From Smokestack to SUV: The Individual as Regulated Entity in the New Era of Environmental Law

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I. INTRODUCTION

> A cardinal principle in dealing with every type of legal arrangement is to keep steadily in view the kinds of people to whom the directions of the arrangement in question are initially addressed—who the people are, in other words, who are expected to act or refrain from acting in accordance with the arrangement if it works successfully, and under what circumstances they are expected to act.[1]

If asked to envision a polluter, most of us would describe a tall stack from a large industrial facility billowing smoke or a pipe releasing foaming liquid into a stream. The environmental laws and academic commentary of the last thirty years reflect this common conception. With few exceptions, the environmental laws enacted since the 1970s have directed command and control requirements at large industrial sources of pollution. Similarly, in law reviews, books and congressional hearings, advocates of command and control regulation have battled with economic incentive enthusiasts over the optimal measures for regulating large industrial sources.[2] The participants in this debate differ on the effectiveness of various regulatory instruments and the need for regulatory reform, but they share an important, although often unspoken, premise: that the principal

1. HENRY M. HART, JR. & ALBERT M. SACKS, THE LEGAL PROCESS: BASIC PROBLEMS IN THE MAKING AND APPLICATION OF LAW 118 (William N. Eskridge, Jr. & Philip P. Frickey eds., 1994).

2. Command and control advocates have pointed to the ability of administrative agencies to implement prescriptive environmental statutes and the pollution reductions that have resulted from these statutes. *See, e.g.*, Howard Latin, *Ideal Versus Real Regulatory Efficiency: Implementation of Uniform Standards and "Fine-Tuning" Regulatory Reforms*, 37 STAN. L. REV. 1267 (1985); Thomas O. McGarity, *Some Thoughts on "Deossifying" the Rulemaking Process*, 41 DUKE L.J. 1385 (1992); Sydney A. Shapiro & Thomas O. McGarity, *Not So Paradoxical: The Rationale for Technology-Based Regulation*, 1991 DUKE L.J. 729; Rena I. Steinzor, *Devolution and the Public Health*, 24 HARV. ENVTL. L. REV. 351 (2000) [hereinafter Steinzor, *Devolution and the Public Health*]; Rena I. Steinzor, *Reinventing Environmental Regulation: The Dangerous Journey from Command to Self Control*, 22 HARV. ENVTL. L. REV. 103 (1998); Wendy E. Wagner, *The Triumph of Technology-Based Standards*, 2000 U. ILL. L. REV. 83. Critics have noted the rigidity, inefficiency and other weaknesses of these measures and have suggested economic incentives as regulatory alternatives. *See, e.g.*, Bruce A. Ackerman & Richard B. Stewart, *Reforming Environmental Law*, 37 STAN. L. REV. 1333 (1985); Daniel C. Esty, *Toward Optimal Environmental Governance*, 74 N.Y.U. L. REV. 1495 (1999); Louis Kaplow & Steven Shavell, *Property Rules Versus Liability Rules: An Economic Analysis*, 109 HARV. L. REV. 713 (1996); James E. Krier & Stewart J. Schwab, *Property Rules and Liability Rules: The Cathedral in Another Light*, 70 N.Y.U. L. REV. 440, 447-64 (1995); Jonathan Baert Wiener, *Global Environmental Regulation: Instrument Choice in Legal Context*, 108 YALE L.J. 677, 679 (1999).

sources of pollution are large industrial facilities and the principal victims are individuals.[3]

This Article suggests that the reality today is quite different. We are polluters. Each of us. We pollute when we drive our cars, fertilize and mow our yards, pour household chemicals on the ground or down the drain, and engage in myriad other common activities. Although each activity contributes minute amounts of pollutants, when aggregated across millions of individuals, the total amounts are stunning. Industrial sources continue to be major sources of pollution, and other important pollution sources exist, but individuals are now the largest remaining source of many pollutants. The time has come to focus attention in their direction. Treating individuals as regulated entities, however, will require fundamental changes in the theories and methods of environmental law. Moreover, the need to focus on individual behavior exists across a wide range of health, safety and other areas, and will require substantial modifications in many aspects of the post-New Deal regulatory state.

This Article proceeds in six Parts. After the introduction in Part I, Part II examines the environmental regulatory debate. The Part demonstrates the extent to which the debate has focused on large industrial sources, and it explores the importance of source identification. Although a central issue in the debate is the identification of optimal regulatory instruments, source identification is often overlooked and is at least as important. In some cases, environmental harms are caused by both individual and industrial emissions, and environmental goals may be achieved at lower cost if changing individual behavior is one of the options available to regulators. In other cases, individuals and households are the sole or principal remaining source of pollution, and changes in individual behavior may be the only means of achieving environmental goals.[4]

Part III then defines individuals and households as a discrete source category and provides the first profile of the quantities of pollutants released from this source category.[5] The failure to conceive

3. Since at least the early 1990s, several authors have noted the importance of numerous, diffuse sources, but few have evaluated the nature of these sources or the regulatory tools best suited to reducing their environmental impacts, and no one has identified individual behavior as a discrete source category. *See* discussion *infra* notes 68-74.

4. There is widespread, although certainly not universal, agreement among environmental law scholars that additional emissions reductions will be necessary in the United States if economic development is to continue without erosion in existing environmental quality. *See* Richard B. Stewart, *A New Generation of Environmental Regulation?*, 29 CAP. U. L. REV. 21, 28 (2001).

5. In many cases, individual behavior is the obvious source of pollution, and the behavior is beyond the reach of regulatory schemes aimed solely at the producers of consumer products

of individuals and households as a source category has resulted in a virtual wasteland of data regarding the contributions of individual behavior to pollutant releases and environmental harms. Empirical studies rarely collect data on the pollution attributable to individual behavior, and government reports rarely present the data that are collected in a way that identifies individuals as a source category.[6] As a result, academicians, regulators, and the public have a limited understanding of the emissions and harms caused by individual behavior.

To overcome the shortcomings in the available information, Part III draws on data from a wide range of government and other reports to profile individuals and households as a discrete source of pollution. The profile concludes that individuals release almost a third of the chemicals that form low-level ozone or smog, and that households release at least as much mercury to wastewater as do all large industrial facilities combined. For several air toxics, the numbers are even more striking: individuals release fifty times more benzene than all large industrial facilities combined and five times more formaldehyde.[7] In many cases, the proportion of pollution

(e.g., backyard burning). In other cases, the emissions from individuals and households could be attributed either to individual behavior or to the industrial firms that produce consumer products (e.g., automobile tailpipe emissions and the emissions from utilities that produce residential electricity). In these cases, the Article uses the extent to which individuals can control the emissions arising from their behavior as the principal criterion for determining which pollutants should be attributed to individuals and which should be attributed to the producers of consumer products. *See infra* Part III.A.

6. For example, the federal Environmental Protection Agency routinely studies the sources and effects of urban runoff (the leading cause of impaired estuaries in the United States), but these studies typically do not collect or report data in a way that identifies the extent to which pollutants in urban runoff arise from residential as opposed to industrial areas. *See, e.g.*, EPA, NATIONAL WATER QUALITY INVENTORY 2000 REPORT 31 (2001) [hereinafter EPA, 2000 WATER QUALITY REPORT] (concluding that urban runoff is the leading cause of impaired estuarine waters but not distinguishing between residential and other sources of pollutants in urban runoff), http://www.epa.gov/3056/2000report. In fact, the most comprehensive government report from which some indication of the residential share of pollutants in urban runoff can be gleaned is more than twenty years old. *See* EPA, RESULTS OF THE NATIONWIDE URBAN RUNOFF PROGRAM, VOLUME 1—FINAL REPORT 6-28, 6-31 (1983) (concluding that the bodies of water that receive runoff from residential areas are comparable in water quality to those that receive runoff from industrial areas). Similarly, EPA reports often identify the air emissions from motor vehicles, but they do not identify the share of motor vehicle emissions attributable to private individuals. *See, e.g.*, OFFICE OF AIR QUALITY PLANNING & STANDARDS, EPA, NATIONAL AIR POLLUTANT EMISSION TRENDS 1900-1998 (EPA-454/R-00-002) tbls. 3-2, 3-3 (2000) [hereinafter EPA, 2000 AIR TRENDS REPORT] (identifying mobile source nitrogen oxide and hydrocarbon emissions but not distinguishing between the emissions from private vehicles and the emissions from vehicles operated by business, government or other organizations), http://www.epa.gov/ttn/chief/trends/trends98/index.html.

7. *See infra* Part III.

attributable to individuals is growing.[8] Demographic trends explain much of this growth and suggest that the role of individual behavior is likely to become increasingly important over the next several decades. For example, if the population increases by 38 percent over the next thirty years, as it did over the last thirty years, in 2030 roughly 390 million people will live in the United States.[9] In addition, activities with significant adverse environmental consequences, such as miles traveled per vehicle, are increasing at a faster rate than the population.[10]

Despite the large and growing role of individuals, the focus of environmental regulation on large industrial sources may be defensible if individuals are not amenable to regulation. To address this proposition, Part III also briefly explores the extent to which environmental regulators have sought to impose legal requirements on individuals. The same pattern has occurred in area after area: regulators have sought to impose restrictions on individual behavior only rarely, and when they have done so, the restrictions have been unpopular and have provoked a public backlash. Perhaps as a result, few regulations focus directly on individual behavior, and those that do are rarely enforced.[11]

Part IV examines the implications of the dilemma posed by the large individual role in pollution coupled with the public resistance to formal legal regulation of individual behavior. The Part suggests that

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8. A number of studies include data that suggest that individual sources now comprise a substantially larger proportion of the total emissions and environmental quality effects than they did in 1970. *See, e.g.*, EPA, 2000 WATER QUALITY REPORT, *supra* note 6, at 31 (concluding that urban runoff now accounts for a larger percentage of all impaired estuarine waters than industrial discharges); *see also* William F. Pedersen, *Regulation and Information Disclosure, Parallel Universes and Beyond*, 25 HARV. ENVTL. L. REV. 151, 165 n.53 (2001) (noting that industrial sources now account for small percentages of air toxics, ozone, and other pollutants).

9. More than 281 million people live in the United States, and the population grew by 38 percent between 1970 and 2000. *See* EPA, DRAFT REPORT ON THE ENVIRONMENT x (2003) [hereinafter EPA, ENVIRONMENT REPORT], http://www.epa.gov/indicators/roe/pdf/EPA-_Draft_ROE.pdf. The 281 million people currently living in the United States comprise 105.5 million households. U.S. CENSUS BUREAU, AMERICAN FACT FINDER, QT-P10, HOUSEHOLDS AND FAMILIES: 2000 (2000) (estimating the number of households in the United States to be 105,480,101 in 2000), http://factfinder.census.gov/households. The increasing number of individuals is particularly important given individuals' large share of energy consumption generally and fossil fuel consumption in particular. *See* GERALD T. GARDNER & PAUL C. STERN, ENVIRONMENTAL PROBLEMS AND HUMAN BEHAVIOR 258, 273 (1996).

10. *See* discussion *infra* notes 154-158. The risks posed by releases from individuals are more difficult to assess, but for a number of pollutants they appear to be substantial. *See* discussion *infra* notes 104-105.

11. Although environmental laws regulate the products individuals purchase (e.g., automobile tailpipe emissions standards) and the emissions from the industrial facilities that manufacture those products (e.g., automobile manufacturing facilities), the regulatory target in each of these cases is industry, not individuals. *See infra* Part III.B.

the large numbers and unusual alignments of individual polluters; the chronic, long-term nature of their environmental harms; and the effects of insufficient information, cognitive limitations, and social influences on decision making make most command and control and economic incentive efforts difficult to develop and implement. In fact, the lack of effective coercive authority over millions of individuals may render the regulation of individual behavior more akin to the regulation of nations in an international regulatory regime than to the regulation of domestic industrial sources.

Although the traditional regulatory instruments that dominate the debate over the regulation of industrial sources have limited prospects, at least as first order measures, there is reason to believe that individual environmentally significant behavior can be changed through a mix of traditional and new approaches.[12] The goal of this Article is not to demonstrate the extent to which any particular individual behavior can be modified, but to suggest that empirical studies and experience with a wide range of behaviors now undermine the implicit assumption that such modification cannot occur. Rather than dismissing the possibility of changing individual behavior out of hand, the analysis of whether change can be induced at an acceptable cost should be conducted on a behavior-by-behavior basis.[13] In particular, empirical studies suggest that personal and social norms may create non-market corrective pressure to change behavior. If skillfully presented, information may affect the expected utility calculus by triggering norms. Thus, information, alone or in combination with other regulatory instruments, may have substantial effects on individual behavior.

Part V suggests that the growing need to focus on individuals as regulated entities is not limited to environmental law, but extends to health, safety, and other regulatory areas. The focus on reducing risks created by individuals only through regulation of industrial firms is a characteristic not only of the regulatory regime implemented by the federal Environmental Protection Agency (EPA), but also of the regimes implemented by the other federal agencies that were created in the 1960s and early 1970s, such as the National Highway Traffic Safety Administration and the Occupational Safety

12. The term "environmentally significant behavior" has been used in the social psychological literature. *See, e.g.*, Paul C. Stern, *Toward a Coherent Theory of Environmentally Significant Behavior*, 56 J. SOC. ISSUES 407, 407 (2000).

13. Research on seat belt use, smoking, and other behaviors suggests that major shifts can occur where the behavior change will benefit the individual. Where the harms of an individual's behavior are externalized, or where habits or other barriers exist to self-interested change, influencing behavior may be far more difficult. *See* discussion *infra* notes 378-379.

and Health Administration.[14] To address the perceived inability of common law actions and command and control regulation to change individual behavior, the architects of these new regulatory regimes sought to address conduct on a larger scale. In many of these regulatory areas, the preferred target was the firm.[15] As with environmental regulation, however, the firm-focused approach is achieving diminishing returns. For example, individual behavior is not only an increasingly important source of pollution, but it also is the most common cause of motor vehicle crashes, surpassing both vehicle and roadway safety. Similarly, obesity has become the second leading cause of preventable deaths in the United States.[16]

The new focus on individuals as regulated entities will require modifications not only in regulatory instruments, but also in agency expertise and administrative procedures. If individual behavior is to be a regulatory target, scholars will need to improve models designed to explain and predict the influences of legal, economic, social, and psychological incentives on individuals.[17] Agencies will need to shift staffing and resources in response to the new focus. For example, agency resources and staffing may need to be devoted to public information campaigns at levels comparable to those now devoted to informal rule making. Similarly, agencies may need to conduct social psychological analyses of agency regulatory efforts directed at private individuals at the same level of sophistication as is now achieved for economic analyses of command and control regulations directed at industrial sources.[18]

To the extent agency information dissemination begins to rival rulemaking as an important regulatory function, the need for procedural protections also will become more significant. The Administrative Procedure Act (APA) reflects the focus of the New Deal regulatory state on promulgating formal and informal regulations to direct the conduct of large firms. In contrast, the procedural

14. *See* JERRY L. MASHAW & DAVID L. HARFST, THE STRUGGLE FOR AUTO SAFETY 4 (1990); *see also* Nicholas S. Zeppos, *The Legal Profession and the Development of Administrative Law*, 72 CHI.-KENT L. REV. 1119 (1997) (discussing the legal profession's resistance to the regulatory state).

15. *See* MASHAW & HARFST, *supra* note 14, at 229 (discussing seat belt regulation).

16. *See* discussion *infra* notes 395-396.

17. In the last decade, substantial progress has been made in the development of models that account for social influences on behavior. *See, e.g.*, Paul C. Stern, *Information, Incentives, and Proenvironmental Consumer Behavior*, 22 J. CONSUMER POL'Y 461, 467 (1999) (discussing model of environmentally significant behavior).

18. In addition, to the extent members of Congress, regulators, and interest groups are concerned that changes in individual behavior will not occur, agencies may need to conduct rigorous, quantitative assessments of the effects of information-based efforts on behavior. *See* discussion *infra* notes 398-400.

protections of the APA for the most part do not extend to the types of agency actions that are likely to be directed toward individuals, such as data disclosure and public information campaigns. Procedural safeguards will be needed to ensure that some measure of the public access, transparency in agency decision making, and careful deliberation that are required by the APA for rulemaking is extended to agency information dissemination efforts.

In Part VI, the Article concludes by suggesting that in light of the surprisingly large role of individuals as risk-creators, scholars in environmental law and other regulatory fields may need to take a fresh look at the extent to which the law can—and should—influence individual behavior.

II. THE ENVIRONMENTAL REGULATORY DEBATE

Over the last three decades, advocates of command and control regulation and economic incentive measures have engaged in a debate that has been described as "the ceaseless sport of environmental law."[19] In recent years the focus has broadened somewhat to include the relative merits of informational regulation.[20] Part II examines the targets of the academic debate over environmental regulation. This Part demonstrates that although the participants in the debate differ

19. Wiener, *supra* note 2, at 679.

20. *See* discussion *infra* notes 51-67. Although the debate has concerned the relative merits of these regulatory instruments, it also reflects underlying differences about the goals of environmental protection. Command and control advocates often begin with a public welfare perspective that assumes that environmental standards are necessary to protect the public interest. They seek to design and implement regulatory instruments to achieve those standards. *See, e.g.*, Latin, *supra* note 2, at 1284. For a discussion of the public welfare perspective on regnlation, see MASHAW & HARFST, *supra* note 14, at 8. Economic incentive enthusiasts emphasize the need to achieve efficiency and are apt to view environmental standards as variable based on the costs of control. *See* Ackerman & Stewart, *supra* note 2, at 1333; Bruce A. Ackerman & Richard B. Stewart, *Reforming Environmental Law: The Case for Market Alternatives*, 13 COLUM. J. ENVTL. L. 171 (1988); Daniel Dudeck & John Palmisano, *Emissions Trading: Why Is This Thoroughbred Hobbled?*, 13 COLUM. J. ENVTL. L. 217 (1988). Despite the fundamental differences between command and control and economic incentive advocates, there is widespread agreement that a principal underlying justification for state action to address pollution, regardless of the instrument, is that environmental quality is a public good that will not be adequately protected in the absence of government intervention. The under-protection will arise because the costs of using the good are not borne by the user, but are externalized. In the classic analysis, the tragedy of the commons arises as users of common resources make decisions that are individually rational but collectively deficient. *See* Garrett Hardin, *The Tragedy of the Commons*, 168 SCI. 1243, 1244 (1968). Resolution of the problem without government intervention may be difficult because of the transaction costs of negotiating with the multitude of other users of the good and because of incentives for free riding. In the absence of government intervention, these problems thus hinder the development of private solutions to public goods problems. For the classic discussion of collective action problems, see MANCUR OLSON, THE LOGIC OF COLLECTIVE ACTION: PUBLIC GOODS AND THE THEORY OF GROUPS 1-52 (1971).

widely in their views of environmental protection, they have almost uniformly presumed that industrial facilities should be the principal, if not sole, regulatory targets.

A. Regulation of Industrial Sources

The assumption that industrial facilities are the appropriate targets of environmental regulation has a distinguished lineage stretching back more than forty years. In his seminal 1960 article, Ronald Coase began his analysis with "the standard example," which he described as "that of a factory the smoke from which has harmful effects on those occupying neighboring properties."[21] In a 1972 article that shaped much of the modern environmental regulatory debate, Calabresi and Melamed explored and built upon the Coasian analysis.[22] Calabresi and Melamed suggested that legal resolution of "the pollution problem" can be understood by viewing rights to pollute or be free from pollution as entitlements protected by property rules or liability rules.[23] Entitlements and the legal rules that protect them are determined by the state to avoid the "might makes right" allocation that would otherwise occur.[24] The article identified the

21. Ronald Coase, *The Problem of Social Cost*, 3 J. L. & ECON. 1, 1 (1960). The Coasian analysis has not only had a substantial impact on the academic regulatory debate, but also on legal education. *See, e.g.*, A. MITCHELL POLINSKY, AN INTRODUCTION TO LAW AND ECONOMICS 13 (3d ed. 2003) (describing the Coase Theorem by suggesting that the reader "[c]onsider a factory whose smoke causes damage to the laundry hung outdoors by five nearby residents"); RICHARD L. REVESZ, FOUNDATIONS OF ENVIRONMENTAL LAW AND POLICY 4, 16-17 (1997) (noting that Coase examines a situation involving "a factory that emits fumes and a laundry that is harmed by the presence of these fumes" and asking students to "think of the victim of pollution as an individual who suffers as a result of pollution emitted by a firm" and to explore "[w]hat are sources of transaction costs when there is a single polluter and a single pollutee? What are the sources of transaction costs when many pollutees must bargain with a single polluter?"). For a discussion of the alignment of the parties when individuals are understood to be the sources of pollution, see discussion *infra* notes 273-79.

22. Guido Calabresi & A. Douglas Melamed, *Property Rules, Liability Rules, and Inalienability: One View of the Cathedral*, 85 HARV. L. REV. 1089 (1972); Krier & Schwab, *supra* note 2, at 440 (describing the Calabresi and Melamed article as "perhaps the most widely known and influential contribution" applying Coase's insights).

23. Calabresi & Melamed, *supra* note 22, at 1089-90 (noting the existence of property, liability, and inalienability rules and analyzing the applicability of property and liability rules to pollution problems).

24. *Id.* at 1090. In brief, entitlements protected by property rules are absolute, protected by the right to obtain injunctive relief, and can be taken from the holder only upon payment of the value the holder assigus to the entitlement (e.g., an interest in real property that can be protected with injunctive relief). *Id.* at 1092. Entitlements protected by liability rules may be taken from the holder at an objectively determined value (e.g., eminent domain and nuisance cases in which injunctive relief is not available). Entitlements protected by inalienability rules may not be transferred between a willing buyer and seller (e.g., because of the seller's incapacity). Using this construct, Calabresi and Melamed evaluate the various potential

importance of the assignment of the entitlement as well as the available legal rules for protecting the entitlement.[25]

Equally important, Calabresi and Melamed reinforced implicitly the operational premise for the debate going forward. The premise is that the environmental harms worthy of attention are caused by one or a relatively small group of firms, and the victims are individuals, generally in large numbers. For example, Calabresi and Melamed contrast "having more widgets" with "breathing the pollution that widget production implies."[26] Although they use singular terms at times when describing a polluter and victim, for the bulk of their application of property, liability, and inalienability rules to pollution, their analysis assumes one polluter and 10,000 victims.[27]

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assignments of entitlements and legal rules to determine the optimal forms of government intervention for resolving the pollution problem. Calabresi and Melamed initially analyze a situation in which one party is a polluter and another is a victim. *Id.* at 1115-24. Following Coase, they note that when the least cost avoider can be determined, the government can place the entitlement not to be affected by pollution on the other party. *Id.* at 1118-19. They acknowledge that in many cases involving pollution the government cannot make the determination of which party is the least cost avoider. *Id.* at 1119-20. In theory, in the absence of transaction costs and uncertainty about valuation, it should not matter who is granted the entitlement: if the entitlement is misallocated, Coasian bargaining will lead to an efficient outcome. *See id.* at 1091, 1094 (citing R.H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960)). Calabresi and Melamed recognize, however, that where the least cost avoider cannot be determined and the parties face bargaining problems, the government cannot simply assign the entitlement to either party and assume that the parties will bargain to an efficient outcome. In a situation in which there is one polluter with multiple victims, property rules may not be efficient even if the polluter's cost of control is less than the victims' damages, because the victims may have incentives to hold out in the face of an offer from the polluter. *Id.* at 1119. In addition, if the victims' damages are higher than the polluter's costs of control, free rider problems may undermine the victims' attempts to buy out the polluter. As a result, the initial entitlement protected by a property rule is often not subject to trading, and property rules in the classic pollution scenario Calabresi and Melamed envision often will not lead to an efficient outcome.

25. Calabresi and Melamed appear to conclude that when the lowest cost avoider cannot be determined and transaction costs are high, liability rules are preferable to property rules because liability rules will provide incentives for parties to act efficiently. *Id.* at 1119. For example, Calabresi and Melamed note that when harm occurs but the least cost avoider cannot be determined "traditional legal doctrine" will determine that a nuisance exists and impose damages but not enjoin the nuisance. *Id.* at 1119-20 (citing Madison v. Ducktown Sulphur, Copper & Iron Co., 83 S.W. 658 (Tenn. 1904)). Liability rules thus produce outcomes that are similar to those that would be reached if transaction costs did not prevent the parties from bargaining. Liability rules require greater state intervention than property rules, however, because the government must not only assign the entitlement, it must determine its value (via a court). At least implicitly, the use of entitlements backed by liability rules thus assumes that the government has the ability to determine the value of the harm and to enforce a judgment. For a discussion and critique of the conventional reading of Calabresi and Melamed regarding the importance of valuation problems, see Krier & Schwab, *supra* note 2, at 451-55. *But see* Kaplow & Shavell, *supra* note 2, at 729-30.

26. Calabresi & Melamed, *supra* note 22, at 1097.

27. *Id.* at 1119 ("[a]ssume we enjoin Taney and there are 10,000 injured Marshalls"). Later, when discussing their "fourth rule," Calabresi and Melamed assume "a factory which, by using cheap coal, pollutes a very wealthy section of town and employs many low income workers to

They characterize situations with one polluter and multiple victims as "the normal ones in the pollution area."[28] This premise would become entrenched over the next three decades, when the vast majority of the literature focused on two general categories of instruments: command and control regulations and economic incentives.

1. Command and Control

In a command and control system, the government sets both the environmental ends to be achieved (e.g., national air quality standards) and the methods by which they will be achieved (e.g., pollution control requirements for major sources).[29] Command and control environmental regulation is typified by statutory mandates that require EPA to set specific end-of-pipe emissions levels, often based on a determination of the "best available technology" (BAT) to control emissions.[30] Congress and EPA have targeted the command and control requirements principally at large industrial facilities.[31] Advocates of command and control have pointed out that, despite substantial increases in economic activity, command and control regulations have achieved remarkable reductions in emissions over the last thirty years, particularly from BAT controls on large industrial point sources and controls on automobile tailpipe emissions. In addition, command and control proponents suggest that the technology-based requirements of many command and control regulations have been far easier to develop and implement than

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produce a product purchased primarily by the poor." *Id.* at 1121. They thus include the concerns of the employees and customers of the industrial firm in the analysis. This is the closest Calabresi and Melamed come to the multiple plaintiff-multiple defendant analysis discussed *infra* notes 277-279.

28. *Id.* at 1119.

29. Command and control government regulation may be viewed as a form of property rule in which government, not a private party, holds the entitlement and enforces the rule protecting the entitlement. *See* Kaplow & Shavell, *supra* note 2, at 705. Alternatively, such regulation may be viewed as a "conduct instrument" distinct from price (taxes, subsidies and liability rules) and quantity (tradable allowances and property rules) instruments. *See* Wiener, *supra* note 2, at 704. Much of the literature treats command and control regulation as a distinct category, and this Article does so as well.

30. *See, e.g.*, Clean Water Act, 33 U.S.C. § 1311(b)(2)(A) (2000) (requiring "application of the best available technology economically achievable").

31. For example, one EPA rule sets a precise limit (0.0014 pounds per 1,000 pounds maximum for any one day) of pentachlorophenol in the wastewater of "bleached kraft facilities where pulp and fine papers are produced." *See* 40 C.F.R. § 430.25(b)(2) (2003). Although in theory a kraft mill can achieve the discharge limit through a variety of means, standards such as this one are set based on an evaluation of the effectiveness and costs of particular pollution control technologies, and the effect may be to dictate the pollution control technology adopted by the mill.

competing regulatory schemes.[32] Command and control enthusiasts also suggest that these requirements provide equitable treatment to the regulated community, and that compliance with these requirements is efficient to monitor and enforce.[33]

From the outset, command and control advocates have focused on imposing regulatory requirements on large industrial sources. For example, one of the most influential early defenses of command and control regulations focuses on the benefits of BAT approaches, which are almost exclusively directed at large industrial facilities.[34] A more recent defense of command and control methods points to their administrative efficiency and assumes that the "regulatees" are industrial firms.[35] Rarely have command and control advocates suggested targeting entities other than large industrial facilities.[36]

2. Economic Incentives

Advocates of economic incentives have criticized the inefficiency, rigidity, fragmentation, and lack of democratic accountability that arise from command and control regulation.[37] They have identified two principal types of alternatives.[38] The first are property or tradeable allowance schemes (sometimes referred to as Coasian schemes), which provide the holder with an entitlement to generate or be free from an environmental harm.[39] The second are

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32. *See* Shapiro & McGarity, *supra* note 2, at 739-44.

33. *See id.*

34. *See* Latin, *supra* note 2, at 1271.

35. *See* McGarity, *supra* note 2, at 1397, 1414-17 (examining EPA responses to judicial review of Clean Water Act technology-based "best practicable technology" rule makings); Shapiro & McGarity, *supra* note 2, at 739-44 (defending technology-based regulation on normative grounds).

36. An exception is Thomas McGarity's focus on automobile inspection and maintenance programs. *See* Thomas O. McGarity, *Regulating Commuters to Clear the Air: Some Difficulties in Implementing a National Program at a Local Level*, 27 PAC. L.J. 1521 (1996).

37. *See, e.g.*, Stewart, *supra* note 4, at 21. Economic incentive strategies differ from command and control strategies in that although the government sets the environmental ends to be achieved (e.g., through the quantity of marketable allowances created, the level of taxes or subsidies, or the assignment and oversight of private property or liability rules), it allows the market to allocate the costs of achieving the environmental ends. Importantly, even in economic incentive strategies, so long as government intervenes to avoid "might makes right," government is at least implicitly making decisions about the desired level of environmental protection. For a discussion of the informational demands on government when using economic incentives to address environmental problems, see Bradley C. Karkkainen, *Information as Environmental Regulation: TRI and Performance Benchmarking, Precursor to a New Paradigm?*, 89 GEO. L.J. 257, 270 (2001).

38. For an overview of the economic regulatory instruments available to environmental regulators, see Wiener, *supra* note 2, at 679-80, 704-35.

39. *See* Coase, *supra* note 21.

price-based schemes, such as taxes, subsidies and liability rules (sometimes referred to as Pigouvian schemes after the economist A.C. Pigou), which require a source to pay the social cost of an environmental harm.[40] Although economic incentive enthusiasts note that the appropriate economic incentive will vary based on several factors, they have pointed to the efficiency and incentives for innovation created by these types of instruments generally.[41]

The concept of using marketable allowances to control pollution has been a leading contribution of economic incentive advocates. Marketable allowances were proposed as early as the 1960s, although full debate did not begin in earnest until the early 1980s, after the high costs and rigidity of the command and control system became apparent.[42] Advocates of market allowance schemes have asserted that such schemes will address many of the ills created by command and control regulation, and marketable allowances have been used on the federal level in several regulatory programs.[43] For example, Congress included a statutory sulfur dioxide emissions trading scheme

40. *See* A.C. PIGOU, THE ECONOMICS OF WELFARE (4th ed. 1932).

41. *See* Ackerman & Stewart, *supra* note 2, at 1333-40. Critics of economic incentives generally have noted that many of the informational shortcomings that make command and control regulations difficult to develop also plague some economic incentives. As Bradley Karkkainen has noted, "[s]tandard justifications for environmental regulation tacitly presuppose that central regulators will be able to isolate, analyze and understand discrete problems, their causes, and potential cures well enough to craft effective solutions through regulatory intervention." Karkkainen, *supra* note 37, at 283. In recent years, scholars have presented differing views on whether property rules or liability rules are preferable for cases such as pollution when the information about harm is limited. James Krier and Stewart Schwab have noted that liability rules will function poorly when information about harm is limited, making it difficult for courts to determine the actual level of harm. *See* Krier & Schwab, *supra* note 2, at 447-64. A concern with a liability rule is that if a court could not ascertain the harm of pollution, it migbt set the damages at a level below the firm's prevention cost, thus inducing the firm to pollute. Assigning an entitlement to the victim protected by a property rule would avoid this problem. Calabresi and Melamed suggested that inalienability rules may be justified where costs are externalized but the objective measurement is difficult, but the example they used involved a moral prohibition on slavery. Calabresi & Melamed, *supra* note 22, at 1111-12, 1125-27. Louis Kaplow and Steven Shavell have asserted that so long as a court makes its best estimate of harm, which they define to be "the average harm for cases characterized by the facts the court observes," liability rules are superior to property rules. Kaplow & Shavell, *supra* note 2, at 719. They argue that if prevention costs are high, a property rule will lead a firm on average not to pollute even when the costs of prevention exceed the cost of the pollution.

42. The concept of marketable allowances was proposed in the 1960s by J.H. Dales. *See generally* J.H. DALES, POLLUTION, PROPERTY & PRICES 93-97 (1968) (proposing the development of markets in pollution rights). The debate over their use began in earnest after a proposal by Professors Ackerman and Stewart. Ackerman & Stewart, *supra* note 2, at 1333-40.

43. For a discussion of marketable allowance schemes, see Jonathan R. Nash & Richard L. Revesz, *Markets and Geography: Designing Marketable Permit Schemes to Control Local and Regional Pollutants*, 28 ECOLOGY L.Q. 559, 572-77 (2001).

in Title IV of the 1990 Clean Air Act Amendments.[44] Emissions trading has been implemented to a lesser extent on a regional and local level as well, and is the subject of national and international air pollution initiatives.[45]

The focus of economic incentive proponents has been on large industrial facilities. For example, advocates of marketable allowance schemes have directed their attention toward the air and other emissions from large industrial facilities.[46] Similarly, one recent examination of property and liability rules noted that multiple parties may exist on both sides, but analyzed the "classic pollution parable" with "a single P [polluter] and many Rs [residents]."[47] Another assumed that polluters are "firms" when examining property and liability rules.[48] When applying the analysis to environmental harms, the authors discuss "industrial pollution" and evaluate examples in which bargaining problems arise because there are many victims.[49] Only when discussing the reasons why distributional concerns should not affect their conclusion that liability rules are preferable to property rules do the authors discuss a situation in which there are large numbers of individuals causing pollution as well as large numbers of victims.[50] Thus, much of the scholarship assigns individuals the role of victims and assumes that there will only be one or a handful of industrial polluters.

3. Informational Regulation

In recent years, legal scholars have begun to move beyond the command and control versus economic incentives debate to focus on the limited ability of either regulatory instrument to steer the behavior of industrial sources in the face of an increasingly complex,

44. *See* Clean Air Act Amendments of 1990, Pub. L. No. 101-549, 104 Stat. 2399 (codified as amended at 42 U.S.C. §§ 7651-7651o (2000)).

45. *See* Nash & Revesz, *supra* note 43, at 572-77. In addition, recent "Clear Skies" legislation proposes to extend emissions trading to additional pollutants. *See, e.g.,* Clear Skies Act of 2003, H.R. 999, 108th Cong. § 403 (2003) (requiring the EPA Administrator to establish an allowance system for emissions of sulfur dioxide, nitrogen oxides and mercury). Emissions trading concepts also have been proposed for and in some cases included in initiatives to address global climate change gases and other international environmental pollutants. *See* Wiener, *supra* note 2, at 709-14.

46. *See, e.g.*, Ackerman & Stewart, *supra* note 2, at 1341-51 (discussing implementation of tradeable rights system for facilities subject to BAT controls).

47. Krier & Schwab, *supra* note 2, at 460.

48. Kaplow & Shavell, *supra* note 2, at 719.

49. *Id.* at 748.

50. *Id.* at 735 (discussing a "population of injurers whose prevention costs vary").

evolving economy.[51] Instead, the more recent scholarship has identified the need for the use of additional regulatory instruments, either alone or in combination with command and control and economic measures.[52] One of the most promising developments is the concept that information may be a surprisingly effective and efficient regulatory instrument.[53] Informational regulation enthusiasts suggest that disclosure may be preferable to command and control and economic regulatory instruments in several ways. For example, information disclosure may be less expensive for regulators and regulated entities than command and control requirements, may be more flexible and efficient than command and control or market mechanisms, and may enhance deliberative democracy.[54] Critics have

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51. *See, e.g.*, Eric W. Orts, *Reflexive Environmental Law*, 89 NW. U. L. REV. 1227 (1995).

52. *See* Esty, *supra* note 2, at 1549-72 (discussing optimal environmental strategies); Stewart, *supra* note 4, at 151-73 (discussing elements of an ideal regulatory system).

53. *See* Cass R. Sunstein, *Informational Regulation and Informational Standing:* Akins *and Beyond*, 147 U. PA. L. REV. 613, 613 (1999) (calling informational regulation or regulation through disclosure "one of the most striking developments in the last generation of American law"); *see also* WESLEY A. MAGAT & W. KIP VISCUSI, INFORMATION APPROACHES TO REGULATION (1992); Michael Barsa, *California's Proposition 65 and the Limits of Information Economics*, 49 STAN. L. REV. 1223 (1997); Paul R. Kleindorfer & Eric W. Orts, *Informational Regulation of Environmental Risks*, 18 RISK ANALYSIS 155 (1998); David Markell, *The Role of Deterrence-Based Enforcement in a "Reinvented" State/Federal Relationship: The Divide Between Theory and Reality*, 24 HARV. ENVTL. L. REV. 1, 99 (2000); Richard H. Pildes & Cass R. Sunstein, *Reinventing the Regulatory State*, 62 U. CHI. L. REV. 1 (1995). For an interdisciplinary examination of informational regulation and other new regulatory instruments, see generally NAT'L RESEARCH COUNCIL, NAT'L ACAD. OF SCIENCES, NEW TOOLS FOR ENVIRONMENTAL PROTECTION: EDUCATION, INFORMATION AND VOLUNTARY MEASURES (Thomas Dietz & Paul C. Stern eds., 2002) [hereinafter NRC, NEW TOOLS FOR ENVIRONMENTAL PROTECTION]. Of course, informational regulation is not new. Several scholars have noted that informational regulation has common law origins, and has been used in a variety of New Deal-era and more modern regulatory laws. *See, e.g.*, Karkkainen, *supra* note 37, at 284; Sunstein, *supra*, at 618-24. Indeed, the use of information as a tool for governments to regulate industry behavior originated long before the New Deal. Nineteenth century railroad regulators debated the role of information disclosure versus command and control (e.g., for controlling tariffs) in the regulation of what was a new, complex, and rapidly evolving industry. The early railroad regulatory efforts used both instruments, although ultimately much of railroad regulation settled on command and control regulation. *See* JAMES W. ELY, JR., RAILROADS AND AMERICAN LAW 85 (2001) (noting that railroad development in the mid-1800s confronted governments with complex problems and that "legislators and judges were simply not in a position to supervise the dynamic and complicated operations of railroad companies").

54. *See* Sunstein, *supra* note 53, at 625 (noting that information is a "far less expensive and more efficient strategy than command-and-control" and that "deliberative democracy requires a certain degree of information, so that citizens can engage in their monitoring and deliberative tasks"). As Sunstein has noted, information may be seen as a public good and governmental regulatory requirements may be necessary to address market failures that result in an undersupply of information. *See id.* at 624; *see also* Christopher H. Schroeder, *American Regulatory Policy: Have We Found the "Third Way"? Third Way Environmentalism*, 48 U. KAN. L. REV. 801, 823 (2000) (describing informational regulation as a "third way" regulatory measure).

pointed out that simply replacing command and control requirements with informational and other "soft" requirements may undermine compliance incentives for industrial sources, jeopardizing the environmental gains of the last three decades.[55]

Even in the new field of informational regulation, however, the principal focus of the regulatory debate and of existing environmental regulations has been on large industrial firms.[56] The Toxic Release Inventory (TRI) is the leading example of informational regulation in environmental law.[57] The distinctive feature of the TRI is that it uses information to regulate firm conduct: it requires public disclosure of toxic release data by regulated facilities but does not set permissible

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55. *See, e.g.*, Clifford Rechtschaffen, *Deterrence vs. Cooperation and the Evolving Theory of Environmental Enforcement*, 71 S. CAL. L. REV. 1181, 1215 (1998); Steinzor, *supra* note 2, at 353.

