern statutes of limitations tend to be more liberal. The most liberal “discovery rule” does not start the limitations clock

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77. See 1A F. Grad, TREATISE ON ENVIRONMENTAL LAW § 4A.05, at 4A-154 (1983) (compilation of all states' limitation periods for latent diseases).
82. Id. at 169.
83. See Seltzer, supra note 5, at 830.
until the plaintiff has discovered or has reason to discover his injury. In many cases, however, even the liberal rules hinder suits.

Three problems still hamper a litigant's efforts to bring a suit under the liberal rules. First, in most states, the statute of limitations begins running when the plaintiff suffers an injury. A plaintiff, however, still might not know the cause of his injury, who is responsible for it, or whether it supports a cause of action. Second, many injuries first manifest themselves in relatively mild stages. Someone who contracts a case of acne is unlikely to begin searching for a chemical corporation to sue, thinking he is suffering from chloracne, a disease resulting from exposure to benzene. Finally, the statute of limitations clearly would bar any suit for anticipated physical harms not manifested by any present injury. The statutes of limitations therefore hinder toxic-tort litigation.

Unreasonable Behavior

A court's analysis of liability often questions the reasonability of the defendant's behavior. Behavior must be unreasonable to constitute negligence or nuisance. A similar standard applies in de-

85. Some state courts have extended the discovery rule to include the period when the plaintiff discovers the facts giving rise to the cause of action, not just the fact of injury. See, e.g., Cadieux v. International Tel. & Tel. Corp., 593 F.2d 142 (1st Cir. 1979); Caron v. United States, 548 F.2d 366 (1st Cir. 1976); Frank Cooke, Inc. v. Hurwitz, 10 Mass. App. 99, 406 N.E.2d 678 (1980); Gilbert v. Jones, 523 S.W.2d 211 (Tenn. Ct. App. 1974).
86. See Cadieux v. International Tel. & Tel. Corp., 593 F.2d 142, 144 (1st Cir. 1979).
87. Hooker Chemical and Plastics Corp. dumped 400,000 cubic yards of chemical wastes in Montague, Michigan. The waste has been linked to reproductive dysfunction, to liver, kidney, and lung damage, to nerve degeneration, and to psychiatric disturbances. Its initial effects, however, are only headache and nausea. See Six Case Studies, supra note 20, at 214-26. Similarly, dioxin poisoning, linked with birth defects, liver damage, and central-nervous-system disorders, initially causes only headaches, nausea, and pain in urination. See id. at 188-92.
88. See Seltzer, supra note 5, at 830.
90. See Trauberman, supra note 6, at 192.
termining liability for abnormally dangerous activities and for strict liability.

In determining whether an activity is reasonable, courts usually apply some form of cost-benefit analysis. Cost-benefit analysis involves balancing both the defendant's cost of preventing the plaintiff's injury and the social utility of the defendant's conduct against the harm to the plaintiff. For many reasons, this analysis results in inadequate compensation for the toxic-tort plaintiff. For example, a plaintiff's inability to introduce data, either because the industry never compiled the information or because the evidence was lost or destroyed during the time between exposure and injury often skews the cost-benefit analysis in the defendant's favor. Even if a plaintiff can get useful information, he will have difficulty estimating the costs to the defendant of preventing the injury. Legal, technical, and economic problems will confound the average plaintiff's attempts to present this information to the court. Even when the court can determine the defendant's cost of prevention, it seldom can assign meaningful monetary val-

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91. Section 520 of the Restatement (Second) of Torts includes, as a factor in determining whether an activity is abnormally dangerous, the "extent to which its value to the community is outweighed by its dangerous attributes." RESTATEMENT (SECOND) OF TORTS § 520, at 36 (1977). If the activity's social value exceeds its dangerous attributes, the activity is not considered abnormally dangerous. Id. comment k.

92. Although the Restatement (Second) of Torts refers to the liability of producers selling unreasonably dangerous products as "strict liability," RESTATEMENT (SECOND) OF TORTS § 402A comment a (1967), courts often balance the product's risk against its benefit. Trauberman, supra note 6, at 193 n.72.

93. This general approach is outlined in RESTATEMENT (SECOND) OF TORTS §§ 826-827 (1965).


95. Trauberman, supra note 6, at 193-94.

96. See G. Calabresi, supra note 41, at 198-235 (difficulty in ascertaining costs); A. Freeman, The Benefits of Environmental Improvement (1979) (difficulty in ascertaining benefit).

97. Baram, supra note 7, at 490; Pfenningstorf, supra note 7, at 360-61, 384.


ues to the loss of human life and mental anguish.  

When they assess liability, some courts attempt to determine whether a defendant acted reasonably at the time of the waste's discharge. Often, however, the discharge occurred before regulatory standards existed. Further, plaintiffs often face obstacles in determining what the defendants knew or should have known at the time of the injury, especially given the greater experience and resources of the average defendant.

The social value of the defendant's business can complicate the assessment of the costs of that business. The court may subrogate the individual's claim to what it perceives as the greater social good. In such an evaluation, the court may view the speculative threat to an industry as a greater harm than plaintiff injury. Such a view results largely from courts' unfamiliarity with cost-


101. See, e.g., New Jersey v. Ventron, No. 2996-75, slip op. at 49 (N.J. Super. Ct. Ch. Div. Aug. 27, 1979) ("While the discharge of mercury might be considered unreasonable, unwarranted, or unlawful by today's standards, the actions of the defendants must be measured as of the date they occurred.").


103. See Pierce, supra note 94, at 1297-98. Sometimes, the defendant's greater experience leads to exaggerated estimates of the costs of chemical control and underestimates of the potential health and environmental costs in the absence of controls. See Baram, supra note 7, at 490.


105. See W. Rodgers, Environmental Law 116-21 (1977); Pfenningstorf, supra note 7, at 360-61, 384.
benefit analysis.  

A better approach to determining unreasonable behavior would bypass cost-benefit analysis. By placing the costs of damage upon the chemical industry, the courts would place liability on the party that can best estimate the harms and benefits of its conduct. This approach is superior to placing the costs on a plaintiff that has little control over the dangerous activity, that cannot assess reliably the economics of the industry, and that is excluded from the industry’s decision-making process.

The Problem of Legal Causation

A toxic-tort plaintiff must show by a preponderance of the evidence that the defendant’s behavior was a substantial cause of his injury. This task involves three factual issues: (1) isolating the harmful substance, (2) tracing its pathway from polluter to victim, and (3) establishing the etiology of the harmful substance. In sum, the plaintiff must establish a cause-in-fact relationship between the defendant’s conduct and his injury. In demonstrating this connection, the common law firmly places the burden of proof on the plaintiff. A showing of possible cause is insufficient; the plaintiff must prove the connection beyond a “reasonable probability.”


110. Soble, supra note 6, at 706.


Legal causation ultimately bars recovery in toxic waste cases. Even if sufficient evidence exists for the plaintiff to prove injury or the danger of future injury from the disposal of waste, the high standard of causation still defeats most actions. Comparison may be made with asbestos cases, where courts have found adequate proof of causation. Unlike disease from hazardous waste, physicians understand the process by which the inhalation of asbestos dust leads to respiratory disease and cancer. In sharp contrast to asbestos, no medical explanations fully describe the health effects of common chemical toxins.