56. Some have examined the use of information to steer consumer behavior and have noted the need to focus on areas in which labels are more effective than price to convey information about the environmental effects of products. *See, e.g.*, Mary L. Lyndon, *Information Economics and Chemical Toxicity: Designing Laws to Produce and Use Data*, 87 MICH. L. REV. 1795 (1989); Peter S. Menell, *Structuring a Market-Oriented Federal Eco-information Policy*, 54 MD. L. REV. 1435 (1995). Others have noted that product disclosure schemes such as California Proposition 65 may require information disclosure for individual decision making that may be ineffectual or counter productive. *See* Christine Jolls et al., *A Behavioral Approach to Law and Economics*, 50 STAN. L. REV. 1471, 1533-37 (1998); Sunstein, *supra* note 53, at 626-27 (noting that "[p]eople have a limited ability to process information" (citing JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES (Daniel Kahneman et al. eds., 1982)). Even if information has the desired influence on some of its targets, its benefits may be inequitably distributed. In particular, those who lack education may gain proportionately less benefit. Also, where risks are placed on those not in a contractual relationship with the risk creator, there may be no avenue available to the person whose risk is increased to do anything about the risk. *See id.* at 628-29 (noting that "[t]be most promising setting involves a market failure in the provision of information and reason to believe that information can be provided in such a way as to be understandable to tbe people who receive it").

57. *See* Karkkainen, *supra* note 37, at 260 (suggesting that TRI is a "watershed" in the development of innovative environmental regulatory tools). Congress included TRI as Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA), Pub. L. No. 99-499, 100 Stat. 1741 (1986) (codified at 42 U.S.C. §11023(a)-(c) (2000)). Information disclosure also has been described as a "new model" of environmental regulation. *See* DAVID WHEELER, INFORMATION IN POLLUTION MANAGEMENT: THE NEW MODEL (New Ideas in Pollution Regulation, Working Paper, Econ. of Indus. Pollution Control Research Project, 1997), http://www.worldbank.org/nipr/work_paper/ninfo/index.htm. Examples of informational regulation in environmental law in addition to TRI include the pesticide labeling requirements of the Federal Insecticide, Fungicide and Rodenticide Act, 7 U.S.C. § 136a(c)(9) (2000), the requirement for regulated businesses to prepare and disclose risk management plans for hazardous air pollutants under Section 112(r) of the Clean Air Act Amendments of 1990, 42 U.S.C. § 77412(r) (2000), and the requirement of the Safe Drinking Water Act Amendments of 1996 that community drinking water providers prepare and disseminate to consumers annual "consumer confidence reports." 42 U.S.C. § 300g-3(c)(4) (2000). Information-based approaches also have been proposed for other areas of environmental law. *See, e.g.*, Michael P. Healy, *Information Based Regulation and International Trade in Genetically Modified Agricultural Products: An Evaluation of the Cartegena Protocol on Biosafety*, 9 WASH. U. J. L. & POL'Y 205 (2002) (suggesting application of information disclosure techniques to regulation of genetically modified organisms).

limits on toxic releases. Only large industrial facilities are subject to the reporting requirements.[58] The TRI provisions have been hailed in the academic literature as one of the primary environmental law innovations of the last two decades and as "the wave of the future."[59] TRI enthusiasts suggest that TRI circumvents the "information bottleneck" that confronts command and control and economic incentive measures by requiring regulated entities to disclose data on toxic chemical releases.[60] The public disclosure of TRI data may induce firms to reduce emissions for a variety of reasons.[61] TRI also may have democracy benefits by increasing citizen participation and by enhancing the legitimacy of agency decision making.[62]

In the most expansive view, the use of TRI and other informational regulation, in combination with other instruments, constitutes a new "reflexive environmental law."[63] In this view, the

58. *See* 42 U.S.C. §11023(b)(1)(A); Pedersen, *supra* note 8, at 155 (describing the facilities that meet these requirements as "large industrial facilities").

59. *See* DANIEL A. FARBER, ECO-PRAGMATISM: MAKING SENSIBLE ENVIRONMENTAL DECISIONS IN AN UNCERTAIN WORLD (1999); Daniel Esty, *Next Generation Environmental Law: A Response to Professor Stewart*, 29 CAP. U. L. REV. 199 (2001) (describing a new "information age" in environmental law); Pederson, *supra* note 8, at 155 (describing TRI and other "social cost disclosure" programs as a "stepping stone" toward improved environmental regulation); Sunstein, *supra* note 53, at 622, 625 (describing TRI as "an exceptional success story" and "the wave of the future"). Richard Stewart has identified the TRI reporting scheme as one of only two instances in the three decades following 1970 when Congress has enacted statutes with "significant use of alternatives to the command system" (the other being the sulfur dioxide emissions trading program of the 1990 Clean Air Act Amendments). Stewart, *supra* note 4, at 24.

60. *See generally* Karkkainen, *supra* note 37, at 283-86.

61. For firms, the generation and disclosure of TRI data facilitates both internal and external monitoring of environmental performance. The performance monitoring and benchmarking functions of TRI avoid many of the shortcomings of command and control and market-based regulatory instruments and create incentives for continuous improvement. *Id.* at 261. By creating performance metrics and facilitating monitoring without creating fixed levels at which releases are permissible, TRI creates incentives for continuous improvement. In contrast, command and control requirements may create a "ceiling" of simply complying with environmental requirements. Market mechanisms can have the same effect at the emissions level established through the market response to government-established taxes, subsidies, or tradeable allowances. *Id.*

62. *See* Sunstein, *supra* note 53, at 625 (noting the democracy effects of informational regulation). The TRI provisions have even been described as a new form of "democratic experimentalism." *See* Michael C. Dorf & Charles F. Sabel, *A Constitution of Democratic Experimentalism*, 98 COLUM. L. REV. 267 (1998); *see also* Pedersen, *supra* note 8, at 151, 154-55, 183 (asserting that TRI represents a form of "social cost disclosure" that can improve the performance of EPA and other agencies by engendering pressure on EPA to better define its regulatory goals, and placing EPA in the role of objective expert gathering, interpreting, publishing and refining environmental data). Over the long run, the TRI data and other informational regulatory schemes may thus enhance the legitimacy of EPA decision making and reduce susceptibility to interest group capture. *See* Orts, *supra* note 51, at 1335.

63. Reflexive environmental concepts have been advanced in the sociology literature, *see generally* GUNTHER TEUBNER ET AL., ENVIRONMENTAL LAW AND ECOLOGICAL RESPONSIBILITY: THE CONCEPT AND PRACTICE OF ECOLOGICAL SELF-ORGANIZATION (1994) (suggesting that

informational regulatory approach of TRI is a primary aspect of second generation or "reflexive" regulation—regulation that moves away from command and control approaches toward more flexible, information-based environmental incentives for reducing pollution. Proponents of reflexive environmental law assert that the complexity of environmental problems undermines both command and control and market mechanisms as regulatory tools.[64] Reflexive environmental law proponents suggest a greater "proceduralization" of environmental law in the form of "procedures for regulated entities to follow," such as internal firm management systems, "[r]ather than detailed pronouncements of acceptable behavior."[65]

Although the notion of informational regulation in the instrument choice debate is relatively new, the principal focus has remained on industrial sources. Perhaps because the emergence of informational regulation has coincided with a growing recognition that sources other than large industrial facilities are important causes of environmental harms, or perhaps because informational regulation's leading example, TRI, so clearly excludes all sources other than large industrial facilities, its advocates have tended to note the importance of a range of additional sources.[66] Nevertheless, informational regulation enthusiasts have directed the bulk of their analyses and prescriptions toward large industrial sources.[67]

B. The Sources of Environmental Harms

The focus of the regulatory debate on large industrial sources is problematic if other sources cause a meaningful amount of

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reflexive environmental law leads to "ecological self-organization"), and in the legal literature. *See* Orts, *supra* note 51, at 1227.

64. *See* David W. Case, *The Law and Economics of Environmental Information as Regulation*, 31 ENVTL. L. REP. 10,773 (2001); Orts, *supra* note 51, at 1227. The need to establish concrete outcomes undermines the ability of both command and control and market mechanisms to address evolving, complex environmental problems. *Id.* at 1264. Although Orts targets several sources of environmental harms, his prescriptive focus is on corporate firms. He recommends that EPA require firms to conduct self-audits of environmental management systems and environmental performance, and suggests greater use of environmental management schemes to steer firm behavior. *Id.* at 1264. Orts has described the production and use of information in regulation as "a primary aspect of the reflexive model." *See* Kleindorfer & Orts, *supra* note 53, at 156 n.9. Orts and Kleindorfer appear to define informational regulation in a way that focuses on firm behavior by stating that "informational regulation is any regulation which provides to third parties information on company operations." *Id.* at 156.

65. Orts, *supra* note 51, at 1264.

66. *See, e.g.*, Karkkainen, *supra* note 37, at 334; William F. Pedersen, *Can Site-Specific Pollution Control Plans Furnish an Alternative to the Current Regulatory System and a Bridge to a New One?*, 25 ENVTL. L. REP. 10, 486 (1995); Pedersen, *supra* note 8, at 166-68.

67. *See, e.g.*, Karkkainen, *supra* note 37, at 334.

environmental harm and if those other sources require different regulatory measures. In recent years, legal scholars have recognized that after several decades of regulations directed principally at industry, there are indications that non-industrial sources cause a large and growing proportion of the remaining environmental harms.[68] For example, anecdotal information suggests that many types of sources release large quantities of toxic chemicals. According to an estimate by the Office of Technology Assessment, the total quantity of toxic chemicals released in 1988 by the large industrial facilities subject to TRI reporting requirements represented only 5 percent of the total releases of toxic chemicals in that year.[69] A number of scholars have noted that numerous, diffuse, non-point sources are of increasing importance.[70] Recent work has explored the importance of several non-industrial sources of pollutants, including the service sector[71] and agriculture.[72] In addition, a number of scholars have

68. Richard Stewart acknowledges "the achievements to date of our command regulation system in achieving significant reductions in pollution and improved waste management by large industrial facilities," but asks whether the regulatory system is well suited for "what some have termed 'second generation' environmental problems." Stewart, *supra* note 4, at 26. Stewart includes in the "second generation" sources that will require additional attention "those generated by small sources of pollution and waste sources and the burgeoning service economy," *id.*, and states that "discharges from small, non-point or area sources must be significantly curtailed, including those in the consumer services, and agricultural sectors." *Id.* at 28.

69. *Hearing Before the United States Senate Subcomm. on Superfund, Ocean & Water Protection of the Comm. on Env't & Public Works*, 101st Cong. 4 (May 10, 1989) [hereinafter OTA, Senate Testimony] (statement of Kirsten Oldenburg, Deputy Director, Hazardous Waste and Waste Reduction Projects, Office of Technology Assessment) (stating that "the enormous amount of releases reported to the public a few weeks ago, the 20 billion pounds of toxic chemicals, we feel is just the tip of the toxic tower. We estimate that as many as 400 billion pounds, or 200 million tons, of these substances in wastes, pollutants, and discharges are probably being generated by American industry, and the public is subject to even more if you consider non-point sources such as automobiles."). Remarkably, the Office of Technology Assessment estimate did not include individuals and households as sources when determining that 95 percent of toxics were not included in the initial round of TRI reporting. The OTA estimate was limited to industrial sources and did not include the toxic releases from motor vehicles or other individual and household releases. *Id.*

70. *See, e.g.*, Daniel C. Esty & Marian R. Chertow, *Thinking Ecologically: An Introduction*, *in* THINKING ECOLOGICALLY: THE NEXT GENERATION OF ENVIRONMENTAL POLICY 1, 15 n.3 (Marian R. Chertow & Daniel C. Esty eds., 1997) [hereinafter THINKING ECOLOGICALLY] (noting that "we have done a great deal to address the biggest 'point' sources of pollution; we have done much less to control "nonpoint" emissions. These diffuse harms persist in part because they are hard to see, not easily measured or matched to the ills they inflict, and difficult to prevent or control."); Stewart, *supra* note 4, at 28 (suggesting that "discharges from small, non-point or area sources must be significantly curtailed, including those in the consumer services, and agricultural sectors"); Michael P. Vandenbergh, *An Alternative to Ready, Fire, Aim: A New Framework to Link Environmental Targets in Environmental Law*, 85 KY. L.J. 803, 818-23 (1997) (identifying types of "second generation" environmental problems).

71. *See* James Salzman, *Beyond the Smokestack: Environmental Protection in the Service Economy*, 47 UCLA L. REV. 411 (1999).

noted the importance of small businesses, although the sector has not been profiled comprehensively.[73]

Despite the growing recognition that non-industrial sources are responsible for a large proportion of the remaining environmental harms, the notion that individuals are an important source category has only been identified in rare circumstances.[74] Some have noted the importance of "second generation" sources generally, and some have mentioned individuals in the context of informational regulation. To the extent individuals have been a part of the mix, however, the focus has been largely on how to regulate the manufacturers that sell pollution-causing products to individuals. When individuals have been identified as sources of pollutants, typically automobile use and consumer activity have been the only environmentally significant behaviors identified.[75] No one has identified the contributions of individuals on a comprehensive basis or explored the implications for regulatory instrument choice. As a result, little analysis has been conducted of the potential instruments that may be available to reduce the emissions from individuals or the optimal allocation of

72. *See* Jan G. Laitos & Thomas A. Carr, *The Transformation on Public Lands*, 26 ECOLOGY L.Q. 140 (1999); J.B. Ruhl, *Farms, Their Environmental Harms, and Environmental Law*, 27 ECOLOGY L.Q. 263 (2000); C. Ford Runge, *Environmental Protection from Farm to Market*, *in* THINKING ECOLOGICALLY, *supra* note 70, at 200.

73. Richard J. Pierce, *Small Is Not Beautiful: The Case Against Special Regulatory Treatment of Small Firms*, 50 ADMIN. L. REV. 537, 559-60 (1998) (concluding that small businesses "are responsible for a massively disproportionate share of water and air pollution"); *see also* Markell, *supra* note 53, at 23 (discussing the Small Business Fairness Enforcement Act). Several scholars have noted the large volume of toxics that are not subject to TRI reporting because small businesses are exempt. *See* Karkkainen, *supra* note 37, at 334; Pedersen, *supra* note 66, at 10,486.

74. The commentators who have identified individuals as discrete sources of pollution appear to assume that individual behavior contributes a share of overall emissions that is too small to merit regulatory attention or that individual behavior is too difficult to control. *See, e.g.*, William F. Pedersen, *Contracting with the Regulated for Better Regulations*, 53 ADMIN. L. REV. 1067, 1095 n.74 (2001). For example, Eric Orts has suggested that "[a] reflexive environmental law might require each citizen to report the 'environmental impact' of the individual or family in the past year." Orts, *supra* note 51, at 1268. According to Orts, such a required annual disclosure might "increase the amount of self-reflection and social communication concerning serious environmental issues—in this case, an internal self-critical reflection about one's personal environmental habits." *Id.* Orts concluded that such an approach would be impractical for individuals and families, but he suggested that it "is not a far-fetched idea" for large industrial companies. *Id.*

75. *See* OTA Senate Testimony, *supra* note 69, at 4 (discussing automobile use); *see also* Karkkainen, *supra* note 37, at 334 (concluding that TRI is "radically underinclusive" because it excludes "most small businesses, non regulated sectors, and diffuse sources like automobiles and farms"); Pedersen, *supra* note 8, at 191 (recommending addition of "small sources—for example, gas stations" to TRI). The problems arising from consumer product consumption have been noted by several authors. *See, e.g.*, Douglas A. Kysar, *Law, Environment and Vision*, 97 NW. U. L. REV. 675, 711-13 (2003); James Salzman, *Sustainable Consumption and the Law*, 27 ENVTL. L. 1243 (1997).

pollution control costs across large industrial sources, individuals and other types of sources.

This oversight has tremendous significance. Not only does the selection of regulatory targets affect instrument choice and the costs of achieving environmental standards, but it also may affect the underlying environmental standards themselves. In some cases, the cost of compliance will influence the level at which the environmental standard is set.[76] For these regulatory programs, adding consideration of individuals or other sources may lower the costs of achieving environmental protection, and thus may lead to more stringent standards. On the other hand, under current laws some environmental standards must be set without regard to cost, although cost considerations may affect the measures chosen to achieve the standards. An example is the establishment of National Ambient Air Quality Standards (NAAQS) for "criteria pollutants" such as low-level ozone.[77] For these types of environmental standards, the broadening of regulatory targets may determine whether the standard will be achieved at all, may increase the speed with which the standard is achieved, or may reduce the costs of achieving it.

The existence of many types of significant pollution sources, the importance of regulatory targets for environmental standard-setting, and the variability in the regulatory tools that are effective in steering the behavior of those sources all suggest that regulatory target identification is a critical aspect of regulatory reform. Although a focus on industrial sources in the regulatory debate may have been reasonable in the first era of environmental law, in the next era regulatory target identification should precede any debate about the appropriate regulatory instruments. Both academic scholarship and government policy making would be far more productive if an identification of the sources targeted, as well as their environmental emissions or harms, preceded each proposal for regulatory reform.[78] Part III does so for individuals and households. In doing so, Part III

76. For example, several BAT standards require EPA to evaluate the cost of control in determining the environmental standard that will be applied to a particular emission from a particular industrial category. *See, e.g.,* Clean Air Act, 42 U.S.C. § 7429(a)(2)(1) (2000) (requiring the Administrator to set new source performance standards for reduction of air emissions from solid waste combustion facilities "taking into consideration the cost of achieving such emission reduction").

77. The EPA Administrator may not consider costs when setting National Ambient Air Quality Standards under Clean Air Act Section 109, 42 U.S.C. § 7409. *See* Whitman v. Am. Trucking Ass'ns, 531 U.S. 457 (2001).

78. *See* GARDNER & STERN, *supra* note 9, at 256 (noting that "quantitative and technical information" rather than "intuition and informal personal impressions" should be used for determining the targets for efforts to change environmentally significant behaviors).

demonstrates that the implicit premise of the instrument choice debate—that large industrial sources constitute the only meaningful source of environmental harms—is no longer sustainable.

III. INDIVIDUALS AS SOURCES

No comprehensive studies have quantified the individual and household pollutant emissions in the United States or their effects on human health and the environment. In fact, government reports rarely identify individuals as a source category, and no government agency or office has the mission of gathering, analyzing, and publishing data on the environmental emissions and harms caused by individuals, much less assessing and developing policies tailored to change their environmentally significant behaviors. Private non-governmental organizations similarly have not focused on analyzing and reporting data on individuals.[79] The result of this gap in data collection and reporting is that a reliable accounting of the contribution of individuals to pollutant emissions in some cases is not possible based on the available information.[80] In other cases, although individual behavior has been linked to pollution, the linkage has been anecdotal and is of limited value to policymakers.[81] For example, one

79. A few non-governmental organizations have profiled or supported efforts to profile some aspects of the emissions and environmental effects of individuals and households. *See, e.g.*, MICHAEL BROWER & WARREN LEON, THE CONSUMER'S GUIDE TO EFFECTIVE ENVIRONMENTAL CHOICES: PRACTICAL ADVICE FROM THE UNION OF CONCERNED SCIENTISTS 43-80 (1999) (identifying the environmental impacts from household consumption); JOHN C. RYAN & ALAN THEIN DURNING, STUFF: THE SECRET LIVES OF EVERYDAY THINGS 7-66 (1997) (identifying the results of a Northwest Environment Watch study of the environmental effects of a day in the life of a typical Seattle-area consumer); Leonardo Academy, Inc., How Much Air Pollution Do We Cause? (profiling the air emissions of an average American household), *at* http://www.cleanerandgreener.org/schools/pollution.htm (last visited Apr. 4, 2003). In addition, several non-governmental organizations have generated reports on the emissions of specific substances, such as global climate change gases, that provide some basis for calculating the individual and/or household contribution. *See, e.g.*, JOHN M. BALBUS & MARK L. WILSON, PEW CTR. ON GLOBAL CLIMATE CHANGE, HUMAN HEALTH & GLOBAL CLIMATE CHANGE: A REVIEW OF THE POTENTIAL IMPACTS IN THE UNITED STATES (2000), http://www.pewclimate.org/global-warming-in-depth/all_reports/human_health/index.cfm.

80. A reliable quantification requires not only additional data gathering in some cases but also the type of careful analysis of detailed reports that is difficult for policymakers working under pressing time demands and virtually impossible for the public.

81. The difficulty of using anecdotal data to make regulatory resource allocation decisions has been well documented in environmental law. *See, e.g.*, Timur Kuran & Cass R. Sunstein, *Availability Cascades and Risk Regulation*, 51 STAN. L. REV. 683 (1999); Ruhl, *supra* note 72, at 27-91; Saltzman, *supra* note 71, at 444-60. One nonprofit group has concluded that the average household contributes 458 pounds of low level ozone or smog-forming pollutants per year. Leonardo Academy, Inc., *supra* note 79, at 1. This is the only published report that attempts to aggregate the contributions of individuals and households to ozone precursors, but the total is simply the EPA estimate of all of the emissions nationwide of one (nitrogen oxides) of the two

organization's widely reported characterization of petroleum pollution by individuals suggested that the combination of individual dumping of used motor oil into municipal storm sewers and runoff from urban and suburban streets releases fifteen times more oil to the ocean each year than the Exxon Valdez spill.[82] If this estimate is correct, then as much as 154 million gallons of oil reach the ocean from these sources each year, and the releases from individuals and households account for a substantial portion of that total.[83] But this 154 million gallon total is more than double the best estimate from the most recent report by the National Research Council of the National Academy of Sciences (the 2003 NRC report) of *all* releases to oceans. Further, the 2003 NRC report cautions against being "tempted to calculate the 'Exxon Valdez-equivalence' by comparing the quantity of petroleum released from a specific source to that released during the Exxon Valdez spill."[84] This example is not intended to criticize prior attempts to characterize individual sources, but to demonstrate the difficulty of assessing individuals as a source category based on the currently available data.

Nevertheless, Part III demonstrates that sufficient non-anecdotal, reliable data are available from which to begin building a profile of individuals as sources of pollution. Part III.A provides a foundation for the profile, which is presented in Part III.B. The profile demonstrates that for a number of important pollutants, individuals constitute a surprisingly large source, both in terms of the quantity of pollutants released and their potential adverse effects. In fact, for several pollutants, individuals account for a far larger proportion of the overall quantities released than the combined total from all large

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pollutants (nitrogen oxides and hydrocarbons) that form ozone divided by the number of households in the United States. *See* LEONARDO ACADEMY, INC., CONSUMER GUIDE TO GREEN ENERGY CHOICES (1999), http://www.cleanerandgreener.org/download/GreenEnergy.pdf; Telephone Interview by John Lucas with Steve Olson, Leonardo Institute (May 28, 2003).

82. Margot Higgins, *Individuals Called Biggest Threat to Oceans*, ENVTL. NEWS NETWORK (Jan. 15, 2003) (reporting polling results by the Ocean Project suggesting that public knowledge of the functions of the ocean and causes of ocean pollution was lacking), http://www.enn.com/news/enn-stories/1999/12/120399/oceanpoll_7801.asp.

83. The Exxon Valdez spill released approximately 35,000 tons of oil. *See* NAT'L RESEARCH COUNCIL OF THE NAT'L ACADS., OIL IN THE SEA III: INPUTS, FATES, AND EFFECTS 22 (2003) [hereinafter 2003 NRC REPORT]. The product of 15 and 35,000 is 525,000 tons, and 525,000 tons times 294 gallons per ton is 154,350,000 gallons. *Id.*

84. According to the report, the ecotoxicological effects of petroleum releases are caused not by the volumes released to the environment but by the dose of petroleum hydrocarbons available to the organism. *Id.* According to the NRC study, "dose is rarely directly proportional to the amount released." *Id.* At the same time, the NRC report recognized the importance of quantifying releases as a means of identifying areas for further study. *Id.* at 17.

industrial facilities.[85] In addition, individuals' proportionate share may be growing as population, consumption, and activity levels increase, and as command and control and other regulatory instruments reduce emissions from large industrial sources.[86]

A. Individuals as a Source Category

1. Defining Individuals and Households

At the outset, simply defining "individuals" as a source category is an important task. For the purposes of this analysis, an individual is defined to mean a person acting in a private capacity, not in the course of employment. Emissions in some cases are more susceptible to measurement by household (e.g., emissions from residential electricity consumption), and a household is defined as all of the individuals living in the same housing unit.[87] The emissions attributable to individuals in the course of their employment are excluded because different means of controlling behavior are available when individuals function as employees than when they function as private individuals (e.g., command and control, economic, or other instruments directed at employers). In addition, the inclusion of all emissions generated in the course of employment or in the production of consumer goods and services would lead to the problem that all pollution ultimately could be attributed to individuals, but doing so negates the utility of the category. To avoid the over-inclusiveness problem, the profile does not apportion to individuals the emissions from the industrial sources that manufacture consumer goods. For example, although the profile apportions to individuals the emissions

85. By "large industrial facilities" I mean those non-governmental facilities that are subject to TRI reporting requirements. *See* 42 U.S.C. § 11023(b)(1)(A) (2000); Pedersen, *supra* note 8, at 151 (describing the facilities subject to TRI requirements as "large industrial facilities").

86. *See* sources cited *supra* note 6.

87. This is consistent with the approach followed by the United States Census Bureau, which defines households to include

> all the people who occupy a housing unit. A housing unit is a house, an apartment, a mobile home, a group of rooms, or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters. Separate living quarters are those in which the occupants live separately from any other people in the building and which have direct access from the outside of the building or through a common hall. The occupants may be a single family, one person living alone, two or more families living together, or any other group of related or unrelated people who share living arrangements.

U.S. Census Bureau, American Community Survey, Using the Data: Subject Definitions, http://www.census. gov/acs/www/UseData/Def/Hhld_rel.htm (last modified Mar. 24, 2004).

from consumer solvent use, it excludes the emissions released during the manufacturing of consumer solvents.

The profile attributes to individuals the emissions from several types of sources that could be assigned to either the industrial or individual category. For example, the emissions from on-road and non-road motor vehicle use could be assigned to the motor vehicle manufacturers or to the individuals who operate the motor vehicles. Similarly, the emissions attributable to residential electricity use could be assigned to electric utilities or residential electricity users. Where individuals have a substantial ability to control the emissions by changing the amount or manner of use, and where data are available, the profile includes these emissions in the individual category. The profile thus includes the emissions from private individuals' motor vehicle use and from the electricity generated for residential use. Data on the emissions from a range of other consumer behaviors that are largely within individuals' control, such as other home energy use and certain consumer product use, were not readily available and were not included in the profile.

2. A Typology of Environmentally Significant Behavior

Individual environmentally significant behavior includes at least four distinct types of activities. First, *consumer product choices* are perhaps the most obvious and have been the subject of the most academic commentary and regulatory attention.[88] Consumer product choices may have been the subject of the most regulatory activity because consumer product manufacturers are easy targets for regulatory efforts, such as product content or labeling requirements. Although the individual source category may be easily conflated with consumers, a focus only on consumer product choices will exclude many individual behaviors that have potentially significant environmental impacts, yet fall outside the consumer category.[89] For example, the extent to which individuals idle their vehicles may have surprisingly large effects on ozone precursor production, yet a consumer focus will address this issue only obliquely by addressing consumer vehicle or fuel purchases.[90]

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88. *See, e.g.*, Menell, *supra* note 56, at 1436 (noting that "[i]n the United States, the principal thrust of public policy in this area has been focused on point-of-purchase labeling of environmental claims").

89. An example is that home disposal of used motor oil has surprisingly large effects on water quality, yet a consumer focus is more likely to address the purchase of new motor oil, with only attenuated effects on the disposal of used motor oil.

90. *See* discussion *infra* note 274. As discussed above, conflating individuals with consumers as a source category also may create an over-inclusive category: the consumer sector

Second, *activity types* are important. Whether individuals drive or take mass transportation to work can have tremendous implications for the environment. Similarly, whether individuals use manual or motorized watercraft may have large implications for the impact of individuals on estuarine environments.[91]

Third, *activity levels* are less obvious but equally important. Examples include the frequency with which an individual uses a car, furnace or household solvent. If an individual purchases a car that is 50 percent cleaner than an alternative vehicle, yet drives it twice as much, a focus on activity levels, rather than simply consumer product choices, will be necessary to capture the full environmental effects of individual behavior.

Fourth, and equally important in many cases, is the *activity location.* The use of a personal watercraft in the open ocean may have minimal effects given the assimilative capacity of the environment and the flora and fauna present in the open ocean. Use of the same watercraft in a sensitive marine ecosystem may be quite a different matter, as the 2003 NRC report suggests.[92] Similarly, use of a particular solvent outdoors may not be harmful if it does not result in significant human exposure and degrades quickly in the environment. Use of the same solvent indoors may present a significant human health risk. The spatial distribution of residential and commercial activities also may be remarkably important. A community that is widely dispersed will require greater use of resources for transportation and will have larger amounts of impervious surfaces (e.g., roads and parking lots), with resulting environmental impacts, than one that combines high density in some locations with undeveloped land in others.[93]

B. The Contribution of Individuals to Environmental Pollution and

ultimately could include essentially all economic activity, thus all industrial and government emissions could be attributed to individuals. This approach would not distinguish emissions from household behaviors that are under a substantial degree of control by the individual from emissions that are generated hy industrial or other sources to meet consumer demands, and thus are under only indirect individual control. As a result, attributing all industrial emissions to consumers would not provide a valuable tool for identifying and changing the contributions of various source categories.

91. *See* 2003 NRC REPORT, *supra* note 83, at 22.

92. *See id.*

93. Academicians and government agencies have recognized the importance of suburhan sprawl for a host of environmental issues, including air pollution, non-point source water pollution and others. *See generally* GAO, LAND USE: FEDERAL AGENCIES CAN DO MORE (2001) (identifying potential government actions to reduce the environmental effects of sprawl); NEW GROUND: THE ADVENT OF LOCAL ENVIRONMENTAL LAW (John R. Nolon ed., 2003) (noting the growing importance of local environmental requirements).

Environmental Harms

The contributions of individuals can be assessed from a variety of perspectives, including the types of pollutants released (e.g., toxics or conventional pollutants), the quantities of pollutants released (both absolute and relative to industrial or other sources), the media to which the pollutants are released (air, water, and land), and the effects on human health and the environment. Although a comprehensive analysis is not possible based on existing data, the profile examines individuals' emissions of several important pollutants: low-level ozone or smog, mercury, several air toxics from mobile sources, pesticides, and petroleum. Individuals contribute substantial quantities of other pollutants not profiled here, including air pollutants such as climate change gases,[94] carbon monoxide,[95] and particulate matter,[96] as well as various toxic chemicals in consumer products that are released to air, land and water.[97] EPA has

94. Substantial quantities of climate change gases are released by driving and other individual behaviors. *See* OFFICE OF AIR AND RADIATION, EPA, EMISSION FACTS (EPA 420-F-00-013) 2 (2000) (the average annual carbon dioxide emissions of a passenger car are 11,450 pounds, and light trucks emit 16,035 pounds), http://www.epa.gov/otaq/consumer/f00013.htm. Each gallon of gasoline burned in a motor vehicle releases about twenty pounds of carbon dioxide, including 5.47 pounds of carbon, into the atmosphere. ARNOLD W. REITZE JR., AIR POLLUTION CONTROL LAW: COMPLIANCE & ENFORCEMENT 270 (2001); OFFICE OF SCIENCE & TECH. POLICY, EXECUTIVE OFFICE OF THE PRESIDENT, CLIMATE CHANGE STATE OF KNOWLEDGE 1-6, 9 (1997).

95. Tailpipe emissions controls on passenger cars have reduced emissions of carbon monoxide by roughly 90 percent over pre-1970 cars, and ambient levels of carbon monoxide have dropped. OFFICE OF MOBILE SOURCES, EPA, OMS FACT SHEET #3: AUTOMOBILES AND CARBON MONOXIDE (EPA 400-F-92-005) 1 (1993), http://www.epa.gov/otaq/consumer/03-co.htm. Nevertheless, 95 percent of all carbon monoxide emissions in cities arises from tailpipe and minor source emissions, much of which can be attributed to individuals. EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at 2-1 to 2-2; *see also* OFFICE OF AIR & RADIATION, EPA, REDUCING AIR POLLUTION FROM NONROAD ENGINES (EPA420-F-00-048) 2 (2000) [hereinafter EPA, NONROAD ENGINES REPORT] (concluding that lawn and garden equipment produces 62 percent of the carbon monoxide from non-road sources), http://www.epa.gov/otaq/regs/nonroad/foo48.pdf.

96. Particulate matter ("PM") is an air pollutant with important human health effects that is released in substantial quantities by individuals. EPA, NONROAD ENGINE REPORT, *supra* note 95, at 2 (concluding that lawn and garden equipment produces 11 percent of the PM from non-road sources). A number of studies have focused on PM from motor vehicle emissions and its health effects. *See, e.g.*, Michael Brauer et al., *Air Pollution From Traffic and the Development of Respiratory Infections and Asthmatic and Allergic Symptoms in Children*, 166 AM. J. RESPIRATORY CRITICAL CARE MED. 1092 (2002); Yifang Zhu et al., *Concentration and Size Distribution of Ultrafine Particles Near a Major Highway*, 52 J. AIR & WASTE MGMT. ASS'N 1032 (2002).

97. The total quantity of toxic chemicals included in consumer products is unknown, as are the fate and effects of these chemicals. One public interest group has suggested that the toxic chemicals contained in consumer products produced by large industrial facilities may exceed the total amount of hazardous waste generated by those facilities by ten to twenty times. INFORM, The Community's Right to Know More 7, http://www.informinc.org/rtkm_07.php (last visited May 10, 2004). For a list of consumer products that are found in household hazardous waste, see

estimated that individuals generate 1.6 million tons of household hazardous wastes annually, and that the average home has accumulated up to 100 pounds of hazardous wastes.[98] Some seemingly innocuous behaviors, such as the use of consumer products[99] and the burning of waste materials in barrels,[100] may release substantial

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Office of Solid Waste, EPA, List of Common HHW Products, http://www.epa.gov/epaoswer/non-hw/muncpl/hhw-list.htm (last visited May 10, 2004). According to one source, household hazardous wastes generated from consumer products are a "serious problem" and can damage sewage treatment plants when disposed of down sinks, pollute drinking water, harm sanitation workers when improperly disposed of in garbage, harm septic tanks, and add to runoff when applied to yards or disposed of down storm sewers. UNIV. OF MO., MANAGING HOUSEHOLD HAZARDOUS WASTE (Univ. of Mo., Household Hazardous Waste Project, Publication No. WM6004, 1993), http://muextension.missouri.edu/explore/wasteman/wm6004.htm.

98. EPA, ENVIRONMENT REPORT, *supra* note 9, at B-2 (citing Office of Solid Waste & Emergency Response, EPA, Household Hazardous Waste (Oct. 29, 2002), http://www.epa.gov/epaoswer/non-hw/muncpl/hhw.htm). Remarkably, the definitive periodic EPA report on household waste excludes consideration of hazardous wastes in the household waste stream. *See* OFFICE OF SOLID WASTE & EMERGENCY RESPONSE, EPA, MUNICIPAL SOLID WASTE IN THE UNITED STATES: 2000 FACTS AND FIGURES (EPA 530-R-02-001) 25 (2002). EPA has estimated that 206 million pounds of "toxic chemicals in waste" were disposed of in RCRA Subtitle C facilities in 2000, or roughly 2.9 percent of the TRI releases. EPA, ENVIRONMENT REPORT, *supra* note 9, at 3-8. In May 1989, the OTA testified that 500 million tons of RCRA-defined hazardous wastes were generated annually in the United States. OTA, Senate Testimony, *supra* note 69, at 5. The OTA noted that this figure included mixtures with non-toxic chemicals, such as water, and RCRA wastes that are not toxic, such as flammable wastes and some acids. *Id.* Individuals also generate roughly 4.5 pounds of solid waste per day, a figure that is far higher than the amount generated in the 1960s, but that has remained constant over the last decade. EPA, ENVIRONMENT REPORT, *supra* note 9, at 3-14.

99. Toxic chemicals in consumer products are released by individuals when the products are used, flushed down drains, discarded on-site or through informal off-site dumping on land or into storm sewers, burned in trash barrels, or sent off-site for disposal (e.g., to landfills or incinerators). There is some indication that although industrial releases of toxic chemicals have declined since 1988, the quantities included in consumer products has not. *See, e.g.*, TED SCHETTLER ET AL., GREATER BOSTON PHYSICIANS FOR SOC. RESPONSIBILITY & THE MASS. PUB. INTEREST RESEARCH GROUP EDUC. FUND, GENERATIONS AT RISK: HOW ENVIRONMENTAL TOXINS MAY AFFECT REPRODUCTIVE HEALTH IN MASSACHUSETTS: EXECUTIVE SUMMARY 2 (1996) (noting that "[e]nvironmental release of chemicals with some evidence of reproductive toxicity have declined substantially since reporting requirements were established in Massachusetts. However, the amount of these chemicals incorporated into products has not changed siguificantly."), http://www.safe2use.com/data/precaut.htm. In addition, publicly owned treatment works, which treat household wastewater, may not be equipped to treat toxic chemicals, leading some toxic chemicals in consumer products to pass through to waterbodies. *See* ASS'N OF METRO. SEWERAGE AGENCIES, EVALUATION OF DOMESTIC SOURCES OF MERCURY 7 (Aug. 2000) [hereinafter AMSA, DOMESTIC SOURCES OF MERCURY], http://www.amsa-cleanwater.org/pubs/mercury/mercury.pdf.

100. An EPA study found that the toxic chemicals released into the air when household products are burned in backyard barrels include hydrogen cyanide, polychlorinated biphenyls, chlorobenzenes, polychlorinated dibenzo-p-dioxins, aldehydes, ketones, hydrogen chloride, hydrogen cyanide, and various other VOCs and metals. *See* PAUL M. LERNIEUX, EPA, EVALUATION OF EMISSIONS FROM THE OPEN BURNING OF HOUSEHOLD WASTE IN BARRELS, TECHNICAL REPORT (1997), http://www.epa.gov/ttn/catc/dir1/barlbrn1.pdf. Air toxics are also released through other forms of combustion, such as the use of furnaces and water heaters, and gas and wood stoves. EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at 7-1 to 7-6.

quantities of pollutants when the totals from individual activities are aggregated. These releases also may have substantial environmental and human health effects. For example, EPA reports that consumer products, such as paint, are among the sources of toxic chemicals in urban runoff,[101] and urban runoff is one of the leading causes of water pollution in the United States.[102] Individuals also contribute to environmental harms through activities that do not involve the release of chemical pollutants, such as destroying endangered species or filling wetlands. The effects of these activities are worthy of further study but are beyond the scope of this profile. For each of the pollutants profiled here, the discussion first identifies the potential environmental and human health effects posed by the pollutants released, then assesses the quantities released by individuals as compared to large industrial facilities (and other types of sources where data are available), and concludes with an analysis of the regulatory efforts taken to date.[103]

The profile focuses more on the quantities of pollutants emitted than on the risks posed by these pollutants. Not all types of pollution are equal, and not all releases of the same type of pollutant are worthy of the same level of regulatory effort. Although the risks presented by the pollutants profiled are identified where possible, often it is not possible to make the leap from specific quantities or types of releases to specific risks or harms.[104] Identifying quantities released

101. EPA, 2000 WATER QUALITY REPORT, *supra* note 6, at 31. A project conducted by the University of Missouri concluded that releases by individuals and households that enter waterways through storm drains include antifreeze, fertilizers, motor oil, paint and other household hazardous waste (e.g., paint thinners, cleaners, auto waxes and swimming pool chemicals). UNIV. OF MO., STORM DRAINS AND WATER QUALITY 2-5 (Univ. of Mo., Household Hazardous Waste Project, Publication No. WM6011, 1994), http://muextension.missouri.edu /explore/wasteman/wm6011.htm.

102. EPA, 2000 WATER QUALITY REPORT, *supra* note 6, at 31.

103. *See* discussion *infra* notes 106-271.