The typical incident of waste pollution involves many contaminants from many contamminators. To expect the plaintiff to prove that one of those many contaminants caused his particular injury is unreasonable. Even experts often cannot assess the contribution of each contaminant to the plaintiff's disease. The high cost of securing the necessary epidemiologic and toxicologic studies, specialized counsel, and expert testimony only adds to the plaintiff's

115. A number of commentators have discussed the difficulties inherent in demonstrating causation in cases of injury from hazardous waste. See, e.g., Ginsberg & Weiss, Common Law Liability for Toxic Torts: A Phantom Remedy, 9 Hofstra L. Rev. 859 (1981); Seltzer, supra note 5; Trauberman, supra note 6; Note, Hazardous Wastes: Preserving the Nuisance Remedy, 33 Stan. L. Rev. 675 (1981).

116. Sufficiency of evidence turns upon simple statistical comparison. The plaintiff must prove substantial injury and the hazardous nature of the pollution. The presence of local levels of ill health, in substantial excess of surrounding levels, may prove substantial injury. Similarly, pollution levels become hazardous once they significantly exceed levels in surrounding areas. Evidence of excessive levels of pollution and injury represents evidence sufficient to build a case. Seltzer, supra note 5, at 824 n.11.

117. See Ginsberg & Weiss, supra note 115, at 923 ("the level of certainty required by the legal system may be impossible to attain"); Soble, supra note 110, at 706 ("producing the evidentiary showing required to sustain the substantive proof of legal causation is an undertaking of no small magnitude").


119. See Borel v. Fibreboard Paper Prods. Corp., 493 F.2d 1076, 1083 (5th Cir. 1973), cert. denied, 419 U.S. 869 (1974) ("The medical testimony adduced at trial indicates that inhaling asbestos dust in industrial conditions . . . can produce the disease of asbestosis.")

120. The hazardous waste dump in Cohaney Aquifer, New Jersey, for example, although generated solely from Union Carbide's Bound Brook, New Jersey plant, included a long list of carcinogens. Among the wastes were aromatic hydrocarbons, benzene, toluene, styrene, xylene, ketones, alcohols, trichloroethylene, acrylonitrile and phenolic resins. Six Case Studies, supra note 20, at 339, 343.

121. Seltzer, supra note 5, at 823.
Scientific and Legal Causation

In diagnosing disease induced by an environmental factor, scientists often use a conventional model of biological causation. The model measures the severity of human exposure by the proximity to the waste or by the degree of direct contact with the waste. Scientists use the degree of exposure to calculate the likelihood of injury, often by comparing the long-term effects of such chemicals on laboratory animals.

Scientists invariably express the outcome of this sophisticated analysis in the form of a probability. A study of the incident at Love Canal, for instance, produced a statistical correlation between proximity to hazardous waste and higher rates of birth defects, miscarriages, nervous breakdowns, and other illnesses among the residents of the area. Scientists have abandoned a direct-causation theory in favor of a statistical theory—inferring "causation"

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122. S. Epstein, supra note 23, at 472.
125. Very few tests measure the degree of contact and the amount of absorption of chemicals into the human body. Therefore, the model estimates adverse effects by relying on quantification of exposure. Rather than being able to state that ten milligrams of benzene have been absorbed into the plaintiff's body, for example, tests will point to his being exposed to two parts per million of benzene for one hundred days.
126. Seltzer, supra note 5, at 815.
127. See Monson, Effects of Industrial Environment on Health, 8 Env'tl. L. 663 (1978) (overview of forms of epidemiologic studies).
from a sufficiently significant correlation.129

Commentators have widely criticized this reliance on correlation. Some scientists object to extrapolation from the high doses of chemicals used in the studies to the relatively low but prolonged dosages affecting victims of waste disposal.130 Indeed, some scientists theorize that a threshold dosage exists below which no adverse effects will occur.131 Other critics have questioned the use of animal data in analyzing the effects on human physiology.132

Medical studies cannot replicate the exact pathways that toxic chemicals travel to reach the injured party.133 Many diseases result

129. Seltzer, supra note 5, at 821; see also Large & Michie, supra note 113, at 595. The standard statistical tool for assessing risks of environmental disease is the chi-square analysis. Such analysis determines the likelihood of error in making a statistically significant correlation between health effects and exposure to waste. Although the percentages are arbitrary, "statistical significance" is generally established if there is less than a three- to five-percent chance that the exposure-disease association could be accidental. If the likelihood exceeds three to five percent, the connection is considered a random occurrence. See H. Blalock, Social Statistics 212-28 (1960); Kennedy The Politics of Preventive Health, 84 Tech. Rev. 58, 59-60 (1981).


132. Such critics claim that humans have background chemical residues that do not exist in animals. See D. Rall, Threshold?, Env'tl. Health Perspectives 22, 164-65 (1978) ("The human population is different. ... The mouse (or rat) doesn't smoke or breathe hydrocarbons or sulfur oxides from fossil fuels, doesn't drink, doesn't take medicine, doesn't eat bacon or smoked salmon."); see also S. Epstein, supra note 23, at 53; Large & Michie, supra note 113, at 502-93; McGovern, Toxic Substances Litigation in the Fourth Circuit, 16 U. Rich. L. Rev. 247, 297 (1982). Most experts in toxicology agree, however, that such data provides accurate data on health effects in humans. See IRLG Report, supra note 130, at 39,682.

from the interaction of several substances. As a result, a plaintiff cannot refute a defendant's allegation of alternate causation of the plaintiff's injury. Courts regularly deny recovery because of the plaintiff's inability to demonstrate the toxic path.

Methods for replicating toxic pathways are improving. Evidence of a plaintiff's personal habits may eliminate alternative causes of injury. Increasingly sophisticated testing methods also aid the plaintiff in isolating the toxins in his body. More important, the problems in demonstrating pathways are largely functions of dealing with individual defendants. A court can rely more confidently on a study of an entire population located near a waste dumpsite.

Despite these scientific questions, most problems with courts' application of the data are less technical. Between exposure and injury, intervening factors may affect the course of the plaintiff's


134. Human Health and Environment, supra note 25, at 267-76, 287-93 (discussing biological mechanisms and determinants of toxicity).

135. Trauberman, supra note 6, at 200.

136. See, e.g., Magnolia Petroleum Co. v. Williams, 222 Miss. 538, 543, 76 So.2d 385, 387 (1954) (court denied recovery for injury resulting from contaminated well water on grounds that plaintiff could not establish direction contamination traveled underground).


Despite the slow rate of groundwater, dye tests have been used effectively. See Swift & Co. v. People's Coal & Oil Co., 121 Conn. 579, 583, 186 A. 629, 631 (1936); Reinhart, 201 Pa. Super. at 618, 193 A.2d at 672 (1963); Burr v. Adam Eidemiller, 386 Pa. 416, 419, 126 A.2d 403, 406 (1956).

Finally, courts are more receptive to proof that the onset of contamination coincided with the start of defendant's operations. See Reiserer v. Murfin, 183 Kan. 597, 600, 331 P.2d 313, 315-16 (1958); Palmer Corp. v. Collins, 214 Ky. 838, 284 S.W. 95, 97 (1926); Harper-Turner Oil Co. v. Bridge, 311 P.2d 947, 950-51 (Okla. 1957).

138. See Schlichtkrull v. Mellon-Pollock Oil Co., 301 Pa. 560, 152 A. 832 (1930) (denying recovery based on failure of plaintiff to isolate contaminated well water as sole source of his kidney stones).


140. See Gelpe & Tarlock, The Uses of Scientific Information in Environmental Deci-
Defendants may become difficult to locate or may have gone bankrupt.

Despite its increasing sophistication, most courts have refused to admit probability evidence to demonstrate causation. The courts view such evidence as speculation which cannot meet the standard of "reasonable medical certainty" necessary for the plaintiff to carry his burden of proof. Statistical predictions of future injury are especially suspect. Courts have ruled this evidence insufficient to support a jury's finding of causation.

This rejection of statistical evidence results from a misunderstanding of the scientific principles underlying that evidence. Even in cases of high probabilities and well-explained studies, judges may dismiss the evidence if the defense introduces any medical testimony disputing the methodology upon which the study relied.
This judicial disregard of medical studies effectively denies compensation to toxic tort victims. In Woburn, Massachusetts, many persons living near a waste dump became ill.\textsuperscript{156} The Commonwealth of Massachusetts Department of Public Health sponsored an epidemiologic study.\textsuperscript{151} Although no study could demonstrate a direct causal relationship,\textsuperscript{162} a statistically significant correlation existed between toxic exposure and cancer.\textsuperscript{163} A ruling barring such evidence inevitably will lead to the court's denial of compensation to the residents even though medical experts had diagnosed the injuries as resulting from improper disposal at the waste dump.\textsuperscript{154} Courts already have excluded such evidence in the case of Vietnam veterans alleging injury from exposure to the Agent Orange defoliant.\textsuperscript{165}

A few courts have advocated increased reliance on medical studies.\textsuperscript{156} In situations of intentional dumping, courts have lowered the plaintiff's burden of proof on the causation issue.\textsuperscript{167} This inconsistency illustrates the discomfort judges experience in refusing to admit the only evidence that a plaintiff can introduce to prove to have entered plaintiff's wells, the case faltered because of conflicting medical testimony. \textit{Id.}

\textsuperscript{150} Diperna, 'Leukemia Strikes a Small Town, THE N.Y. TIMES MAGAZINE 100 (Dec. 2, 1984).

\textsuperscript{151} Seltzer, \textit{supra} note 5, at 800-01.

\textsuperscript{152} This inability to prove causation can be traced to three reasons. First, the migratory pathway taken by the toxins from the site has not been reconstructed. Second, studies have not conclusively demonstrated a relationship between proximity to the toxins and disease. Finally, epidemiologic studies indicate correlations alone, not causation. See INTERIM REPORT ON THE GROUND WATER QUALITY OF EAST AND NORTH WOBURN MASSACHUSETTS, EPA FIT PROJECT TDD No. FI-8010-04B (1981); MASS. DEPT. OF PUBLIC HEALTH, CANCER MORTALITY IN WOBURN: A THREE DECADE STUDY 1949-78 (1981); Seltzer, \textit{supra} note 5, at 819.

\textsuperscript{153} In the Town of Woburn, between 1969 and 1978, fourteen cases of childhood leukemia were identified even though only seven cases were expected. This excess is statistically significant. The likelihood of such a difference occurring by chance is less than \textit{6} in \textit{1000}. In the 1974 to 1978 period alone, deaths from cancer in Woburn rose by 23 percent. Seltzer, \textit{supra} note 5, at 801 nn.19-20.

\textsuperscript{154} Seltzer, \textit{supra} note 5, at 820-21.

\textsuperscript{155} Both the government and the manufacturers of Agent Orange denied any link between exposure to the chemical and the illnesses. Payne, \textit{Beyond Vietnam, Beyond Politics, Beyond Causes . . ., BARRISTER, Spring 1979, at 13.}

\textsuperscript{156} See infra note 211.

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his claim. Other courts have admitted circumstantial evidence\textsuperscript{158} or merely have required the evidence to support a "reasonable inference" of causation.\textsuperscript{159} Some courts have even suggested that our legal system adopt the extreme Japanese model, which eliminates burdens of proof.\textsuperscript{160}

The best solution would allow courts to accept statistical evidence of probability.\textsuperscript{161} For decades, courts accepted probability evidence in the area of racial discrimination,\textsuperscript{162} in determining whether to grant equitable relief,\textsuperscript{163} and in establishing the dangerous nature of a substance.\textsuperscript{164}

Judges disallow this evidence largely because of their unfamiliarity with the science of statistics.\textsuperscript{165} Admitting the evidence would result in a precise estimate of damages and would therefore produce more just results.

**Proximate Cause**

Should the plaintiff succeed in demonstrating a general causal connection between the defendant's behavior and his injury, he still must prove that the defendant's behavior was the proximate

\begin{itemize}
  \item \textsuperscript{158} See Sunary Mid-Continent Oil Co. v. Tisdale, 366 P.2d 614, 615 (Okla. Sup. Ct. 1961). While such evidence "need not have the attribute of certainty . . . it must be a presumption well founded in reason and logic; mere guess and conjecture is not a substitute for legal proof." Ciuba v. Irvington Varnish & Insulator Co., 27 N.J. 127, 139-40, 141 A.2d 761, 767 (1958); see also Kulas v. Public Serv. Elec. & Gas. Co., 41 N.J. 311, 319, 196 A.2d 769, 773 (1964).
  \item \textsuperscript{159} See, e.g., Donley v. Amerada Petroleum Corp., 152 Kan. 518, 523, 106 P.2d 652, 655 (1940).
  \item \textsuperscript{160} Such an approach would eliminate the concept of the formal burden of proof from environmental litigation altogether and instead allocate responsibility among the parties for coming forward with particular facts, such as health risks of the disposal.
  \item \textsuperscript{161} See infra notes 185-235 and accompanying text.
  \item \textsuperscript{162} See infra note 207.
  \item \textsuperscript{163} See, e.g., Carolina Envtl. Study Group v. United States, 510 F.2d 796 (D.C. Cir. 1975); Reserve Mining Co. v. EPA, 514 F.2d 492 (8th Cir. 1975), modified, 529 F.2d 181 (1976); Village of Wilsonville v. SCA Serv. Inc., 77 Ill. App. 3d 618, 396 N.E.2d 552 (1979), aff'd, 86 Ill. 2d 1, 426 N.E.2d 824 (1981).
\end{itemize}
cause of the injuries.\textsuperscript{166} Proximate cause turns on a policy judgment. By focusing on whether the plaintiff's injuries are so remote from the defendant's behavior that the defendant reasonably could not have foreseen them, the proximate cause rule promotes the social policy of holding liable only those that can be considered truly responsible for their acts.\textsuperscript{167}

Courts traditionally employ the foreseeability test in determining whether certain behavior is a proximate cause of an injury.\textsuperscript{168} The test asks if one could reasonably foresee the plaintiff's injury as resulting from the defendant's negligence.\textsuperscript{168} In strict liability suits, courts have adopted a variety of approaches to proximate cause,\textsuperscript{170} but these approaches still require a sufficiently close connection between the defendant's conduct and the harm. Often, courts employ the negligence foreseeability test.\textsuperscript{171} Even in a strict liability suit, therefore, a court will bar a plaintiff's claim if the toxic risk was unforeseeable.\textsuperscript{172}

When looking for proximity of cause and effect, judges and juries intuitively look at the time and place of the defendant's behavior and of the plaintiff's injury. This rarely helps the toxic-tort plaintiff. The ultimate injury often arrives far from the defendant's industrial plant and almost always long after any exposure.\textsuperscript{173}

\begin{enumerate}


\item[168.] W. PROSSER, supra note 108, § 43.


\item[170.] See, e.g., W. PROSSER, supra note 108, § 79, at 518; \textit{Restatement (Second) of Torts} § 519(2) (1976); Note, supra note 169, at 716-17.


\item[172.] Cf. W. PROSSER, supra note 108, at 250-70.