104. The assessment of the risk created by the release of a particular pollutant may involve many variables. For example, the relatively constant, low-level releases over a long period of time from 100,000 households of a substance that breaks down in the environment and does not bioaccumulate may have less harmful effects than the same quantity emitted in a pulse over a short period of time from an industrial facility. In other situations, such as those involving the release of substances that are persistent and that bioaccumulate, the concentration of the initial release may be less important than the total quantity released. The location of releases from individuals also may occur in areas, such as coastal estuaries, that lead smaller quantities to create greater risks. 2003 NRC REPORT, *supra* note 83, at 21-22 (discussing releases from personal watercraft to sensitive estuaries). Similarly, EPA has concluded that exposure to mutagenic carcinogens early in life may pose a substantially greater risk than later exposure. OFFICE OF RESEARCH & DEV., EPA, DRAFT REPORT OF THE SUPPLEMENTAL GUIDANCE FOR ASSESSING CANCER SUSCEPTIBILITY RESULTING FROM EARLY-LIFE EXPOSURE TO CARCINOGENS (2003), *available at* http://www.epa.gov./science1/pdf/final scagsreport091203drft.pdf. As a result, exposure of children to household chemical and pesticide use may be far more important than

nonetheless is an important starting point, without which an assessment of the risks created and the optimal government response cannot begin.[105]

1. Low-Level Ozone

Ozone is formed by reactions involving oxides of nitrogen (NOx) and hydrocarbons (principally volatile organic compounds or VOCs), in the presence of sunlight.[106] Although ozone at high levels in the atmosphere protects the earth against harmful ultraviolet radiation generated by the sun, ozone near the ground is the main constituent of smog.[107] Ozone is a potent lung irritant that causes lung damage, chest pain, coughing, nausea, throat irritation, and congestion.[108] It also may exacerbate bronchitis, heart disease, emphysema, and asthma.[109] In addition, ozone reduces the growth of plants by interfering with the production and storage of starches, causing damage to crops and other vegetation.[110] In some plant species, the

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previously recognized. For a discussion of the factors considered in environmental and human health risk determinations, see SCI. ADVISORY BD., EPA, REVIEW OF THE SECTOR FACILITY INDEXING PROJECT (EPA-SAB-EEC-97-012) A-4 (1997), http://www.epa.gov/sab/pdf/eec9712.pdf.

105. For example, the chair of the study that generated the 2003 NRC Report acknowledged that the quantitative data in the study provide a baseline and guide for further studies. 2003 NRC REPORT, *supra* note 83, at ix.

106. NOx and VOCs are commonly referred to as ozone precursors. Ozone is a gaseous molecule with three oxygen atoms. OFFICE OF MOBILE SOURCES, EPA, FACT SHEET OMS 4: AUTOMOBILES AND OZONE (EPA 400-F-2-006) 1 (1993) [hereinafter OMS, AUTOMOBILES AND OZONE], http://www.epa.gov/otaq/consumer/04-ozone.pdf. VOCs in vehicle emissions consist of a mixture of hydrocarbons and nitrogen oxides that contain varying amounts of nitrogen and oxygen. OFFICE OF MOBILE SOURCES, EPA, EMISSION FACTS: IDLING VEHICLE EMISSIONS (EPA 420-F-98-014) 2 (1998). Ozone concentrations tend to be elevated during the summer months (sometimes referred to as the "ozone season") and tend to be highest on hot summer afternoons. OMS, AUTOMOBILES AND OZONE, *supra*, at 1.

107. Office of Transp. & Air Quality, EPA, Mobile Source Emissions—Past, Present and Future: Definitions, http://www.epa.gov/otaq/invntory/overview/definitions.htm (last modified Apr. 14, 2003).

108. OFFICE OF AIR & RADIATION, EPA, AIRNOW: WHAT YOU CAN DO 2 (2003), http://www.epa.gov/airnow/consumer.html (noting that ozone has a number of human health effects, including that it "can limit the ability to take a deep breath, and it can cause coughing, throat irritation, and breathing discomfort. There is also evidence that ozone can lower resistance to respiratory disease (such as pneumonia), damage lung tissue, and aggravate chronic lung disease (such as asthma or bronchitis)").

109. OFFICE OF AIR QUALITY & PLANNING STANDARDS, EPA, OZONE: GOOD UP HIGH, BAD NEARBY 1-2 (1994) [hereinafter EPA, BAD NEARBY] (noting that exposure to ozone can affect vulnerable populations, such as children, the elderly, and individuals with respiratory problems, as well as those without particular vulnerabilities, and that healthy adults are particularly affected by ozone during heavy exercise), http://es.epa.gov/techinfo/faccts/ozone3.html.

110. EPA, BAD NEARBY, *supra* note 109, at 2. EPA has estimated that the costs to agriculture of ozone levels above the new 8-hour standard are two to three billion dollars per year. EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at 1-1.

effects may not become evident for years, but long-term adverse effects may occur in various ecosystems, including those with endangered plants and wildlife.[111] In response to new studies on the effects of ozone, EPA in 1997 promulgated a new, tougher standard (commonly called the eight-hour standard because it is measured over an eight hour period) for ozone to replace the earlier one-hour standard.[112]

a. Individual Contribution

Individuals and households contributed at least 26 billion pounds (12,979,700 tons) of ozone precursors in 1998,[113] or roughly 246 pounds of ozone precursors per household.[114] Individuals and households thus contributed more than 30.6 percent of all low-level ozone precursors nationwide. Industrial, commercial, government, and other types of sources contributed the remainder. Table 1 identifies the volumetric and percentage contributions of each of the individual sources that were included in the estimate.

111. *See* EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at 1-1 to 1-2; EPA, BAD NEARBY, *supra* note 109, at 3 (noting that the effects include reductions in crop yields and noting that ozone limits the ability of plants and trees to fight diseases). In addition to the effects on plants and animals, ozone also has other non-human health effects, such as contributing to regional haze and reducing visibility, with adverse effects on tourism. *See* EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at 6-1 to 6-4 (noting sources of visibility impairment).

112. National Ambient Air Quality Standards for Ozone, 62 Fed. Reg. 38,856 (July 18, 1997) (codified at 40 C.F.R. §§ 50.9-.10); *see also* Whitman v. American Trucking Ass'ns, 531 U.S. 457 (2001) (reviewing the EPA eight-hour ozone standard). EPA has estimated that full attainment of the new 8-hour ozone standard could result in human health effects with a monetary benefit of $1.5 to $8.5 billion dollars per year in the United States. *See* EPA, REGULATORY IMPACT ASSESSMENT ES-17 (1997), http://www.epa.gov/ttn/oarpg/naaqsfin/ria.html. The monetary benefit estimate does not include other benefits that could result when full attainment of the new standard is achieved, including reduced incidents of pulmonary inflammation, decreased susceptibility to respiratory infection, and environmental and other non-human health benefits. *Id.* at ES-16.

113. The 12,979,700 ton figure is 30.6 percent of the 42,370,000 tons that EPA estimates to be the total 1998 production of ozone precursors in the United States. EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at tbl. ES-1. The 42,370,000 tons of ozone precursors includes 17,920,000 tons of VOCs and 24,450,000 tons of NOx. *Id.*

114. U.S. CENSUS BUREAU, *supra* note 9. The average household share of 246 pounds was calculated by dividing the total amount of ozone precursors produced by individuals (12,972,700 tons) by the total number of households in America (105.5 million households). EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at tbls. 3-2, 3-3.

Table 1:

Individual Sources of Ozone Precursor Emissions (in tons)[115]

Source Category	*Individual Amount*	*Share of Individual*	*Individual Share of Total*
On-road Motor Vehicles			
Cars	4,295,700	33.1%	10.1%
Light-duty Trucks	3,243,900	25.0%	7.6%
Subtotal	7,539,600	58.1%	17.7%
Non-road Motor Vehicles			
Recreational Marine Vehicles	668,000	5.1%	1.6%
Lawn & Garden Equipment	1,037,200	8.0%	2.4%
Recreational Gas Engines	240,200	1.9%	0.6%
Subtotal	1,945,400	15.0%	4.6%
Fuel Comb. Elec. Util.			
Residential	2,155,000	16.6%	5.1%
Subtotal	2,155,000	16.6%	5.1%
Consumer Product Use			
Consumer Solvents	1,099,000	8.5%	2.6%
Pesticide Application	30,400	0.2%	0.1%
Architectural Coatings	210,300	1.6%	0.5%
Subtotal	1,339,700	10.3%	3.2%
Total	**12,979,700**	**100.0%**	**30.6%**

The individual activities included in the 30.6 percent estimated share of total national ozone precursor emissions are as follows: (1) operation of on-road motor vehicles (including cars and light-duty trucks, e.g., pick-up trucks and sport utility vehicles or SUVs);[116] (2)

115. The table was compiled from data in the sources identified *infra* notes 116-34. All figures are for 1998 unless otherwise specified.

116. The EPA on-road motor vehicle category includes heavy-, medium- and light-duty trucks, as well as cars. EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at tbl. 3-3. The estimate of

operation of non-road motor vehicles (including lawn and garden equipment, recreational marine equipment, and certain other recreational vehicles, such as all-terrain vehicles and off-road motorcycles);[117] (3) residential electricity consumption (including the emissions from electric utilities attributable to residential electricity consumption);[118] and (4) consumer product use, including consumer use of solvents,[119] pesticides,[120] and architectural coatings (e.g., household paints).[121]

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individuals' ozone precursor emissions omits all heavy- and medium-duty trucks, as they are unlikely to be owned and operated by individuals acting outside of their employment. As to cars and light-duty trucks, the estimate also includes only the emissions from the proportion of light-duty gasoline cars and trucks not likely to be owned or operated by individuals acting outside of their employment. According to the U.S. Department of Energy, individuals acting outside the scope of employment comprised 76.3 percent of all light-duty car drivers, and the same group comprised 82.5 percent of all light-duty trucks driven on roadways in the United States in 2000. ENERGY INFO. ADMIN., ASSUMPTIONS FOR THE ANNUAL ENERGY OUTLOOK 2003 (2003), http://www.eia.doe.gov/oiaf/aeo/assumption/transportation.html.

117. EPA identifies this category as "off-road" or "non-road" motor vehicles. EPA, NONROAD ENGINES REPORT, *supra* note 95, at 1. The term "non-road" is used in this Article. According to EPA, non-road vehicles are a "diverse collection of engines, equipment, vehicles, and vessels. The category includes outdoor power equipment, recreational vehicles (including boats, snowmobiles, etc.), farm and construction machinery, lawn and garden equipment, marine vessels, locomotives, aircraft, and many other applications." *Id.* The profile excludes the emissions from several types of non-road motor vehicles that EPA includes in the category but that are not likely to be operated by individuals during the summer, sucb as snowmobiles, or that are not likely to be operated by individuals acting outside of their employment, such as aircraft, locomotives and construction equipment. OFFICE OF TRANSP. & AIR QUALITY, EPA, FINAL RULE FOR CLEANER LARGE INDUSTRIAL SPARK IGNITION ENGINES, RECREATIONAL MARINE DIESEL ENGINES, AND RECREATIONAL VEHICLES (EPA 420-F-02-037) ch. 6 (2002) (stating that snowmobiles emitted approximately 205,000 tons of VOCs and 1,400 tons of NOx in 2000), http://www.epa.gov/otaq/cleanrec.htm. The emissions levels from non-road vehicles will be declining as a result of new EPA regulations and state voluntary agreements, but as with on-road motor vehicles, these emissions reductions will be offset to some extent as the number of these vehicles increases. According to EPA, all non-road engines in 2000 contributed 3,677,000 tons of hydrocarbons (as compared to 3,772,000 tons of highway hydrocarbon emissions), and 5,461,000 tons of nitrogen oxide emissions (as compared to 7,988,000 tons of highway nitrogen oxide emissions). EPA, NONROAD ENGINES REPORT, *supra* note 95, at 2 (predicting that new regulations will reduce nonroad diesel emissions of nitrogen oxides by 60 percent by 2008).

118. According to a Department of Energy estimate of the overall electric sales in the United States, the individual/residential share comprises 35.7 percent of the total electricity purchased in the United States in 2001. *See* ENERGY INFO. ADMIN., ANNUAL ELECTRIC POWER INDUSTRY REPORT tbl. 2c, http://www.eia.doe.gov/cneaf/electricity/esr/table1abcd.xls#A105; *see also* GARDNER & STERN, *supra* note 9, at 273 (referring to individual and bousehold percentage of all fossil fuel consumption); ENERGY INFORMATION ADMINISTRATION, ELECTRICITY INFOCARD 2001 (2001) (noting that individuals consumed at least 35 percent of the electricity produced in the U.S. in 2000), bttp://www.eia.gov/neic/brochure/elecinfocard.html.

119. The consumer solvent category includes the use of personal care and household products that contain solvents such as hairsprays, deodorants, paint thinners, and dishwashing products. EPA, 3 EMISSION INVENTORY IMPROVEMENT PROGRAMCHAPTER 5: CONSUMER AND COMMERCIAL SOLVENT USE (1996) [hereinafter EPA, AIR INVENTORY CONSUMER SOLVENTS REPORT] (identifying several of the products used in this category), http://www.epa.gov/ttn/cbief/eiip/techreport/volume03; *see also* EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at tbl. 3-3

Not surprisingly, automobiles and light-duty trucks are the largest single source of ozone precursors from individuals, accounting for approximately 17.7 percent of the total amount of ozone precursors emitted nationwide in 1998.[122] In some areas, the percentage contribution from cars and light trucks is much higher.[123] By comparison, no single industrial source category comes close to 17.7 percent of the total.[124]

In addition, many seemingly innocuous activities other than automobile driving also have substantial impacts on ozone formation. For example, in 1998, individual use of non-road vehicles, including lawn and garden equipment, recreational marine equipment (e.g., motorboats and personal watercraft using inboard and outboard engines), all-terrain vehicles, and off-road motorcycles comprised 4.6 percent of all ozone precursors emitted nationwide.[125] The

(noting that consumer solvents accounted for 1,099,000 tons or 6 percent of all national emissions of VOCs in 1998).

120. The consumer pesticide category includes the use of pesticides approved for home and garden use. EPA, 3 EMISSION INVENTORY IMPROVEMENT PROGRAM CHAPTER 9: PESTICIDES—AGRICULTURAL AND NONAGRICULTURAL 9.2-1, tbl. 9.6.6 (2001) [hereinafter EPA, AIR INVENTORY PESTICIDES REPORT] (noting that pesticides contain VOCs), http://www.epa.gov/ttn/chief/eiip/techreport/volume03; *see also* EPA, AIR INVENTORY CONSUMER SOLVENTS REPORT, *supra* note 119, at 5.2-4, tbl. 5.2-1 (noting that the consumer pesticide category includes products approved for home and garden use); EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at tbl. 3-3 (noting that total pesticide application accounted for 405 tons or 2.3 percent of national emissions of volatile organic compounds in 1998).

121. EPA, ECONOMIC IMPACT AND REGULATORY FLEXIBILITY ANALYSES OF THE FINAL ARCHITECTURAL COATING VOC RULE 1-12 (1998) (stating that "do-it-yourselfers" consumed 41 percent of the total gallons of architectural coatings used in the United States in 1991), http://www.epa.gov/ttnecas1/regdata/eiaaim.pdf; EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at tbl. 3-3 (noting that all architectural coatings accounted for 491 tons or 2.7 percent of all national emissions of VOCs in 1998); *see also* EPA, 3 EMISSION INVENTORY IMPROVEMENT PROGRAM DOCUMENT CHAPTER 3: ARCHITECTURAL SURFACE COATING (1995) [hereinafter EPA, AIR INVENTORY ARCHITECTURAL COATINGS REPORT] (noting that consumer paint use generates hydrocarbon air emissions), http://www.epa.gov/ttn/chief/eiip/techreport/volume03.

122. According to EPA data, in 1998 individuals emitted 4,295,700 tons of ozone precursors from light-duty cars and 3,243,900 tons from light-duty trucks. EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at tbls. 3-2, 3-3. The totals were calculated by reducing the totals from all light-duty cars and light-duty trucks by the percentages of private individual operation of each. In total, light-duty gasoline cars and trucks emitted 9,613,000 tons of ozone precursors in 1998, which constituted approximately 23 percent of the total amount of ozone precursors emitted in that year. *Id.* In contrast, light-duty cars and trucks owned and operated by businesses, government agencies and other non-individual owners contributed roughly 5 percent of all ozone precursors nationwide. *Id.*

123. *See, e.g.*, Craig N. Oren, *Getting Commuters Out of Their Cars: What Went Wrong?*, 17 STAN. ENVTL. L. J. 141, 152 (1998).

124. *See* EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at tbls. 3-2, 3-3 (identifying VOC and NOx emissions by source category).

125. In 1998, non-road motor vehicles contributed 18.3 percent of all ozone precursor emissions from all sources nationwide. *Id.* Obviously, individuals use many types of non-road vehicles, but this profile only attributes the emissions from lawn and garden equipment,

subcategories of non-road vehicle use attributable to individuals also include several large sources of ozone precursors. For example, lawn and garden equipment was responsible for approximately 2.4 percent of the total amount of ozone precursors emitted nationwide.[126] Although new mowers are 70 percent less polluting than old mowers, using an older model lawn mower (many of which are still frequently used today) for two hours produces the same quantity of ozone precursors as driving between 100 and 300 miles in a late-model automobile.[127] Similarly, recreational marine equipment contributed

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recreational marine equipment, all terrain vehicles, and off-road motorcycles to individuals from non-road vehicles. *Id.* The profile excludes emissions from non-recreational marine vehicles, locomotives, aircraft, and other vehicles unlikely to be owned and operated by individuals outside of the scope of their employment.

126. EPA includes lawn and garden equipment in the off-road or non-road category. *See* EPA, NONROAD ENGINES REPORT, *supra* note 95, at 2-4. Lawn and garden equipment produced approximately 1,037,200 tons of ozone precursors in 1998. *Id.* Although lawn and garden equipment produces less than 3 percent of the total NOx emissions categorized as non-road emissions by the EPA, it also produces 40 percent of tbe non-road VOC emissions. *Id.* at 2. Lawn and garden equipment also contributes a large percentage of the carbon monoxide (62 percent) and particulate matter (11 percent) emissions categorized as non-road emissions by EPA. *Id.* (identifying percentage values). All lawn and garden equipment ozone precursor emissions were assumed to be generated by individuals. The 2.4 percent total is derived from data in the 2000 EPA Air Trends Report, which identifies a total from all sources of 42.37 million tons of ozone precursors produced per year. EPA, AIR TRENDS REPORT, *supra* note 6, at tbls. 3-2, 3-3. The non-road report provided percentages for lawn and garden equipment emissions in 2000 (40 percent of the total VOC non-road emissions and approximately 1 percent of the total NOx emissions from non-road vehicles). EPA, NONROAD ENGINES REPORT, *supra* note 95, at 2. These percentages were multiplied by the total NOx (5,280,000 tons) and VOC (2,461,000 tons) emissions from non-road vehicles provided in the Air Trends Report. EPA, AIR TRENDS REPORT, *supra* note 6, at tbls. 3-2, 3-3. The 2.4 percent figure is approximate because the non-road report does not give an exact number of tons of NOx produced by lawn equipment. *Id.* at 2. The lawn and garden equipment total was assumed to be 52,800 tons, which is 1 percent of the non-road NOx emissions. *Id.* The 52,800 estimate was based on the assumption that the category entitled "other" in the non-road report constituted 3 percent of the total NOx emissions from non-road sources. *Id.* This "other" category included only individual activities, namely lawn and garden equipment use, recreational marine equipment use, and recreational gas engine use. *Id.* The 3 percent was apportioned equally among these three categories (1 percent each). *Id.* (concluding that 3 percent of the total NOx emissions come from the three non-road sources noted above).

127. In addition to the direct emissions from lawn and garden equipment, ozone precursors are emitted from gasoline re-filling and other activities. *See* OFFICE OF MOBILE SOURCES, EPA, YOUR YARD AND CLEAN AIR 1-2 (1996) (recommending that individuals avoid spilling gasoline when filling lawn and garden equipment, properly maintain the equipment, consider replacing dirtier equipment, use manual tools, reduce mowing time, decrease lawn area, and recycle rather than re-sell old equipment), http://www.epa.gov/otaq/consumer/19-yard.pdf); EPA, OFFICE OF TRANSP. & AIR QUALITY, LAWN AND GARDEN (SMALL GASOLINE) EQUIPMENT 1, http://www.epa.gov/otaq/equip-ld.htm (last viewed May 10, 2004). Even when spilling does not occur, portable gas cans may be a surprisingly large source of ozone precursors. The California Air Resources Board has estimated that the 9.2 million residential gas cans and 600,000 commercial gas cans in California contribute 87 tons per day of ozone precursors in the state, a figure that was expected to grow to 96 tons per day before the imposition of new regulations on gas cans and spouts. CAL. AIR RES. BD., NEW REGULATIONS FOR PORTABLE GAS CANS AND GAS CAN SPOUTS (1999), [hereinafter CARB, GAS CAN REGULATIONS], http://www.arb.ca.gov/msprog/

roughly 1.6 percent of the total ozone precursors emitted nationwide.[128]

Another major category of individual contributions to ozone precursor emissions arises from individuals' residential electricity consumption. Government estimates suggest that on average individuals in the United States consume approximately 35.7 percent of the electricity generated from electric utilities, much of which is generated from burning fossil fuels, such as coal, oil and natural gas.[129] As a result, in 1998 individuals' electricity use constituted roughly 5.1 percent of the total amount of ozone precursors emitted nationwide by all sources.[130]

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spillcon/gascanfs/gascanfs.htm. The 87 tons per day is the equivalent of approximately one million cars. *Id.* The gas cans contribute to the release of ozone precursors through permeation through the plastic (polyethylene) walls of some gas cans, fumes that escape during fuel dispensing, spilling, and evaporation through vent holes and inadequately capped spouts. *Id.*

128. EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at tbls. 3-2, 3-3. More than 12 million marine engines are operated in the United States. The vast majority of these marine engines are owned and operated by individuals, and they are among the largest contributors to NOx and VOC emissions in many parts of the United States. Office of Air & Radiation, EPA, Boating Pollution Prevention Tips (1996) (suggesting steps for existing vehicle operation and fueling, and new vehicle purchase to reduce air emissions), *at* http://www.epa.gov/otaq/boat-fs.htm. As much as 30 percent of the fuel used in the two-stroke engines that have been commonly used for personal watercraft and motorboats is not burned or is only partially burned and passes directly into the air or water. Lorraine McCarthy, *New Jersey: Industry Agrees on Deadline to Ensure Certain Marine Engines Are Low-Polluting*, STATE ENV'T REP. (BNA), A-2 (Mar. 4, 2003) (discussing New Jersey voluntary agreement on emissions reductions and noting that New Jersey has approximately 225,000 registered personal watercraft and boats with outboard motors).

129. *See* sources cited *supra* note 118; *see also* DEP'T OF ENERGY, PERCENT OF U.S. ELECTRICITY SALES BY CLASS OF CONSUMER (2000) (noting that residential electricity use constituted 35.7 percent of the total electricity used in the United States in 2000), http://www.eia.gov/neic/brochure/elecinfocard.html; DEP'T OF ENERGY, SALES TO BUNDLED AND UNBUNDLED CONSUMERS, ANNUAL ELECTRIC POWER INDUSTRY REPORT tbl. 1b (2001) (noting that residential electricity use constituted 35.7 percent of electricity purchased in the United States in 2001), http://www.eia.doe.gov/cneaf/electricity/esr/table1abcd.xls#A105; GARDNER & STERN, *supra* note 9, at tbls. 10-5, 10-6 (noting that in the United States individuals also consume 35 percent of all fossil fuel, of which 40 percent is used for transportation, 23 percent for space heat, 14 percent for motors and appliances, 11 percent for water heat, 6 percent for lighting, and 6 percent for cooling).

130. EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at tbls. 3-2, 3-3. If individuals contribute 35.7 percent of these emissions, the individual share of fuel combustion emissions was 2,155,000 tons. The fuel combustion category includes additional subcategories that were not included in the estimate of individuals' contributions to ozone precursors, including residential wood burning and burning in backyard barrels. The "residential wood burning" category includes wood used for wood stoves and fireplaces. Residential wood burning alone contributes 69.4 percent (or 620,000 tons) of the total amount of VOCs produced by all types of fuel combustion, which demonstrates the large role that individuals play in fuel combustion emissions. *Id.* at tbl. 3-3. The residential wood-burning emissions identified in the 1998 Air Trends Report are the total for the entire year. Telephone Interview by John Lucas with Megan Von Isenburgh, Librarian, EPA Office of Air Quality Planning and Standards (June 4, 2003). Residential wood burning was not included

Household consumer product use is another surprisingly large source of ozone precursors. Three types of household consumer product use are particularly important: consumer solvent use, private home and garden pesticide use, and individual architectural coating use. Consumer solvent use, such as the use of household cleaners, produced more than a million tons of ozone precursors nationwide in 1998.[131] Consumer solvent use thus constituted approximately 2.6 percent of the total ozone precursors emitted from all sources. To put the consumer solvent use figure into perspective, the million ton total exceeds the combined total of all ozone precursor emissions from EPA's Metal Processing, and Chemical and Allied Product Manufacturing categories.[132]

The use of architectural coatings and pesticides around the home also produces a large quantity of ozone precursors.[133] Nationwide, private individuals use 41 percent of all paints and other architectural coatings.[134] As a result, the individual share of

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in the estimate because it is likely that a large percentage of the 620,000 tons of ozone precursor emissions reported are released during the winter, not during tbe summer ozone season.

131. EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at tbl. 3-3 (noting that consumer solvent use accounted for 1,099,000 tons or 6.1 percent of national emissions of VOCs in 1998). The California Air Resources Board (CARB) has noted that consumer products that release ozone precursors include deodorants, hair spray, cleaning products, and insecticides and that "[a]lthough each product only contains a small amount of VOCs, Californians use half a billion of these items every year." CAL. AIR RES. BD., CONSUMER PRODUCTS AND SMOG (2003), http://www.arb.ca.gov/html/brochure/consprod.htm. According to CARB, consumer products released 265 tons of smog-forming pollutants every day in the Los Angeles area in 1990, more than all of the refineries and gas stations combined. *Id.* CARB has phased in new requirements for twenty-eight product categories since 1990 and has set a goal of 85 percent reductions by 2010. *Id.* According to CARB, the average cost of reducing VOCs from consumer products is between twenty-five and eighty-five cents per pound of VOC emissions. *Id.* This compares favorably to the $5 per pound average cost of industrial VOC emissions reductions. *See* CAL. AIR. RES. BD., GAS CAN REGULATIONS, *supra* note 127, at 1-2.

132. *See* EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at tbls. 3-2, 3-3.

133. *See id.* at tbl. 3-3 (noting that architectural coatings accounted for 491 tons or 2.7 percent of the national VOC emissions in 1998). The percentages vary on a state-by-state basis. For example, the New York Department of Environmental Conservation has estimated that 8.2 percent of the VOC emissions in the state arise from the combined total of architectural and industrial maintenance coatings. *See* N.Y. DEP'T OF ENVTL. CONSERVATION, PROPOSED AMENDMENTS TO AIR POLLUTION REGULATIONS, http://www.dec.state.ny.us/website/dar/amendments.html (last visited May 10, 2004).

134. The 41 percent figure is based on data indicating that "residential do-it-yourselfers" consumed 41 percent of the total gallons of architectural coatings used by all sources in the United States in 1991. EPA, ECONOMIC IMPACT AND REGULATORY FLEXIBILITY ANALYSES OF THE FINAL ARCHITECTURAL COATING VOC RULE 1-12 (1998), http://www.epa.gov/ttnecas1/regdata/eiaaim.pdf. For the profile, individuals were assumed to be responsible for 41 percent of the air emissions from the coatings (as applied to 1998 data from the 2000 Air Trends Report). *Id.* This assumption was based on the fact that the emission factors used by the EPA are virtually equivalent for all types of these coatings, therefore the type of product used by consumers should not have an effect on the total amount of VOCs released. *Id.* The 41 percent figure will increase if

architectural coating emissions nationwide in 1998 was 0.5 percent of the total ozone precursors emitted from all sources.[135] This 0.5 percent share may have significant impacts on a regional basis. The South Coast Air Quality Management District, the principal air regulatory body for the Los Angeles area, has estimated that on an average day drying paint releases more smog-forming compounds than all the oil refineries and gas stations combined in the Los Angeles area.[136] Similarly, home pesticide use contributes a notable percentage of the total volume of ozone precursors nationally.[137] Pesticides often include VOCs, and EPA's air office estimates that between 7 percent and 8 percent of all pesticides in the United States are used in private homes and gardens.[138] As a result, the individual share of pesticide emissions in 1998 accounted for 30,400 tons or 0.1 percent of the total ozone precursors emitted from all sources nationwide.[139]

b. Regulatory Response

To combat high ozone levels, the Clean Air Act (CAA) principally employs command and control requirements directed at large industrial facilities and automobile manufacturers. The CAA

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the painting of private residences by professional painters is added to the do-it-yourselfer total, but the former figure is not readily available, and it is unclear how much control individuals exercise over paint selection and application by professional painters.

135. EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at tbls. 3-2, 3-3.

136. In the Los Angeles area, car and truck use (178 tons per day) and consumer product use (108 tons per day) are the top two sources of VOC emissions. Gary Polakovic, *Chemicals in Home a Big Smog Source*, L.A. TIMES, Mar. 9, 2003, at C1 (reporting on data from the South Coast Air Quality Management District). The top industrial source, industrial paints and coatings (48 tons per day), is a distant third. *Id.* The total VOCs from commercial paints and coatings (28 tons per day) exceeds tbe total for petroleum marketing (22 tons per day). *Id.*; *see also* S. COAST AIR QUALITY MGMT. DIST., 25 WAYS YOU CAN CLEAN THE AIR 2 (2003) (noting that the combined VOC emissions for architectural coatings used by individual, commercial, and industrial sources is equivalent to the emissions from 1.3 million new vehicles).

137. EPA, AIR INVENTORY PESTICIDES REPORT, *supra* note 120, at 9.2-2 (noting tbat solvents comprise roughly half of the constituents of pesticides by weight); *see also* EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at tbls. 3-2, 3-3 (noting that all pesticide application accounted for 405,000 tons or approximately 1 percent of the national emissions of ozone precursors in 1998).

138. EPA, AIR INVENTORY PESTICIDES REPORT, *supra* note 120, at 9.2-2 (noting that bome pesticide use constitutes 7 to 8 percent of the total ozone precursor emissions by all pesticides).

139. *Id.* at tbls. 3-2, 3-3 (the figures indicate that the individual share of pesticide ozone precursor emissions was 0.2 percent of tbe total VOCs emitted in 1998). For this study, it was assumed that 7.5 percent of pesticide emissions could be attributed to individuals based on the contribution from pesticide use in private homes and gardens. *See id.* The total pesticide contribution was 405,000 tons of ozone precursors in 1998. *Id.* The amount attributable to individuals may be higher if further data on non-commercial farming indicates a large individual share. *See* EPA, AIR INVENTORY PESTICIDES REPORT, *supra* note 120, at 9.2-2 (noting that 68 percent-75 percent of pesticides are used on agricultural land or pastures).

requires EPA to set and periodically update national ambient air quality standards (NAAQS) for ozone and other criteria air pollutants based on their human health and other effects. The CAA then uses a complex mix of federal technology-based pollution controls imposed on major industrial sources, tailpipe standards imposed on motor vehicle manufacturers, and to a lesser extent, measures designed to induce states to control other sources, such as dry cleaners and automotive repair shops.[140]

The technology-based requirements imposed on industry and auto manufacturers are the centerpiece of the CAA ozone control requirements. The stringency of the technology-based controls on major industrial sources has increased over time and has reduced emissions on a per-source basis by a substantial percentage.[141] Similarly, the per-vehicle tailpipe emissions standards imposed on auto manufacturers have become increasingly stringent and have reduced per-vehicle emissions by up to 90 percent.[142] EPA and the states also have imposed regulations on consumer product manufacturers that limit the ozone precursors in some consumer products.[143]

Efforts to control individual behavior through command and control regulation have been far more limited and far less successful. For example, the CAA includes provisions (strengthened in the 1990 Clean Air Act Amendments) that require EPA to impose tough inspection and maintenance (sometimes called "smog check")

140. Smaller sources, such as dry cleaners and automotive repair shops, are often identified as "area sources" and are subject to controls in the State Implementation Plans (SIPs) adopted by some states. *See* REITZE, *supra* note 94, at 58. The CAA requires each state to develop and receive EPA approval of an SIP that outlines how the state will ensure that its air quality meets federal standards. *See* 42 U.S.C. § 7410(a)(1) (2000). If a state fails to submit an adequate SIP it may be subject to sanctions such as the withholding of federal highway funds and ultimately EPA may be required to promulgate a Federal Implementation Plan (FIP). *Id.* §§ 7410(c), 7509(b)(1).

141. Reductions in the per-facility release of ozone precursors from major industrial sources have been in the range of 30 percent for NOx and 45 percent for VOCs. REITZE, *supra* note 94, at 33.

142. EPA tailpipe emissions standards for motor vehicles required by the 1990 Clean Air Act Amendments (the "Tier I" standards) reduced per-vehicle tailpipe emissions during the 1990s. *See* REITZE, *supra* note 94, at 280. New tailpipe standards (the "Tier II" standards) are expected to lead to further declines in per-vehicle NOx and VOC emissions beginning in 2004, but these reductions are expected to be offset to some extent by further increases in the number of vehicles and VMT per vehicle. EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at 3-6 to 3-7 (noting that under the Tier II standards, cars will be required to reduce NOx emissions by 77 percent and trucks and SUVs will be required to reduce emissions by up to 95 percent).

143. *See, e.g.*, Clean Air Act § 183(e), 42 U.S.C. § 7511b(e) (2000); National Volatile Organic Compound Emission Standards for Consumer Products, 63 Fed. Reg. 48,819 (Sept. 11, 1998) (codified at 40 C.F.R. pts. 9 & 59) (promulgating VOC emissions standards for consumer products).

requirements for automobile owners in air quality regions that fail to meet the ozone NAAQS.[144] Although these programs have been shown to reduce per-vehicle emissions by ensuring that tailpipe emissions controls are functioning, they have been very unpopular and have been rejected outright in some areas.[145] Perhaps the least popular EPA efforts have been those that have imposed or have induced states to impose transportation control measures that restrict the frequency or speed of vehicle use.[146] For example, an EPA effort to require the Los Angeles area to adopt vehicle use limitations in the early 1970s produced an uproar and resulted in amendments to the Clean Air Act barring EPA from further efforts to impose such requirements.[147]

144. *See, e.g.*, Clean Air Act § 182(c)(3)(C); Vehicle Inspection and Maintenance Program for State Implementation Plans, 57 Fed. Reg. 52,950 (Nov. 5, 1992) (codified at 40 C.F.R. pt. 51). The inspection and maintenance requirements also are required for areas that are designated as nonattainment for carbon monoxide. For an overview of the vehicle inspection and maintenance program, see McGarity, *supra* note 36.

145. *See* Vehicle Inspection and Maintenance Program for State Implementation Plans, 57 Fed. Reg. 31,058, 31,059 (proposed July 13, 1992) (codified at 40 C.F.R. pt. 51) (concluding that inspection and maintenance programs may reduce auto emissions up to 24 percent); *see also* McGarity, *supra* note 36, at 1578-1600 (describing the negative reactions by states to adoption of enhanced inspection and maintenance programs). In addition, Section 182(d)(1)(B), which was added in the 1990 CAA Amendments, required EPA to develop an employee trip reduction program. 42 U.S.C. § 7511a(d)(1)(B). Although the program was directed at large employers, it was very unpopular and Congress removed the provision from the CAA in 1995. *See* Pub. L. No. 104-70, 109 Stat. 773 (1995); Oren, *supra* note 123, at 143-44.

146. Clean Air Act § 108(f) requires EPA to publish information regarding transportation control measures. 42 U.S.C. § 7408(f). Many control measures are designed to change behavior by combining positive and negative incentives. Measures to make driving less appealing include reducing the amount of parking available, increasing charges for parking, increasing bridge and road tolls, and restricting certain lanes to high occupancy vehicles during peak hours. Other measures create incentives to make carpooling and public transit more appealing. For example, some cities pay owners of older cars to "scrap" their old, inefficient cars. *See* TRANSP. AIR QUALITY CTR., EPA, TRANSPORTATION CONTROL MEASURES: ACCELERATED VEHICLE RETIREMENT 2 (1998), http://yosemite.epa.gov/aa/tcmsitei.nsf/9bd6f3b7217f80c28525652f0053e105/c2f7e1d6b69ece73852565d90075b889/$FILE/S98001.pdf. Approximately 8,400 pre-1971 cars were scrapped in Los Angeles in the early 1990s. *Id.*

147. Section 110(a)(2)(B) of the 1970 CAA Amendments required that SIPs include control measures "including but not limited to land use and transportation controls" if other measures were inadequate to achieve the NAAQS. Clean Air Act Amendments of 1970, Pub. L. No. 91-604, 84 Stat. 1676, 1680 (amended by Pub. L. No. 95-95, § 108(a)(2), 91 Stat. 685, 693 (1977) (codified as amended at 42 US.C. § 7410(a)(2)(B) (2000))); *see also* Clean Air Act Amendments of 1990, Pub. L. No. 101-549, 104 Stat. 2689 (codified at 42 U.S.C. § 7410(a)(2)) (prohibiting EPA from interfering with local governments' authority "to plan or control land use"). For a discussion of EPA's effort to impose transportation control measures on the Los Angeles area, see Eli Chernow, *Implementing the Clean Air Act in Los Angeles: The Duty to Achieve the Impossible*, 4 ECOLOGY L. Q. 537, 548 (1975) (discussing the transportation control measures included in the federal implementation plan for the Los Angeles area) and Craig Oren, *How a Mandate Came from Hell: The Makings of the Federal Employee Trip Reduction Program*, 28 ENVTL. LAW. 267, 278 (1998) (noting that the federal implementation plan drafted by EPA for the Los Angeles area triggered such an adverse public reaction that according to one former EPA administrator "[t]he foundations of EPA are still trembling"). The adverse reactions to EPA efforts to use

Similarly, state and local efforts to reduce emissions by reducing speed limits have been hugely unpopular. An effort in 2002 to reduce speed limits to 55 miles per hour in the Houston area provoked outrage and was ultimately withdrawn.[148]

Despite the promulgation of various emissions control regulations following the enactment of the Clean Air Act in 1970, and improvements in ambient levels of ozone and other air pollutants, there are indications that the requirements directed principally at large industrial sources and motor vehicle tailpipe emissions have hit a wall.[149] After improving during the 1970 to 1990 period, ambient ozone levels leveled off and in some cases began to rise in the 1990s. In the period between 1970 and 1998, ozone precursor emissions nationally decreased by roughly 18 percent,[150] and ambient levels improved during the 1980-1999 period, with one-hour levels declining by 20 percent and eight-hour levels decreasing by 12 percent.[151] These

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transportation control measures to limit driving were not restricted to the Los Angeles area. For example, EPA proposed a plan for Boston during the early 1970s that would have reduced the number of cars on the road by 20 percent. *See* Thomas B. Bracken, *Transportation Controls Under the Clean Air Act: A Legal Analysis*, 15 B.C. INDUS. & COM. L. REV. 749, 758 (1973-74). To achieve this goal, the plan provided that each car would be issued a sticker in one of five possible colors. *Id.* On each weekday, all cars with a specific color sticker would not be allowed on the roads. This would have required commuters to arrange for alternate transportation on one day each week, and the "intensity of public opposition" resulted in it never being implemented. *Id.*

148. *See, e.g.*, Tony Freemantle, *55 MPH Begins Signing Off Freeways This Week*, HOUS. CHRON., Nov. 5, 2002, at A1. The 55 mile per hour speed limit was announced in May 2002 hut was reversed on Monday, November 4, 2002. *Id.* Opponents of the speed limit increase criticized the governor for using his office to gain a political advantage by announcing the return to higher speed limits just before the election. *Id.*; *see also* Rad Sallee, *Officials Push Pedal on Demise of 55 Limit*, HOUS. CHRON., Nov. 2, 2002, at A1 (describing the 55 mile per hour speed limit as "[d]espised and ignored since it was imposed"). Reductions in speed limits can lead to substantial reductions in vehicle emissions of ozone precursors. *See* OFFICE OF POLICY PLANNING & EVALUATION, EPA, THE EFFECTS OF RAISING SPEED LIMITS ON MOTOR VEHICLE EMISSIONS (1997), http://www.epa.gov/otaq/invntory/spd2-rpt.pdf.