\item[173.] See generally Note, supra note 144, at 362-68 (discussing court treatment of unfore-
A Proposal for Reform

Only statistics can link cancers to their causative agents. Any viable proposal for correctly incorporating the social costs of cancer into product cost must rely on that statistical evidence. Quantitative risk assessment, the best such evidence, can estimate the number of cancers that a defendant will cause in a particular population. Armed with this evidence of future harm, plaintiffs from a community surrounding a toxic waste site may prevail. Although no individual plaintiff can prove he will be injured, the class as a whole can confidently expect a certain number of injuries among themselves. Since the proof of injury relies on statistics rather than individual medical examination, plaintiffs may recover before the injuries appear. Plaintiffs, introducing evidence that defendant's behavior will cause twenty cancers in the future, will recover compensation for those twenty cancers, discounted to present value.174

Such a radical departure from tort doctrine may appear too extreme. The use of either of two "legal fictions" will achieve the same ends. First, suits may be brought for the fear of cancer. Such suits have common law precedents.175 One can assume that as the risk of cancer increases, so does a particular individual's fear of contracting it. For example, an individual told he has one chance in three of contracting cancer will most likely be more agitated than if he has one chance in ten thousand. The damages recovered for "cancerphobia" will vary directly with the size of the risk. An individual's recovery for fear of future cancer will equal the liability for actually contracting cancer multiplied by his statistically seeable risks).


proven risk of contracting cancer. Although this approach concentrates on present individual injury, the final outcome will be similar to assessing the defendant industry with the costs of causing a number of cancers in the future.

Individual suits for being placed "at risk" by the defendant's behavior can achieve similar results. Although suggested by commentators,176 and occasionally employed by courts,177 "at risk" recovery does not promise as efficient an allocation of resources as a class suit. The costs of litigation will dissuade many plaintiffs. Further, the high confidence in risk analysis disappears when that analysis is applied to individuals rather than to large populations.178 Indeed, many of these individual suits would immediately be dismissed for failing the "more-probable-than-not" test.179

Both of these approaches must be recognized as fictions. They do not compensate the injury. Plaintiffs who become ill after "fear of risk" suits may sue again. Such double litigation is inefficient because it requires society to expend judicial resources for multiple suits without ending the dispute. Allowing the second recovery


178. See infra note 198.

179. See, e.g., Jackson v. Johns-Manville Sales Corp., 727 F.2d 506, 516-17 (5th Cir. 1984) (plaintiff "is not entitled to any compensation [for damages] if the proof does not establish a greater than 50 percent chance."); Wilson v. Johns-Manville Sales Corp., 684 F.2d 111, 119 (D.C. Cir. 1982) (future consequences must be established in terms of reasonable probabilities); Martin v. Pacific Gas & Elec. Co., 203 Cal. 291, 301, 264 P. 246, 250-51 (1928) (jury instructed that "damages may only be awarded for injury or suffering reasonably certain to result in the future"); Hahn v. McDowell, 349 S.W.2d 479, 482 (Mo. Ct. App. 1961) (testimony inadmissible because it did not show that cancer was reasonably certain to result from the injury); City of Waco v. Teague, 168 S.W.2d 521, 527 (Tex. Civ. App. 1943) (testimony of future injury inadmissible because it was "more of a possibility than a probability"); Coffman v. McFadden, 68 Wash. 2d 954, 961, 416 P.2d 99, 103 (1966) (testimony on future cancer "does not meet the test of reasonable probability") (emphasis in original). See generally King, supra note 174; Note, supra note 176; Note, supra note 174.
doubles the social cost of accidents, depresses supply, and increases price.\textsuperscript{180} Therefore, courts should ignore these legal fictions in favor of the more efficient class action mechanism.

Because the plaintiff need not wait until his injury manifests itself, he avoids the problems of statutes of limitations and inability to locate defendants. The proposal helps the chemical industry as well. Quantitative risk assessment precludes a Johns-Mansville scenario\textsuperscript{181} in which an industry suddenly has to bear the costs of thirty years of production.

A suit by a class of plaintiffs avoids causation problems. Homeowners who live near a waste site will make up the class, and the epidemiologic studies upon which the risk assessment is based will use the homeowners as the population under study. This procedure most accurately predicts the number of cancers that will occur in the population (class) as a result of the defendant's behavior.\textsuperscript{182} The procedure also removes the traditional obstacle to using predictive data in the courts to demonstrate causation—that the study predicts only population injury and not individual injury. No longer must the court inquire whether a particular cancer is caused by the defendant or is part of the background rate of cancer. The court can compensate the entire class, certain that the cancers induced by the defendants will occur regardless of the background rate. The class, in turn, can either divide the recovered funds or purchase insurance against any future cases of cancer.\textsuperscript{183} The in-

\begin{itemize}
\item \textsuperscript{180} Plaintiffs still have recourse to the conventional tort of intentional infliction of emotional distress. The mental distress associated with manufacture, however, is not the same type of product cost as accidents. The more difficult requirements of a mental distress claim reflect a social decision to allow manufacture despite incidental fear and anxiety of the citizenry. Most likely, there are certain risks that we must undergo solely because we are members of society. Artificial foods, sedentary occupations, being drafted to fight wars—all represent health risks. Perhaps the risk of industrially caused illness is a similar shared cost for participating in an advanced and industrialized society.
\item \textsuperscript{181} See supra note 3.
\item \textsuperscript{182} Opting out of the suit would be unreasonable for a potential class member because it represents his only chance for recovery. Such behavior, if it did occur, would not destroy the quantitative risk data. If those who opt out are randomly distributed, then the data need only be discounted by the percentage of the population that opted out. For example, one hundred people live around a waste dump. Risk study shows that ten future cancers will arise. Ten of the one hundred opt out of the class action. The results of the data need only be decreased ten percent.
\item \textsuperscript{183} For a discussion of insurance-fund judgments, see Rosenberg, supra, note 176, at 919-24; Shavell, \textit{Theoretical Issues in Medical Malpractice}, in \textit{The Economics of Medical}
dustry disposes of all the legal problems relating to the particular waste dump involved: those members of the population that opted out of the class are unlikely to recover on an individual basis because of their inability to prove individual causation. Persons who later move to the neighborhood and become exposed to the waste will be barred from suit by moving to the nuisance.\textsuperscript{184}

This strategy may be the only way to ensure the less-than-wealthy plaintiff of an opportunity for success. A large number of people together can bear the litigation costs of gathering scientific evidence of causation. Absent the probabilistic approach to proof, each individual must hire experts, secure highly trained counsel, and purchase or conduct environmental studies.

Above all, the chemical industry immediately will internalize all of the costs of their products. Under the present tort system, even if toxic-tort plaintiffs ultimately succeed in their suits, the effect of litigation upon the cost of products is unlikely to occur until twenty or thirty years after production began. Society therefore endures twenty or thirty years of misallocated resources. If a plaintiff can bring suit immediately, the industry will pass on the cost of dumping the waste to consumers. The market then can allocate resources to achieve the best social use of those resources.

\textit{Economics of Deterrence}

A free market allocates resources according to supply and demand.\textsuperscript{185} If the cost of a product rises, its demand falls.\textsuperscript{186} These market mechanisms help a society to allocate its resources properly. To achieve such allocation, however, the product must be priced properly. If the price is too low, the society will find itself with too many low-priced products.

Tort liability is one way to ensure that society places the correct price on a product. Assume, for example, that Glossop Industries,

\textsuperscript{184} People living near the waste dump still can sell their homes. Recall that the industry still is liable under a variety of state and federal statutes to clean up their waste dump. Once that happens, the housing market should reopen.


\textsuperscript{186} \textit{Id.} at 381-88.
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located in Easby, produces spats. Glossop spends $9.50 in labor, materials, and overhead to produce a spat, which retails for $10.00. Suppose, however, for each 100 spats made, that Glossop employees have accidents, causing $100,000 damages. The accident damages clearly are part of the cost of production. The production costs of each spat include labor, materials, overhead, and a certain percentage of the injuries. If Glossop is liable in tort for these damages, the damages will be reflected in the cost to the consumer. The price will rise to $10.10 for each spat. The market will experience a decreased demand for spats as people realize that they do not want spats at that price. Society will be unwilling to expend more resources for spats, and a proper allocation will be achieved. Alternatively, suppose that Glossop is not liable, and the worker must bear the costs of his injury or must recover from an independent compensation fund. The price of spats will remain unchanged. People will continue to buy spats at an artificially high rate because the cost will be artificially low. Society thus will misallocate its resources.

Now, instead of workplace hazards, substitute the disposal of hazardous waste. Suppose that as a result of the hazardous waste disposal Easby’s cancer rate increases eighty percent. Instead of fifty cancers a year, Easby’s hospitals report ninety cancers a year. These social costs of production, like workplace accidents, should not escape the market. If the plaintiff can show that he was more probably injured by the defendant than not, he will recover in tort, as he did for the workplace accident.

At this point, however, the uniqueness of cancer thwarts the tort system’s attempts to internalize production costs. In the workplace, absent some alternate cause, an accident can be attributed to the industrial process. There are no spontaneous injuries. Similarly, when the fish in a lake begin to die, something caused that death. We can take the fish, analyze them for chemical residue, describe the breakdown in biological pathways, and discover the polluter. We cannot, however, do this for cancer. There is a background rate of cancer. Some cancers occur without any discernable cause. Because we do not know their cause, such cancers can be treated as spontaneous. More importantly, courts cannot distinguish those who die of cancer because of exposure to carcinogens from those whose cancers arise naturally. The court, then, denies
the plaintiff recovery because he cannot prove by a preponderance of evidence that the defendant caused his injury.

What aids the plaintiff, however, is the fact that the background rates of sufficiently large populations are easily estimated. If the cancer rate rises meteorically after a waste dump opens nearby, the probability that the polluted waste caused the cancers satisfies the more-probable-than-not test. Some courts still will refuse to impose liability because no proof of causation exists. A growing number of courts, however, accept that high levels of probability demonstrate that the injury more probably arose from the defendant's behavior than not. Although such an approach better approximates our notions of a just decision, it still fails as a mechanism to allocate resources.

Suppose that Glossop causes seven of ten cancers experienced in a community. Each plaintiff recovers after proving that the defendant more probably caused his injury than not. The industry now pays for ten cancers, having caused only seven. The reflected cost is too high, and the resources are misallocated. Alternatively, suppose that Glossop only causes two cases of cancer. Each plaintiff will be able to show only a two-fifths chance that Glossop caused his cancer. Because that is less than fifty percent, the proof fails the more-probable-than-not test. Glossop pays for no cancers. In some cases, therefore, the industry pays for cancers it never caused. In other cases, it does not have to pay for those that it did cause.

187. See supra note 136.
188. See supra notes 156-60.
189. The risk is not two-tenths. Initially, only ten cancers occurred in the community. Seven of them were due to Glossop's actions; three were the natural background rate. When Glossop causes only two cancers, the total number of cancers in the community drops to five.
190. It is tempting to assume that, in the long run, the excessive payments of some companies will cancel out the lack of any payments for others. Apart from notions of legal tidiness, equity requires that, all else being equal, we assess cost of harms against those causing them. Further, in the long run, the economics of such a system would favor the industry. In the end, we wish to deter accidents that rise above the level tolerated by society. This lack of tolerance is reflected in the refusal to pay a high price for products. The more-probable-than-not test sets up a strong deterrent against companies, whose behavior more than doubles the cancer rate. Once they drop below that level, i.e. cause fifty percent or less, they are free from liability. Thus, in the long run, industries will be driven to pollute at a rate causing fifty percent of the surrounding cancers. At that rate, there is only social cost, un-
Quantitative Risk Assessment

Quantitative risk assessment aims to predict statistically the number of cancer cases that will result from exposure to a particular carcinogen. It arrives at estimates through the known carcinogenic potency of the chemical involved and the extent of the population's exposure. Because physicians do not understand precisely how cancer develops, this methodology provides the best, if not the only, way of determining the toxic effects of defendants' activities.

The three most common techniques to measure risk from exposure to chemicals are epidemiologic evidence, animal bioassays, and short-term tests. None of these techniques can measure exactly an individual's risk from exposure in any particular case. Each has its shortcomings.

Epidemiologic studies have been criticized because of the inherent imprecision of comparing different population groups. Statistical adjustments exist, however, to accommodate this and reflected in price, and no countervailing excessive liability on the producer.


192. Epidemiology attempts to identify carcinogens and estimate their risk through correlations between rates of cancer incidence in a human population and specific environmental factors. G. FRIEDMAN, PRIMER ON EPIDEMIOLOGY 1 (2d ed. 1980). There are two types of epidemiologic studies—"cohort" studies and "case control" studies. Cohort studies compare groups with different exposures to a chemical and the differences in their disease rates. Case control studies compare those who contract a certain type of cancer with a control group that does not, to identify differences in their environmental conditions. See Cole, The Evolving Case-Control Study, 32 J. CHRONIC DISEASES 15 (1979); IRLG REPORT, supra note 130, at 39, 858, 39, 862.

193. An animal bioassay compares the incidence of cancer in one group of animals administered a test substance with a control group that has not been exposed to the substance. Leape, Quantitative Risk Assessment in Regulation of Environmental Carcinogens, 4 HARV. ENVTL. L. REV 86, 93 n.44 (1980).

194. Short-term tests usually involve microorganisms BB or tissue cultures. Cell populations are subjected to chemical agents and then examined for mutations or other cellular abnormalities. Trauberman, supra note 6, at 187 n.46.


196. See J. FLEISS, STATISTICAL METHODS FOR RATES AND PROPORTIONS (2d ed. 1981); Cochran, Some Methods of Strengthening the Common X(2) Tests, 10 BIOMETRICS 417 (1954); Mantel & Haenzel, Statistical Aspects of the Analysis of Data from Retrospective Studies of Disease, 22 J. NAT'L CANCER INST. 719 (1959).
other discrepancies. The most severe criticism is directed at the inability of epidemiologic data to prove that a particular chemical caused a specific individual's case of cancer. Although epidemiology may prove that of twenty incidents of cancer, ten result from chemical exposure, the study cannot distinguish a case of leukemia caused by a toxic-waste dump from a case that is a part of the general background rate of cancer.

Animal bioassays suffer from different drawbacks. The cost of laboratory animals forces scientists to rely on high doses and small populations. These adjustments make the resulting data controversial.

Short-term tests determine carcinogenicity by analyzing single cells. Although incorrect approximately ten percent of the time, short-term tests can aid scientists in estimating the potential harm of a chemical.