149. Total NOx emissions from all sources increased almost 17 percent between 1970 and 1998. EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at 3-3 & tbls. 3-2, 3-3 (identifying total emissions of NOx and VOCs by decade). During the same period, VOC emissions decreased by almost 58 percent. *Id.*

150. *See id.* at tbl. 3-3. As discussed above, an interesting trend is that NOx emissions over this thirty year period have actually increased slightly, while VOC emissions have dropped significantly. *Id.* (noting that 1970 NOx production was 20,928,000 tons as compared to 24,450,000 tons in 1998 and 1970 VOC production was 30,982,000 as compared to 17,920,000 tons in 1998).

151. *See* OFFICE OF AIR & RADIATION, EPA, NATIONAL AIR QUALITY & EMISSIONS TRENDS REPORT 1999, at 30 (2001) [hereinafter EPA, 1999 AIR QUALITY REPORT] (noting that EPA uses "the composite mean of the annual second-highest daily maximum 1-hour ozone concentration" as the statistic to evaluate trends in one-hour ozone standard compliance and "the annual fourth-highest 8-hour daily maximum ozone concentration" as the statistic to evaluate trends in eight-hour standard compliance), http://www.epa.gov/air/aqtrnd99/toc.html. The report concludes that the data must be interpreted with caution given changes in monitoring techniques over the 1980-1999 period, but it concludes that although one-hour ozone levels improved by 20 percent

gains largely were accomplished before the 1990s, however. The one-hour ozone levels demonstrated only modest improvement in the 1990-1999 period, and the eight-hour ozone levels did not improve.[152] An analysis by geographic region demonstrates that although ozone levels decreased in all regions of the country when the 1980-1999 period is examined in the aggregate, over the last decade of that period (1990-1999), both one-hour and eight-hour ozone levels increased in the Southeast, Mid-Atlantic, Midwest, and North Central regions. Similarly, the eight-hour ozone concentrations in rural areas increased nationwide, and concentrations in twenty-five national parks increased by almost 8 percent during the 1990-1999 period.[153]

The leveling off of ozone levels in recent years can be explained in part by examining individuals as a source category. In particular, the contribution of motor vehicles to low-level ozone demonstrates how population growth, along with individuals' consumer product choices, activity levels, and activity locations, has muted the environmental effects of regulation in recent years. On-road motor vehicles contributed 35 percent of the NOx emissions and 42 percent of the total VOC emissions in the United States in 1970. By 1998, on-road motor vehicles contributed 33 percent of NOx emissions and 30 percent of VOC emissions.[154] The relatively stable percentage of total NOx and VOC emissions contributed by on-road motor vehicles is the result of the substantial reductions in per-vehicle tailpipe emissions being offset by several factors. Shifts in consumer product choices have occurred from smaller, less polluting vehicles to larger, more

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over this period, they leveled off in the last decade, showing only a 4 percent decrease. *Id,* National eight-hour ozone levels decreased 12 percent over the same 20-year period, but no progress has been made over the last decade. *Id.*

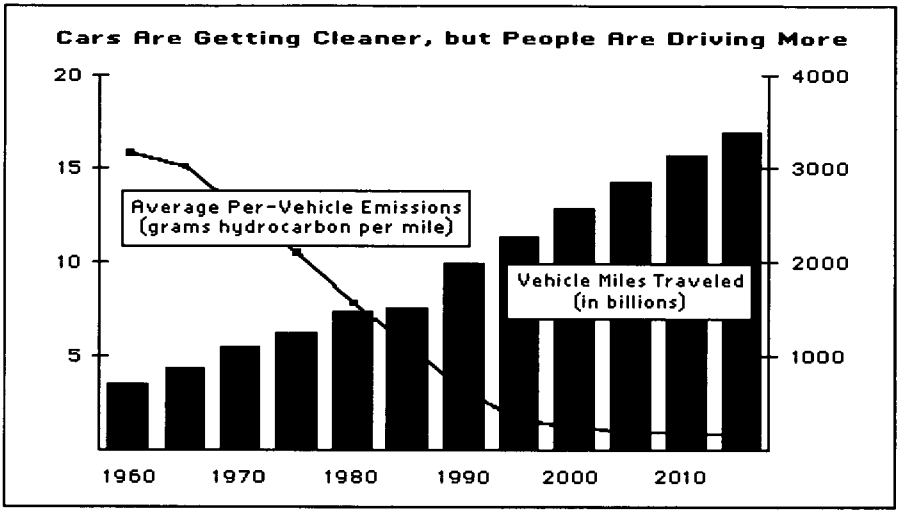
152. *Id.*

153. *Id.* at ES-1, 29, 36 (identifying the increase in one-hour ozone levels in certain urban and rural areas as a national trend "worth noting" and attributing the increases in one-hour and eight-hour ozone levels to increases in NOx emissions and weather conditions favorable to ozone formation). One-hour ozone levels decreased 15 percent between 1981 and 1994, and remained between 0.10 ppm and 0.12 ppm from 1994 to 2000. *See id.* at 33.

154. EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at 3-6 (reporting that VOC emissions from on-road vehicles have declined by approximately 59 percent since 1970, and that NOx emissions levels from on-road vehicles are slightly higher than they were in 1970 due to the more than doubling in VMT during that period). The EPA also has concluded that in 1970 on road motor vehicles contributed 35 percent of NOx emissions and 42 percent of VOC emissions. *See id.* EPA data indicate that on-road motor vehicles contributed 32.7 percent of NOx emissions in 1998 and 30 percent of VOC emissions. *See id.* at tbls. 3-2, 3-3; *see also* EPA, NATIONAL AIR QUALITY AND EMISSIONS TRENDS REPORT 16, 22, 30 (1997) (concluding that the transportation sector contributes a greater percentage of total NOx and carbon monoxide emissions, and a stable share of VOC emissions), http://www.epa.gov/oar/aqtrnd97/brochure. Note that in 1997 the transportation sector overall accounted for approximately 76.6 percent of all carbon monoxide emissions, 39.9 percent of VOC emissions and 49.2 percent of NOx emissions. *Id.*

polluting pick-up trucks and SUVs.[155] In addition, increased population levels, increased activity levels, and population dispersal all have contributed to a more than doubling since 1970 of the number of vehicles on the road and the vehicle miles traveled (VMT).[156] Thus, although per-vehicle tailpipe emissions have decreased by as much as 90 percent since 1970, VMT is doubling roughly every twenty years.[157] The trends in VMT and per-vehicle tailpipe emissions are set forth in Figure 1 below.[158]

Figure 1:



155. For example, in the mid-1990s EPA estimated that SUVs release two-thirds more NOx and VOCs on an annual basis than automobiles. *See* Oren, *supra* note 123, at 166 n.156 (comparing EPA, ANNUAL EMISSIONS AND FUEL CONSUMPTION FOR AN "AVERAGE" PASSENGER CAR (1995) with EPA, ANNUAL EMISSIONS AND FUEL CONSUMPTION FOR AN "AVERAGE" LIGHT TRUCK (1995)). The disparity between SUVs and automobiles will narrow after the Tier II tailpipe standards are fully implemented in 2007, but SUVs and other heavier vehicles will continue to have greater environmental effects than lighter passenger vehicles.

156. EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at 3-6 (noting that VMT more than doubled between 1970 and 2000). The stability in individuals' emissions relative to other sources also is affected by the increasingly stringent emissions reduction requirements on industrial point sources. *See id.*; *see also* OFFICE OF MOBILE SOURCES, EPA, AUTOMOBILE EMISSIONS: AN OVERVIEW 1 (1994) [hereinafter EPA, AUTO EMISSIONS OVERVIEW], http://www.epa.gov/otaq/05-autos.htm.

157. For a discussion of VMT trends, see EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at 3-7; OFFICE OF MOBILE SOURCES, EPA, YOUR CAR AND CLEAN AIR: WHAT YOU CAN DO TO REDUCE POLLUTION (EPA 400-F-93-002) 1 (1994), http://www.epa.gov/otaq/consumer/18-youdo.pdf. Clean Air Act tailpipe standards for automobiles have required roughly 90 percent reductions in VOC emissions, and 75 percent in NOx emissions. *See* Clean Air Act § 202(b)(1)(A)-(B), 42 U.S.C. §§ 7521(b)(1)(A)-(B) (2000).

158. Figure 1 is reproduced from OFFICE OF MOBILE SOURCES, EPA, AUTOMOBILES AND OZONE, FACT SHEET OMS-4 (1993), http://www.epa.gov/otaq/invntory/overview/vmt.htm.

As a result of these trends, the reduction in the contribution of automobiles to ozone precursor emissions has been modest, and EPA has concluded that "in numerous cities across the country, the personal automobile is the single greatest polluter, as emissions from millions of vehicles on the road add up."[159]

In sum, individuals play a major role in the production of ozone precursors in the United States. Individuals contributed at least 30.6 percent of the total amount of ozone precursors produced in the United States in 1998, and potentially more.[160] Yet although regulatory measures in some cases have been directed at the manufacturers of consumer products, they rarely have been directed at changing individual behavior. Those that have been directed at individual behavior have met with widespread resistance. Not surprisingly, a large portion of the country continues to have air that does not meet the NAAQS for ozone.

2. Mercury

EPA has identified mercury as a persistent, bioaccumulative toxic (PBT) chemical.[161] PBT chemicals are of particular concern

159. *See, e.g.*, EPA, AUTO EMISSIONS OVERVIEW, *supra* note 156, at 1, 4; *see also* OFFICE OF MOBILE SOURCES, EPA, ENVIRONMENTAL FACT SHEET: TRANSPORTATION CONTROL MEASURES 2 (1997) (noting that "technology has reached a point where further refinements to emissions controls would produce only minor reductions in emissions, and at large cost. . . . If present trends continue, the increase in vehicle emissions due to increases in the total number of vehicles on the road, and the amount they are driven, will overwhelm the benefits gained from improved emission controls on vehicles.").

160. Individuals also contribute to the production of ozone precursors through other activities that were not included in the 30.6 percent estimate. The potential additional contributions include the following: (1) household waste disposal; (2) consumer adhesive use; (3) use of additional types of non-road motor vehicles, such as marine diesel vehicles and private airplanes; (4) vehicle fires; (5) yard waste and backyard barrel burning; (6) residential wood combustion; and (7) others. *See, e.g.*, EPA, EMISSION INVENTORY IMPROVEMENT PROGRAM DOCUMENT SERIES VOLUME III AREA SOURCES 2.2-1 (2001) (noting that residential wood combustion generates NOx and hydrocarbons), http://www.epa.gov/ttn/chief/eiip/techreport/volume03.

161. Mercury is one of 16 PBT chemicals on the TRI list, and mercury compounds are one of four PBT chemical categories. Persistent Bioaccumulative Toxic (PBT) Chemicals; Lowering of Reporting Thresholds for Certain PBT Chemicals; Addition of Certain PBT Chemicals; Community Right-to-Know Reporting, 64 Fed. Reg. 58,666 (Oct. 29, 1999) (codified at 40 C.F.R. § 372.65) [hereinafter EPA, PBT List] (adding PBT chemicals to the TRI list). Mercury also is one of EPA's 30 Waste Minimization Priority Chemicals. EPA, WASTE MINIMIZATION PRIORITY CHEMICALS & CHEMICAL FACT SHEETS [hereinafter EPA, WASTE MINIMIZATION LIST], http://www.epa.gov/epaoswer/hazwaste/minimize/chemlist.htm (last modified Feb. 25, 2004). In addition, "mercury compounds" are listed as hazardous air pollutants under Clean Air Act Section 112(b)(1), 42 U.S.C. § 7412(b)(1) (2000). EPA also has identified mercury as one of the 33 air toxics "that present the greatest threat to public health in the largest number of urban

because they do not degrade quickly in the environment and accumulate in the food chain. Human exposure to mercury may cause acute and chronic health effects. Acute exposure at high levels results in central nervous system effects such as tremors and slowed motor nerve function.[162] Even at low levels, mercury exposure over long periods of time can have several adverse effects, including central nervous system disorders.[163] In recent years, elevated concentrations of mercury have been detected in fresh and salt water fish, and 95 percent of all human exposure to mercury arises from fish consumption.[164] In fact, California recently sued several restaurants for failing to post warnings regarding the mercury concentrations in several types of popular fish.[165]

a. Individual Contribution

For mercury and several other pollutants, sufficient data exist to allow a comparison of individual contributions with the emissions contributed by the large industrial facilities that are subject to TRI reporting.[166] Table 2 provides a comparison of the releases of mercury from individuals and households versus large industrial facilities.

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areas." EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at 7-2 & tbl. 7-1. Mercury and mercury compounds also were included in the EPA 33/50 Program, a voluntary initiative announced in 1989 that selected 17 chemicals for voluntary industry reductions. OFFICE OF POLLUTION PREVENTION & TOXICS, EPA, 33/50 PROGRAM: THE FINAL RECORD 1 (1999) [hereinafter EPA, 33/50 PROGRAM], http://www.epa.gov/opptintr/3350/3350-fnl.pdf.

162. *See* OFFICE OF TRANSP. AND AIR QUALITY, EPA, TECHNICAL SUPPORT DOCUMENT: CONTROL OF EMISSIONS OF HAZARDOUS AIR POLLUTANTS FROM MOTOR VEHICLES AND MOTOR VEHICLES FUELS 69 (2000) [hereinafter EPA, CONTROL OF MOBILE SOURCE HAPS] (noting that inhaling high-levels of mercury also can result in kidney damage), http://www.epa.gov/otaq/regs/toxics/r00023.pdf .

163. *Id.*

164. MARQUITA K. HILL, UNDERSTANDING ENVIRONMENTAL POLLUTION 217 (1997).

165. *See, e.g.*, California v. Bennigans, et al., No. bc293749 (Cal. Super Ct. filed Apr. 10, 2003); *see also* Pat Phibbs, *Mercury: California Says Restaurants Failed to Warn Customers About High Levels*, DAILY ENV'T REP. (BNA), A-8 (Apr. 14, 2003).

166. For some substances, sources other than individuals and large industrial facilities are responsible for substantial quantities of overall emissions as well. For example, for some air pollutants, "area sources," consisting in large part of small businesses (such as dry cleaners and auto repair shops) may emit small amounts of toxics per business, but large amounts in the aggregate. The emissions from these types of sources are often not quantified, however, and with several exceptions are not included in the comparisons. *See* EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at 7-1, 7-4 (noting that "smaller area sources" of air toxics include sources "such as neighborhood dry cleaners" and that an "area source" of air toxics is "any stationary source . . . that does not qualify as a major source" under Clean Air Act Section 112(a)). EPA has read "smaller area sources" to mean "smaller *industrial* sources," however. National Air Toxics Program: The Integrated Urban Strategy, 64 FED. REG. 38,706 (July 19,1999) [hereinafter EPA, Urban Air Toxics Strategy] (describing the strategy required by Clean Air Act Section 112(c)(3)

Table 2:

Sources of Mercury (in pounds)

Emissions Type	*Individual Amount*	*Large Industries Amount*	*Combined Total*	*Individual Percentage of Total*
Air	33,538	117,743	151,281	22%
Wastewater	1,749	1,805	3,554	49%
Land	20,000	228,283	248,283	8%
Total	**55,287**	**347,831**	**404,118**	**14%**

The relative contributions of individuals and large industrial sources to mercury releases are difficult to establish because mercury is released in many ways to air, water, and land, and estimates of mercury releases vary widely.[167] Nevertheless, the contributions of individuals from several types of activities can be quantified and compared to the releases from large industrial facilities. As with ozone, one individual activity that releases mercury is the residential use of electricity that is generated by fossil fuel-fired electric utilities. Coal-fired utilities are a primary source of air emissions of mercury in

and (k) as "including 30 [hazardous air pollutants] specifically identified as being emitted from smaller industrial sources known as 'area sources' ").

167. *See, e.g.,* EPA, MERCURY STUDY REPORT TO CONGRESS VOL. II: AN INVENTORY OF ANTHROPOGENIC MERCURY EMISSIONS IN THE UNITED STATES ES-6 (1997) [hereinafter EPA, 1997 MERCURY REPORT] (estimating that during the 1994-1995 period annual mercury emissions were 158 tons or 316,000 pounds, including 141 tons or 282,000 pounds from "point sources," a category that includes large industrial facilities as well as other sources); OFFICE OF ENVTL. INFO., EPA, 2001 TOXICS RELEASE INVENTORY PUBLIC DATA RELEASE REPORT tbl. 3-34 (1996) [hereinafter EPA, 2001 TRI PUBLIC DATA RELEASE] (indicating that in 2001 all large industrial facilities reported releasing 150,463 pounds of mercury). The mercury-emitting facilities that are subject to TRI reporting changed significantly for the 1998 reporting year with the addition of electric utilities and mining. *See* Addition of Facilities in Certain Industry Sectors; Revised Interpretation of Otherwise Use; Toxic Release Inventory Reporting; Community Right-to-Know, 62 Fed. Reg. 23,834 (May 1, 1997). For example, metal mining contributed roughly 88 percent and electric utilities contributed roughly 3 percent of all TRI-reported on-site and off-site releases of mercury and mercury compounds in 2001. EPA, 2001 TRI PUBLIC DATA RELEASE, *supra,* at 3-54, 3-57. Thus, prior to the addition of utilities and mining to the TRI database, TRI emissions accounted for a small percentage of the overall mercury air emissions. OFFICE OF ENVTL. INFO., EPA, TRI EXPLORER DATABASE (1996) [hereinafter EPA, 1996 TRI EXPLORER DATABASE] (noting that the air releases from TRI facilities totaled approximately 8.6 tons of mercury and mercury compounds in 1996); *see also* EPA, CONTROL OF MOBILE SOURCE HAPS, *supra* note 162, at tbl. IV.A-1 (identifying mercury emissions from mobile sources).

the United States,[168] and approximately 35.7 percent of all electricity generated from electric utilities is for residential use.[169] As a result, if the residential share of all electricity consumption is the same as the residential share of all electricity generated by fossil fuel-fired units, in 2001 individuals accounted for 32,538 pounds of the total mercury released by utilities to the air.[170]

Individuals also release mercury from the use of mobile sources.[171] Although cars, light-duty trucks, and on-road motorcycles do not contribute measurable amounts of mercury, mercury emissions do occur from the two-stroke and four-stroke gasoline engines of non-road motor vehicles.[172] Individuals contributed approximately 1,000 pounds of mercury through the use of these mobile sources.[173] When added to the 32,720 pounds generated from electric utility use, the resulting 33,538 pound total[174] is 22 percent of the combined total releases to air by individuals and all large industrial facilities.[175]

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168. *See* EPA, 1997 MERCURY REPORT, *supra* note 167, at ES-10 (noting that coal-fired utilities released roughly 33 percent of all anthropogenic mercury air emissions in the 1994-1995 period); Barry J. Goehler, *Control of Mercury Emissions from Coal-Fired Electric Power Plants*, 9 ENVTL. LAW. 119, 136 (1996) (noting that mercury air emissions from coal-fired electric utilities in 1994 were 51.34 tons).

169. *See* sources cited *supra* note 118. In addition to coal, fossil fuel-fired utilities may burn oil or natural gas.

170. EPA, 2001 TRI PUBLIC DATA RELEASE, *supra* note 167, at tbl. 3-41 (indicating that in 2001, the mercury air emissions from large industrial sources were 150,463 pounds, and that electric utilities contributed 91,144 pounds of that amount).

171. Mobile sources as a whole only contributed 6.8 tons of mercury air emissions in 1996, or 4.2 percent of all air emissions of mercury in that year. OFFICE OF TRANSP. & AIR QUALITY, EPA, THE PROJECTION OF MOBILE SOURCE AIR TOXICS FROM 1996 TO 2007: EMISSIONS AND CONCENTRATIONS fig. 2 (2001) [hereinafter EPA, MOBILE SOURCE PROJECTION], http://www.epa.gov/otaq/regs/toxics/r01038.pdf; EPA, 2001 TRI PUBLIC DATA RELEASE, *supra* note 167, at tbl. 3-46 (noting that in 2001, electric utilities reported 148,394 pounds (74.2 tons) of mercury released both on-site and off-site, of which 91,144 pounds (45.4 tons) were released into the air).

172. EPA, MOBILE SOURCE PROJECTION, *supra* note 171, at tbl. 6.

173. In 1996, individuals contributed 1,000 pounds of mercury from all mobile sources. *Id.* As discussed below, individuals also contribute to mercury air emissions when mercury vapors are released from fluorescent and certain other bulbs (e.g., if they are broken during use or when they are discarded). Although the total quantity of mercury released to the air from all fluorescent bulbs has been estimated to be 8,800 pounds per year, the share attributable to individuals is unclear and this source was not included in the total. *See* EPA, 1997 MERCURY REPORT, *supra* note 167, at fig. 3-1 (estimating 4.0 megagrams or metric tons per year released to air from mercury in discarded lamps). A metric ton can be converted to a U.S. short ton by multiplying by 1.1023. *See* EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at 1-4. Thus, a total of 4.4 U.S. short tons or 8,800 pounds were released to the air through lamp breakage.

174. The 0.5 ton figure is 0.3 percent of the total national mercury air emissions and 6 percent of the total releases reported in 1996 by all TRI facilities. EPA, MOBILE SOURCE PROJECTION, *supra* note 171, at tbls. 6, 9. The individual contribution to mercury air emissions from mobile sources is comprised solely of the emissions from gasoline powered 2-stroke and 4-stroke engines of non-road motor vehicles. *Id.* at 25. Individuals were assumed to be responsible

In addition, a rough estimate of the releases of mercury to wastewater can be derived from the data in several reports.[176] According to a study conducted by the Association of Metropolitan Sewerage Agencies (AMSA), the concentration of mercury in domestic wastewater is 138 nanograms (ng) of mercury per liter (L) of water.[177] Remarkably, common household products and toiletries make up approximately 15 percent of the total mercury found in domestic wastewater.[178] Household products that may include trace amounts of mercury include shaving cream, deodorants, soap, shampoo, toothpaste, mouthwash, detergents, soft drinks, and some foods.[179] Based on an average water flow, the AMSA study suggests that an average household contributes 20.6 ng/L of mercury in wastewater,

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for all of these emissions because this category only includes lawn and garden equipment, recreational marine equipment, all-terrain vehicles, off-highway motorcycles, and snowmobiles.

175. The 22 percent figure was arrived at by dividing the 33,538 pound total attributable to individuals by 151,281 pounds. The 151,281 pound figure is the sum of the 117,743 pound total air release figure from industry that is not attributable to individuals and the 33,538 pounds that are attributable to individuals.

176. AMSA conducted the study to evaluate the contribution of domestic sources to mercury contamination of wastewater. AMSA, DOMESTIC SOURCES OF MERCURY, *supra* note 99, at 7.

177. *Id.* at 3. A nanogram (ng) is a billionth of a gram.

178. *Id.* at 7. The source of the remaining 85 percent is unclear according to the AMSA report, although the report concludes that mercury present in human waste may constitute as much as 83 percent of the total quantity of mercury in domestic wastewater. *Id.* at 10-11. The sources of the mercury in human waste in large part may arise from mercury in dental fillings. *Id.* at 11. Silver dental amalgams include up to 50 percent mercury, and although they can be placed on teeth, if removed they must be treated as a toxic substance. *See* Byron Swift, *A Better, Cheaper Way to Regulate Mercury*, 29 ENVTL. REP. 1721, 1725 (1999). In addition, the AMSA report notes that improper disposal of thermometers may contribute as much as an average of six grams per day of mercury to domestic wastewater. AMSA, DOMESTIC SOURCES OF MERCURY, *supra* note 99, at 12 (citing a study that estimated that on an annual basis approximately 1.6 percent of all households discarded a thermometer to the sewer and that each thermometer released 0.5 grams of mercury). Other contributions identified in the AMSA study include infiltration and inflow into the sewer system, mercury used in religious rituals and folk medicine, and the use of thimerisol, a preservative, in some vaccines. *Id.* at 12-13.

179. For example, the AMSA study evaluated various products and found that mercury concentrations in soap and shampoo ranged from 835 ng/L to 25,000 ng/L, shaving cream ranged from 90 ng/L to 670 ng/L, soft drinks and drink mixes ranged from 25 ng/L to 6,070 ng/L, food coloring ranged from 96 ng/L to 137,000 ng/L, and fruits and vegetables ranged from 116 ng/L to 874 ng/L. AMSA, DOMESTIC SOURCES OF MERCURY, *supra* note 99, at 7. The AMSA Study concluded that household and toiletry items "were found to contain substantial concentrations of mercury," but that "the feasibility of controlling these sources would require a national effort." *Id.* at 13. Overall, the study concluded that "domestic waste contributes appreciable concentrations of mercury to POTW influent waste streams and must be considered when addressing mercury control strategies and the likelihood of virtual elimination of mercury. Background mercury concentrations averaging more than 100 ng/L can be expected in POTW wastewater influents, even if complete elimination of industrial point source discharges is accomplished." *Id.* at 14.

which amounts to 0.075 grams of mercury annually.[180] Although this is a minute amount, when the total is multiplied by the number of households in the country, the total quantity released annually to wastewater from all households in the United States is 1,749 pounds.[181] In comparison, the total quantity released to surface water from all large industrial facilities in 2001 was 1,805 pounds.[182] The quantity of mercury released to water by households thus is roughly equivalent to the quantity released to surface water from all large industrial facilities.

Individuals also release substantial quantities of mercury to land. Household product use contributes to mercury concentrations in landfills and other areas (e.g., through roadside and other dumping). Individuals release mercury through the disposal of batteries, fluorescent lighting, thermometers, discarded electrical equipment, thermostats, and other household products.[183] The amount of mercury in household batteries has declined significantly in recent years, but one projection in the mid-1990s estimated that at least 198,000 pounds of mercury would still be released annually as of 2000.[184] In

180. AMSA, DOMESTIC SOURCES OF MERCURY, *supra* note 99, at 10. According to the AMSA study, "average household flow" is 545,040 liters (144,000 gallons) per year. *Id.* When the concentration of mercury in domestic wastewater (138 ng/L) is multiplied by the quantity of wastewater generated per year (545,040 liters), a total quantity of mercury released per year per household can be determined (0.075 grams).

181. To calculate the total quantity of mercury released to domestic wastewater, this profile utilized the AMSA report figures (138 ng/L) for the domestic wastewater mercury concentration, and household wastewater quantity (45,420 L/month or 545,040 L/year). *Id.* at 3, 8. The 138 ng/L was multiplied by 545,000 L/year of domestic wastewater to arrive at 75,215,520 nanograms. The 75,215,520 nanograms figure was divided by 1,000,000,000 to arrive at .0752155 grams per year. The .0752155 grams per year figure was then multiplied by 105,480,101 households to arrive at 793,373.84 g/year released from all households. One pound includes approximately 453.6 grams. *See* WILLIAM L. MASTERTON & EMIL J. SLOWINSKI, CHEMICAL PRINCIPLES: USING THE INTERNATIONAL SYSTEM OF UNITS 9 tbl. 1 (4th ed. 1977) (providing conversion tables). The 793,373.84 g/year figure divided by 453.6 grams per pound yields a total of 1749.1 pounds.

182. To compare the total releases of mercury to surface water from industry and the total in wastewater from households, compare EPA, 2001 TRI PUBLIC DATA RELEASE, *supra* note 167, at 3-57, with AMSA, DOMESTIC SOURCES OF MERCURY, *supra* note 99, at 3, 7-10.

183. *See* EPA, 1997 MERCURY REPORT, *supra* note 167, at 4-18.

184. *See* HILL, ENVIRONMENTAL POLLUTION, *supra* note 164, at 215 tbl. 9.1. In addition, a 1992 study projected that although the mercury in consumer batteries would decline by the year 2000, consumer batteries would still comprise 56 percent of the total quantity of mercury in municipal solid waste. David J. Hurd, *Getting a Charge Out of the Waste Stream: The Status of Consumer Battery Recovery,* RESOURCE RECYCLING 42, 44 (1992). The current percentage of all batteries containing mercury that are used by private individuals and the quantity of mercury released through battery use and disposal are unclear. *See, e.g.,* Jeremy Arling, *Recycling & Take-Back Opportunities for Batteries, With Particular Attention to Household Alkaline Batteries,* 34 ENVTL. L. REP. 10347, 10359 (2004) (concluding that "[t]here is a severe lack of public data regarding the composition of the battery market"). As of the late 1990s, however, consumers used roughly four billion batteries per year, or roughly fifteen per individual in the United States, and consumer batteries resulted in roughly 146,000 tons of waste per year. *See*

addition, fluorescent bulbs in use in 2000 contained an estimated 82,000 pounds of mercury.[185] The percentage of batteries and fluorescent bulbs used and discarded by individuals, and the amount of mercury in each battery and fluorescent bulb are unknown. As a result, the quantity of mercury attributable to the disposal of batteries and fluorescent bulbs by individuals and households is not possible based on the available data. Even if only 5 percent of the mercury from the projected 2000 battery disposal nationwide is attributed to individuals (approximately 10,000 pounds), however, and a small amount from fluorescent bulbs, thermometers and other consumer products (10,000 pounds), then the individual total released to land is 20,000 pounds, as compared to a total of 228,283 pounds released to off-site disposal by all large industrial facilities combined in 2001.[186]

b. Regulatory Response

Although mercury emissions from many large industrial sources to air, water, and land are regulated, few restrictions have been placed on individual behavior relating to mercury. For example, an individual who disposes of mercury on the ground or in household waste might be subject, at least in theory, to the federal statutes governing the disposal of hazardous wastes (the Resource Conservation and Recovery Act)[187] or the release of hazardous

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Gary A. Davis, Catherine A. Wilt, Patricia S. Dillon & Bette K. Fishbein, Extended Product Responsibility: A New Principle for Product-Oriented Pollution Prevention 6-5 (1997) (unpublished report on file with the author). At the same time, the amount of mercury in batteries has declined substantially, and the total quantity released from consumer battery use and disposal may now be far less than the 198,000 pound estimate, which is based on a projection published in 1997. In particular, the Mercury-Containing and Rechargeable Battery Management Act, Pub. L. No. 104-142, became effective in 1996 and sharply restricts the amount of mercury in batteries. *See* Swift, *supra* note 178, at 1724. According to EPA, as of the late 1990s lead-acid batteries (e.g., automotive batteries) were the principal remaining batteries used by private individuals with mercury levels of significant concern. EPA, 1997 MERCURY REPORT, *supra* note 167, at 4-18.

185. HILL, *supra* note 164, at 219.

186. EPA, 2001 TRI PUBLIC DATA RELEASE 2001, *supra* note 167, at 3-57, tbl. 3-41.

187. The Resource Conservation and Recovery Act (RCRA) is silent on whether household hazardous wastes are subject to regulation. To be a hazardous waste, a substance must first be a solid waste. *See* RCRA Section 1004(5), (27), 42 U.S.C. § 6903(5), (27) (2000). The RCRA definitions of *solid waste* and *hazardous waste* make no reference to household waste, *id.*, but EPA excluded household hazardous wastes from RCRA regulation in 1980. The regulatory language states as follows: "(b) *Solid wastes which are not hazardous wastes.* The following solid wastes are not hazardous wastes: (1) Household waste. . . . 'Household waste' means any material (including garbage, trash, and sanitary wastes in septic tanks) derived from households (including single and multiple residences. . . .)". Hazardous Waste Management System: Identification and Listing of Hazardous Waste, 45 Fed. Reg. 33,084, 33,120 (Nov. 13, 1980) (emphasis in original) (codified at 40 C.F.R. pt. 261.4(b)(1)) [hereinafter EPA, 1980 Household Waste Exclusion]. EPA noted that this exclusion was not of a category of regulated entities, but

substances (the Comprehensive Environmental Response, Compensation and Liability Act or Superfund),[188] but in practice the behavior of private individuals has not been regulated under either statute.[189] Similarly, many states and localities have imposed

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rather a specific type of waste. *Id.* at 33,099. In excluding household hazardous wastes, the Agency relied on the following statement from the RCRA legislative history: "[The hazardous waste program] is not to be used to control the disposal of substances used in households or to extend control over general municipal wastes based on the presence of such substances." *Id.* (quoting S. Rep. No. 94-988, 94th Cong., 2nd Sess., at 16). EPA also stated that it "believes that medicinal drugs and ointments, household cleaning agents and solvents, waste oils, paints and pesticides purchased at grocery, drug, or hardware stores may be disposed of as part of a consumer's household waste." *Id.* EPA expanded the exclusion in 1984 to include wastes from campgrounds, picnic grounds and similar areas. Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Final Rule and Denial of Rulemaking Petition, 49 Fed. Reg. 44,978 (Nov. 13, 1984) (codified at 40 C.F.R. pt. 261.4(b)(1)). According to EPA, the household waste exclusion is limited by two criteria. First, the waste "must be generated by individuals on the premises of a temporary or permanent residence." *Id.* Second, the "waste stream must be composed primarily of materials found in the wastes generated by consumers in their homes." *Id.* Congress amended RCRA in 1984 and did not add language addressing hazardous wastes from individuals. *See* Hazardous and Solid Waste Amendments of 1984, Pub. L. No. 98-616, 98 Stat. 3221 (codified at scattered sections of 42 U.S.C.).

188. At least in theory, private individuals can be held liable under any of four categories under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA): owners and operators of a facility, former owners and operators, generators of hazardous substances, and transporters of hazardous substances. *See* 42 U.S.C. § 9607(a). For example, as to generators, CERCLA states that "any person who by contract, agreement, or otherwise arranged for disposal or treatment, of hazardous substances owned or possessed by such person" may be liable. 42 U.S.C. § 9607(a)(3). CERCLA defines a person as "an individual, firm, corporation, association . . . ." *Id.* § 9601(21). In the Small Business Liability Relief and Brownfields Revitalization Act (SBLRBRA) Congress exempted residential property owners who generate municipal solid waste from CERCLA liability. Small Business Liability Relief and Brownfields Revitalization Act, Pub. L. 107-118, §§ 102, 221, 222, 115 Stat. 2356 (Jan. 11, 2002) (codified at 42 U.S.C. § 107(p)(1)(a)).

189. As discussed above, although RCRA does not include an express exclusion for household hazardous waste, the RCRA regulations do exclude hazardous wastes generated by homeowners. *See* discussion *supra* note 187. Perhaps as a result, although more than seventy judicial decisions have cited the provision stating that the EPA Administrator may assess a civil penalty against any person, the defendant in nearly all these decisions has been a business or government agency, or an individual acting as an employee or owner of one of these organizations. *See, e.g.*, United States v. Charles George Trucking, Inc., 34 F.3d 1081 (1st Cir. 1994); W.R. Grace & Co. v. EPA, 959 F.2d 360 (1st Cir. 1992). The few cases in which private individuals have been a party generally have involved citizen suits brought against businesses and have not been cases in which private individuals are alleged to have violated RCRA. *See, e.g.*, Potter v. Asarco Inc., No. 8:96CV555, 1999 U.S. Dist. LEXIS 15763 (D. Neb. June 29, 1999); Davis v. Sun Oil Co., 953 F. Supp. 890 (S.D. Ohio 1996). As to CERCLA, prior to the SBLRBRA discussed above, a strict reading of the statute would have included private individuals in the categories of parties liable for response costs. EPA generally has not attempted, however, to impose CERCLA liability on individuals acting in a private capacity. *See, e.g.*, OFFICE OF ENFORCEMENT & COMPLIANCE ASSURANCE, EPA, ANNUAL REPORT ON ENFORCEMENT AND COMPLIANCE ASSURANCE ACCOMPLISHMENTS IN 1999 (2000) [hereinafter EPA, 1999 ENFORCEMENT ACCOMPLISHMENTS REPORT]. On rare occasions prior to the enactment of the SBLRBRA, private litigants sought to impose response costs on homeowners, *see, e.g.*, B.F. Goodrich v. Murtha, 840 F. Supp. 180 (D. Conn. 1993) (declining to grant a motion for summary

restrictions on the use of mercury by manufacturers in some consumer products and on the disposal of certain household hazardous wastes, but only rarely, if ever, have these provisions been enforced against private individuals.[190] Instead, many local governments have had more success by combining these restrictions with voluntary collection stations for mercury-containing products and other household hazardous wastes, and by implementing public information campaigns regarding household hazardous waste disposal.[191]

3. Air Toxics from Mobile Sources

EPA evaluates the releases of air toxics from two major categories of mobile sources: on-road vehicles (e.g., cars, trucks, and motorcycles) and non-road vehicles (e.g., recreational vehicles, construction equipment, and aircraft).[192] This section focuses on individuals' contributions from mobile sources to emissions of three

judgment against homeowners who disposed of municipal solid waste), but the SBLRBRA appears to foreclose most actions of this type in the future.

190. For a summary of state laws restricting the use of mercury in consumer products, see EPA, PRODUCT STEWARDSHIP: MERCURY IN PRODUCTS: STATE/LOCAL INITIATIVES (2002), http://www.epa.gov/epaoswer/non-hw/reduce/epr/products/mstate.html; *see also* 42 U.S.C. §§ 6942-43 (authorizing states to implement solid waste management plans upon EPA approval). Using this authority, many states have increased fees for landfill disposal and banned disposal of specific items. Increased disposal fees create an incentive to reduce the quantity of waste sent to landfills, but this incentive is "at best indirect, affecting municipalities rather than individuals." Richard L. Revesz, *Federalism and Environmental Regulation: A Public Choice Analysis,* 115 HARV. L. REV. 553, 610 (2001). In contrast, disposal bans directly affect individuals by prohibiting the disposal of specific items with the rest of their household trash. These hans have become more common during the 1990s. For example, according to a 1992 survey, 33 out of 37 states had disposal bans on vehicle batteries, 22 on tires, and 12 on oil. Jim Glenn, *The State of Garbage in America*, BIOCYCLE, May 1992, at 30, 33 tbl. 5. According to a 2000 survey, 32 out of 40 states had disposal bans on vehicle batteries, 30 on tires, and 19 on oil. Nora Goldstein & Celeste Madtes, *The State of Garbage in America*, BIOCYCLE, Nov. 2000, at 40, 48 tbl. 5. Other items banned include specific types of batteries (other than car batteries), antifreeze, and products containing mercury. To enahle consumers to dispose of these products, some states require manufacturers to take them back and tben dispose of them. Glenn, *supra*, at 32.

191. Many state and local governments provide educational information and try to make disposal convenient to encourage residents to manage their hazardous waste disposal. *See, e.g.*, Cal. Integrated Waste Mgmt. Bd., Household Hazardous Waste, *at* http://www.ciwmb.ca.gov/hhw (last modified Apr. 16, 2004); Tenn. Dep't of Env't & Conservation, Household Hazardous Waste Program http://www.state.tn.us/environment/dca/hhw (last visited May 10, 2004). Larger cities often have permanent recycling centers that accept hazardous household wastes for no charge. Smaller cities and rural areas often have a designated collection day on which products are accepted at a specified location for no charge. Some programs offer free pick-up of hazardous materials to farmers who may have difficulty transporting large quantities to a collection center. *See* DIV. OF CMTY. ASSISTANCE, TENN. DEP'T OF ENV'T & CONSERVATION, GOT USED OIL?, THE P2ALERT 1 (2002), http://www.state.tn.us/environment/dca/pdf/P2Alertsummer02.pdf.

192. *See generally* EPA, CONTROL OF MOBILE SOURCE HAPS, *supra* note 162 (identifying vehicle types included in the on-road and non-road categories).

substances that are TRI-listed toxic chemicals and are also classified by EPA as Clean Air Act hazardous air pollutants: acetaldehyde, benzene, and formaldehyde.[193] The effects of these and other hazardous air pollutants on human health and the environment are difficult to assess, but these three chemicals (as well as mercury) are among the thirty-three chemicals that EPA has concluded present "the greatest threat to public health in the largest number of urban areas."[194] Overall, EPA has estimated that mobile sources (including all on-road and non-road vehicles, not just those operated by private individuals) are responsible for roughly half of the cancer deaths caused each year by hazardous air pollutants.[195] According to one study, air toxics released from mobile sources (including benzene, formaldehyde, and others) are the largest contributor to the total carcinogenic risk in the Los Angeles area.[196] In addition, some results suggest that living near high-traffic roadways is a risk factor in childhood cancer and childhood leukemia, perhaps due to benzene tailpipe emissions.[197] Furthermore, children living in central urban areas have 71 percent higher blood benzene levels than those in more rural areas.[198] Toxics from motor vehicles also may affect occupants of other vehicles on the road. Measured levels of some air pollutants

193. In addition to the three profiled toxic chemicals, other TRI-listed toxic chemicals such as acrolein and 1,2-butadiene also are released by individuals' motor vehicle use in larger quantities than by all industrial facilities. *See* OFFICE OF ENVTL. INFO., EPA, TRI EXPLORER DATABASE (2001) [hereinafter EPA, 2001 TRI EXPLORER DATABASE], bttp://www.epa.gov/triexplorer/chemical.htm; EPA, CONTROL OF MOBILE SOURCE HAPS, *supra* note 162, at tbl. IV.A-1.

194. *See* EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at 7-5, tbl. 7-2 (discussing the Integrated Urban Air Toxics Strategy under Clean Air Act § 112(c)(3), (k)); EPA, Urban Air Toxics Strategy, 64 Fed. Reg. 38,706 (July 19, 1999). In recent litigation, plaintiffs attempting to block highway construction have asserted that adverse health effects arise from living near roadways. *See, e.g.*, Sierra Club v. U.S. Dep't of Trans., 245 F. Supp. 2d 1109, 1113 (D. Nev. 2003) (involving highway expansion in Las Vegas, Nevada).

195. *See* Oren, *supra* note 123, at 152 (citing *Implementation and Enforcement of Clean Air Act Amendments of 1990: Hearings Before the Subcomm. on Oversight and Investigations of the House Comm. on Commerce*, 104th Cong. 209 (1995) (statement of Mary Nichols); H.R. REP. NO. 101-490, pt. 1, at 152, 316 (1990)).

196. JACK BROADBENT ET AL., SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT FINAL REPORT ON MATES-II PROGRAM 7.1 (2000) (on file with author).

197. Robert L. Pearson et al., *Distance-Weighted Traffic Density in Proximity to a Home Is a Risk Factor for Leukemia and Other Childhood Cancers*, 50 J. AIR & WASTE MGMT. ASS'N 175, 179 (2000); *see also* E.G. Knox & E.A. Gilman, *Hazard Proximities of Childhood Cancers in Great Britain from 1953-80*, 51 J. EPIDEMIOLOGY & COMMUNITY HEALTH 151, 156 (1997) (finding an excess of childhood leukemia cases for children that lived within 4 kilometers of a motorway and a significant deficit beyond 4 kilometers).

198. E. Jermann et al., *Belastung von Kindern durch Benzol and andere verkehrsbedingte Immissionen [Exposure to Benzene, Toluene, Lead and Carbon Monoxide of Children Living in Central Urban Area with High Traffic Density]*, 189 ZBL. HYG. 50 (1989) (in Dutch with an abstract in English).

inside automobiles have been shown to exceed ambient levels.[199] Of course, motor vehicle emissions also include particulate matter, ozone precursors, and other substances. Identifying which of these substances, if any, causes specific health or environmental effects is a daunting task.

a. Individual Contribution

Through the use of motor vehicles, individuals account for a remarkably large proportion of the releases of several toxic chemicals to the air.[200] The individual contribution to acetaldehyde, benzene, and formaldehyde can be identified from data on emissions from cars and light trucks in the United States.[201] The figures likely underestimate the individual share of these toxic releases because they do not include other individual activities that may produce emissions of these chemicals, such as consumer product use, fossil fuel burning, and other burning.[202] The relative contributions of individuals and large industrial sources of these three air toxics are identified in Table 3.

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199. *See* Charles Rodes et al., Measuring Concentrations of Selected Air Pollutants Inside California Vehicles, Final Report, ARB Contract No. 95-339 (Dec. 1998) (unpublished manuscript), *available at* http://www.arb.ca.gov/research/indoor/in-vehsm.htm.

200. *See* EPA, Air Trends: Toxic Air Pollutants (stating that transportation generates more than 50 percent of all hazardous air pollutants), http://www.epa.gov/airtrends/toxic.html (last modified May 4, 2004).

201. For non-road vehicles, all vehicles likely to be used exclusively or predominantly by private individuals were included (e.g., lawn and garden equipment, recreational marine engines, off-highway motorcycles, snowmobiles, and ATVs were included, but not locomotives and airplanes). EPA, MOBILE SOURCE PROJECTION, *supra* note 171, at tbls. 5, 8. The individual component of these emissions was calculated by adding the total amount of emissions from light-duty gas vehicles (cars) to light-duty gas trucks, on-road motorcycles, and non-road 2- and 4-stroke gasoline engines. *See* discussion *supra* note 116. As with the ozone precursor calculations, the car emissions were multiplied by 76.3 percent, the total percentage of car usage by individuals, and the light-duty truck emissions were multiplied by 82.5 percent. *See* discussion *supra* note 116. All of the emissions from highway motorcycles and non-road gasoline engines were attributed to individuals.

202. *See generally* Lernieux, *supra* note 100 (identifying the air pollutants emitted from burning household waste in barrels). Overall, motor vehicles accounted for 21 percent of the emissions of all hazardous air pollutants in 1997. EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at 20, fig. 3-6 (reporting that on-road motor vehicles, off-road motor vehicles and "area/other" sources contribute 75 percent of air toxics emissions, and that major industrial point sources contribute 25 percent). Area sources (e.g., small businesses and some individual releases) thus account for 54 percent of air toxics emissions. *Id.* The 21 percent figure attributed to motor vehicles by EPA does not exclude motor vehicles operated for industrial or other businesses, thus the 21 percent figure cannot be allocated entirely to individuals. *See id.*

Table 3:

Sources of Air Toxics (in tons)

Emissions Type	*Individual Amount*	*Large Industries Amount*	*Combined Total*	*Individual Percentage Of Total*
Acetaldehyde	20,598	6,410	27,008	76.3%
Benzene	203,751	4,092	207,843	98.0%
Formaldehyde	54,489	5,765	60,254	90.4%
Total	**278,838**	**16,267**	**295,105**	**94.5%**

i. Acetaldehyde

Acetaldehyde has been identified as a probable human carcinogen, indicating that animal testing has shown that humans could develop cancer from exposure to acetaldehyde.[203] Acetaldehyde is formed as a result of incomplete combustion of both gasoline and diesel fuel, and therefore can be found in vehicle exhaust.[204] Individuals comprise a very large share of acetaldehyde emissions and emitted 20,598 tons of acetaldehyde in 1996 from mobile sources alone.[205] The 20,598 ton individual total dwarfs the quantity released by large industrial facilities. The air emissions of acetaldehyde from large industrial facilities were 6,410 tons in 1996 or 6.5 percent of the total national emissions of acetaldehyde in that year.[206] Thus, individuals' mobile source use alone, excluding releases from other individual and household activities, released over three times more acetaldehyde than the total released by all large industrial facilities.

203. EPA, Integrated Risk Information System [hereinafter EPA, IRIS DATABASE], http://www.epa.gov/iris (last modified Dec. 22, 2003); EPA, CONTROL OF MOBILE SOURCE HAPS, *supra* note 162, at 50. According to EPA, acetaldehyde may have both chronic and acute human health effects. EPA, CONTROL OF MOBILE SOURCE HAPS, *supra* note 162, at 50. The acute effects on human health include irritation of the eyes, skin, and respiratory tract. *Id.*

204. EPA, CONTROL OF MOBILE SOURCE HAPS, *supra* note 162, at 49. Mobile sources are the primary cause of acetaldehyde emissions and comprise approximately 70 percent of all acetaldehyde emitted in the United States in 1996. *Id.* at tbl. IV.A-1.

205. EPA, MOBILE SOURCE PROJECTION, *supra* note 167, at tbls. 5, 8. The total constitutes 20.7 percent of the total national emissions of acetaldehyde. *Id.*

206. *See* EPA, CONTROL OF MOBILE SOURCE HAPS, *supra* note 162, at tbl. IV.A-1. *See generally* EPA, 1996 TRI EXPLORER DATABASE, *supra* note 167 (providing overall and sector-specific data for all toxics reported under in the TRI database).

ii. Benzene

Benzene has also been identified as a human carcinogen.[207] Benzene emissions are formed from both vehicle exhaust and evaporative processes, as well as by the burning of coal and oil.[208] Mobile sources are the primary cause of benzene air emissions.[209] As a result, individuals comprise a very large proportion of benzene emissions, releasing 203,751 tons of benzene in 1996.[210] Total air emissions of benzene nationwide by large industrial facilities were 4,092 tons in 1996.[211] Individuals thus released, simply through motor vehicle use, almost fifty times more benzene to air than all large industrial facilities combined.

iii. Formaldehyde

Formaldehyde has been identified as a probable human carcinogen.[212] It is formed from incomplete combustion of gasoline and diesel fuel, and is also emitted from some building materials, home furnishings, and other consumer products.[213] Mobile sources are the primary cause of all air emissions of formaldehyde, and, as a result, individuals comprise a very large source of formaldehyde emissions.[214] Individuals emitted 54,489 tons of formaldehyde in 1996

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207. *See* EPA, CONTROL OF MOBILE SOURCE HAPS, *supra* note 162, at 53. Also, several blood diseases have been linked to continuous exposure to benzene. *Id.* (noting that pre-leukemia and aplastic anemia have been linked to benzene exposure).

208. *See* EPA, IRIS DATABASE, *supra* note 203; EPA, CONTROL OF MOBILE SOURCE HAPS, *supra* note 162, at 52, 53.

209. Mobile sources comprised approximately 76 percent of all benzene emitted in the United States in 1996. EPA, CONTROL OF MOBILE SOURCE HAPS, *supra* note 162, at tbl. IV.A-1. Releases of benzene to indoor air occur through environmental tobacco smoke, paint supplies, stored gasoline, and the automobile emissions that occur in attached garages. OFFICE OF RADIATION & INDOOR AIR, EPA, THE INSIDE STORY: A GUIDE TO INDOOR AIR QUALITY 13 (1995) [hereinafter EPA, THE INSIDE STORY], http://www.epa.gov/iaq/pubs/insidest.html#Look7.

210. The 203,751 tons constituted 58.0 percent of the total national air emissions of benzene in that year. EPA, MOBILE SOURCE PROJECTION, *supra* note 167, at tbls. 5, 8.

211. The 4,092 tons constituted only 1.2 percent of the total national amount of benzene emitted in that year. EPA, 1996 TRI EXPLORER DATABASE, *supra* note 167; EPA, CONTROL OF MOBILE SOURCE HAPS, *supra* note 162, at tbl. IV.A-1.

212. *See* EPA, CONTROL OF MOBILE SOURCE HAPS, *supra* note 162, at 62 (noting human health effects of formaldehyde).

213. *Id.* at 61.

214. Mobile sources comprised roughly 49 percent of all formaldehyde emitted in 1996. *Id.* at tbl. IV.A-1. Other individual activities that release formaldehyde include tobacco smoking and the use of some household products, building materials, gas stoves, and kerosene space heaters. EPA, THE INSIDE STORY, *supra* note 209, at 13.

from mobile sources,[215] as compared to large industrial facilities, whose formaldehyde air emissions were only 5,765 tons.[216] As with the other air toxics, the individual share thus is far larger than that of all large industrial facilities combined.

b. Regulatory Response

EPA has regulated toxic air emissions from mobile sources principally through tailpipe emissions standards imposed on motor vehicle manufacturers. As discussed in connection with the ozone profile, pursuant to the 1990 CAA Amendments, EPA has adopted new Tier II motor vehicle emissions standards that will be phased in over the 2005-2007 time period. As a result, the projections for all of these toxics improve when looking at the data for 2007. Nevertheless, mobile source emissions from individuals will remain a substantial proportion of the total. After the new Tier II mobile emissions standards are fully in place in 2007 for new motor vehicles, the quantity of emissions of the three toxics from mobile sources is expected to decrease by roughly one-third.[217] Reductions will occur in acetaldehyde,[218] benzene,[219] and formaldehyde[220] emissions, but again activity levels will be important: increases in the number of vehicles and the VMT per vehicle will undercut much of the gains from the

215. The 54,489 tons constituted 15.8 percent of the total national air emissions of formaldehyde in that year. EPA, MOBILE SOURCE PROJECTION, *supra* note 167, at tbls. 5, 8.

216. The 5,765 tons constituted 1.6 percent of the total national air emissions of formaldehyde in that year. EPA, 1996 TRI EXPLORER DATABASE, *supra* note 167; EPA, CONTROL OF MOBILE SOURCE HAPS, *supra* note 162, at tbl. IV.A-1.

217. *See* EPA, MOBILE SOURCE PROJECTION, *supra* note 167, at tbls. 4, 5. Older vehicles will not be subject to the new standards, but will comprise a declining proportion of the inventory of all vehicles on the road over time. *Id.* The Tier II standards are not designed to reduce hazardous air pollutants but will have that effect. *Id.* at 3

218. After the Tier II standards have been phased in 2007, the volume of acetaldehyde emitted from mobile sources is expected to decrease to 41,539 tons, a 40 percent reduction from 1996. *See* EPA, MOBILE SOURCE PROJECTION, *supra* note 167, at tbl. 4. Nevertheless, individuals will still contribute a large share of all emissions. In 2007, individuals are expected to emit 10,090 tons of acetaldehyde from mobile sources alone, or 24 percent of acetaldehyde emissions from all mobile sources in the United States. *Id.* at tbls. 5, 8. This 10,090 figure is almost twice the 1996 releases to air from all TRI facilities. EPA, 1996 TRI EXPLORER DATABASE, *supra* note 167.

219. In 2007, the volume of benzene emitted from mobile sources is expected to decline to 147,060 tons, a decrease of 43 percent from 1996. EPA, MOBILE SOURCE PROJECTION, *supra* note 167, at tbl. 4. In 2007, individuals are expected to emit 116,279 tons of benzene from mobile sources alone, or 79 percent of benzene emissions from all mobile sources in the United States. *Id.* at tbls. 5, 8.

220. In 2007, the volume of formaldehyde emitted from mobile sources is expected to decline to 96,201 tons, a decrease of 44 percent from 1996. *Id.* at tbl. 4. In 2007, individuals are expected to emit 58,882.8 tons of formaldehyde from mobile sources alone, or 61 percent of formaldehyde emissions from all mobile sources in the United States. *Id.* at tbls. 5, 8.

Tier II tailpipe reductions imposed on auto manufacturers. As a result, even after these reductions, individuals will remain a far larger source of each of these chemicals than all large industrial facilities combined.

4. Pesticides

Several pesticides are among EPA's 30 Waste Minimization Priority Chemicals, a list that was developed through an intra-agency analysis to identify the most important PBT substances.[221] No comprehensive assessment has been conducted of the human health and environmental impacts of individual and household pesticide use, but a variety of sources give some indication of the potential quantities released and their environmental effects. In addition to contributing to low-level ozone as discussed above, household pesticide use can have effects through human or animal exposure in the yard or home, and can contaminate the surface water and ground water. This profile will examine the presence of household pesticides in urban runoff and indoor air.

Household pesticide and fertilizer use has been shown to lead to the presence of toxics in urban and suburban runoff.[222] Pesticides in runoff may be discharged either directly to storm sewers, which typically flow untreated to rivers, lakes, and streams, or may be washed directly into the receiving waters. Activity location is an important factor in two ways. Proper application of pesticides away from impervious surfaces may lead to lower concentrations in urban runoff than applications that leave pesticides on or near sidewalks, driveways or streets. In addition, the residential patterns of the individuals using the pesticides matter. Urban and suburban runoff arises in part because surfaces that might absorb polluted rainwater are often paved or otherwise become impervious in developed areas. For example, studies have estimated that in areas of medium density single family homes, anywhere from 25 percent to 60 percent of the

221. EPA, WASTE MINIMIZATION LIST, *supra* note 161, at 1. In addition, several pesticides are on the TRI list of toxic chemicals and have been classified by EPA as PBT chemicals. EPA, PBT List, 64 Fed. Reg. 58,666 (Oct. 29, 1999). The human health and environmental effects of household pesticide and fertilizer use are the subject of debate in the mass media. *See, e.g.*, Thom Patterson, *Does Green Grass Come with Health Risks?*, CNN.COM/HEALTH (July 17, 2002) (suggesting that "[p]ediatricians say it is not uncommon for children to get sick after being exposed to lawns recently sprayed with anti-insect chemicals" but also quoting a horticulture professor for the proposition that "[t]here shouldn't be a problem if consumers follow the directions on the container. Most lawn chemical products are as safe as or safer than many chemicals we use daily inside our homes."), http://www.cnn.com/2002/HEALTH/07/12/lawn.chemicals/index.html.

222. *See* EPA, 2000 WATER QUALITY REPORT, *supra* note 6, at 52.

surfaces are impervious.[223] Population dispersal, such as occurs with suburban sprawl, thus may exacerbate runoff problems by increasing the amount of impervious surfaces.

The impacts of household pesticides in runoff can be assessed in several ways. Studies have concluded that urban runoff has significant adverse effects on the flora and fauna of urban and suburban water bodies.[224] EPA has concluded that urban runoff is among the leading causes of impaired water quality across all types of water bodies in the United States, and it is the leading cause of impaired water quality in estuaries.[225] According to EPA, urban runoff and storm sewers are a pollution source for 45 percent of impaired estuaries in the country.[226] As with other areas of individual environmentally significant behavior, government agencies do not collect or report data on individuals and households as a source category, so the extent to which household pesticide use is a cause of water bodies not meeting water quality standards is unclear. The relative usage rates of pesticides by households, discussed below, suggests, however, that the quantities released are substantial. In addition, the EPA Nationwide Urban Runoff Program did not detect significant differences in pollutant concentrations between the urban runoff from residential, commercial, and mixed urban areas.[227] A further indication of the contribution of household pesticide and fertilizer use to impaired water bodies is a model of Chesapeake Bay water quality, which suggests that polluted urban runoff is at least as

223. Thomas R. Schueler, *The Importance of Imperviousness*, 1 WATERSHED PROTECTION TECH. 3 (1994), *cited in* National Pollutant Discharge Elimination System—Regulations for Revision of the Water Pollution Control Program Addressing Storm Water Discharges, 64 Fed. Reg. 68,722, 68,725 (Dec. 8, 1999) [hereinafter EPA, Phase II Storm Water Regulations] (codified at 40 C.F.R. §§ 9.122-9.124); *see also* Envtl. Def. Ctr., Inc. v. EPA, 344 F.3d 832 (9th Cir. 2003), *petition for cert. filed sub nom.* Tex. Cities Coalition on Stormwater v. EPA, 72 U.S.L.W. 3513 (U.S. Dec. 15, 2003) (No. 03-1125).

224. *See* EPA, Phase II Storm Water Regulations, 64 Fed. Reg. at 68,725 (citing studies).

225. *See* EPA, 2000 WATER QUALITY REPORT, *supra* note 6, at 29, 33-39, 50-51. Pesticides also can interfere with the operation of publicly owned treatment works. EPA, CITIZEN'S GUIDE TO PEST CONTROL AND PESTICIDE SAFETY 25 (1995).

226. Urban runoff and storm sewers also were a source of pollution in 21 percent of impaired lakes, ponds and reservoirs, and 13 percent of impaired rivers. EPA, 2000 WATER QUALITY REPORT, *supra* note 6, at 50.

227. EPA, ENVIRONMENTAL IMPACTS OF STORMWATER DISCHARGES: A NATIONAL PROFILE 14 (1992); *see also* BARRY LEWIS, NONPOINT SOURCES, PART TWO: LIFESTYLE DECISIONS CAN HAVE SERIOUS EFFECTS, KNOW YOUR ENVIRONMENT 2 (1996) ("Farmers are trained in pesticide and fertilizer management and are aware how much of a particular chemical is sufficient for a certain problem—and when is the most appropriate time to make an application to minimize potentially harmful effects. One has to wonder how many homeowners are knowledgeable enough to exercise the same standard of care."), http://www.acnatsci.org/research/kye/10nps2.html

large a source of water pollution as all contamination from industrial discharges and sewage sources combined.[228]

Pesticides and other pollutants also may affect indoor air quality. EPA estimates that on average 75 percent of homes use some form of pesticide indoors each year and that 80 percent of an individual's exposure to pesticides occurs within the home.[229] As discussed above, pesticides and a variety of consumer products release VOCs. An EPA study found the levels of a number of common VOCs to be two to five times higher indoors than outdoors, and the differences occurred without regard to whether the homes were located in highly industrial or rural areas.[230] One study conducted for the Consumer Product Safety Commission found that outdoor air contained on average less than ten different VOCs, whereas indoor air contained approximately 150.[231] Although EPA has stated that indoor air quality is "a serious issue," it has acknowledged that "[t]here is no comprehensive monitoring of the quality of indoor air in the U.S., and the actual levels for many pollutants are not well understood."[232] There is reason to believe, however, that pesticides and other chemicals released in the home are worthy of closer scrutiny.

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228. *See, e.g.*, R. Cohn-Lee & D. Cameron, *Urban Storm Water Runoff Contamination of the Chesapeake Bay: Sources and Mitigation*, 14 ENVTL. PROF. 10, 23 (1992).

229. EPA, THE INSIDE STORY, *supra* note 209, at 14.

230. *Id.* at 12.

231. ELLEN J. GREENFIELD, HOUSE DANGEROUS: INDOOR AIR POLLUTION IN YOUR HOME AND OFFICE 4 (1991) (citing OAK RIDGE NAT'L LAB., STATUS REPORT ON INDOOR AIR QUALITY MONITORING STUDY IN 40 HOMES (1984)). EPA has concluded that consumer solvents accounted for 1,099,000 tons of VOCs in 1998, and although the extent to which the initial release of these VOCs was to indoor air is unclear, the indoor air total is likely to be substantial. EPA, 2000 AIR TRENDS REPORT, *supra* note 6, at tbl. 3-3. Not all solvent use occurs indoors, but if even a small proportion of the 1,099,000 tons is emitted indoors, the emissions could have substantial effects. In fact, indoor air risks were ranked fourth among cancer risks in EPA's 1990 landmark "Regulating Risk" study, and indoor radon was first on the list. EPA, REDUCING RISK: SETTING PRIORITIES AND STRATEGIES FOR ENVIRONMENTAL PROTECTION 8, 18 (1990). To date, the primary areas of focus for those concerned with indoor air quality, bowever, have been radon and environmental tobacco smoke (ETS or "secondhand smoke") rather than VOCs. *See, e.g.*, EPA, Air and Radiation: Why be Concerned 3 (listing only radon and second hand smoke as the pollutants of interest for indoor air quality), http://www.epa.gov/air/concerns/#indoor (last modified Aug. 19, 2003); EPA, ENVIRONMENT REPORT, *supra* note 9, at 1-10 (listing several possible sources of indoor air pollution, but only offering statistics on ETS and radon).

232. EPA, ENVIRONMENT REPORT, *supra* note 9, at 1-10. Among the publicly available sources of information on indoor air quality are the websites for the California Indoor Air Quality Program, http:// www.cal-iaq.org, and for the Home Indoor Air Quality Knowledge Base, http://dehs.umn.edu/homeiaq/homeiaq.html. *See also* DEP'T OF THE ENV'T & HERITAGE, AUSTRALIAN GOV'T, STATE OF KNOWLEDGE REPORT: AIR TOXICS AND INDOOR AIR QUALITY IN AUSTRALIA tbl. 6-1 (2001), http://www.ea.gov.au/atmosphere/airtoxics/sok/chapter6.html (listing chemicals detected in the home).

a. Individual Contribution

Table 4 presents comparisons of pesticide use among different sources. Given that pesticides are principally used for agriculture rather than by large industrial facilities, the profile compares three categories of pesticide users: individual, agricultural, and a combined category including industrial, commercial, and governmental users.[233]

Table 4:

Sources of Pesticide Releases (in million pounds)

Estimate	*Individual Amount*	*Com./Gov't Amount*	*Agriculture Amount*	*Individual Percentage*
1999 EPA Estimate	140	148	985	11%
2001 EPA Estimate	N/A	N/A	N/A	7%-8%

EPA estimated home and garden pesticide use to be 140 million pounds in 1997.[234] In comparison, approximately 985 million pounds were used for agriculture, a substantial increase over the 1992 level of 892 million pounds.[235] Finally, 148 million pounds were used for industrial, commercial, and governmental applications (such as on rights-of-way and for landscaping around businesses).[236] Individuals thus accounted for 11 percent of total pesticide use.

Other EPA estimates differ to some extent.[237] For example, EPA also has estimated that approximately 67 million pounds of "active ingredient pesticides" are applied to private lawns every year,

233. The 1999 EPA estimate in the table is drawn from a report by the National Center for Food and Agricultural Policy. *See* NAT'L CTR. FOR FOOD & AGRIC. POLICY, PESTICIDE USE IN U.S. CROP PRODUCTION: 1997 NATIONAL SUMMARY REPORT (2000). The 2001 EPA estimate is drawn from an EPA air emissions inventory. *See* EPA, AIR INVENTORY PESTICIDES REPORT, *supra* note 120, at 9.2-2. Although pesticide manufacturers are subject to TRI reporting requirements, the agriculture sector is not subject to TRI reporting generally. Thus, TRI estimates are of limited use in profiling the sources of pesticide releases. *See* EPA, 2001 TRI PUBLIC DATA RELEASE, *supra* note 167. "N/A" denotes not applicable.

234. EPA, ENVIRONMENT REPORT, *supra* note 9, at 3-10.

235. *Id.* (citing NAT'L CTR. FOR FOOD & AGRIC. POLICY, *supra* note 233).

236. *Id.*

237. *See* Lewis, *supra* note 227, at 2 (noting that EPA has estimated that approximately 67 million pounds of active ingredient pesticides are applied to 67 million private lawns every year).

or an average of roughly one pound per private lawn.[238] As discussed in the analysis of low-level ozone, an EPA assessment of the VOC air emissions from pesticides estimated that between 7 percent and 8 percent of all pesticides used in the United States are used for exterminating home and garden pests.[239] As a result, as identified in Table 1 above, home pesticide use also contributes a notable percentage of the total volume of ozone precursors released to the air on a nationwide basis.[240]

Assessing the relative human health and environmental effects of individual and household pesticide use is even more difficult than assessing the relative quantities used. EPA has not published data that would allow a complete profile of the quantities of pesticides released by private individuals to all media, much less an assessment of the human health and environmental effects. EPA has estimated, however, that one third of all pesticide application occurs in urban environments.[241] This estimate is roughly consistent with the combined total of home and garden pesticide use (140 million pounds) and industrial, commercial, and governmental use (148 million pounds), or a total of 288 million pounds, as compared to the 892 to 985 million pounds used for agricultural applications. Home and garden use thus may comprise roughly half of the pesticide use in urban areas, and it may be expected to comprise a similar share of the pesticides in urban runoff.[242]

b. Regulatory Response

As with household hazardous waste disposal, little, if any, effective regulation of private individuals' use and disposal of pesticides occurs at the federal, state, or local levels. For example, EPA has indicated that it lacks authority to regulate indoor air.[243] In addition, although the federal statute that regulates pesticides, the

238. The disparity between the 67 million pound estimate of "active ingredients" and the 140 million pound estimate may arise because the former estimate does not include non-active ingredients, which can comprise a large proportion of the total weight of a pesticide.

239. EPA, AIR INVENTORY PESTICIDE REPORT, *supra* note 120, at 9.2-2 (noting that home pesticide use constitutes 7 percent to 8 percent of the total ozone precursor emissions by all pesticides).

240. *See id.*

241. *See* Lewis, *supra* note 227, at 2.

242. Pesticides are one of the principal components of contaminated urban runoff, along with runoff of air deposition from car emissions, car maintenance wastes, pet wastes, litter and household hazardous wastes. *See* EPA, Phase II Storm Water Regulations, 64 Fed. Reg. 68,722, 68,725 (Dec. 8, 1999).

243. EPA, ENVIRONMENT REPORT, *supra* note 9, at 3-10.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA),[244] by its terms is applicable to individuals' use of pesticides, in practice the statute has been interpreted and enforced in ways that exclude private individuals from its requirements. In theory, an individual can be in violation of FIFRA in several ways. For example, it is unlawful for any person "to detach, alter, deface, or destroy. . . any labeling required under" FIFRA or "to use any registered pesticide in a manner inconsistent with its labeling."[245] A review of reported decisions under FIFRA and EPA enforcement reports suggests that in practice the FIFRA requirements typically are enforced against agribusinesses, industrial pesticide manufacturers and their owners or employees, and rarely, if ever, against private individuals.[246]

244. At least in theory, a private individual's ability to use a registered pesticide is limited by its classification and labeling. A registered pesticide may be classified for restricted use, general use, or both. A pesticide labeled for restricted use may only be applied by or under the supervision of a certified applicator. 7 U.S.C. § 136a(d)(1)(B)-(C) (2000). A pesticide labeled for general use can be applied by private individuals, but the use must be consistent with its label and labeling. *Id.*; *id.* § 136j(a)(2)(G). FIFRA uses the terms "label and labeling" broadly. They include all written, printed, or graphic material directly on, attached to, or in anyway included with the pesticide, its containers, or wrappers. *Id.* § 136(p).

245. *Id.* § 136j(a)(2)(A), (G).

246. For example, at least thirty-three cases have cited 7 U.S.C. § 136j(a)(2)(G), the provision making it unlawful to use a pesticide inconsistent with its labeling. None of these cases allege misuse by a private individual. Instead, in each case the alleged misuse was by an entity such as a pesticide manufacturer or formulator, an exterminator, a lawn care company, a city, a park service, or other firm or organization, or an owner or employee of one of these types of entities. *See, e.g.*, Or. Envtl. Council v. Kunzman, 714 F.2d 901 (9th Cir. 1983); George's Pest Control Serv. v. EPA, 572 F.2d 204 (9th Cir. 1977); Bradley v. Brown, 852 F. Supp. 690 (N.D. Ind. 1994). Of course, these cases only represent those cases in which a party sought judicial review of the agency's action and the judicial review resulted in a reported decision. EPA can impose civil penalties for FIFRA violations in administrative actions, and often judicial actions do not result in a reported decision. As a result, it is possible that private individuals have been fined in administrative proceedings or in enforcement actions that did not result in a reported decision. Recent EPA enforcement reports do not reveal any actions, however, against private individuals. *See, e.g.*, EPA, 1999 ENFORCEMENT ACCOMPLISHMENTS REPORT, *supra* note 189, at 27. In addition, the FIFRA statutory language suggests that although private individuals are within the scope of the regulated behavior, the primary targets for violations are industry and its managers and employees. For example, a private individual may not be subjected to a civil fine of more than $1,000, but a registrant, commercial applicator, wholesaler, dealer, retailer, or other distributor may be fined up to $5,000. 7 U.S.C. § 136*l*(a)(1)-(2). In addition, focus on industry is evident in the civil penalty provisions, which identify three factors for calculation of the penalty amount, "the size of the business of the person charged, the effect on the person's ability to continue in business, and the gravity of the violation." *Id.* § 136*l*(a)(4). Individuals and industry also are treated much differently for criminal penalties. The maximum criminal penalty is $1,000 for a private individual but $50,000 for a registrant, applicant for a registration, or producer. *Id.* § 136*l*(b)(1)-(2). A registrant, applicant, or producer may be imprisoned for up to one year; the maximum length of imprisonment for a private individual is thirty days. *Id.* The only exception to these provisions is for violations in which there is intent to defraud, where all people are subject to the same fines and length of imprisonment. *Id.* § 136*l*(b)(3).

To address pesticides and other pollutants in urban runoff, the Clean Water Act requires EPA to promulgate storm water regulations, and EPA has done so in two parts. EPA promulgated the Phase I storm water regulations in 1990. The Phase I regulations apply to large industrial sources, construction sites, and municipalities.[247] EPA promulgated the Phase II regulations in 1999, and they apply to smaller municipalities and construction sites.[248] The Phase I and Phase II regulations do not impose requirements on individual behavior or require state or local governments to do so, but the Phase II regulations do require local governments to conduct public information campaigns to reduce contaminants in storm water.[249] The effective date for the Phase II regulations was March 2003, and it remains to be seen whether the public information campaigns conducted in response to the regulations will reduce individuals' contributions to pollutants in storm water discharges.

5. Petroleum

Petroleum and its constituents also can have adverse human health and environmental effects.[250] Over the last thirty years, the quantity, fate, and effects of petroleum released to oceans in North America have been the subject of three landmark studies by panels of scientists assembled by the National Research Council of the National Academy of Sciences. Although the 2003 NRC report does not specifically address individuals as a source category, it includes data that suggest that the petroleum released by individuals may have substantial environmental effects. In particular, the report demonstrates the importance of activity location in evaluating individual pollutant releases. The report concludes that although not all petroleum releases are likely to have adverse effects, the petroleum released from two sources with large individual and household contributions, land runoff and two-stroke engines, "is particularly significant because, by their very nature, these activities are almost

247. *See* National Pollutant Discharge Elimination System Permit Application Regulations for Storm Water Discharges, 55 Fed. Reg. 47,990 (Nov. 16, 1990) (codified at 40 C.F.R. pts. 122-124).

248. EPA, Phase II Storm Water Regulations, 64 Fed. Reg. 68,722, 68,723 (Dec. 8, 1999).

249. *See id.* at 68,754-55.

250. Petroleum contains a number of constituents that are on the TRI list of toxic chemicals. Examples of TRI-listed toxic chemicals that are constituents of petroleum include aromatic compounds such as benzene, ethylbenzene, xylene, and toluene. 2003 NRC REPORT, *supra* note 83, at 19-20. Aromatic compounds may comprise 1 percent to 20 percent of the total hydrocarbons in crude oil, and polycyclic aromatic hydrocarbons (PAHs) may comprise 0.2 percent to 7 percent. PAHs may be the constituent that is most toxic to the environment. *Id.* at 20.

exclusively restricted to coastal waters. In fact, the estuaries and bays that receive the bulk of the load are often some of the most sensitive ecological areas along the coast."[251] Similarly, EPA has noted that used oil and other petroleum products are a significant constituent of polluted urban and suburban runoff.[252]

a. Individual Contribution

The data on petroleum releases attributable to individuals and other sources are not sufficient to profile the individual share fully. Nevertheless, the 2003 NRC report provides several important insights about the contributions of individuals.[253] The report identifies three anthropogenic sources of petroleum releases to the oceans: petroleum extraction, transportation of petroleum, and petroleum consumption.[254] The report estimates that the total amount of petroleum that enters the waters off of North America annually from these three sources is 29 million gallons, of which 25 million gallons are released by petroleum consumption, 2.7 million gallons by petroleum transportation, and 880,000 gallons by petroleum

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251. *Id.* at 4. According to the 2003 NRC report:

> No spill is entirely benign. Even a small spill at the wrong place, at the wrong time, can result in significant damage to individual organisms or entire populations . . . . Despite the significant progress made in understanding the behavior and effect of petroleum spills on the marine environment and on preventing their occurrence in the first place, relatively little work has progressed on understanding the threat posed by small, chronic releases of petroleum from all sources. Insights have been made from long-term studies of sites of major spills or polluted harbors, but to a large degree, the significance (in terms of environmental damage) of the large inputs from land-based or other chronic releases is not known. Recent studies, however, suggest that PAH, even in low concentrations, can have a deleterious effect on marine biota.

Id.

252. EPA has concluded that the pollutants discharged through runoff and storm sewers "contribute high levels of pollutants, including heavy metals, toxics, oil and grease, solvents, nutrients, viruses and bacteria into receiving waterbodies." EPA, Phase II Storm Water Regulations, 64 Fed. Reg. at 68,727-28. Among the pollutants discharged by individuals to waterbodies are "used motor oil, household toxic materials, radiator fluids, and litter." *Id.* at 68,729.

253. 2003 NRC REPORT, *supra* note 83, at 2-3. The study reviewed releases of petroleum to the ocean from North America, not just the United States. *Id.* According to the study, natural seepage releases off of North America amount to 47 million gallons per year, petroleum extraction (oil and gas exploration or production) releases amount to 880,000 gallons, petroleum transportation (refining and distribution) releases amount to 2.7 million gallons, and petroleum consumption releases amount to 25 million gallons. *Id.* Petroleum consumption includes "[r]eleases that occur during the consumption of petroleum, whether by individual car and boat owners, non-tank vessels, or runoff from increasingly paved urban areas . . . ." *Id.* at 3. According to the study, a ton of oil may be converted to 294 U.S. gallons. *Id.* at 189, app. B.

254. A fourth category, natural seeps, accounts for 47 million gallons. *Id.* at 2. Although it is a surprisingly large figure, the seepage is a natural phenomenon not under human control and is not the subject of this profile. *See id.* at 2-3 (discussing the effect of natural seeps).

extraction.[255] Thus, on average, petroleum consumption during the 1990-1999 period was responsible for almost 85 percent of the petroleum released from anthropogenic sources to North American marine waters, and 32.8 percent of all the petroleum released into these waters from all sources.[256]

Petroleum consumption emissions occur from several different sources, including land-based petroleum use that enters the ocean through rivers and runoff, as well as recreational marine vessel use, oil spills, operational discharges, atmospheric deposition, and jettisoned aircraft fuel. The 2003 NRC report suggests that "these typically small but frequent and widespread releases contribute the overwhelming majority of the petroleum that enters the sea due to human activity."[257] According to the report, the runoff from on-land petroleum consumption to rivers, wastewater systems, and storm water systems is the most significant source of petroleum consumption emissions. Two-stroke engines in recreational marine vehicles, such as boats with two-stroke outboard motors and personal watercraft (almost all of which are operated by private individuals), are also a significant source.[258] Of the petroleum consumption categories, individuals play a role in land-based runoff, recreational marine vessel use, and atmospheric deposition. These three categories contribute 23.7 million gallons of petroleum each year or 96 percent of the emissions caused by petroleum consumption.[259]

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255. *Id.* at 2-3, 86.

256. *Id.* at 3, tbl. 2-2. The "best estimate" of the total quantity of releases from petroleum consumption is 84,000 tons. The contributions to the 84,000 total from the subcategories of petroleum consumption are as follows: (1) land-based petroleum use that enters the ocean through rivers and runoff, 54,000 tons (64 percent); (2) recreational marine vessel use, 5,600 tons (6.7 percent); (3) oil spills from non-tank vessels, 1,200 tons (1.4 percent); (4) operational discharges from vessels 100 gross tons or larger, 100 tons (0.12 percent); (5) operational discharges from vessels under 100 gross tons, 120 tons (0.14 percent); (6) atmospheric deposition, 21,000 tons (25 percent); and (7) jettisoned aircraft fuel, 1,500 tons (1.8 percent). *Id.* at tbl. 2-2.

257. *Id.* at 2.