The shortcomings of epidemiologic studies and animal bioassays do not preclude their use by potential plaintiffs. Critics claim only

197. If populations have shifted and have not been followed by the investigator, it is impossible to compute directly the disease-incidence rates in the exposed and nonexposed populations. The relative risk may be approximated, however, by using an "odds ratio" technique. See Fleiss, Confidence Intervals for the Odds Ratio in Case Control Studies: The State of the Art, 32 J. CHRONIC DISEASES 69 (1979). When hospital controls are used, the relative risk also is liable to a "Berksonian Bias." See Berkson, Limitations of the Application of Fourfold Analysis to Hospital Data, 2 BIOMETRICS 47 (1946). Because the maximum increase in the odds ratio is three, subtraction of that factor from the study is accomplished easily. See A. LILIENTHAL & D. LILIENTHAL, FOUNDATIONS OF EPIDEMIOLOGY 202 (2d ed. 1980).

198. See Dickson, Medical Causation by Statistics, 17 Forum 792, 803, 805-07; Dorf, A Commentary on the Use of Epidemiological Evidence in Demonstrating Cause-in-Fact, 7 HARV. ENV. L. REV. 429, 431 (1983); Large & Mitchie, supra note 113, at 594-95; Leape, supra note 193, at 92-93.


200. COUNCIL ON ENVTL. QUALITY, SIXTH ANNUAL REPORT 29-30 (1975).

201. See Carter, How to Assess Cancer Risks, 204 SCI. 811, 811-13 (1979); Leape, supra note 193, at 94-95.

202. The most widely used short term test is the Ames test. That test measures a chemical's mutagenic affect in salmonella bacteria as an indicator of its carcinogenicity. IRLG REPORT, supra note 130, at 39, 869.


204. Id. at 592; Meselson & Russell, Comparisons of Carcinogenic and Mutagenic Potency, in ORIGINS OF HUMAN CANCER 1473-81 (Cold Spring Harbor Laboratory, 1977); Leape, supra note 193, at 96.
that incorrectly monitored studies underestimate the true extent of carcinogenicity. Results indicating the carcogenicity of some substances are reliable; those suggesting noncarcinogenicity are less reliable.

As a final product, quantitative risk assessment estimates the number of incidents of cancer or other disease in a particular population that will result from a particular exposure. Fifty rads of radiation, for example, result in additional cases of leukemia over the next twenty years for every persons exposed. Such estimates may be based on general exposure, for example, to the various chemicals in a rubber plant, or to particular chemicals. Quantitative risk assessment can measure the injurious effects of a particular toxic spill on a particular community. Of all the study methods, quantitative risk assessment represents the best method of determining the risk posed by a particular practice on a particular population.


206. Positive findings in one form of study, therefore, are always sufficient to override a negative result in another. IRLG Report, supra note 130, at 39, 871; see also Carcinogens, 3 Chem. Reg. Rep. (BNA) 1664, 1665 (Feb. 1, 1980).


208. See Monson, Effects of Industrial Environment on Health, 8 Env. L. 663 (1978).

209. See, e.g., CAG Final Report on Arsenic 19 (Nov. 27, 1978) (3.18 deaths per year); Carcinogen Assessment Group's (CAG) Final Report on Benzene 2 (June 10, 1979) ("number of cases of leukemia per year in the general population due to ambient atmospheric benzene is about 90 with a 95% confidence interval from 34 to 235"); CAG Final Report on Diflubenzuron (Mar. 20, 1979); Benzene, 6 Chem. Reg. Rep. (BNA) 560 (July 30, 1982) ("100 parts per million of Benzene over a working lifetime results in 140 to 170 cases of leukemia per 1000 workers").


211. See, e.g., Forgetson, Liability for Long Term Latent Effects of Toxic Agents, 50 A.B.A. J. 142 (1964); Hall & Silbergeld, Reappraising Epidemiology: A Response to Mr. Dore, 7 Harv. Envtl. L. Rev. 441 (1983); see also Ethyl Corp. v. EPA, 541 F.2d 1, 26 (D.C. Cir. 1976) (best to combine toxicology and chemical research with epidemiology), cert. de-
Traditionally, courts have distrusted statistical evidence. That distrust recently has begun to wane. The use of statistics is common in employment discrimination cases, in the determination of jury discrimination, and in personal injury and wrongful death suits. In a quasi-criminal context, courts even have allowed evidence of statistical paternity tests. Courts have begun to realize that science has outpaced them in efforts to determine the effects of behavior, and the courts have sought, albeit slowly, to catch up.

Administrative agencies have relied on risk assessment data in both framing and enforcing regulations. A small, but growing, number of cases have used statistical evidence to prove their case. For example, in Cramer v. Morrison, 88 Cal. App. 3d 873, 153 Cal. Rptr. 865 (1979), the court used statistical evidence to prove that the defendant was liable for the plaintiff's injuries. Similarly, in Carleyon v. Weeks, 387 So. 2d 465 (Fla. Dist. Ct. App. 1980), the court used statistical evidence to prove that the defendant was liable for the plaintiff's injuries.
number of courts have begun to use risk assessment data in determining the effects of hazardous activity. The increase may reflect the recognition that in cases of chemical injury, plaintiffs have few options besides using statistical data. Only through studying large populations can the background rates be distinguished from the rate of disease incident to exposure.

Quantitative risk assessment fits well in the litigation process. It offers a reliable standard of proof, requiring only statistical modification to apply to particular facts, and the ability to predict the future damages that will arise from present behavior. Although at first the data may be difficult to interpret, its widespread use indicates that it is mastered easily. Mathematical significance tests readily assess the validity of any conclusions drawn from the data. Defendants may gather their own data to disprove plaintiff claims or may introduce expert testimony to attack the method-
ology of the study.\textsuperscript{226}

Risk assessment data can prove a biological relationship between chemical exposure and disease. The evidence is circumstantial, but courts have allowed plaintiffs to rely on circumstantial evidence to demonstrate causation by a preponderance of the evidence.\textsuperscript{227} When the plaintiff class itself is the population studied,\textsuperscript{228} the evidence is especially relevant.\textsuperscript{229} Once courts agree that tort law should internalize the social costs of activities,\textsuperscript{230} courts must accept risk assessment data because it is the plaintiff's sole method of proving causation.

When an individual uses risk assessment data to demonstrate that he should recover for his injury, courts generally have required a correlation of greater than fifty percent in order to meet the more-probable-than-not standard. If fifty incidents of cancer occur in a particular population, therefore, a study indicating that twenty of them arose from defendant's action precludes recovery in each of those twenty suits because each plaintiff can only prove a forty-percent chance that the defendant caused his cancer.\textsuperscript{231} In a class action, however, the defendant is liable for causing the twenty cancers. The correlation no longer is important. Instead, the court must evaluate the reliability of the study results. The defendant should compensate the plaintiffs for at least the number of cancers in the statistical interval with a confidence of fifty-one percent.\textsuperscript{232} Although this standard is based on the common more-

\textsuperscript{226} For a discussion of some of the standards of reliability to which an epidemiologic study should be compared, see Dore, supra note 198, at 438-40.

\textsuperscript{227} W. PROSSER, supra note 108, \S\ 4, at 6.

\textsuperscript{228} For a discussion of the problems associated with extrapolating the results of a study of a restricted group to a population at large, see Ames, supra note 195; Dore, supra note 198, at 456; IRLG Report, supra note 130, at 39,862.


\textsuperscript{230} See supra notes 7, 186-90 and accompanying text.

\textsuperscript{231} See Note, supra note 109, at 592 n.37.