258. *Id.* at tbl. 2-2. These two sources combined comprise two-thirds of all releases from petroleum consumption. *Id.* at 3. Recreational marine engines release petroleum to waterbodies because up to 30 percent of fuel passes through the combustion chamber unburned or partially burned and is released to the air or water. *See* discussion *supra* note 128. Reductions in these emissions should begin with the implementation of new regulations effective in 2006, although the new regulations only apply to new, not existing recreational marine engines. 2003 NRC REPORT, *supra* note 83, at 81. Many local governments are aware of these impacts and have attempted to use public information campaigns to address them. For example, agencies in the Los Angeles area ran television advertisements designed to discourage people from pouring motor oil down storm sewers and informing them that storm sewers lead to local waterbodies. Ann E. Carlson, *Recycling Norms*, 89 CAL. L. REV. 1231, 1282 n.202 (2001).

259. 2003 NRC REPORT, *supra* note 83, at tbl. 2-2 (noting that land-based river and runoff contributes 54,000 tons of hydrocarbons per year, recreational marine vessels contribute 5,600 tons of hydrocarbons per year, and atmospheric deposition is responsible for an average of 21,000

Although individuals certainly play a major role in the emissions from these three categories, it is difficult to determine the individual portion from these raw numbers. The report identifies recreational marine vehicles as a growing source that was not included in an earlier 1985 study.[260] According to the report, recreational marine vehicles release 1.47 million gallons of petroleum annually, a total that comprises approximately 5 percent of the total releases of petroleum from all human-related activities.[261]

The report also concludes that 15.9 million gallons of petroleum were released annually through land-based inputs.[262] The total represents 56.2 percent of the total releases from human-related activities. The sources of land-based releases include municipal wastewaters, non-refinery industrial discharges, refinery discharges, urban runoff, river discharges, and ocean dumping.[263] The report describes land-based sources as "the most poorly documented" of the sources of releases from petroleum consumption and does not identify the extent to which individuals and households contribute to land-based sources of petroleum releases.[264] Nevertheless, the discussion makes it clear that individuals are likely to contribute in several ways, including urban runoff (both through direct dumping and runoff of chemicals that are present on the ground as a result of atmospheric deposition arising from petroleum combustion), municipal wastewater (through discharges to storm water and wastewater systems), and river discharges.[265] Other reports provide a more anecdotal snapshot

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tons of hydrocarbon emissions from petroleum use each year). The total thus was 80,600 tons of hydrocarbons, at 294 gallons per ton.

260. *Id.* at 81.

261. *Id.* at tbl. 2-2. The total figure reported was 5,000 tons, which was converted to gallons using 294 gallons per ton. *See id.* at 219-20, app. F (noting that only emissions from two-stroke engines were included in the estimate and that total emissions of all recreational marine vehicles were reduced by 50 percent to account for the total quantity released to fresh water that "either did not connect to the coastal water or was included in [the section in the report] on petroleum hydrocarbon inputs from nonpoint sources"). Reductions in the releases to surface water will occur with new EPA regulations on recreational marine vehicles. *See id.* at 81 (noting that new EPA regulations will reduce air emissions by 75 percent).

262. *Id.* at 80-81.

263. *Id.* at 233. Note that one estimate of gasoline consumption in North America in 2000 was 428.8 million tons. *Id.* at 247. Individuals contribute to PAHs in storm water runoff through the air deposition of automobile exhaust. *Id.* at 247, 250.

264. *Id.*

265. The study estimated the land-based releases from the inland and coastal basins of the United States and Canada. *Id.* The study used oil and grease as a surrogate for petroleum because of the availability of oil and grease data in urban runoff, wastewater discharges and rivers. *Id. at* 78. According to the study, "although individual releases may be very small, the cumulative load from all land-based sources accounts for about half of the total average, annual load of petroleum to the marine environment from human related activities." *Id.* at 79.

of the potential magnitude of the individual contribution to land-based releases. For example, one state has estimated that private individuals in the state generate more than one million gallons of used oil per year.[266]

The 2003 NRC report concludes that atmospheric deposition accounts for 6.2 million gallons or 22 percent of all petroleum released annually to oceans in North America.[267] The individual share of atmospheric deposition at this point cannot be calculated based on the available data, but given the substantial contribution of on-road and non-road motor vehicle use to petroleum releases, the individual share is likely to be large. In short, although it is clear that individuals comprise a source of petroleum emissions via their use of on-road and non-road motor vehicles, this is an area in which individual releases have not been studied sufficiently to allow comparisons to be made.

b. Regulatory Response

As with the other pollutants profiled, few regulatory requirements have been directed at individual behavior. New standards have been imposed on manufacturers of recreational marine vehicles to address air emissions, and those standards also are projected to reduce the vehicles' contribution to petroleum releases to water.[268] After struggling for years with the appropriate regulatory approach for regulation of used motor oil, EPA has concluded that not subjecting used motor oil to regulation as a hazardous waste will be more likely to induce proper disposal than would a more stringent regulatory regime.[269] Similarly, the Phase I and Phase II storm water regulations discussed above do not have requirements directed at individuals' disposal of petroleum products, but the storm water regulations do require local governments to take steps to inform the public and induce voluntary reductions in petroleum and other storm water releases.[270] In addition, state, local, and private public

266. Tenn. Dep't of Env't & Conservation, Used Oil Collection Act of 1993: Fact Sheet, http://www.state.tn.us/environment/dca/oil/oilfactsheet/php (last visited May 10, 2004).

267. NRC 2003 REPORT, *supra* note 83, at tbl. 2-2. The percentage was calculated by dividing 21 tons by 96 tons, the total from all anthropogenic sources.

268. *See* discussion *supra* note 117.

269. Studies suggest that regulating used oil as a hazardous waste may lead to increased illegal dumping and more substantial overall environmental quality impacts. *See* Mark A. Cohen, *Monitoring and Enforcement of Environmental Policy*, *in* INTERNATIONAL YEARBOOK OF ENVIRONMENTAL AND RESOURCE ECONOMICS 1998/1999 1 (Tom Tietenberg & Henk Folmer eds., 1999) (citing H. Sigman, *Midnight Dumping: Public Policies and Illegal Disposal of Used Oil*, 29 RAND. J. ECON. 157 (1998)).

270. *See* EPA, Phase II Storm Water Regulations, 64 Fed. Reg. 68,722, 68,754-55 (Dec. 8, 1999) (discussing requirements for municipal public information campaigns).

information campaigns, including efforts to stencil storm drains with information that informs potential dumpers that the drain leads to a local water body, have been directed at individual used oil and other disposal.[271]

C. Implications of the Source Profile

The profile provides an initial assessment of the quantities of several types of pollutants released by individuals as well as individuals' relative contribution in comparison with large industrial facilities and other sources. The profile suggests, at a minimum, that a comprehensive analysis of the quantities of the most important pollutants released by individuals, as well as their fate and effects, is overdue. The 2003 NRC report on petroleum releases may serve as a valuable model for such an approach. The effort is necessary to provide policymakers with a more complete understanding of the pollution problem in this country, and the trends in contributions from source types, as well as the appropriate allocation of societal resources toward reducing their emissions. Rational policy making in the absence of this information will be difficult at best.

More provocatively, the profile indicates that both in the aggregate and with regard to specific types of pollutants and specific media, the releases by individuals and households pose significant challenges to the existing regulatory regime. In some cases new requirements on consumer product manufacturers will reduce the pollutant emissions from each product, but the increases in population, dispersal of population, activity levels, and consumption and disposal rates discussed above often will lead to greater contributions by individuals in absolute terms. As regulatory controls continue to clamp down on industrial sources, the relative contributions from individuals also will increase. In short, the absolute and relative contributions of individuals to many types of pollution will increase absent changes in the application of existing regulatory instruments or the use of new instruments. The next Part discusses the changes that may be necessary to avoid this result.

271. *See id.*; *see also* PAMELA PACKER & ROBIN SHEPARD, WATER ACTION VOLUNTEERS PROGRAM, STORM DRAIN STENCILING: IMPACTS ON URBAN WATER QUALITY 1, 4 (1999) (concluding that storm drain stenciling program in Wisconsin communities increased awareness of "basic storm water facts").

IV. THE ENVIRONMENTAL REGULATORY DEBATE REVISITED

Although the instrument choice debate has assigned the central role to industrial polluters, the profile presented above suggests that this is often an incorrect premise. Part IV explores the implications of taking individuals seriously. It first identifies the distinctive characteristics of individuals and the environmental harms they cause. It then suggests that these characteristics will require new thinking about the optimal mix of environmental regulatory instruments. In addition, empirical studies and recent experience with efforts to use combinations of regulatory instruments suggest that individual behavior is more malleable than once believed. As a result, legal scholars and regulators should reconsider the role of individuals in creating harms and the ability of government to steer individual behavior. In particular, greater use of informational regulation and norm management, alone or in combination with other instruments, may induce changes in many environmentally significant behaviors.[272]

A. The Characteristics of Individuals as a Source Category

Individuals differ from large industrial firms in a variety of ways that have important implications for regulatory instrument choice. The discussion below begins with an examination of the differences in the alignments of potential parties and interests that arise when individuals create environmental harms. It then explores the differences in the types of harms created and the differences in risk perception and decision making.

1. Alignments of Potential Parties and Interests

Private individuals are the source of environmental harms in several scenarios, with alignments of potential parties and interests that are significantly different from the single polluter-multiple victim assumption that underlies much of the instrument choice debate. Three of these scenarios are presented below. For each scenario, in addition to individuals, industrial or other sources may also contribute to the same environmental harms.

272. In some cases, the analysis also leads to new perspectives on the instrument choice debate regarding *industrial* sources as well. *See* discussion *infra* notes 365-366.

a. Single Individual, Internalized Harm

In the first scenario, an individual engages in behavior that causes harm to that individual (e.g., A v. A). For example, the user of a lawn mower may breath its fumes or the user of a household pesticide or consumer solvent may inadvertently ingest some of the chemical. A variation of this scenario occurs when a single individual causes harm to other members of a household, who will often be related to, or otherwise important to, the individual creating the harm (e.g., A v. A').[273] Variants of this scenario may exist where individuals differ in the extent to which they value the polluting activity or the resource polluted. To the extent the same individual causes and bears the full costs of the harm, however, there is no externality. Assuming the individual is utility maximizing, the harm should only occur because the individual is unaware of the potential for harm, prefers the harm to the cost of avoidance, or is unable to refrain from creating the harm because of physical, economic, social, or psychological constraints.[274] In contrast to most industrial pollution, many of the

273. Harms to other members of the same household could be treated as a distinct scenario but are not treated as such here. To the extent other household members are either closely related to the individual causing the harm or are important for emotional or other reasons, harms to other members of the household may be presumed to provoke many of the same behaviors as harms to the individual. The validity of this assumption will vary with the type of relationship between the polluting individual and the member of the household who is exposed to the pollution.

274. Of course, some of the harms caused by individual behavior are analogous to industrial emissions in that the harms are externalized. Examples include the harms caused by most automotive emissions, which are not borne by the automobile driver but by those who breathe the ambient air, and the runoff of household pesticides, which in some cases are borne by the ecosystems of the receiving waters and those who use them, and only very indirectly by the pesticide-using individuals.

In addition, as with individuals' environmentally harmful behavior, industrial pollution is often not in the rational interest of the polluter. Much has been written about how firms have used data on toxic chemical emissions to identify inefficiencies in manufacturing and chemical handling. *See, e.g.*, Karkkainen, *supra* note 37, at 260-63. For individuals, the parallel is that many environmentally harmful behaviors are the product of habits or a lack of information, and are not in the individual's interest. For example, studies suggest that vehicle idling for more than fifteen seconds produces excess emissions of ozone precursors as compared to turning off the engine and restarting it. OFFICE OF MOBILE SOURCES, EPA, EMISSION FACTS: IDLING VEHICLE EMISSIONS 3 (1998) (providing factors for estimating idling emissions of nitrogen oxides and hydrocarbons for various vehicle types while idling), http://www.epa.gov/OMSWWW. Idling also uses gasoline. In some cases, such as where the idling enables air conditioner use, or where turning the vehicle on or off has safety implications, increases wear and tear on the vehicle, or requires a meaningful amount of effort, idling a vehicle may be in an individual's self-interest. But in many cases, idling not only has harmful effects on the ambient air, it also is not in the individual's interest. For example, in some situations the cost of the gas consumed during idling may exceed the wear and tear costs that arise from restarting the car. Similarly, use of quantities of pesticides in excess of those required to achieve a particular goal often will not be in the individual's interest. Thus, many of the environmentally harmful activities engaged in by

harms caused by individuals are borne by the same individuals or the members of their households.[275] Thus, the alignment of the parties in this scenario is quite different from the traditional single industrial polluter-multiple victim assumption.

In two other scenarios, the environmental harms only occur because numerous individuals all engage in one or more activities that result in pollution that is externalized to some extent.[276] The scenarios involving multiple individuals are discussed below.

b. Multiple Individuals, Internalized Harm

In the second scenario, the behavior of numerous individuals causes harm to the same or essentially the same group of individuals (e.g., 10,000 As v. 10,000 As). For example, multiple individuals may release air toxics that remain within the airshed in which the individuals live. Similarly, the activity of multiple individuals may contaminate urban runoff that leads to an estuary that the same individuals use for fish consumption and recreation. As with the self-exposure scenario, variants of this scenario may exist where individuals differ in the extent to which they value the polluting activity or the resource polluted. Although the group as a whole may benefit if the polluting behavior is reduced, for a variety of reasons the individuals may not organize to enforce limits on the behavior.[277] For

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individuals are not the product of rational, self-interested behaviors. The implication for instrument choice is that appeals to altruism may not be necessary to induce changes in some behaviors. Instead, simple provision of information about the consequences to the individual of the behavior may be effective, assuming the individual is functioning as a rational actor and is not subject to external constraints (whether physical, economic, psychological, or social).

275. Government intervention cannot be based on the existence of an externality (since none exists), distributional justice grounds, or on what Calabresi and Melamed termed "other justice" grounds. Calabresi & Melamed, *supra* note 22, at 1100; *see* Richard L. Revesz, *The Race to the Bottom and Federal Environmental Regulations: A Response to Critics*, 82 MINN. L. REV. 535, 536 (1997) (noting the importance of "protection of a minimum level of public health" as a goal for environmental law). In short, we may opt to intervene to protect an individual's health from falling below some societally determined minimum threshold, even if that requires intervening in the types of individual household behaviors that do not cause human health or environmental harms to others. These efforts tend to be very unpopular, however. *See* J. CLARENCE DAVIES & JAN MAZUREK, POLLUTION CONTROL IN THE UNITED STATES: EVALUATING THE SYSTEM 169-75 (1998) (discussing the importance of intrusiveness in environmental law).

276. This Article refers to numerous individuals because in many cases harm will occur only when numerous individuals' small releases exceed the assimilative capacity of the environment in some way or create exposure that exceeds the dose necessary to trigger a particular adverse health effect. For any one individual, the particular behavior that causes the pollution may or may not be utility maximizing.

277. As with the first scenario, the behavior also may occur because the individuals are unaware of the potential for harm, or are unable to refrain from creating the harm because of physical, economic, psychological, or social constraints.

example, although the harm caused by the group members may remain within the group as a whole, any one individual may incur less of the costs of the polluting activity or capture more of the benefits than another. In this scenario, utility-maximizing individuals thus may prefer the harm to the cost of avoidance. In addition, free rider problems may provide disincentives to those group members who might benefit from collective action.

The alignment of the parties in this scenario is distinct from the traditional single industrial polluter-many victim scenario in two important ways. First, there are multiple sources of pollution as well as multiple victims. Second, the interests of the sources and the victims overlap to a significant extent. Although each individual member of the group has a personal interest in engaging in a particular activity, the individual also suffers harm from the aggregate effect of her actions and many other similar ones. The environmental harm of the activity is thus externalized to a more limited extent than occurs with the more traditional single industrial polluter-multiple victim alignment.

c. Multiple Individuals, Externalized Harm

The third scenario resembles the second in that the behavior of numerous individuals causes harm, but in this case the harm is externalized to another group of individuals (e.g., 10,000 As v. 10,000 Bs). The others who are harmed may be different individuals in the same geographic area, individuals in a different geographic area, or individuals in future generations.[278] Examples that fit this scenario are those in which multiple individuals create low-level ozone precursors that form smog in one airshed that drifts to another airshed, or in which the urban runoff from one city damages an estuary that individuals in another city use for fishing and recreation. As with the self-exposure scenario, variants of this scenario may exist where individuals differ in the extent to which they value the polluting activity or the resource that is polluted. Here, however, the group is causing harm to another group, and the pollution costs are entirely externalized for all the individuals. In this scenario, a utility-

278. An example of an intergenerational effect scenario is one in which the urban runoff from a city leads to damage to an estuary that is not immediately apparent, but that sets in motion irreversible ecological damage (e.g., depletion of fish stocks or the inability to use the estuary for recreation) that only manifests itself after several generations. For a discussion of the importance of inter-generational effects, see Kysar, *supra* note 75, at 688-91; DISCOUNTING & INTERGENERATIONAL EQUITY (Paul R. Portney & John P. Weyent eds., 1999); Daniel A. Farber & Paul A. Hemmersbaugh, *The Shadow of the Future: Discount Rates, Later Generations, and the Environment*, 46 VAND. L. REV. 267 (1993).

maximizing individual is likely to prefer the harm to the cost of avoidance.[279] Absent extraordinary circumstances, at the group level the preferred option will not be to reduce the polluting behavior. At the individual level, even if some individuals do favor reductions in the polluting behavior, collective action problems may prevent the individuals from organizing to enforce limits on the behavior.

The alignment of the parties in this third scenario is similar to the traditional single industrial polluter-multiple victim alignment in that in both cases the environmental harms are externalized. In addition, the interests of the sources and the victims do not overlap in this scenario. The scenario differs, however, in that there are many sources of pollution as well as many victims.

2. Environmental Harms

In addition to distinctive alignments of parties, the releases of pollutants and the environmental harms caused by individuals have several features that are important for environmental instrument choice. The typical releases of pollutants by individuals differ from those of industrial firms in a variety of ways. First, as noted in the second and third scenarios above, with individuals there are often many sources of the pollutant.[280] In contrast, for industrial emissions, the source is often only one or a handful of facilities in a particular area or industry sector. Second, with individuals each release is often of a small quantity over any given time period and will only comprise a large quantity when aggregated with numerous other individual releases or when measured over a long time period. In contrast, single releases from industrial firms are often of substantial size and are more likely to occur in concentrated pulses. Third, the release or other activity that causes the environmental harm is often not visible when caused by individuals.[281] There are few analogues in individual

279. As with the first scenario, the behavior also may occur because the individuals are unaware of the potential for harm, or are unable to refrain from creating the harm because of other constraints.

280. The importance of the widespread, diffuse nature of sources for environmental law and policy has been widely noted, although it has not been tied to the importance of individuals as a source category. *See, e.g.*, Allen V. Kneese, *Confronting Future Environmental Challenges*, RESOURCES, Summer 2002, at 1 (noting that among the three factors that characterize the "emerging environmental problems" is the fact that "sources of pollution are widespread and sometimes diffuse").

281. *See, e.g.*, Office of Solid Waste, EPA, Municipal Solid Waste: Household Hazardous Waste ("Improper disposal of household hazardous wastes can include pouring them down the drain, on the ground, into storm sewers, or in some cases putting them out with the trash. The dangers of such disposal methods might not be immediately obvious, but improper disposal of

behavior to the industrial smokestack. Auto emissions for all but the most heavily polluting cars are not visible. The differences in tailpipe emissions between a compact car and an SUV are not immediately apparent. Similarly, applying home and garden fertilizers or pesticides does not appear to be a polluting activity by itself. The presence of nutrients or pesticides in the runoff that occurs during the next rainstorm is for all intents and purposes invisible to the user and her neighbors. In contrast, many (although certainly not all) industrial emissions are more visible.

In addition, the harms caused by individuals' releases of pollutants or other behavior are often distinct from those caused by industrial releases. Not only are the releases from any one individual smaller and less visible, but the harms arising from individual behavior in many cases are less visible as well. In fact, environmental harm may only arise from individual behavior when many sources are aggregated. In addition, the low concentrations and long time periods involved in many releases from individuals make it more likely that these releases will generate gradual, and in some cases almost imperceptible, changes in ecosystem health, as compared to the sometimes dramatic die-offs of flora and fauna that occur from pulses of industrial pollution. Individuals may release more petroleum to surface water than oil tanker spills, but the immediate result of dead otters and oily coastlines is less likely to occur, even though in some cases the releases from individuals may be quite damaging over the long run. Similarly, the human health effects of many types of individual behavior are more likely to be chronic than acute.[282] Individuals release over a million tons of solvents to the atmosphere each year, but because the releases from each of 281 million Americans are small, they often do not cause immediate, acute health effects. Nevertheless, they may increase the risks of cardiopulmonary disease and certain cancers to the population as a whole. Industrial releases are more likely to result in dramatic, acute human health

these wastes can pollute the environment and pose a threat to human health."), http://www.epa.gov/epaoswer/non-hw/muncpl/hhw.htm (last modified June 6, 2003).

Although this Article refers to pollutant releases, the analysis also is applicable to behaviors that do not involve pollutant releases but cause environmental harms, such as habitat destruction. *See, e.g.*, Anthony DePalma, *Crossing Their (Flight) Path: Development and Sprawl Replace DDT as Top Threat to Bald Eagles*, N.Y. TIMES, Jan. 31, 2004, at A12.

282. The characteristics of the harms caused by individuals often will make causation difficult to establish. The same characteristics often will make it difficult to establish the magnitude of the harm when individuals are the polluters. In addition, long latency periods and the resulting inter-generational risk-shifting may be greater for individual harms, thus exacerbating collective action problems. *See* discussion *infra* notes 334-336.

effects, such as the thousands of deaths caused by the release of methyl isocyanate at Bhopal, India in 1984.

3. Influences on Individual Behavior

The influences on individual behavior differ from the influences on the behavior of large industrial firms in several ways that are important for environmental instrument choice. In particular, inadequate information, cognitive limitations, and social influences all may have a greater effect on the environmentally significant behavior of individuals than they do on firms. Several of these phenomena may lead the general public, regulators, and courts to underestimate systematically the human health and environmental harms of individual behavior and thus may influence not only the types of instruments available to steer individual behavior, but also the decision to regulate in the first place.

a. Information

Information is widely regarded as a choke point for environmental decision making by policymakers and by industry.[283] Although policymakers and industrial firms struggle to gather and process sufficient information about environmental harms and the costs of avoidance, they likely have far more information than private individuals. This conclusion is supported by the limited available empirical studies. For example, surveys demonstrate that individuals' understanding of basic human health and ecological processes is minimal.[284] Similarly, private individuals' understanding of their role in causing pollution is remarkably low. Although pollsters and social scientists rarely ask individuals to identify the sources of environmental harms, the available data suggest that individuals systematically underestimate their role.[285]

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283. *See, e.g.*, Karkkainen, *supra* note 37, at 263; *see also* Richard S. Murphy & Erin A. O'Hara, *Mistake of Federal Criminal Law: A Study of Coalitions and Costly Information*, 5 SUP. CT. ECON. REV. 217, 218 (1997) (discussing the importance of information costs and their impact on mistake of law excuses in federal criminal statutes).

284. *See, e.g.*, Michael P. Vandenbergh, *The Social Meaning of Environmental Command and Control*, 20 VA. ENVTL. L.J. 191, 197-99 (2001) (discussing results of National Environmental Education and Training Foundation survey).

285. Questions about the causes of pollution are not commonly included in public opinion polls and appear to be included less often now than in the 1960s. *See* The Odum Institute, Public Opinion Poll Question Data Base, *at* http://www2.irss.unc.edu/data_archive/pollsearch.html (last visited May 10, 2004). When the question has been asked, industry has received more blame for environmental problems than individuals by respondents in both national and regional surveys. For example, according to a nationwide Roper poll published in 1990, 50 percent of the national

b. Cognitive Limitations

Even if individuals are exposed to information about the harms caused by their behavior, cognitive limitations may influence how they respond to that information, and thus the prospects of regulatory instruments for making behavioral change. The influence of cognitive limitations on decision making under uncertainty has spawned a vast literature in the last decade.[286] Examples of these cognitive limitations include the difficulty many people have in evaluating low probability events, and an "alarmist bias" that arises from the fact that "frightening information is more salient and potent than comforting information."[287]

Although many of the cognitive limitations discussed in the legal literature to date emphasize the likelihood that individuals will over-react to information about the risks arising from industrial pollution, the characteristics of releases from individuals may cause the opposite effect. For example, people also suffer from "optimistic bias," which leads them to underestimate their likelihood of having accidents or contracting diseases.[288] This may influence individuals'

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population cited industrial waste and 42 percent accidental oil spills as causes of water pollution problems. THE ROPER ORG., THE ENVIRONMENT: PUBLIC ATTITUDES AND INDIVIDUAL BEHAVIOR 6 (1990). In contrast, only 24 percent cited trash and litter thrown into streams and 9 percent cited run-off from city streets and parking lots. *Id.* The same pattern occurs for the perceived causes of air pollution. A majority of Americans (55 percent) cited smoke from factories and mills and 34 percent cited smoke from power plants as causes of air pollution. *Id.* at 8. In contrast, only 12 percent cited fumes that evaporate from paints, gasoline, and dry cleaners and 6 percent cited household cleaners and other chemicals in the home. *Id.*

286. *See, e.g.*, Jolls et al., *supra* note 56, 1524-27 (giving examples such as unrealistic optimism and hindsight reasoning). More recently, Gregory Mitchell has suggested that individuals are not uniformly irrational, and that cognitive limits are quite context-dependent. *See* Gregory Mitchell, *Why Law & Economics' Perfect Rationality Should Not Be Traded for Behavioral Law & Economics' Equal Incompetence*, 91 GEO. L. J. 67, 69-77 (2002).

287. Sunstein, *supra* note 53, at 627. Studies of risk perceptions by individuals who have reviewed the warning labels required under California Proposition 65 provide an example. As Sunstein has noted,

> Consumers appear to think that twelve of every 100 users of a product with the required warning will die from cancer, an estimate that exceeds reality by a factor of 1000 or more. With respect to information, less may be more. If information is not provided in a clear and usable form, it may actually make people less knowledgeable than they were before, producing overreactions, or underreactions, based on an ability to understand what the information actually means.

Id. at 627 (citing W. KIP VISCUSI, PRODUCT-RISK LABELING: A FEDERAL RESPONSIBILITY 11-16 (1993) [hereinafter VISCUSI, PRODUCT-RISK LABELING]; W. KIP VISCUSI, RATIONAL RISK POLICY 5 (1998)); W. Kip Viscusi, *Predicting the Effects of Food Cancer Risk Warnings on Consumers*, 43 FOOD DRUG COSM. L.J. 283, 288 (1988)).

288. Sunstein, *supra* note 53, at 628 (citing Jolls et al., *supra* note 56, at 1524-27). Examples include the findings that roughly 90 percent of people surveyed believe that they are above average drivers (and therefore believe that they are less likely to have an automobile accident) and that 97 percent believe themselves to be either average or above average in ability to avoid

use of pesticides and other toxics around the home. People also have excessively steep discount rates, which induce them to under-value the benefits of changes in behavior that will not accrue for several years.[289] This may affect a wide variety of environmentally significant behaviors such as investments in energy efficient (hence generally less polluting) cars, furnaces, and other equipment. Although the role of cognitive limitations in creating an "alarmist bias" has been discussed at length elsewhere, the potential for cognitive limitations to lead to an underestimation of harms generally has been less of a focus.[290] The cognitive limits on the ways in which individuals think about the types of environmental harms they cause thus may have important implications for instrument choice.

Two other cognitive phenomena have received less attention in the legal literature but are potentially important to instrument choice regarding individual environmentally significant behavior. First, cognitive dissonance may play a role by affecting individuals' conceptions of the sources of pollution and estimation of harms.[291] Individuals have a desire to make their attitudes, beliefs, cognitions, and behaviors as consistent as possible.[292] If a person experiences inconsistency among different thoughts or between thoughts and actions, the person generally will take steps to reduce the inconsistency.[293] Alternatively, a person may simply avoid information that is inconsistent with her beliefs.[294] In the case of environmental behavior, people are likely to avoid information that would make them feel bad about themselves or their actions. If they are told that their actions are environmentally unsound, rather than weighing the costs and benefits of their actions, they may try to reduce

power mower and bicycle accidents. *Id.* (citing SHELLEY E. TAYLOR, POSITIVE ILLUSIONS: CREATIVE SELF-DECEPTION AND THE HEALTHY MIND 10-11, 116 (1993)).

289. *See, e.g.*, Jerry A. Hausman, *Individual Discount Rates and the Purchase and Utilization of Energy-Using Durables*, 10 BELL J. ECON. 33, 50-53 (1979).

290. For work identifying the concerns about overestimating and underestimating risks, see CASS R. SUNSTEIN, RISK AND REASON 49 (2002); VISCUSI, PRODUCT-RISK LABELING, *supra* note 287, at 61-65 (focusing in particular on the over-estimation problem); Kuran & Sunstein, *supra* note 81, at 757.

291. Festinger proposed the theory of cognitive dissonance in 1957. *See* LEON FESTINGER, A THEORY OF COGNITIVE DISSONANCE (1957). For a discussion of cognitive dissonance in the legal literature, see Dan M. Kahan, *Social Influence, Social Meaning, and Deterrence*, 83 VA. L. REV. 349, 358 (1997).

292. *See* SHARON S. BREHM ET AL., SOCIAL PSYCHOLOGY 199 (4th ed. 1999). Festinger believed this desire was as basic as the need for food. FESTINGER, *supra* note 291, at 3-4.

293. BREHM ET AL., *supra* note 291, at 199-200.

294. FESTINGER, *supra* note 291, at 30.

dissonance by adding consonant cognitions.[295] Identifying corporate polluters as the only important sources of environmental harms may reinforce this process by giving individuals someone else to blame.[296]

Second, the environmentally significant behavior of individuals also may be influenced to a surprisingly large extent by habits. Habits are remarkably important exceptions to the assumption that individuals make ongoing utility calculations, and habits are resistant to change.[297] Research has shown that habits tend to truncate the traditional subjective expected utility calculation by creating a "habitual mindset."[298] When individuals are in this habitual mindset, they do not take into account all of the necessary factors for making a logical calculation.[299] Thus, models of thinking and choice that rely on logical or reasoned calculations are most predictive only in the absence of a strong habit.[300] For instance, when deciding on a mode of transit

295. Consonant cognitions are one of the mechanisms used to reduce cognitive dissonance. For instance, if a person had resolved to go on a diet, but had just consumed a substantial chocolate mousse, she might think to herself, "Chocolate mousse is very nutritious." BREHM ET AL., *supra* note 292, at 200, tbl. 6.5.

296. This thought process may give rise to a different kind of consonant cognition: "Sure I'm not the most pro-environmental individual in my neighborhood, but I'm not as bad as the chemical plant down the road." *See also* Bradley Bobertz, *Legitimizing Pollution Through Pollution Control Laws: Reflections on Scapegoating Theory*, 73 TEX. L. REV. 711, 718 (1997) (describing the "scapegoating" phenomenon in environmental law); Kenneth A. Manaster, *Ten Paradoxes of Environmental Law*, 27 LOY. L.A. L. REV. 917, 931 (1994) (noting the common approach of "labeling different categories of participants as good guys or bad guys—the cowboy-hero environmental protection types wearing the white hats versus the sinister despoilers of nature and public health wearing the black hats."); Oren, *supra* note 123, at 148 (noting the inability to blame industry for pollution arising from increases in motor vehicle use); Vandenbergh, *supra* note 284, at 208 (noting the social meaning effects of command and control statutes)..

297. *See* Bas Verplanken & Henk Aarts, *Habit, Attitude, and Planned Behavior: Is Habit an Empty Construct or an Interesting Case of Goal-directed Automaticity?*, *in* EUROPEAN REVIEW OF SOCIAL PSYCHOLOGY 101, 111 (Wolfgang Stroebe & Miles Hewstone eds., 1999). When an individual is functioning in this "habitual mindset," not all of the necessary factors for making a logical calculation are taken into account. *Id.* The authors contend that habits save cognitive time and energy by circumventing the stages in the decision-making process, *id.* at 119, and that individuals with a strong habit use fewer facts to reach a travel mode decision, suggesting that rational deliberation over a range of choices may only occur in the absence of a habit. *Id.* at 124. Although forcing individuals to attend to the circumstances surrounding their choice may induce individuals to consider more information than they would under the habitual mindset, *id.* at 121-22, such processing may not be sufficient to induce behavioral change. *Id.*

298. *See id.*; *see also* Ulf Dahlstrand & Anders Biel, *Pro-Environmental Habits: Propensity Levels in Behavioral Change*, 27 J. APPLIED SOC. PSYCHOL. 588, 588 (1997) (noting that "[t]he advantage of having a habit is that you do not have to think and consider different alternatives each time you act in a certain situation"); Bas Verplanken et al., *Habit, Information Acquisition, and the Process of Making Travel Mode Choices*, 27 EURO. J. SOC. PSYCHOL. 539, 540-42 (1997) (reporting on the results of three studies of the effects of habit on decision making).

299. Verplanken & Aarts, *supra* note 297, at 111.

300. *Id.* at 124.

for a particular trip, individuals who have a strong habit of using a particular mode tend to consider fewer trip factors (e.g., weather and distance) than those with a weak habit.[301] In fact, individuals with a strong travel mode habit specifically ignore information about alternatives to that habit.[302] Strong habits also may impede the influence of personal norms.[303] Furthermore, habits may be at least as good a predictor of future behavior as intentions or attitudes.[304]

By circumventing decisional processes, habits save cognitive time and energy.[305] Because all of the necessary factors for a rational decision are not taken into account, however, habits that formed because they were efficient at one time may not be efficient when circumstances change.[306] A general habit of car use, for instance, may lead to inefficient outcomes in individual situations (e.g., when walking would have been more efficient because of a short travel distance and an absence of parking).[307] Research suggests that forcing individuals to attend to the circumstances surrounding their choice will encourage them to consider more information than they would under the habitual mindset.[308] Increased information or information

301. Henk Aarts et al., *Habit and Information Use in Travel Mode Choices*, 96 ACTA PSYCHOLOGICA 10-11 (1997); *see also* Verplanken & Aarts, *supra* note 297, at 124 (concluding that the cognitive orientation accompanying habitual behavior limits attentiveness to new information).

302. Verplanken et al., *supra* note 298, at 546-47, 549. This effect still exists even when attitude toward the travel mode is taken into account. *Id.*

303. *See* Judith A. Ouellette & Wendy Wood, *Habit and Intention in Everyday Life: The Multiple Processes by Which Past Behavior Predicts Future Behavior*, 124 PSYCHOL. BULL. 54, 62 (1998) (finding that the influence of subjective norms is greater in contexts that encourage deliberative thought and less in contexts that facilitate habit formation).

304. *Id.* at 61.

305. Verplanken & Aarts, *supra* note 297, at 119; *see also* Ouellette & Wood, *supra* note 303, at 61, 63-64 (finding that stable contexts are most conducive to habit formation and that in those contexts, habits are most predictive of behavior); Verplanken et al., *supra* note 298, at 555 (finding that individuals with a strong travel mode habit acquire less information than those with a weak habit).

306. Ouellette & Wood, *supra* note 303, at 57; Verplanken & Aarts, *supra* note 297, at 111.

307. Verplanken et al., *supra* note 298, at 558. In addition, a rational individual would likely take into account the exercise benefits of walking or biking.

308. Verplanken & Aarts, *supra* note 297, at 121-22. For instance, holding participants accountable for their travel mode choices increases the amount of information they acquire. Verplanken et al., *supra* note 298, at 557. At the same time, accountability does not seem to change the decision strategy that individuals use, suggesting that they are merely seeking out more information to justify their choice. *Id.* Alternatively, asking people to attend to the decision process changes both the depth of information required and the complexity of the decision process used. *Id. But see id.* at 555 (finding that asking those with a strong habit to attend to their decision process results in an initial increase in decisional complexity, but over time those individuals revert back to the habitual mindset).

processing may lead some to try an alternative to their habit.[309] To effectuate behavior change, however, a mere increase in information acquisition or processing may not be enough.[310] For the new behavior to become a new habit,[311] additional measures may be necessary to ensure that the alternative is at least as useful or attractive as the old habit.[312] Once a new habit (e.g., recycling) is acquired, however, it may be continued even if the costs of doing so are high.

c. *Social Influences*

Individuals also may be more influenced by informal social control than are industrial firms. Studies suggest that personal norms—the belief that one has a personal obligation to act even where others will not reward the act—and social norms—the belief that others value an act and will informally reward it or sanction noncompliance—play a large role in individual environmentally significant behavior.[313]

Although the personal and social norms of business managers also have a substantial (and largely overlooked) influence on corporate environmental performance, the effects of social influences are likely to have more pronounced effects on individuals than on large industrial firms.[314] Social influences may affect corporate managers'

309. Dahlstrand & Biel, *supra* note 298, at 599. Dahlstrand and Biel propose a seven step model by which old habits can be broken and new habits can be formed. In the study cited here, however, they only examine three general levels of habit change. *Id.* at 589-91. They examine pro-environmental consumer behavior, but their insights are valuable for driving habits as well. *See* Jörgen Garvill et al., *Effects of Increased Awareness on Choice of Travel Mode*, 30 TRANSP. 63, 75-78 (2003) (indicating that individuals with a strong habit of using a car for transport can be made to drive less).

310. Verplanken & Aarts, *supra* note 297, at 121-22; *see* Aarts et al., *supra* note 301, at 10-14.

311. Dahlstrand & Biel, *supra* note 298, at 599 (noting a correlation between the viability of an alternative and its propensity for becoming a new habit); *see also* Ouellette & Wood, *supra* note 303, at 70. Of course, once a desired behavior has become habitual, regulators may need to intervene less to sustain it.

312. Dahlstrand and Biel offer one explanation by whicb habits may be changed. Dahlstrand & Biel, *supra* note 298, at 588. They studied a simplified version of their proposed 7-stage process for habit change, *id.* at 591-92, and posited that the attitude-behavior link is strongest when there is no habit and weakest when a habit is in place. *Id.* at 588. In particular, they examined how to convince individuals to buy environmentally friendly (EF) products and found that information alone might be enough to get people to at least consider buying EF products, but for a habit of buying EF products to develop, the specific characteristics of the EF products (e.g., price) were more relevant than the information provided about the products' environmental effects. *Id.* at 599.

313. *See, e.g.*, Stern, *supra* note 17, at 461-63.

314. *See* Michael P. Vandenbergh, *Beyond Elegance: A Testable Typology of Norms in Environmental Compliance*, 22 STAN. ENVTL. L. J. 55, 63, 76-78 (2003).

decisions, employee morale, or shareholder, customer, or supplier decision making.[315] Yet firms have a reasonably clear principal objective: to maximize shareholder value in pecuniary terms. Firms also are influenced by various internal and external governance mechanisms designed to ensure that the pecuniary objective is achieved. Even outside formal governance rules, studies suggest that firm employees use a "desiccated language" that frames moral or other non-pecuniary issues in a way that may lessen their influence on managers' decision making.[316] Thus, to the extent the firm governance structure functions properly, social influences on managers that do not maximize shareholder value will be limited. Although this is an area worthy of further study, at least for large, publicly traded firms whose performance is defined by the market in pecuniary terms, it is fair to assume that social influences will have less effect on firm behavior than on the behavior of private individuals.

B. Implications of Individuals for Environmental Regulation

In light of the distinctive characteristics discussed above, re-conceptualizing individuals as a source category will require a fundamental reexamination of the theories and methods of environmental regulation. In particular, adding individuals to the target list for potential environmental regulation will require reconsideration of the strengths and weaknesses of existing instruments and development of new instruments or combinations of instruments. This Part provides an initial examination of the effects of treating individuals as regulated entities on environmental regulatory instrument choice.

1. Command and Control Regulation

Command and control regulations that seek to lessen the environmental harms caused by individuals may be directed at the firms that produce consumer products or at individual behavior directly. As discussed above, the vast majority of the command and control regulations that seek to reduce environmental harms from individuals take the form of emissions controls directed at the industrial facilities that produce consumer products or restrictions on

315. *See* Mark A. Cohen & Sally S. Simpson, *The Origins of Corporate Criminality: Rational Individual and Organizational Actors*, *in* DEBATING CORPORATE CRIME 33, 35 (William S. Lofquist et al. eds., 1997); Karkkainen, *supra* note 37, at 294-327.

316. *See* ROBERT JACKALL, MORAL MAZES 104 (1990).

the environmentally harmful characteristics of consumer products, whether automobiles, thermostats, or home cleansers. This regulatory approach is responsible for many of the gains that have been made in reducing the impacts of individuals on the environment. In addition, there may be substantial additional room for cost-effective restrictions on the manufacturers of consumer products.[317] This approach will continue to face diminishing returns, however, as the most significant products are regulated and as increasing population and activity levels continue to overwhelm product-based restrictions.

The use of command and control requirements to change individual environmentally significant behavior has been less successful and, at least in the near term, is unlikely to be effective, efficient, or politically feasible. The thousands or millions of potential regulatory targets for any given environmental problem, the widespread belief that individuals are not significant pollution sources, and the cognitive barriers to changing that belief all make individual behavior extremely difficult to regulate through command and control instruments, particularly at the federal level. As the discussion of regulatory measures in Part III suggests, past attempts to do so generally have failed miserably.[318] Even at the state and local level, the experience with command and control regulation as the sole regulatory instrument has been mixed. In particular, the cost of enforcement against large numbers of individuals makes behavior change based solely on the threat of formal legal sanctions unlikely. To the extent environmental harms caused by individuals are difficult to detect, enforcement is expensive and intrusive. Even if sufficient resources were devoted to the effort, tbe intrusiveness of enforcing these regulations may undermine compliance or produce a political backlash. Empirical studies suggest that the difficulties of fully enforcing command and control approaches against individual behavior present tbe risk of increasing, rather than decreasing, environmental harms. For example, a study of the effects of a proposed increase in regulatory requirements on used motor oil suggested that noncompliance would be widespread and that tbe net impact of the new requirement would be increased releases of used

317. In some cases, regulations that focus on changing the products used by individuals may be more cost-effective than regulations on other sources. For example, portable gas can and gas can spout standards promulgated by the California Air Resources Board were expected to cost between $6 and $11 per can, or $2.01 per pound of ozone precursors. CARB, GAS CAN REGULATIONS, *supra* note 127, at 2. In contrast, other emissions control strategies for sources of ozone precursors in California were estimated to cost approximately $5 per pound. *Id.*

318. *See* discussion *supra* notes 144-148 (discussing driving restrictions).

oil.[319] Similar conclusions have been reached about volumetric charges for household garbage: studies suggest that although they may reduce the volume of garbage disposed of at a landfill, they also may increase illegal dumping.[320]

When combined with informational regulation and economic incentives, however, some types of direct command and control regulations on individuals, such as restrictions on the disposal of household hazardous waste and motor oil, appear to have been successful. Some states and local governments have combined laws limiting the disposal of household hazardous waste in landfills with investments in free or low-cost waste collection or drop-off options.[321] Others have combined laws requiring individuals to recycle with investments in the infrastructure necessary to make recycling convenient.[322] Some extension of local government controls over individual behavior, where combined with other regulatory instruments, thus may be effective.[323]

To date, the experience with pure command and control approaches suggests that, at least as a first order measure, such approaches are not a viable option on their own for changing individual environmentally significant behavior. They may be more effective when combined with other regulatory instruments, or when

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319. *See* discussion *supra* note 269.

320. *See* Carlson, *supra* note 258, at 1244, 1292-93 (discussing studies of garbage reduction programs).

321. More than 3,000 local governments have developed household hazardous waste collection programs. *See* Office of Solid Waste, *supra* note 281; *see also* EPA, PESTICIDE REGISTRATION NOTICE 2001 3 (Sept. 7, 2001). Local governments have attempted to regulate individual environmentally significant behavior for years in the form of restrictions on disposal of household hazardous wastes and air pollution ordinances. *See* Nash & Revesz, *supra* note 43, at 579 (noting the early use of smoke ordinances directed at coal as a heating fuel by municipalities). Some local governments even have "environmental courts" to adjudicate health code violations and other environmentally significant violations, including littering and illegal dumping, local air and water quality violations and asbestos removal violations. *See, e.g.*, Shelby County Environmental Court, at http://www.co.shelby.tn.us/county_gov/court_clerks/gen_session_court/envirocourt.

322. *See* Carlson, *supra* note 258, at 1243-45.

323. The efforts underway to achieve the new EPA eigbt hour ozone NAAQS may provide an example of an area in which local governments may have success using command and control measures directed at individuals. *See supra* text accompanying note 112. The combination of a federal standard for ozone, federal support for state and local public information campaigns, and some local, time-limited restrictions on backyard burning, lawn mowing, or other ozone precursor-emitting activities may be both politically feasible and effective at reducing the individual share of ozone precursor emissions. The prospects for federal command and control regulation of individual behavior are less rosy. Even wben statutory or regulatory authority has existed, it typically has not been exercised by EPA, an outcome that is not surprising given the negative reactions to the rare attempts to regulate individual behavior. *See* discussion *supra* notes 144-148.

used as a second order measure after information and other regulatory instruments have had an influence on heliefs and norms. In addition, the expressive effects of command and control measures may play an important role in the regulation of individual behavior. Enactment of command and control measures may signal a social consensus regarding a particular behavior, and thus may influence personal or social norms.[324] In combination with other forms of informational regulation or economic incentives, this expressive function may have a greater effect on individual behavior than the largely nonexistent threat of formal legal sanctions.[325] In sum, although command and control measures are unlikely to be effective as the exclusive instrument for steering individual environmentally significant behavior, their expressive effects, in combination with informational regulation and other measures, may be quite important.

2. Economic Incentives

The principal focus of economic incentive enthusiasts has been on the development of tradeable allowance schemes for the emissions from large industrial sources, and these schemes have had a number of visible successes over the last twenty years.[326] At the same time, economic incentives have been used only to a very limited extent to address individual environmentally significant behavior.[327] The situations in which individual behavior occurs, the characteristics of the environmental harms that arise, and the characteristics of individual behavior discussed above all present challenges to the use of economic incentives.

For example, in theory property rules could be used to regulate pollution by individuals. To address individual behavior, property

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324. *See* Richard McAdams, *The Origin, Development, and Regulation of Norms*, 96 MICH. L REV. 338, 356-57 (1997); Cass R. Sunstein, *On the Expressive Function of Law*, 144 U. PA. L. REV. 2021, 2046 (1996) (noting the potential expressive effects of emissions trading programs).

325. The expressive effects of environmental laws that are directed at individual behavior but that are rarely enforced will require careful study. For example, widespread belief that a statute is not enforced could undermine the intended effect of the statute. *See, e.g.*, Kahan, *supra* note 291, at 379 (noting the effects of non-enforcement of tax laws). In those situations, it may be preferable to have no command and control law directed at individual behavior rather than one that is not enforced.

326. For an overview of marketable allowance schemes and other economic regulatory instruments, see Wiener, *supra* note 2, at 679-80, 704-35.

327. As Ann Carlson has noted, despite the evidence that deposits on recyclable containers increase recycling, no state has enacted a bottle bill in more than fifteen years. Carlson, *supra* note 258, at 1245. A partial commodification of highway High Occupancy Vehicle lanes in San Diego highways appears to have generated increases in carpooling and reductions in congestion. Lior Jacob Strahilevitz, *How Changes in Property Regimes Influence Social Norms: Commodifying California's Carpool Lanes*, 75 IND. L. J. 1231 (2000).

rights could be assigned to goods that are now over-consumed, such as air, water, and undeveloped ecosystems, and parties could bargain to efficient outcomes regarding their use. But as Calabresi and Melamed noted in their analysis of industrial pollution, the barriers to implementing a property rights scheme for many types of pollution make its prospect as a regulatory instrument dubious.[328] These problems are only exacerbated when the polluters include numerous individuals. As discussed above, many of the human health and environmental impacts of individual behavior are the product of very small, diffuse releases of pollutants that cause harms that are chronic, not acute, and that are widely distributed among victims, in many cases non-human victims such as flora and fauna. Identifying, distributing, and enforcing rights to these goods often would be a monumental and expensive task. In addition, as a result of the numbers and characteristics of individuals discussed above, transaction costs often will be high, and thus Coasian bargaining will rarely occur. The development of a workable property rights scheme thus will be difficult.

Market mechanisms have been used in the Clean Air Act to control acid rain precursor emissions on a nationwide basis, and several regional efforts have been undertaken to use market trading to address air pollution.[329] However, the examples of successful marketable allowance schemes may not be indicative of the prospects for success when individuals are the polluters. The marketable allowance systems that have succeeded thus far have been implemented for stationary sources where baseline emissions were available and the number of regulated sources was manageable.[330] Extending market mechanisms to individual behavior may present a range of problems. For example, such a program would be expensive to establish and administer, no baselines exist from which to determine initial allocations, and the value of any one allowance to any one individual would be miniscule and in many cases not worth the transaction costs involved in trading it.

Moreover, the concerns that have been raised about the social meaning effects of commodifying pollution, although perhaps fairly dismissed as to schemes that are largely the subject of corporate emissions and are not widely known by the general public, may be much more important if those schemes are extended to individual

328. Calabresi & Melamed, *supra* note 22, at 1090-92.

329. *See, e.g.,* Nash & Revesz, *supra* note 43, at 599-605 (discussing regional NOx trading programs).

330. For a discussion of regional and local trading initiatives, see Nash & Revesz, *supra* note 38.

behavior.[331] To the extent individual behavior is steered as much by norms as by legal sanctions or economic incentives, as the discussion below suggests, a shift in the meaning of certain individual behaviors from "polluting" to something less value-laden may generate a sub-optimal level of social control on individuals' environmentally significant behavior.

In the Calabresi and Melamed analysis and among economic incentive enthusiasts generally, the next move is to a liability rule. Yet the notion that a court action against individuals as polluters could even be brought, much less be brought to a satisfactory conclusion, is hard to envision. Where the harms arise from long-term exposures and are chronic rather than acute, plaintiffs may be unlikely to bring claims. The scenario involving one individual causing harm to herself or members of her household is the most straightforward. Although common law tort actions are potentially available against other members of a household, often it will not be in the interest of the potential plaintiff to sue another member of the same household.[332]

The scenarios involving large numbers of defendants as well as plaintiffs present even greater challenges. Often thousands or millions of individual polluters will be implicated, as opposed to at most a handful as is often the case for industrial sources. The large number of plaintiffs and defendants casts doubt on the ability of any scheme that requires common law actions to enforce legal rules, whether based on property or liability rules.[333] For example, coordination problems will arise not only on the plaintiffs' side, but on

331. As Sunstein has noted, environmentalists have raised concerns that tradeable allowance systems may have an unintended effect on social meanings. Sunstein, *supra* note 324, at 2046. In short, by creating a market in rights to pollute, marketable allowance schemes may undermine the notion that pollution is bad. In so doing, they may undermine norms against pollution. *See id.* For an interesting example of a commodification that appears not to have had an adverse effect on social meanings or social norms, see Strahilevitz, *supra* note 327.

332. Although rare, environmental litigation between individuals in the same household has occurred. *See, e.g.*, Steven Dujak, *Notice and Comment: News That's Reused*, ENVTL. F., Sept./Oct. 1998, at 19 (noting a 1997 case in which a Chicago man sued his wife in federal District Court for a Clean Air Act violation based on the EPA determination that second-hand smoke is a carcinogen. The case was dismissed after the wife agreed to stop smoking.).

333. Of course, liability rules already exist. Nuisance, trespass, and other actions are, at least in theory, available now to limit the type of individual conduct that creates the human health and environmental harms discussed in Part III, yet few if any common law tort actions have been brought regarding these harms. This Article is not the place for a comprehensive analysis of this issue, but for a number of reasons existing liability rules appear to have had little effect on this conduct.

the defendants' side as well.[334] In addition, the plaintiffs and defendants often will be the same or at least have interests that overlap to a significant extent. Courts will be reluctant to enforce rules protecting entitlements where the classes of plaintiffs and defendants have overlapping interests and membership.[335] In addition, a suit by individuals as victims against individuals as polluters may confront a cognitive dissonance problem, forcing victims to acknowledge that they are also polluters.[336]

Even assuming that the plaintiffs could overcome these hurdles and bring an action, the long-term, almost invisible degradation of goods such as waterways polluted by urban runoff present substantial challenges for liability rules.[337] The burden on the plaintiffs to demonstrate causation would be almost insurmountable.[338] In addition, a court would face difficulty valuing the harm, even if only to the extent the court attempted to calculate the average harm of the cases of this type brought before it.[339] Finally, the large number of defendants would make any remedy difficult to enforce.[340]

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334. As Kaplow and Shavell note, if not all victims sue, tort actions may result in damages that are systemically low. Kaplow & Shavell, *supra* note 2, at 731 n.54. This is likely to be the case where each individual has only suffered minor harms.

335. *See* Diamond v. Gen. Motors Corp., 97 Cal Rptr. 639, 641-42 (Cal. Ct. App. 1971). The *Diamond* case involved a suit seeking an injunction on behalf of all Los Angeles residents against all major stationary sources of air pollution as well as the sale and registration of new cars in Los Angeles. *Id.* at 641. The suit was dismissed in part because of the overlap in interests and membership between the classes of plaintiffs and defendants. *Id.* at 642-44. For an analysis of the case, see Manaster, *supra* note 296, at 933-34.

336. The court in *Diamond* observed that "[w]e do not deal with a simple dispute between those who breathe the air and those who contaminate it." 97 Cal. Rptr. at 645; *see also* Manaster, *supra* note 296, at 934 (observing that "Pogo's insight ["we have met the enemy and he is us"] prevailed, and the popular dichotomy again was shown to be illusory").

337. This problem could be addressed by reconceptualizing citizen suits to give citizen victims the ability to sue citizen polluters, as opposed to only industrial polluters or government agencies, but these types of actions are likely to be infrequent and unsuccessful. *See* discussion *supra* note 189.

338. *See* discussion *supra* notes 37-50. In their discussion of property and liability rules, Kaplow and Shavell do not account for the plaintiffs' burden of establishing causation. Kaplow & Shavell, *supra* note 2, at 731 n.54. The difficulty of establishing causation regarding even the more concentrated, obvious industrial sources of pollution was one reason that command and control requirements were adopted by the federal and state governments beginning in the 1970s. *See, e.g.*, Ethyl Corp. v. EPA, 541 F.2d 1, 28 (D.C. Cir. 1976) ("[w]here a statute is precautionary in nature, the evidence difficult to come by, uncertain, or conflicting because it is on the frontiers of scientific knowledge, the regulations designed to protect the public health, and the decision that of an expert administrator, we will not demand rigorous step-by-step proof of cause and effect. Such proof may be impossible to obtain if the precautionary purpose of the statute is to be served.").

The difficulties in establishing causation would be far greater in the case of multiple, diffuse sources and long-term harms of many individual environmentally significant behaviors.

339. Kaplow and Shavell have argued that so long as a court can ascertain the average harm of environmental pollution, liability rules are preferable to property rules, but the administrative

These factors make actions to enforce liability rules implausible.[341] As a result, an attempt to protect against individual environmental harms with property or liability rules in practice would result in little government intervention to limit those harms, and would represent an implicit risk management decision that the harms caused by individuals do not justify the costs of control.

Taxes are a favorite instrument of economists, and in theory they could be used quite effectively to steer consumer behaviors ranging from driving to electricity and consumer product use.[342] Yet, they are politically radioactive in the United States to such an extent that they are not of more than theoretical interest, at least in the near term.[343] Even the strong supporters of economic measures in the

costs of estimating harm in the case of diffuse, individual-sourced pollution may be very high, and there may be a systemic risk of under-estimation. *See* Kaplow & Shavell, *supra* note 2, at 730 (noting that "[w]e do suspect that damages are too low when there are components of loss that are hard to estimate"). When courts do determine average harm, the characteristics of the harms and cognitive limitations discussed above suggest a high likelihood that they will underestimate these types of harms. Yet elsewhere Kaplow and Shavell assert that "under the liability rule, there will not tend to be much pollution if the risk of cancer is serious, for damages will then be high precisely because the average harm will be high." *Id.* at 729. They note that all findings of fact include some amount of "guesswork." *Id.* at 730. These arguments are weakest in situations in which the knowledge about the carcinogen is imperfect or where the carcinogen has latent effects. When the "polluter" consists of multiple individuals, all releasing minute amounts of numerous compounds, any one of which may have caused harms to multiple victims or to the environment, the assertion that an average risk of harm approach will not lead to under-regulation of certain behavior is even less persuasive.

340. *See* Krier & Schwab, *supra* note 2, at 453 (noting that not only do parties face "transaction costs," but courts face "assessment costs" in determining harm, and that the assessment costs can be large in environmental cases).

341. Given that government command and control requirements, private property actions, and nuisance actions are not feasible against many individual environmentally significant behaviors, in the approach followed by Calabresi and Melamed individuals may be thought to have by default an entitlement to pollute that is protected by a property rule. This is roughly analogous to the situation of polluting nations in the international environmental arena. *See* Wiener, *supra* note 2, at 768 (noting that "[a]n externality itself is an involuntary exchange forced on the victim by the source").

342. *See* PIGOU, *supra* note 40. Price-based tools such as taxes, subsidies, and liability rules also have been selected as the instrument of choice for some environmental problems. In the United States, tax schemes have been used in a variety of ways, such as to increase the cost of chemical feedstocks and fund Superfund site cleanups. *See, e.g.*, I.R.C. § 4661 (2000).

343. In Europe, tax schemes have been implemented in the form of commuter taxes to reduce driving in center cities and for other purposes. *See, e.g.*, Sarah Lyall, *Starting Today, Driving in London Is Pound Foolish,* N.Y. TIMES, Feb. 17, 2003, at A3 (describing new congestion zone fees in London). In the United States, however, the political feasibility of using tax and subsidy schemes to address polluting behavior remains uncertain at best, and it has led environmental law scholars to conclude that tax schemes are not worthy of extended discussion. *See, e.g.*, Karkkainen, *supra* note 37, at 278.

academic literature have noted that the prospects for the use of taxes or fees to control pollution in the United States generally are dim.[344]

Subsidies may create perverse incentives, but they also may be a more viable approach than other economic incentive schemes.[345] In fact, recent experience suggests that Congress is eager to enact subsidies that affect environmental protection, although those enacted often have been truly harmful.[346] Nevertheless, subsidies may have surprising importance as a regulatory instrument directed at individual behavior. An assumption of the environmental instrument choice debate is that regulatory tools should be Kaldor-Hicks superior: the benefits of the regulation should exceed the costs such that those who benefit could compensate those who lose, although the compensation need not occur.[347] Kaldor-Hicks superiority is distinct from Pareto superiority, in which those who benefit actually do compensate the losers, and no one is in a worse position.[348] Since a Kaldor-Hicks superior regulatory action leaves some parties in a worse position, despite the net increase in social benefits, government must have the power to enforce its requirements. Both command and control and economic incentive regulatory instruments thus assume an effective governmental authority. But, as the discussion of the characteristics of individuals as a source category suggests, government may have little direct coercive ability against individuals.

Oddly, the regulation of individuals thus may resemble the regulation of countries in international environmental law. In the

344. *See, e.g.*, Stewart, *supra* note 4, at 115-16 (noting that "[t]here has been no significant use of environmental taxes or fees in the United States, with tbe exception of taxes on CFCs and other ozone-depleting substance").

345. This is also the case regarding international environmental law. *See* Wiener, *supra* note 2, at 682.

346. Examples include several farm suhsidies and the recent change that allows small businesses to deduct up to $100,000 for the purchase of vehicles weighing over 6,000 pounds. The favorable tax treatment is only available to those vehicles (e.g., the largest SUVs) *over* 6,000 pounds. These heavier vehicles are more likely to have higher air pollution emissions and lower gas mileage than lighter vehicles. *See* Pamela Najor, *Tax-Cut Bill Would Give Small Businesses Reason to Buy Largest Sport Utility Vehicles*, DAILY ENV'T REP. (BNA) A-6 (May 28, 2003).

347. *See, e.g.*, Wiener, *supra* note 2, at 743 (discussing Kaldor-Hicks superiority). Of course, governments may seek to achieve goals other than efficiency. Environmental harms pose issues of distributional equity both in terms of the environmental harms that occur and the costs of avoidance. Issues of distributional equity may arise among those in the current generation, such as when environmental harms fall disproportionately on ethnic or economic groups. *See, e.g.*, Richard J. Lazarus, *Pursuing "Environmental Justice": The Distributional Effects of Environmental Protection*, 87 NW. U. L. REV. 787 (1993); *see also* Revesz, *supra* note 275, at 536 (noting the protection of a minimum level of human health as a non-efficiency objective of environmental laws). Distributional equity issues also may arise on an inter-generational basis, when one generation shifts the environmental harms of its behavior onto future generations. *See supra* discussion at notes 278-282.

348. *See* RICHARD POSNER, ECONOMIC ANALYSIS OF LAW 14 (5th ed. 1998).

international arena, where no centralized governmental authority is available to command performance by individual countries, Kaldor-Hicks optimality may not be achievable.[349] Simply put, where a governmental authority is unable to force those who will lose to adhere to regulatory commands, government policies that require coercive force to ensure compliance are likely to fail. Instead, achieving a change in behavior may only be possible if the solution achieves Pareto improvement for those who participate: changes in behavior occur because some parties are in a better position, and none is in a worse position.[350]

In situations in which individuals are the sole sources of pollution, the analysis suggests that government strategies that subsidize desired changes in behavior may achieve greater pollution reductions than alternative strategies. The most direct form may occur where government provides a payment directly to individuals, but many other forms also may be possible. For example, many water bodies are impaired by pollution from a combination of industrial point sources and non-point sources such as runoff from individual behavior, agriculture, and other sources.[351] EPA has struggled for years to promulgate a regulation (the Total Maximum Daily Load or TMDL rule) that would establish procedures for addressing water bodies that fail to meet water quality standards despite the imposition

349. *See* Wiener, *supra* note 2, at 743.

350. *See id.* As Wiener has noted, international regulatory regimes are similar (e.g., among treaty signatories) in this way to local neighborhood regulatory regimes (e.g., homeowners associations) in that both require the consent of the regulated parties and therefore must be Pareto-improving for those parties. Jonathan Baert Wiener, *On the Political Economy of Global Environmental Regulation*, 87 GEO. L.J. 749, 790 (1999) (concluding that "treaties are more like voluntarily adopted restrictive covenants than they are like legislated statutes").

351. A second example involves low-level ozone. In many areas of the country, both industrial sources and individual sources contribute to the low-level ozone problem. One role of government in these situations may be to create the incentives and low transaction cost setting that would induce concentrated industrial and other sources to compensate individuals for taking steps that more cost-effectively reduce ozone precursor emissions than would additional controls on industrial sources. For example, industry could be given credits for inducing private individuals to purchase less-polluting lawn and garden equipment or to use mass transportation, such as through supplementing bus fares or funding infrastructure. To some extent, these types of programs already exist in the form of programs that provide firms with incentives to provide financial and other inducements to employees who carpool or use mass transportation and programs that encourage firms to provide individuals with incentives to scrap older, high-emitting vehicles, but these programs are not widespread. Alternatively, industry could be given credits if it can demonstrate that its efforts (e.g., through funding or conducting public information campaigns or providing financial incentives for individuals to reduce polluting activities) generate demonstrable changes in individual behaviors or reductions in ozone precursor emissions.

of effluent limitations on point sources.[352] If EPA or state agencies conceive of individuals as potential regulatory targets and recognize the need for financial inducements to effectuate changes in individual behavior, it may be possible to structure provisions in regulations directed at industrial point sources that provide incentives for industrial sources to demonstrate that they have reduced emissions from individuals in the watershed.[353] For example, industrial sources could be credited for supporting financial incentive programs that induce households to reduce or improve fertilizer and pesticide use, or for funding infrastructure changes, such as providing improved household waste collection options.[354]

These concepts also can be included in trading systems. Some effluent trading occurs now, but water pollution trading programs generally have been difficult to establish.[355] An approach to trading that may be more easily enforced and more politically palatable than many that have been attempted to date is to provide incentives (e.g., through the distribution of excess tradeable allowances) for industrial point sources to fund the pollution reduction activities of individuals and households where the individuals' costs of control are less than those of industry. Although in theory government could do so directly, local industrial sources may be in a better position to identify the least cost avoiders and to manage efforts to reduce their emissions.[356]

The feasibility of pure subsidy schemes and schemes that combine subsidies with other economic incentives will require a

352. *See* Clean Water Act § 303(d), 33 U.S.C. § 1313(d) (2000); Revisions to the Water Quality Planning and Management Regulation and Revisions to the National Pollutant Discharge Elimination System Program in Support of Revisions to the Water Quality Planning and Management Regulation, 65 Fed. Reg. 43,586 (July 13, 2000); Withdrawal of Revisions to the Water Quality Planning and Management Regulation and Revisions to the National Pollutant Discharge Elimination System Program in Support of Revisions to the Water Quality Planning and Management Regulation, 68 Fed. Reg. 13,608 (Mar. 19, 2003) (withdrawing the July 2000 rule).

353. For an EPA policy that takes initial steps in this direction, although without conceiving of individuals as potential regulatory targets, see OFFICE OF WATER, EPA, WATER QUALITY TRADING POLICY STATEMENT (2003) [hereinafter EPA, WATER QUALITY TRADING POLICY STATEMENT]. Trading programs for water pollutants have confronted a number of roadblocks. *See, e.g.*, *Environmentalists Say Water Trading May Create Legal Liability*, INSIDE EPA, Mar. 21, 2003, at 13.

354. Industry also could be given incentives to conduct public information campaigns targeted at individual behavior given that the marketing expertise of many firms far exceeds that of government. In theory, individual behavior change also could be accomplished through the allocation of credits to individuals in a tradeable allowance scheme, but the coordination problems faced by individuals may be an insurmountable barrier.

355. *See* EPA, WATER QUALITY TRADING POLICY STATEMENT, *supra* note 353.

356. At least in theory, the reverse also could occur where it is more efficient for industry to reduce costs than individuals. The transaction costs and free rider problems encountered by individuals make this approach unlikely to succeed.

detailed analysis of the obstacles that have prevented more widespread use of such mechanisms and the types of regulatory interventions that can overcome those obstacles. The obstacles may be both economic (e.g., information costs incurred by government in determining the optimal level of incentives, and the transaction costs of making exchanges and documenting their impact) and psychological (e.g., the likely resistance of business managers to subsidizing individuals' pollution reduction efforts, even if businesses' net costs will decrease). In addition, when subsidies and other economic incentive schemes are applied to individuals as a source category, care must be taken to ensure that the psychological effects of economic incentives do not undermine their effectiveness. For example, in some circumstances financial inducements appear to undermine the psychic benefits an individual receives for performing a cooperative act and may discourage, rather than encourage, the targeted behavior.[357] Nevertheless, it is clear that by combining the concepts of individuals as sources and Pareto improvement, innovative new mechanisms may emerge.

3. Informational Regulation and Norm Management

Perhaps the most important implication of the new focus on individuals as polluters is the need to look beyond the command and control versus economic incentives debate to informational regulation and norm management. Informational regulation has received a great deal of attention in recent years, but it has been principally used to address large industrial sources of pollution (e.g., the TRI toxic chemical release data). Attempts to influence individual environmentally significant behavior have been much less common.

The various forms of informational regulation can be thought of as falling into two categories. The first, descriptive informational regulation, involves simple disclosure of data without an attempt to characterize the information when it is disclosed. Descriptive information may affect behavior simply by changing an individual's beliefs about the costs and benefits of particular actions, or it may influence personal and social norms. The second category, persuasive informational regulation, includes government characterizations of information designed to persuade individuals and other regulated entities to change behavior. Examples range from simple publication of brochures advocating a particular behavioral change to elaborate

357. *See, e.g.*, Ernst Fehr & Armin Falk, Psychological Foundations of Incentives 11-12 (Ctr. for Econ. Studies & Ifo Inst. for Econ. Research, Working Paper No. 714, 2002), http://ssrn.com/abstract_id=294287.

public information campaigns. In this type of informational regulation, the agency activity is a more direct attempt to change or activate norms about a particular activity. Both categories of informational regulation are potentially powerful tools for changing individual environmentally significant behavior, but their uses may differ. Some types of behavior may change after the individual is exposed to descriptive information, while others may require persuasive information. In addition, as discussed in Part V.C, below, descriptive and persuasive information may be subject to different standards under a new statutory provision imposing restrictions on federal agency information dissemination programs.

a. Descriptive Information

The TRI program is perhaps the best example at the federal level of the use of purely descriptive information to change the behavior of large industrial firms. Several empirical studies suggest that TRI data have changed firm behavior, and there is some indication that the effects may be associated with the norms of firm managers, shareholders, or customers, although the role of norms has not been explored in any detail.[358] As to individuals, several laws impose product labeling requirements on manufacturers in an attempt to provide individuals with descriptive information. Attempts to describe the environmental impacts of products, sometimes known as "eco-labeling," range from purely descriptive to more persuasive efforts. On the whole, product labeling schemes have only been undertaken in the United States on a limited scale, and have provoked mixed reviews from legal academicians.[359] FIFRA, the federal pesticide statute, includes extensive product labeling requirements for home and garden pesticides. The FIFRA labels are purely descriptive, requiring product content and use information but not requiring information about the overall advisability of using the pesticide.[360] California Proposition 65 requires manufacturers and retail firms to

358. *See, e.g.*, Shameek Konar & Mark A. Cohen, *Information as Regulation: The Effect of Community Right to Know Laws on Toxic Emissions*, 32 J. ENVTL. ECON. & MGMT. 109 (1997).

359. *See, e.g.*, VISCUSI, PRODUCT-RISK LABELING, *supra* note 287, at 3-5 (noting the mixed success of product hazard warnings). EPA has developed several voluntary labeling programs directed at the manufacturers of consumer products, including Energy Star labels for electronics. Studies of product labeling programs have suggested that market pricing may more accurately reflect the environmental impacts of products than eco-labeling. *See, e.g.*, Menell, *supra* note 56, at 1465 (proposing environmental information on consumer environmental impacts modeled on the nutrition pyramid).

360. *See* FIFRA § 3, 7 U.S.C. § 136a (2000); discussion *supra* notes 244-246.

identify the human health effects of products they make or sell.[361] Studies suggest that the Proposition 65 labeling requirements have had significant effects on manufacturers and consumers. In particular, concerns about the effects of Proposition 65 warning labels have induced many manufacturers to remove substances from their products to avoid labeling requirements.[362] Many consumers appear to misunderstand the Proposition 65 warning labels, however, and studies suggest that they tend to overestimate the risks arising from the products.[363]

Descriptive information has the greatest prospects for success where a behavior is not in the individual's interest and is not the subject of ingrained habits. For example, careless use of household pesticides might change if individuals were aware that 80 percent of all pesticide exposure occurs from household pesticide use.[364] Over the long run, purely descriptive information also may affect personal and social norms. In the near term, however, where behaviors that are harmful to the actor are habitual or where the harms of the behavior are externalized (e.g., the release of air toxics from driving), something more than simple descriptive information may be necessary to change behavior.

b. Persuasive Information

One form of persuasive informational regulation is norm management. Although norm management has been largely unexplored in the environmental literature, in recent years the legal norms scholarship has suggested that agencies may be able to manage norms through information dissemination, serving as "norm entrepreneurs."[365] Although the use of persuasive public information

361. The Safe Drinking Water and Toxic Enforcement Act of 1986, Cal. Health & Safety Code § 25249.6 (West 1999).

362. *See* VISCUSI, RATIONAL RISK POLICY, *supra* note 287, at 40 n.9.

363. *See, e.g.*, *id.* at 40; W. Kip Viscusi, *Predicting the Effects of Food Cancer Risk Warnings on Consumers*, 43 FOOD DRUG COSM. L.J. 283, 288 (1988). Behavior change in response to information on risk may vary based on the way the risk of the behavior is framed. For example, a risk could be expressed as a lifetime cumulative risk (you have a one in ten chance of getting X over the course of your life if you do Y over the course of your life), not a per-occurrence risk (you have a one in 10,000 chance of getting X if you do Y today) to garner the individual's attention and provoke a response. *See* PAUL SLOVIC, THE PERCEPTION OF RISK 77 (2000).

364. *See* discussion *supra* note 229-232.

365. *See, e.g.*, Cass R. Sunstein, *Social Norms and Social Roles*, 96 COLUM. L. REV. 903, 909 (1996) (discussing "norm management"); *see also* Steven Hetcher, *The FTC as Internet Privacy Norm Entrepreneur*, 53 VAND. L. REV. 2041, 2046 (2000) (suggesting that the Federal Trade Commission can be viewed as a "website privacy 'norms entrepreneur'"). For a discussion of the potential influence of environmental laws on norms, see generally NRC, NEW TOOLS FOR ENVIRONMENTAL PROTECTION, *supra* note 53 (noting the importance of social influence on

campaigns may be the most explicit form of norm management, command and control and economic incentive measures also may play a role in norm management. The information conveyed by the enactment of such a law may trigger, reinforce, or change social norms and social meanings.[366]

A number of challenges face norm management efforts regarding individual environmentally significant behavior. A first is overcoming the social meanings of "polluter" (industry) and "citizen" or "victim" (individuals).[367] The pervasiveness of these social meanings can be seen in the distinction that federal statutes draw between those acts that are the subject of federal environmental regulatory and enforcement actions and those that are not. Only in the areas of wetlands and endangered species are individuals routinely the subject of federal environmental regulation and enforcement.[368] According to one scholar, social meaning may explain why. Federal law in this area applies to us because of "what it says about us."[369] In other words,

> at least some of our reasons for not wanting to wipe out the grizzly bear have to do with what it would say about us as a community if we were willing to do so. Specific environmental issues serve to some extent as proxies for deeper concerns about who we are and how we understand our relationship with nature.[370]

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environmentally significant behaviors); Lynn E. Blais, *Beyond Cost/Benefit: The Maturation of Economic Analysis of the Law and Its Consequences for Environmental Policymaking*, 2000 U. ILL. L. REV. 237, 250-51 (2000) (noting that social norms research has a role in expanding the value of economic analysis of environmental law); Carlson, *supra* note 258 (discussing the influence of norms on recycling); Daniel Farber, *Taking Slippage Seriously*, 23 HARV. ENVTL. L. REV. 297, 320-21 (1999) (discussing the growing interest in the relationship between norms and environmental compliance); Vandenbergh, *supra* note 284 (discussing the unintended effects of environmental laws on social meanings, norms and individual behavior).

366. *See, e.g.*, McAdams, *supra* note 324, at 340 (defining a social norm to refer to "informal social regularities that individuals feel obligated to follow because of an internalized sense of duty, because of a fear of social sanctions, or both").

367. *See, e.g.*, Bobertz, *supra* note 296, at 718; Manaster, *supra* note 296, at 931; Vandenbergb, *supra* note 284, at 193. The concept that individuals are victims lies deep in the origins of environmental law and policy. One of the leading texts on the history of environmental policy concludes that in the late 1960s, "both the goals and the villains of the environmental movement were traditional ones. . . .The villains . . . were the traditional villains of American popular folklore: the greedy magnates of big businesses and the bureaucrats of big government." RICHARD N.L. ANDREWS, MANAGING THE ENVIRONMENT, MANAGING OURSELVES: A HISTORY OF AMERICAN ENVIRONMENTAL POLICY 225 (1999).

368. *See* ROBERT PERCIVAL ET AL., ENVIRONMENTAL REGULATION: LAW, SCIENCE, AND POLICY 125 (2003) (noting tbat wetlands and endangered species statutory provisions have been enacted and enforced against individuals but that other command and control approaches directed at individual polluting behavior have not).

369. Sherman J. Clark, *The Courage of Our Convictions*, 97 MICH. L. REV. 2381, 2394 (1999).

370. *Id.*

For some reason, destroying endangered species and wetlands says something about our relationship with nature, whereas spewing air toxics as we drive, or pouring consumer solvents on the ground, at least for many, does not. In short, it may be easier to envision individuals as poachers than as polluters. This may be simply an issue of availability: the environmental harms of paved wetlands and dead eagles are readily apparent, but the harms of diffuse discharges of small amounts of pollutants are not. Cognitive dissonance also may play a role: most of us in our daily lives are able to avoid paving wetlands or killing eagles with little or no effort. Bringing used solvents to a household waste collection center or avoiding driving is, for many of us, far more difficult. The easier solution then is to avoid any inquiry into the effects of our behavior. In any event, current social meanings will be an initial hurdle for any effort to use norm management to change the polluting behaviors of individuals.

A second challenge, as in other regulatory areas, is the deep skepticism among many environmental regulators and activists about the efficacy of informational regulation. The comments of Aldo Leopold, one of the most important early influences on the environmental movement, capture the classical environmental view of informational regulation: "[c]onservation education, in facing up to its task, reminds me of my dog when he faces another dog too big for him. Instead of dealing with the dog, he deals with a tree bearing his trademark. Thus, he assuages his ego without exposing himself to danger."[371] In short, the mission of real regulators is to regulate, not to educate. Given the historical lack of rigorous empirical examinations of public information campaigns, and the pressures on regulatory agencies to back off of industry regulation, the skepticism of environmental activists is understandable. To the extent a focus on using information to change individual behavior is simply a means of avoiding the difficult political, economic, and technical issues involved in regulating industrial facilities, the effort is likely to undermine, not achieve, desired environmental standards. Perhaps as a result, the federal environmental statutes do not require EPA to conduct public information campaigns or other persuasive campaigns directed at individual behavior, and EPA has only made occasional use of these types of persuasive efforts. When EPA has conducted public information campaigns, the campaigns often have been based on little data about individuals' contributions to the environmental harm that is the subject of the campaign and have made limited use of social

371. Aldo Leopold, *Land Use and Democracy*, *in* THE RIVER OF THE MOTHER OF GOD AND OTHER ESSAYS 295, 297-98 (Susan L. Flader & J. Baird Callicott eds., 1985).

science insights on how to steer individual behavior.[372] Similarly, although public information campaigns and other persuasive efforts are more common among state and local governments, the bulk of the state and local efforts to change individual behavior also have been poorly staffed and funded, and often have consisted of simply distributing brochures to the public.[373]

Nevertheless, there is reason for optimism. Experience with informational regulation in several fields suggests that a properly designed public information effort, particularly when used in combination with other regulatory instruments, may be quite successful.[374] As some have noted, laws prohibiting smoking and

372. An example of the limited data supporting EPA public information campaigns arises from a recent effort to induce individuals to change their behavior to reduce releases of certain household chemicals. In 2002, EPA initiated the "Resource Conservation Challenge," a major national effort to conserve natural resources through waste reduction and energy recovery. Office of Solid Waste, EPA, Resource Conservation Challenge, http://www.epa.gov/epaoswer/osw/conserve/index.htm (last modified Mar. 23, 2004). At the announcement of the program, an EPA manager stated that EPA was "challenging all Americans to take personal responsibility for their day-to-day decisions, and to take one small action every day to conserve our natural resources." *Id.* The Resource Conservation Challenge is a two-pronged scheme, calling for an increase in the national recycling rate to 35 percent by 2005 and a decrease in the generation of thirty "Priority Chemicals" by 2005. *Id.* For a list of the thirty Priority Chemicals, see EPA, WASTE MINIMIZATION PRIORITY CHEMICALS & CHEMICAL FACTS SHEETS, http://www.epa.gov/epaoswer/hazwaste/minimize/chemlist.htm (last modified Feb. 25, 2004). One might assume that information gathered by the Office of Solid Waste could be used to trace some emissions to individual and household sources. EPA staff have indicated, however, that data are not available on the quantities of releases of the thirty Priority Chemicals attributable to individuals and households. E-mail from Priscilla Halloran, EPA Office of Solid Waste, to Chelsey Burns (Sept. 25, 2002) (stating that "the information we, in the Office of Solid Waste, tend to use relates to industry and facilities, rather than households . . . . Consumer exposure, household emissions, releases, etc. . . . are areas of information not easily acquired") (copy on file with the author).