\textsuperscript{232} Since increased exposure always must add to the incidence of cancer (because being exposed to twice as much toxic waste cannot cause less cancer), there is a point in the confidence scale where it can be said that it is more likely that the number of cancer incidents is going to be X or greater than X than it is that the number will be less than X. That confidence level is 51%. The court should then allow compensation for the least predicted cancers in that interval, i.e. X. In a particular population, for example, there may be a 10%
probable-than-not test, other standards of liability are possible.\textsuperscript{233} Future commentators, however, should heed two caveats. First, quantitative risk assessment suggests, by proving a causal connection, that some remedy is appropriate. Inquiry into the proper level of confidence concerns only the extent of that remedy.\textsuperscript{234} Second, economics dictates that, if there is any doubt, that doubt should be reconciled in favor of the plaintiff because the industry is the better cost-allocator.\textsuperscript{235}

\textit{Formation of a Class}

The class action\textsuperscript{236} is uniquely suited to actions involving quanti-
tative risk assessment. The results of epidemiologic studies and of risk estimates are particularly persuasive when the entire group upon which the data is based appears before the court. Conversely, the mass tort is uniquely suited to class actions. The class action brings together many persons injured under circumstances that produce similar litigation issues. A common adjudication of these issues greatly eases the court's burden.\textsuperscript{237}

Although courts traditionally have refused to certify classes for mass pollution cases,\textsuperscript{238} they have approved such actions in recent years.\textsuperscript{239} This shift toward a broader construction of Federal Rule of Civil Procedure 23 may be traced to the recognition that the increasingly technical and expensive nature of litigating pollution suits in effect may preclude individuals from seeking compensation for their injuries.\textsuperscript{240}

In order to qualify for class certification under Rule 23, a case must fulfill the criteria of federal diversity jurisdiction.\textsuperscript{241} The requirement of diversity between the defendant and the representatives of the plaintiff class rarely presents difficulties. Only the named representative of the class must have citizenship diverse


\textsuperscript{239} See 3B J. MOORE, FEDERAL PRACTICE \textsuperscript{I} 23.45[3], at 323 n.40 (2d ed. 1948); 7A C. WRIGHT \& A. MILLER, FEDERAL PRACTICE AND PROCEDURE § 1783, at 116 (1972); Comment, Federal Mass Tort Class Actions: A Step Toward Equity and Efficiency, 47 ALB. L. REV. 1180, 1187 (1983).

from the defendants.\textsuperscript{242}

More likely to impede a class action designed along these lines is the $10,000 amount in controversy requirement.\textsuperscript{243} Since 1974, each named plaintiff independently must assert a claim of $10,000.\textsuperscript{244} Although using quantitative risk assessment will itself limit cases failing this jurisdictional test,\textsuperscript{245} situations still may exist in which the recovery of each class member results in less than $10,000.\textsuperscript{246} Courts have devised two methods by which such classes may survive jurisdictional scrutiny.

First, many commentators have suggested that the strict rules of jurisdiction must yield when the suit is brought on a representative basis.\textsuperscript{247} In the recent "Dalkon Shield" class certification,\textsuperscript{248} the court assumed jurisdiction over a nationwide class despite the fact that the majority of the plaintiffs were not within the court's jurisdiction.\textsuperscript{249} Such action indicates an increasing focus on the representatives of the class and a retreat from the stricter requirements of individual jurisdiction.

Alternatively, courts have permitted classes to be formed when injuries are included that cannot be expressed in monetary damage alone. A claim for injunctive relief may overcome the $10,000 juris-

\begin{footnotesize}
\begin{enumerate}
\item As the number of cancers as a percentage of population decreases, the confidence in the estimate also falls. Thus, cases involving thousands of plaintiffs and isolated instances of cancer are likely to fail in court because of insufficient proof.
\item One obvious method to avoid this outcome is to structure the class, and thus the resultant risk study, for maximum per capita recovery. Geographic dimensions of the studied area, for example, might be restricted from an area ten miles in diameter to an area five miles in diameter.
\item Id. at 905.
\end{enumerate}
\end{footnotesize}
dictional requirement by including the "value of the rights which plaintiff seeks to have protected." Although this approach has been adopted in some pollution cases, the class still must prove that the value of the injunctive relief to each individual claimant exceeds $10,000.

In addition to meeting requirements for diversity jurisdiction, federal class actions must meet all the requirements of Rule 23(a) and fit within one of the categories of Rule 23(b).

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253. The federal class action rule is Federal Rule of Civil Procedure 23, which provides in part:

(a) Prerequisites to a Class Action. One or more members of a class may sue or be sued as representative parties on behalf of all only if (1) the class is so numerous that joinder of all members is impracticable, (2) there are questions of law or fact common to the class, (3) the claims or defenses of the representative parties are typical of the claims or defenses of the class, and (4) the representative parties will fairly and adequately protect the interests of the class.

(b) Class Actions Maintainable. An action may be maintained as a class action if the prerequisites of subdivision (a) are satisfied and in addition:

(1) the prosecution of separate actions by or against individual members of the class would create a risk of

(A) inconsistent or varying adjudications with respect to individual members of the class which would establish incompatible standards of conduct for the party opposing the class, or

(B) adjudications with respect to individual members of the class which would as a practical matter be dispositive of the interests of the other members not parties to the adjudications or substantially impair or impede their ability to protect their interests; or

(2) the party opposing the class has acted or refused to act on grounds generally applicable to the class, thereby making appropriate final injunctive relief or corresponding declaratory relief with respect to the class as a whole; or

(3) the court finds that the questions of law or fact common to the members of the class predominate over any questions affecting only individual members, and that a class action is superior to other available methods for the fair and
requires that the class be so numerous that joinder is impractical, that there be questions of law and fact common to the plaintiff class, that the claims and defenses of the named plaintiffs be typical of those of the class, and that the representative parties fairly and adequately represent the interests of the class.

The Rule 23(a)(1) requirement that joinder be impracticable should rarely present an obstacle to certification in mass toxic-tort cases. Most toxic-tort cases affect hundreds of potential plaintiffs. Similarly, mass toxic-tort cases satisfy the Rule 23(a)(2) requirement that common questions of law or fact exist among all members of the class. This requirement rarely poses a problem in mass-accident cases, but is somewhat more troublesome in the toxic-tort context. Courts have denied certification in these cases, citing the individual nature of the harm and causal connection.

efficient adjudication of the controversy. The matters pertinent to the findings include: (A) the interest of members of the class in individually controlling the prosecution or defense of separate actions; (B) the extent and nature of any litigation concerning the controversy already commenced by or against members of the class; (C) the desirability or undesirability of concentrating the litigation of the claims in the particular forum; (D) the difficulties likely to be encountered in the management of a class action.

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254. Impracticability may result from the large size of the class, an impracticability to locate all class members, or the complexity of administering so large a class. Weinstein, Revision of Procedure: Some Problems in Class Actions, 9 Buffalo L. Rev. 453, 459 (1960).


255. The Love Canal class, for example, consisted of 900 plaintiffs. See Mervak v. City of Niagara Falls, 101 Misc. 2d 68, 420 N.Y.S.2d 687 (Sup. Ct. 1979). One problem that may arise, however, is the close proximity of class members to each other. Courts have hinted that the geographical distribution of a proposed class is of considerable importance. See, e.g., Glover v. McMurray, 361 F. Supp. 235, 241 (S.D.N.Y.), rev'd and remanded on other grounds, 487 F.2d 403 (2d Cir. 1973), vacated and remanded on other grounds, 417 U.S. 963 (1974).


257. See Note, supra note 240, at 1190; Note, Mass Accident Class Actions, 60 Calif. L. Rev. 1615, 1619 (1972); Note, supra note 251, at 279; see also In re Gabel, 350 F. Supp. 624, 627 (C.D. Cal. 1972) (recognizing appropriateness of class actions for mass torts).