373. One study found that fifty local programs that attempted to reduce non-point source runoff from households were poorly staffed and had miniscule budgets ranging from $2,000 to $25,000. *See* Thomas R. Schueler, *On Watershed Education*, 3 WATERSHED PROTECTION TECH. 680, *reprinted in* THE PRACTICE OF WATERSHED PROTECTION 629, 630 (Thomas R. Schueler & Heather K. Holland eds., 2000) (noting that the local programs focused on lawn care, septic cleaning and pet wastes, and that staffing levels were between 0.1 and 0.5 staff years). Local and state public information campaigns tend to use measures such as brochures, which are inexpensive but far less effective than television, radio and local newspapers. Two more effective, more expensive techniques used in watershed education are media campaigns (the use of radio, TV, mailings, and signs to educate the general public) and intensive training (the use of workshops and books to provide more in-depth education to a smaller group). *See id* at 631-32 (concluding that "[m]essages sent through television, radio and local newspapers are consistently more influential in reaching residents than any other technique, with up to 30 percent recall rates by the watershed population for each medium.").

For examples of persuasive information efforts on the state level, see Mo. Dep't of Natural Res., Preventing Pollution Begins With You (1995), http://es.epa.gov/techinfo/facts/missouri/miss-p2.html; Georgia Department of Natural Resources, Georgia's Environment 99 (1999), http://www.dnr.state.ga.us/dnr/environ/gaenviron_files/annlrpt_files/gaenv99_14.html.

374. *See* Stern, *supra* note 17. EPA has noted that combinations of public information campaigns and other regulatory activities have had some success in reducing the effects of

requiring seat belt use may have signaled a social consensus and may have facilitated the efforts of private norm enforcers.[375] Both smoking and seat belt use have been the subject of efforts that included combinations of informational regulation and other instruments. For example, both areas included public information campaigns (e.g., anti-smoking and seat belt campaigns), command and control laws (e.g., bans on smoking in certain areas and seat belt use requirements), and economic incentives (e.g., cigarette taxes and child safety seat subsidies). And both areas have demonstrated dramatic changes in individual behavior over a period of several decades.[376]

The experiences with informational regulation to date in the environmental area are consistent with the smoking and seat belt efforts. For example, according to one review of public information campaigns, "dramatic social shifts" have been seen in several regulatory areas that utilized public information campaigns directed at individual behavior, such as recycling, household hazardous waste disposal, littering, and motor oil disposal.[377] Although a number of factors are very important, including external constraints (e.g., the existence or lack of infrastructure for recycling), the characteristics of the population in which the behavior occurs (e.g., the existence of close-, intermediate- or loose-knit groups), and the extent to which the behavioral change conveys a tangible personal benefit to the

individual behavior. For example, EPA has stated that it "believes that there has been increasing success in addressing [non-point source water pollution] problems through initiatives such as storm drain stenciling and recycling programs, including household hazardous waste special collection days." EPA, Phase II Storm Water Regulations, 64 Fed. Reg. 68,722, 68,729 (Dec. 8, 1999). Studies examining the impact of public information campaigns are rare, but some have demonstrated effects on environmentally significant behaviors. For example, a study of the ozone action day program in the Atlanta, Georgia, area demonstrated that a public information campaign combined with employer incentives could reduce vehicle miles traveled on high ozone days. Gary T. Henry & Craig S. Gordon, *Driving Less for Better Air: Impacts of a Public Information Campaign,* 22 J. POL'Y ANALYSIS & MGMT. 1, 45 (2003). Of course, public information campaigns must be well designed and implemented to achieve their intended effects. For example, Kip Viscusi has noted that public information programs that offer little new information have had limited success. VISCUSI, PRODUCT-RISK LABELING, *supra* note 287, at 4.

375. Lawrence Lessig, *The Regnlation of Social Meaning*, 62 U. CHI. L. REV. 943, 1030-31 (1995); *see* Kahan, *supra* note 291, at 377-78; McAdams, *supra* note 324; Sunstein, *supra* note 365.

376. *See* discussion *infra* notes 392-397.

377. Schueler, *supra* note 373, at 630-32. Results of the media campaigns included a decrease of lawn chemical use from 2 percent to 5 percent, a decrease in car washing, oil changing, and radiator draining by 5 percent to 7 percent, and a 10 percent change in grass recycling, fertilizer use, and hand weeding. *Id.* One media campaign resulted in 19 percent of the population reporting that they had changed various behaviors to help the environment. *Id.* Results of the intensive training campaigns included a 10 percent shift from personal to commercial car washing, changes as high as 40 percent in reduced pesticide use, a 10 percent increase in recycling of grass clippings, and a 10 percent decrease in fertilizer use. *Id.*

individual (e.g., the tangible safety benefits of seat belt use versus the intangible psychic benefits of recycling),[378] studies suggest that public information campaigns have led to changes in environmentally significant behaviors of 10 percent to 20 percent or more.[379] Reductions in polluting behaviors of 10 percent to 20 percent may not be meaningful when applied to a handful of industrial facilities, but they may be quite important when multiplied by 281 million people or 105.5 million households. In addition, many of the policy steps that have the potential to lead to improvements in environmental protection over the long term, such as investments in mass transportation and greater density in land use patterns, may be more likely to occur if information is provided in the near term that influences the beliefs and norms of individuals regarding the relationship between individual behavior, human health, and environmental quality.

Developments in theories of human behavior also suggest reason for optimism. In the past, a fundamental barrier to more effective use of informational regulation has been the inability of models of behavior to account for social influences. Economic models based on narrowly defined subjective expected utility have competed with less reductionist social psychological models. As many norms scholars have noted, the economic models that exclude informal social influences on behavior have difficulty accounting for a number of individual environmentally important behaviors that provide little or no tangible benefit to the individual, such as recycling and littering.[380] The more complex social psychological models account for a wide range of social influences on behavior, but have difficulty generating falsifiable hypotheses about any one behavior. The result is that even if environmental policymakers had the time and inclination over the last several decades to examine the available models of behavior, they would have found little to guide the development, testing, and modification of strategies designed to steer individual behavior.

The legal, economic, and social psychological approaches are beginning to converge, however, in ways that may lead to greater

378. ROBERT C. ELLICKSON, ORDER WITHOUT LAW: HOW NEIGHBORS SETTLE DISPUTES 177 (1991) (hypothesizing that "welfare-maximizing norms emerge in close knit settings"); Carlson, *supra* note 258, at 1245 (noting the importance of physical infrastructure for residential recycling); Stern, *supra* note 17, at 463 (noting the importance for models of environmentally significant behavior of whether a particular behavior "brings no tangible personal benefit to those who engage in it"); Lior Jacob Strahilevitz, *Social Norms from Close-Knit Groups to Loose-Knit Groups,* 70 U. CHI. L. REV. 359, 361-67 (2003) (noting the importance of the close-knit, intermediate-knit or loose-knit nature of the group).

379. Schueler, *supra* note 373, at 632-33.

380. *See, e.g.*, McAdams, *supra* note 324; Sunstein, *supra* note 365.

success in predicting individual environmentally significant behaviors. In the last decade, legal norms scholars have suggested ways in which economic models can be broadened to account for the effects of personal and social norms.[381] At the same time, social psychologists have developed models of behavior that are compatible with the legal norms approach.[382] Although substantial differences in approach remain, the ability to model the response of individuals to environmental information appears to be improving.[383] Empirical studies have identified an increasing number of individual environmentally significant behaviors that are influenced by personal or social norms.[384] The studies also suggest that information can change a wide range of behaviors that may be more important for environmental protection than recycling or littering, such as driving and residential electricity use, although the informational regulatory

381. *See, e.g.,* ELLICKSON, *supra* note 378; McAdams, *supra* note 324.

382. For example, Paul Stern and colleagues have proposed the values, beliefs, norms (VBN) model, which suggests that in the absence of other constraints, environmentally significant behaviors can be predicted based on the values, beliefs and norms of individuals. Thomas Dietz & Paul C. Stern, *Toward a Theory of Choice: Socially Embedded Preference Construction*, 24 J. SOCIO-ECON. 261, 266 (1995) (concluding that "processes based on checks and balances among key interests and values are more likely to approximate normatively ideal social choices than are simple quantitative aggregations of individuals' expressions of preference"); Paul C. Stern et al., *A Value-Belief-Norm Theory of Support for Social Movements: The Case of Environmentalism*, 6 HUM. ECOLOGY REV. 81, 85 (1999) [hereinafter Stern, *The Case of Environmentalism*]; Stern, *supra* note 12, at 415 (noting the existence of value orientations that correlate to environmentally significant behaviors). The other leading model that has been applied to environmentally significant behavior is the theory of planned behavior, which suggests tbat behavioral intentions are the product of three variables: (1) the attitude of the individual; (2) the individual's perception of "subjective norms"; and (3) perceived behavioral control. *See generally* Icek Ajzen, *From Intentions to Actions: A Theory of Planned Behavior*, *in* ACTION CONTROL: FROM COGNITION TO BEHAVIOR 11 (Julius Kuhl & Jürgen Beckmann eds., 1985) (describing the theory of planned behavior). Ajzen suggests that increases in these variables lead to increases in behavioral intentions. *See* Thomas J. Madden, Pamela S. Ellen & Icek Ajzen, *A Comparison of the Theory of Planned Behavior and the Theory of Reasoned Action*, 18 PERSONALITY & SOC. PSYCHOL. BULL. 3, 3-5 (1992). The theory has been used in studies of the effects of public information campaigns on driving and other behaviors. *See* Henry & Gordon, *supra* note 374, at 45. For a discussion of the convergence of legal norms and social psychological models of behavior, see Vandenbergh, *supra* note 314, at 72-78.

383. *See, e.g.*, Stern et al., *The Case of Environmentalism*, *supra* note 382, at 85 (citing studies to support the proposition that "[t]he VBN model is supported by a growing body of literature on environmentally relevant behavior").

384. *See generally* Stern, *The Case of Environmentalism*, *supra* note 382 (discussing research on social influences on environmentalism and pro-environmental behavior). One example of early research is a study regarding yard brush burning. The study concluded that individuals who were aware that the air emissions from yard waste burning harm human health and who believed they could reduce the harms were less likely to burn yard waste than others. Kent D. Van Liere & Riley E. Dunlap, *Moral Norms and Environmental Behavior: An Application of Schwartz's Norm-Activation Model to Yard Burning*, 8 J. APPLIED SOC. PSYCHOL. 174, 187 (1978) (describing the relevant norm as "respect for the health of others").

process must be finely tuned to be successful.[385] Overall, it is clear that progress is being made in both developing models of individual environmentally significant behavior and conducting empirical studies to assess their predictive capacity.[386] Policymakers thus now can draw on a growing base of theoretical and empirical work to aid in the design of informational regulation.[387]

V. BEYOND ENVIRONMENTAL LAW: IMPLICATIONS FOR THE REGULATORY STATE

The re-conceptualization of the individual as a source of harms and a worthy target of regulatory efforts also has broader implications for the regulatory state. The premise that the most efficient way to reduce net societal risks is not to regulate individual behavior, but to regulate firm conduct in ways designed to induce firms to reduce the risks of individual behavior, is widespread in regulatory areas outside of environmental protection. The focus on regulating industry, rather than individual behavior, may be seen in the laws and policies implemented by the National Highway Traffic Safety Administration (NHTSA), the Occupational Safety and Health Administration (OSHA), and other federal agencies.[388] This approach may in part have been a rational risk management decision in some areas where firms represented early low-hanging fruit.[389] The approach also may have been the product of skepticism about the ability of government to change individual behavior and to document the change in ways that allow some degree of confidence that the regulatory end has been achieved. As in the environmental area, the suspicion of interest

385. *See, e.g.*, Henry & Gordon, *supra* note 374, at 42. Additional studies on driving include Jörgen Garvill et al., *Effects of Increased Awareness on Choice of Travel Mode*, 30 TRANSP. 63 (2003); Jeffrey A. Joireman et al., *An Interdependence Analysis of Commuting Decisions*, 27 EUROPEAN J. SOC. PSYCH. 441 (1997); Maria Nilsson & Rikard Küller, *Travel Behavior and Environmental Concern*, 5 TRANS. RESEARCH PART D 211 (2000); Annika M. Nordlund & Jörgen Garvill, *Value Structures Behind Proenvironmental Behavior*, 34 ENV'T & BEHAV. 740 (2002).

386. The National Research Council of the National Academy of Sciences has recognized the progress and growing importance of social science in environmental protection efforts. *See* NAT'L RESEARCH COUNCIL, *supra* note 53; NAT'L RESEARCH COUNCIL, HUMAN DIMENSIONS OF GLOBAL ENVIRONMENTAL CHANGE: RESEARCH PATHWAYS FOR THE NEXT DECADE (Paul C. Stern ed., 1996), http://www.nap.edu/catalog/9641.html.

387. Agencies can act through public information campaigns, and Congress can act through statutes that require tbat information be provided to individuals in ways that will trigger, reinforce, or change norms.

388. *See* MASHAW & HARFST, *supra* note 14, at 4.

389. The approach also may have reflected the relative ease with which politicians and regulators may have identified black hats and white hats and directed regulations at the black hats in a wide range of regulatory areas. *See* discussion *supra* note 296.

groups regarding "soft" measures may lead to avoidance of informational regulation or norm management.[390]

For example, the focus of the early advocates of motor vehicle safety on automobile manufacturers and their skepticism of attempts to induce seatbelt use, although now called into question, have been widely discussed. The comments of Aldo Leopold discussed above track the view of the seat belt skeptics.[391] Along the way, however, regulators may have lost sight of the need to understand the role of individuals in risk creation and the ability of government to change individual behavior. Thus, for many years NHTSA pursued requirements for manufacturers to install air bags in cars, rather than seeking to increase individuals' seatbelt use.[392] Recent studies suggest that NHTSA's reluctance to focus on individual behavior may have been costly. Efforts by state and local governments have encouraged seat belt use through a mix of regulatory instruments over the last two decades, including public information campaigns and seat belt laws, and have demonstrated that individual behavior can be changed. For example, seat belt use has increased from 14 percent in 1983 to over 75 percent in 2002.[393] NHTSA may once again be facing a challenge arising from individual behavior. Personal driving behavior, not vehicle design or manufacturing or roadway safety, contributes

390. The same dynamic occurs with privacy concerns regarding information on individuals that is gathered over the Internet. *See* Hetcher, *supra* note 365, at 2044 (noting that interest groups are suspicious of Federal Trade Commission efforts to use non-regulatory means to influence private firms' wehsite privacy policies out of concern that such non-regulatory means are a "ruse" that reflects industry capture). For an account in the popular literature of the role of public interest group concerns about changing individual behavior to achieve greater motor vehicle safety, see Malcolm Gladwell, *How the Fight to Make America's Highways Safer Went Off Course*, NEW YORKER, June 11, 2001, at 50, 59-60 (discussing the views of Ralph Nader and Joan Claybrook regarding public information campaigns to increase seat belt use).

391. The seat belt skeptics included Ralph Nader and Carter Administration NHTSA Administrator Joan Claybrook. *See* MASHAW & HARFST, *supra* note 14, at 4; Gladwell, *supra* note 390. Similarly, in the development of workplace standards for benzene, OSHA early on required reduction of benzene levels by employers in the workplace, rather than assuming that employees could be induced to use respirators. *See* Indus. Union Dep't v. Am. Petroleum Inst., 448 U.S. 607, 653-55 (1980).

392. *See* MASHAW & HARFST, *supra* note 14, at 229. The point is not that the public will react positively to efforts to change its behavior. The negative public reaction to NHTSA's ignition interlock requirement in the auto safety area parallels the negative reactions to EPA's occasional attempts to restrict individual behavior. *See* Motor Vehicle Mfrs. Assoc. v. State Farm Mut. Auto Ins. Co., 463 U.S. 29 (1983) (reviewing federal motor vehicle safety requirements). Instead, the point is that combinations of traditional regulatory tools and informational regulation may have more success, at least over the long run, tban limiting regulation to command and control measures directed at firms.

393. GAO, HIGHWAY SAFETY: FACTORS CONTRIBUTING TO TRAFFIC CRASHES AND NHTSA'S EFFORTS TO ADDRESS THEM 5 (2003), http://frwebgate.access.gpo.gov/cgi-bin/multilb.cgi.

most often to motor vehicle crashes.[394] Personal driving behavior includes factors such as speeding, violating traffic laws, use of alcohol or drugs, inattention (e.g., due to eating[395] or cell phone use[396]), decision errors, and age. Many of these factors are potentially amenable to efforts that combine informational regulation with other measures, but it is unclear whether the lessons of the seat belt era have been learned.

Other health and safety areas also demonstrate the importance of individual behavior and the reluctance of regulators to focus on individual behavioral change. For example, obesity has emerged as the second leading cause of preventable deaths in the United States, with $117 billion spent annually on the direct and indirect medical expenses arising from the condition.[397] Although much of the harm caused by obesity is suffered by the individual causing the harm, family members and others also bear the medical and other costs. Familiar battle lines are forming, with the federal government uncertain of its role (and advocating but not funding public information efforts), citizens' advocates pushing for government regulation of firms (e.g., restaurants and food processors), and industry groups describing the issue as one of "personal responsibility" for individuals while opposing government actions to induce individual behavior change.[398]

For these and other regulatory issues, it may be time to revisit the assumption that individual behavior cannot be changed and to explore the mix of regulatory instruments that can achieve the desired change. As the discussion above suggests, there is reason to believe that through the use of several regulatory instruments, including

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394. *Id.*

395. *See* Press Release, Highway Safety Research Center, University of North Carolina, Unusual UNC Research Confirms Drivers Face Multiple Distractions (Aug. 6, 2003) (concluding that 71 percent of all people eat while driving), http://www.hsrc.unc.edu/pressrelease/press_main.htm.

396. *See* Press Release, National Safety Council, Study Finds "Inattention Blindness" in Behind-the-Wheel Cell Phone Users (Jan. 27, 2003) (concluding that roughly 75 percent of all people report that they use a cell phone while driving and that inattention is a contributing factor in 20 percent to 30 percent of all automobile accidents), http://www.nsc.org/news/policy/multitasking.htm.

397. *See CDC Chief: Obesity Top Health Threat*, CNN.COM/HEALTH (Oct. 29, 2003), http://www.cnn.com/2003/HEALTH/diet.fitness/10/29/obesity.threat.reut; *see also* John F. Banzhaf, III, Using Legal Action to Help Fight Obesity, *at* http://banzhaf.net/obesitylinks (last visited May 10, 2004). Smoking is one of the best examples of a health-related behavior that has changed in response to a mix of public information campaigns, economic incentives, and legal prohibitions. *See* discussion *supra* notes 375-376.

398. *See* Ceci Connolly, *Public Policy Targeting Obesity*, WASH. POST, Aug. 10, 2003, at A1; *see also* Nat Ives, *Food Companies Are Urged to Act to Deflect Blame for the Nation's Increase in Obesity*, N.Y. TIMES, Dec. 4, 2002, at C4.

various forms of informational regulation, government may be able to achieve greater reductions in risks at lower costs across a wide range of safety, health, and environmental risks. A second look at the traditional targets of regulatory instruments and the optimal mix of instruments across a wide range of regulatory areas thus is in order.[399]

To address individual behavior, federal agencies that have spent thirty years targeting large firms almost exclusively will have to change in a variety of ways. More sophisticated use of the social sciences will be required in the development, evaluation, and modification of agency regulatory programs. The organization, staffing, procedures, and funding priorities of federal agencies will need to evolve. The federal-state relationship will need to be reexamined. The use of cost-benefit and risk analysis will need to be adapted to account for individuals as potential regulatory targets and to account for the importance of social, as much as economic, influences on the behavior of the new type of regulatees.[400] A radical redirection is unlikely to occur, and may not be advisable given the continuing importance of industrial sources. Instead, the process will likely occur in an evolutionary fashion. Although a full examination of these issues is beyond the scope of this Article, three early steps of fundamental importance are discussed below.

A. Predicting Social Influences on Behavior

The intellectual infrastructure for influencing social norms will need to be developed in the academic literature and deployed by EPA and other regulatory agencies. In recent years, substantial progress has been made in the development of models that account for social influences, but far more needs to be done.[401] If regulators are to target individual behavior, further progress must be made in explaining and predicting the influences of legal, economic, psychological, and social incentives on individual behavior. In particular, the level of social psychological sophistication of government public information efforts

399. The instrument choice debate also may have not focused sufficiently on the availability and efficient use of government resources for environmental protection. In some cases it may be far more cost effective for government to conduct a public information campaign to induce a 5 percent change in individual behavior than to develop and enforce rules that seek additional gains from particular existing source categories.

400. In some cases, the other principal sources that have been largely overlooked, such as farming and small businesses, may function more like individuals than large industrial firms, and the steps taken by agencies to adapt to individuals as regulatory targets also may facilitate regulation of those sources. In other cases, different approaches will be required.

401. *See* discussion *supra* notes 380-382.

and other regulatory efforts will need to rise to the level now given to the economic analysis of regulations. In some cases, regulatory efforts directed at industry may have unintended consequences that should be understood and avoided. In other cases, public information campaigns may be able to take advantage of the substantial and growing literature on the ways in which individual behavior can be changed. The research on the social influences on behavior suggests that many individual responses to information are counterintuitive, and that there are vast differences in responses based on the content of the message and the medium by which the message is conveyed.

The staffing of federal agencies also reflects the focus of the instrument choice debate: the agencies are dominated by lawyers and economists, and to a lesser extent engineers and natural scientists. Few social psychologists or sociologists are on the EPA staff, and none are employed to review systematically regulatory or information dissemination issues to assess impacts on individual behavior.

Rigorous, quantitative social science research that draws on the best theoretical work yet is closely tailored to support specific regulatory objectives will be necessary. Economies of scale exist at the federal level to conduct, assess, and report to the states and local governments on the general lessons of research on how to influence environmentally significant behaviors. For some issues, states and localities may be better positioned to tailor public information campaigus and other informational regulatory efforts to local populations.[402] For others, EPA may be better situated to play the role of providing information directly to the public as well as to facilitate the activities of state and local governments.[403]

B. Demonstrating Behavioral Change

One of the principal barriers to redirecting agencies toward regulation of individuals is skepticism about the efficacy of measures directed at individuals. The skepticism of regulators and public interest groups toward public information efforts as opposed to command and control regulatory efforts is understandable to anyone who has served in a government regulatory agency. The pressure

402. Although in theory these steps may be taken by states and localities, they often lack the resources to do so. In addition, they often do not place a high priority on "soft" information-based measures. *See, e.g.*, NASHVILLE AREA METRO. PLANNING ORG., 2004-2006 TRANSPORTATION IMPROVEMENT PROGRAM 4 (2003) (listing criteria for Transportation Improvement Program funding), http://www.nashvillempo.org/tip_2002.html.

403. A good example of a current federal effort to facilitate state and local public information campaigns is EPA, It All Adds Up to Cleaner Air, *at* http://www.italladsup/gov (last visited May 10, 2004).

brought to bear on regulatory agencies by regulatory targets to under-regulate generally or to under-regulate as to a particular industrial facility, firm, or sector is tremendous.[404] Regulators and public interest groups are understandably concerned, then, that in the absence of hard, enforceable requirements, promised gains will not be achieved.[405] The fear is that the effect will not be an expansion of the potential targets of regulation or a reduction in the costs of regulation, but deregulation.

The ability to evaluate and demonstrate the efficacy of informational regulation of individual behavior thus may be particularly important. In the face of this concern, the need for rigorous, quantitative assessments of the effects of regulatory efforts on targeted individual behaviors and the resulting changes in emissions and ambient environmental conditions cannot be overstated. Although remarkably little assessment of the effects of industrial regulation occurs, statutory emissions reporting and enforcement programs collect data that provide regulators with some degree of comfort regarding corporate compliance levels. With individual behavior, these measures are not available. In the absence of rigorous, quantitative analyses, the opportunities for waste and de facto deregulation will be substantial.

C. Providing Procedural Protections

The use of informational regulation to change individual behavior also will have important implications for administrative law generally. In particular, the procedural protections of the Administrative Procedure Act (APA) may not be adequate for a regulatory state focused on regulating though information dissemination. Among the unspoken assumptions that underlie the APA are that agencies' most significant regulatory activities are formal and informal rule makings, and that the highly structured, technical rule-making processes required by the APA provide a means

404. *See* C. Boyden Gray, *Public Versus Private Environmental Regulation*, 21 ECOLOGY L.Q. 431 (1994) (noting the lobbying efforts of automobile manufacturers). As the difficulties EPA encountered in attempting to implement the Clean Air Act inspection and maintenance requirements suggest, similar pressures will be brought to bear on anyone who seeks to change individual behavior. *See, e.g.*, McGarity, *supra* note 36 (discussing the resistance to EPA vehicle inspection and maintenance requirements).

405. An example of a policy reflecting this skepticism is that EPA only gives a 3 percent credit to states for voluntary ozone reduction control measures, such as public information campaigns and incentive schemes. RICHARD D. WILSON, OFFICE OF AIR & RADIATION, GUIDANCE ON INCORPORATING VOLUNTARY MOBILE SOURCE EMISSION REDUCTION PROGRAMS IN STATE IMPLEMENTATION PLANS (1997), http://www.epa.gov/oms/transp/trancont/vmep-mem.txt.

for regulated entities and other affected parties to participate in agency regulatory activity.[406] In fact, the unspoken assumptions of the APA have been reasonably accurate for the last fifty years: many of the most important federal agency actions to date have taken the form of formal and informal rule makings directed at corporate behavior. Although the success of the APA is certainly a matter of dispute, the corporate targets and their public interest group antagonists have been quite successful at communicating their views in agency rule-making proceedings.

When agencies turn to informational regulation of individual behavior, however, they are unlikely to rely heavily on formal or informal rule makings. Instead, simple disclosure of descriptive information and persuasive public information campaigns are likely to be among the tools of choice for steering individual behavior. Yet the agency actions involved in these types of informational regulation often will not trigger the procedural requirements applicable to APA rule makings and adjudications. Scholars have begun to turn their attention to the importance of standing and judicial review when agencies engage in informational regulation, but a wide range of important issues remain largely unexplored. These uncertain issues include the extent to which the APA should be amended to require disclosure of proposed agency informational regulatory actions, solicitation of public comment, creation of a public record, and disclosure of the reasons for engaging in informational regulation.[407]

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406. Administrative law not only reflects a bias in favor of regulation, but in favor of coercive governmental action. *See, e.g.*, Lujan v. Defenders of Wildlife, 504 U.S. 555, 576-78 (1992) (rejecting the concept of procedural standing); Heckler v. Chaney, 470 U.S. 821, 832-33 (1985) (concluding that a decision not to initiate an enforcement action is "committed to agency discretion by law" and hence is unreviewable). Informational regulation is often persuasive rather than coercive and thus may fall outside of the paradigm that triggers procedural and judicial safeguards.

407. For an examination of standing and informational regulation, see Sunstein, *supra* note 53, at 653-73. In addition, the optimal procedural protections for informational regulation of individual behavior may differ from the optimal protections for regulation of industrial firms. Even if the APA were amended or interpreted to impose requirements similar to notice-and-comment rule-making procedures on agencies that engage in informational regulation, the APA requirements may be inadequate when the regulated entities are individuals. For example, although the general public participates in rulemakings through attendance at public meetings and letters placed in agency rule-making dockets, the vast majority of the comments that influence rule making occur through focused, detailed comments by sophisticated representatives of regulated industries and the public interest groups organized to combat them. *See, e.g.*, Nash & Revesz, *supra* note 43, at 567 (citing Cary Coglianese, Challenging the Rules: Litigation and Bargaining in the Administrative Process 46-47 (1994) (unpublished Ph.D. dissertation, University of Michigan)). If the targets of agency informational regulation are individuals, not industries, the use of the Federal Register may not be an adequate means of soliciting comments from the regulatory targets. Instead, agencies may need to solicit comments on proposed agency actions in ways that are more accessible to the general public. For example,

Until recently, Congress had not revisited the federal administrative laws in a way that could influence the new focus on the use of informational regulation. That changed in December 2000 when, in a move that has received little attention in the academic literature, Congress enacted the Information Quality Act (IQA).[408] Congress adopted the IQA without legislative history as an amendment to an omnibus spending bill, but the IQA may ultimately play a remarkably large role in steering the informational regulatory activities of EPA and other federal agencies.[409] The IQA required OMB to "provide policy and procedural guidance to Federal agencies for ensuring and maximizing the quality, objectivity, utility, and integrity of information (including statistical information) disseminated by Federal agencies."[410] The IQA also directed OMB to require federal agencies to issue guidelines using the same quality, objectivity, utility, and integrity criteria and to establish "administrative mechanisms allowing affected persons to seek and obtain correction of information maintained and disseminated by the agency."[411] In response to the IQA, OMB and the executive branch agencies have adopted guidelines regarding data quality and administrative appeal mechanisms.[412]

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the Internet may provide opportunities to solicit comments from members of the general public who may be the targets of informational regulation. *See, e.g.*, ENVTL. LAW INST., LIBRARIES AS A COMMUNITY RESOURCE FOR ENVIRONMENTAL INFORMATION (2000), *available at* http://www.eli.org/pdf/libraries00.pdf (last visited Dec. 15, 2003) (evaluating the use of on-line dialogues for public involvement in EPA decision making). An example of a website for an EPA on-line dialogue is available at www.network-democracy.org/epa-pip/wlecome.shtml.

408. *See* Consolidated Appropriations—FY 2001, Pub. L. No. 106-554, § 515, 114 Stat. 2763A-153 to 2763A-154 (2000). For a discussion of the Information Quality Act, see James W. Conrad, Jr., *The Information Quality Act—Antiregulatory Costs of Mythic Proportions?*, 12 KAN. J. L. & PUB. POL'Y 521, 521 (2003) (describing the statute as "the most significant conceptual advance in administrative law in the last three decades"); John D Echeverria & Julie B. Kaplan, *Poisonous Procedural "Reform": In Defense of Environmental Right-to-Know*, 12 KAN. J. L. & PUB. POL'Y 579 (2003) (raising concerns about the effects of the IQA on citizen right-to-know efforts).

409. The only legislative history regarding Section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001 is from the conference report, which states that "[t]he Committee includes a new provision requiring the OMB to develop guidelines for ensuring and maximizing the quality, objectivity, utility, and integrity of information disseminated by federal agencies." See H.R. CONF. REP. NO. 106-756, at 83 (2000).

410. IQA § 515(a).

411. *Id.* §§515(b)(2)(A), (B).

412. *See, e.g.*, Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility and Integrity of Information Disseminated by Federal Agencies, 67 Fed Reg. 8,452 (Feb. 22, 2002) [hereinafter OMB, IQA GUIDELINES]; EPA, OFFICE OF ENVTL. INFO., GUIDELINES FOR ENSURING AND MAXIMIZING THE QUALITY, OBJECTIVITY, UTILITY AND INTEGRITY OF INFORMATION DISSEMINATED BY THE ENVIRONMENTAL PROTECTION AGENCY (2002) [hereinafter EPA, IQA GUIDELINES], http://www.epa.gov/quality/informationguidelines.

To the extent informational regulation is the wave of the future, the IQA may shape the wave. Although the IQA is only beginning to affect agency behavior, the debate in the academic literature already has a familiar ring. The debate has focused on the traditional issues posed by industry and citizens groups seeking industry regulation: will the IQA ensure that data released by EPA is accurate, or will it drain resources away from regulatory efforts to reduce health and environmental risks? Will agency actions pursuant to the rules be subject to judicial review? Will the OMB and EPA guidelines be treated as legislative rules or policy statements for purposes of judicial deference?[413] The resolution of these issues undoubtedly will be important to the further application of environmental requirements to industrial sources, but when the role of individuals is included in the analysis, new concerns arise.

For example, the OMB guidelines broadly define "information."[414] At least in theory, agency dissemination of both descriptive and persuasive information is subject to the guidelines. The OMB guidelines require that agencies "adopt a basic standard of quality (including objectivity, utility, and integrity)" and ensure that the information quality is "appropriate to the nature and timeliness of the information."[415] As to objectivity, two requirements must be met: (1) the information must be presented in an "accurate, clear complete and unbiased manner, which includes presentation in the proper context," and (2) the information must be "accurate, reliable and unbiased."[416] The OMB guidelines recognize the importance of the

413. *See, e.g.*, Conrad, *supra* note 408, at 538-39; Echeverria & Kaplan, *supra* note 408, at 618-22.

414. Although the applicability of the OMB and EPA guidelines to EPA persuasive information campaigns will have a substantial effect on EPA's ability to engage in norm management, both guidelines are ambiguous on this point. The OMB guidelines define "information" to mean "any communication or representation of knowledge such as facts or data, in any medium or form .... This definition does not include opinions, where the agency's presentation makes it clear that what is being offered is someone's opinion rather than fact or the agency's views." OMB, IQA Guidelines, 67 Fed. Reg. at 8,460. The EPA guidelines also include ambiguous language. The EPA guidelines state that information "generally includes any communication or representation of knowledge such as facts or data, in any medium or form" and follow the OMB guidelines by stating that "information" does not include "opinions, where EPA's presentation makes it clear that what is being offered is someone's opinion rather than fact or EPA's views." EPA, IQA GUIDELINES, *supra* note 412, at 16. The OMB and EPA guidelines thus are unclear whether expressions of opinion or "views" by a federal agency are "information" subject to the IQA's objectivity requirement.

415. OMB, IQA Guidelines, 67 Fed. Reg. at 8,458.

416. *Id.* at 8,459. As to risks to health, safety, or the environment, the guidelines draw from the Safe Drinking Water Act to require information to be based on "the best available, peer-reviewed science and supporting studies conducted in accordance with sound and objective scientific practices; and ... data collected by accepted methods or best available methods (if the reliability of the method and the nature of the decision justifies use of the data)." *Id.* at 8,460.

context in which information is presented, and they require the agency to present additional information if necessary to provide the context to ensure the accurate, clear, and unbiased presentation of the disseminated information.

To the extent EPA seeks to influence individual environmentally significant behavior through public information campaigns designed to shape norms, this language may ensure that the most Orwellian aspects of information manipulation will be avoided.[417] At the same time, the language could prevent the Agency from engaging in norm management by conducting a persuasive public information campaign, which might include the use of non-objective hortatory language or the selective presentation of information either to steer norms or to compensate for an information gap, cognitive dissonance, countervailing social influences, or habits. Many questions remain about the scope of the IQA and the extent to which its provisions will be judicially enforceable. The answers will have a profound effect on the use of informational regulation to steer individual behavior.[418]

VI. CONCLUSION

Individuals are important, overlooked sources of pollutants and environmental harms. Despite their importance, individuals have been the subject of little regulation and have not been a focus of the environmental regulatory debate. A variety of reasons may explain the oversight. Although large industries were the most obvious targets in the 1960s and 1970s, and in many cases were likely the least cost avoiders, that argument is often much harder to make after thirty years of increasingly stringent controls on large industrial

417. *See* Lessig, *supra* note 375, at 1018 (noting concerns about Orwellian uses of information). The climate change issue was the subject of the first IQA litigation. *See* Andrew C. Revkin, *Suit Challenges Climate Change Report by U.S.*, N.Y. TIMES, Aug. 7, 2003, at A16 (noting that an anti-regulatory group sued the Bush Administration under the IQA to prevent distribution of a 2000 report on climate change). The litigation was settled and the complaint dismissed with prejudice before a court could rule on whether the IQA creates a right of judicial review. *See* Pat Phibbs, *White House, Institute Agree to Dismiss Suit Alleging Violations of Information Quality Act,* DAILY ENV'T REP. (BNA) A-12 (Nov. 7, 2003).

418. Other important questions along these lines are already beginning to reach the courts. For example, the Ninth Circuit recently rejected a challenge to EPA's authority to require local governments to conduct public information campaigns as a part of the Phase II storm water regulations. Envtl. Def. Ctr., Inc. v. EPA, 344F.3d 832, 848-51 (9th Cir. 2003), *petition for cert. filed sub nom.* Tex. Cities Coalition on Stormwater v. EPA, 72 U.S.L.W. 3513 (U.S. Dec. 15, 2003) (No. 03-1125). In the future, courts also may need to give more thought to the inherent authority of agencies to disclose information within their mission. *See* Conrad, *supra* note 408, at 529 (noting that the Clean Air Act includes broad language authorizing EPA to gather and disclose data on air pollution); Pedersen, *supra* note 8, at 171-72.

facilities. Public choice arguments may explain policymakers' lack of focus on individuals: regulating individual behavior may require politicians to impose requirements directly on voters, rather than allowing voters to believe that the costs of a better environment will be borne by industry. At the same time, it is not clear why small, concentrated, industry groups were unable to shift costs to diffuse, numerous, individual citizens. Alternatively, the social meanings of "citizen" and "polluter" and the scapegoating effects of identifying industry as the sole wearer of the black hat may have explanatory force. Even today, the picture of individuals as polluters will be counterintuitive to many readers.

Regardless of the reasons, the failure to focus on individuals is a yawning gap in the current environmental regulatory regime. Enthusiasts of existing regulatory instruments have yet to tackle the theoretical and practical challenges of steering individual behavior. In the next era of environmental law, they will need to consider new combinations of traditional instruments, as well as new tools, such as informational regulation. The importance of norms for changing individual environmentally significant behavior also may have implications for the instrument choice debate regarding industrial sources. In short, the debate may have understated the effects of norms on firm managers, shareholders, employees and customers, and ultimately on firm behavior.

In addition, a fresh look at the emerging role of individuals across a wide range of regulatory areas is in order. The movement in the 1960s toward regulation of firms to the exclusion of individuals may have taken the complex interactions between formal and informal social control too lightly. By regulating firms almost exclusively, the early approach guaranteed some measure of success. The approach may have been not only quite successful, but the most rational one in the 1960s and 1970s when government was faced with a withering array of risks created from an increasingly densely populated, industrial society. Now that many of the gains from that approach have been won, we are left with the residue. Across a wide range of fields, individuals have received a message from the environmental, health, and safety laws and the administrative apparatus: you are victims of the risky behavior of large industrial firms, and the regulatory state can make you safer by regulating those firms. The effects of that message have not been studied empirically, but certainly the symptoms of individuals' lack of awareness of and concern for the environmental harms they cause are widespread. Moreover, as individuals emerge as important sources of a wide range of societal risks, we may need not only to revisit the ways in which

laws directed at industry may have undermined informal social influences on individual behavior, but also to begin to retool our administrative apparatus to develop new approaches to change individual behavior.

In the long run, achieving a safer society, or simply one in which current levels of safety are achieved at lower cost, may require us to revisit the notion of personal responsibility.[419] The regulation of industrial sources of pollution gave us a thirty year respite from the need to encounter the environmental and other effects of individual and household behavior. The free lunch is over. Even at current levels, individuals and households may contribute levels of pollutants that will lead to an unsustainable environment for future generations. And even if that view is too pessimistic, with population increasing at a rate of 38 percent every thirty years and many other relevant measures of individual behavior increasing at an even greater clip, steering individual environmentally significant behavior can no longer be a relatively unsophisticated, uncoordinated afterthought of policymakers.

This Article thus suggests the opening moves in what will be a long term effort. With some adjustments, the procedural protections and regulatory tools may be available to redirect federal, state, and local efforts toward reducing the risks caused by individual behavior directly, rather than just through the regulation of large industrial firms. The results may not only achieve social goals that now appear unattainable, but may do so at costs that are lower than now imaginable.

419. The concept of individual responsibility may be important for issues far beyond the environmental, health, and safety areas discussed in this Article. *See, e.g.*, Suzanna Sherry, *Responsible Republicanism: Educating for Citizenship*, 62 U. CHI. L. REV. 131, 145-56 (1995) (discussing the focus on individual rights rather than individual responsibilities in modern legal scholarship).