Class actions based on data concerning generalized risks avoid these obstacles. First, causation is not an issue that might vary from individual to individual. The very nature of population studies is that they ignore individual tendencies. Precluding action on that data because individual experiences may differ defeats the purposes of entertaining risk data in the first place. Second, as long as the type of harm remains constant (i.e. cancer), variations in severity should not vitiate a class's claim. Finally, Rule 23(a)(2) does not require that common questions of law or fact outweigh individual issues. Rather, it merely requires that some common issues exist between the claims. This analysis was followed in In re "Agent Orange" Product Liability Litigation in which, despite the existence of individual questions of exposure, the court found sufficient questions of law or fact to fulfill the commonality requirement.

The third requirement of Rule 23(a) is that the claims of the

259. See supra note 198.

In some cases, more than one form of cancer may be anticipated. For instance, a toxic dump of varied chemicals might lead to lung, brain, and breast cancer. For two reasons, mere varieties of cancer should not mitigate against class certification under either Rule 23(a)(2) or Rule 23(b)(3). First, to the court, each class member's injury is identical; each has a risk of injury. Indeed, if the court tried the cases individually, each case would be identical. Each plaintiff would introduce the epidemiologic study. Considerations of judicial economy warrant avoiding that result. See 3B J. Moore & J. Kennedy, Moore's Federal Practice § 23.02[1] (2d ed. 1984) (class actions arose partly out of a desire to reduce the multiplicity of suits).

Furthermore, Rule 23 was created to provide relief to groups of plaintiffs that otherwise would go without remedy because of their number. See generally 7 C. Wright & A. Graham, Federal Practice and Procedure § 1751 (1972). Rule 23(b)(1), authorizing class actions when separate actions may adversely affect class members, exemplifies the protective nature of Rule 23. See 7B C. Wright & A. Graham, Federal Practice and Procedure § 1772 (1972). Although plaintiffs may be required to sue alone when some have graver injuries than others and therefore deserve greater compensation, no similar rationale justifies denying a class certification, resulting in all the members going uncompensated.

261. Predominance of common issues or facts is a requirement of Rule 23(b)(3). See Fed. R. Civ. P. 23(b)(3). If Rule 23(a)(2) also required common issues of fact to predominate, Rule 23(b)(2) would become superfluous. See Note, supra note 240, at 1191.

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parties representing the class be typical of the claims of that class. There should be few obstacles to satisfying this requirement. The recovery of the class is not individual; it is for a group fund. Therefore, any member would satisfy the requirement of typical representation since every member seeks to recover an identical amount from the fund. If the court prefers to approach the case as one for fear of future cancer, then all the individual claims are identical, again satisfying the third requirement.

Finally, Rule 23(a) requires that the class representatives fairly and adequately protect the interests of the class. This requirement is largely to protect the due process rights of absent class members. This issue appears to be no different in a toxic-tort action than in any other class action.

In addition to fulfilling the four requirements of Rule 23(a), a federal class action also must fall into one of the three categories of a class action presented in Rule 23(b). For an assortment of reasons, subsections (b)(1) and (b)(2) of Rule 23 are generally inappropriate for toxic-tort actions. Most frequently used is Rule 23(b)(3), which permits class actions when common questions of law and fact predominate, and when the device is superior to other methods of adjudicating plaintiff rights.

265. See supra notes 174-84 and accompanying text.
266. For discussion of the "fear of future cancer" approach, see supra notes 175-77.
269. For an example of representative certification, see American Trading & Prod. Corp. v. Fischbach & Moore, Inc., 47 F.R.D. 155, 156 (N.D. Ill. 1969) (holding that twelve mass-accident victims properly represented a class of 1200).
270. For text of Rule 23(b), see supra note 253.
271. Rule 23(b)(1) permits class actions where individual suits create a risk of incompatible standards of conduct for parties opposing the class or may result in judgments for some plaintiffs that as a practical matter may dispose of other claims. Because most toxic-tort suits are for damages, litigation of prior actions will not foreclose subsequent suits. Note, supra note 251, at 281-82.

Rule 23(b)(2) permits class actions when plaintiffs seek equitable or declaratory relief from a defendant or defendants who refuse to act on grounds generally applicable to the class. The provision clearly does not encompass purely monetary actions. If an action involves both injunctive and monetary relief, Rule 23(b)(2) still may exclude it if the injunctive relief is not the primary aim of the litigation. See In re "Agent Orange" Prod. Liab. Litig., 506 F. Supp. 762, 790 (E.D.N.Y. 1980); Biechele v. Norfolk & W. Ry. Co., 309 F. Supp. 354, 355 (N.D. Ohio 1969).
In a toxic-tort case, the issues surrounding a defendant's liability most often are the same for all plaintiffs. Individual trials to determine liability would be duplicative. Courts, recognizing the uselessness of such trials, have treated toxic-tort plaintiffs as a single class, if only for the determination of liability.

For some mass-accident cases, the variety of state laws that might apply can preclude certification as a Rule 23(b)(3) class. In the cases discussed in this Note, however, the chance of conflict-of-law questions arising is remote. Because the class is relying on studies of the exposed population, most classes will consist of neighborhoods surrounding waste-disposal sites.

The question of individual variance in causality is the barrier to Rule 23(b)(3) class certification of a toxic-tort class. For reasons similar to those dealing with Rule 23(a)(2), tort cases relying on data of pollution risks should avoid this obstacle. The question is one not of individual causality but of statistical correlation. The class, for purposes of proof, would be treated best as a single individual.

In summation, a class consisting of the population involved in the risk assessment studies often satisfies the Rule 23 criteria. If the class fails to meet the federal requirement, it may still sue as a class under state law.

**CONCLUSION**

If morality were ever the major force in legal reform, it is no longer. Economics has replaced it. Law provides compensation rather than revenge and punitive damages rather than criminal

272. See Note, supra note 257, at 1620.
274. See Note, supra note 257, at 1622-23; Note, supra note 251, at 289-91.
275. See supra notes 256-60 and accompanying text.
277. To list even the more important legal scholarship in law and economics would be impossible. Of the books written on the subject, perhaps G. CALABRESI, THE COSTS OF ACCIDENTS (1970), and R. POSNER, ECONOMIC ANALYSIS OF LAW (2d ed. 1977), are the most important. Among articles, the Symposium on Efficiency as a Legal Concern, 8 Hofstra L. Rev. 485 (1980) provides good examples of economic inquiry into law.
sanction—some even say industrial subsidy rather than impartial justice. Branches of law, such as antitrust, have sprung up with intention, structure, and sanction solely economic. Still we try to reach economic ends with legal tools from another era. Although our ideas of causation work admirably in cases of broken bones and railroad injuries, they belong to a time without classes of plaintiffs, carcinogenic threats, or chemical menace. If law is an economic machine, why not use economic tools to repair it?

Viewing problems of toxic waste in an economic light suggests economic solutions. In some areas of the law, economics may contribute nothing to our understanding. There the social decision is clear, we do not want criminal conversation, for example, or slander. In other areas we are not so certain of social desires. Do we want all chemical hazards prevented? or some? or none? If we want some, which ones? Rather than estimating social wants and translating that estimation into black letter law, economics allows society to make the decision itself. Law internalizes the costs of products and society either buys or forbears buying the product. The market is by no means a legal panacea. Some activities so endanger us that we should ban them. Some markets are so small or liable to monopolistic controls they fail to reflect social desires. Economics is a tool. In cases of economic waste, however, we may use that tool with particular effect.

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