

## **ILLEGAL HAZARDOUS-WASTE DISPOSAL AND ENFORCEMENT IN THE UNITED STATES: A PRELIMINARY ASSESSMENT**

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### **Summary**

Regulations that affect hazardous-waste treatment, storage, and disposal have become increasingly stringent in recent years, leading to dramatic increases in the financial cost of legal waste disposal. A danger of these policies is that firms may respond by diverting larger quantities of waste to illegal disposal routes. Incentives to dispose of wastes illegally, and the frequency of illegal disposal, are likely to vary markedly among firms, and to be correlated with observable attributes. In principle, it should be possible to target enforcement efforts by taking account of such factors. Unfortunately, systematic data needed to describe the quantity and nature of illegally disposed wastes, and to target enforcement efforts, are not available.

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### **1. Introduction**

Hazardous waste is perceived by the American public as the most important environmental issue today [1]. Names like Love Canal and Times Beach have become familiar codewords for the dangers of mismanaging hazardous wastes, although it is significant that considerable doubt remains as to just how much damage actually occurred at these sites. This concern has led to the promulgation of numerous federal and state statutes and regulations to control the handling of hazardous wastes from generation to disposal.

This paper examines one component of the U.S. effort to reduce the damages arising from hazardous waste: government enforcement (both civil and criminal) of the Resource Conservation and Recovery Act (RCRA). RCRA enforcement is only one of several interacting mechanisms for controlling damages from hazardous wastes; others include Superfund (covering closed waste sites), insurance contracts, and private civil liability. Government enforcement may or may not turn out to have an important role; this depends in part

on the effectiveness of the other instruments. It may have a residual function, to be used where other formal and informal controls fail.

This study is an explanatory effort to evaluate the extent and characteristics of illegal disposal and of current enforcement practices in the United States. It relies on review of the literature and interviews with approximately 40 government and industry representatives in three jurisdictions: Massachusetts, Pennsylvania, and Los Angeles County.

After a brief account of the history of RCRA, we describe the difficulties in estimating the scope of illegal hazardous-waste disposal. Section 2 describes the factors that affect firms' choice of disposal method. Section 3 summarizes the diverse enforcement efforts in the three jurisdictions. Section 4 suggests methods that would allow a more accurate assessment of the extent of illegal disposal and better targetting of enforcement resources. We emphasize that we take the existing hazardous-waste standards as a starting point, and evaluate compliance with them. We make no independent judgment about the appropriateness of current standards.

### *Historical background*

The Resource Conservation and Recovery Act (RCRA) was adopted in 1976 with relatively little fanfare. It established a framework for regulating hazardous waste from generation to disposal. The statute defines the characteristics that make a waste hazardous (toxicity, reactivity, corrosivity, and flammability) and grants the Environmental Protection Agency (EPA) broad authority to regulate waste labelling, containment, transportation, and record-keeping, and to establish a system for permitting treatment, storage, and disposal facilities (TSDFs).

Subsequent discovery of numerous contaminated disposal sites led to the 1980 passage of Superfund (The Comprehensive Environmental Response, Compensation, and Liability Act), requiring all firms that contributed hazardous waste to a closed site to undertake cleanup if leakage threatens human health or the environment. By 1984, the perception that EPA had done little to prevent future problems led to passage of the Hazardous and Solid Waste Amendments to RCRA (HSWA). These amendments require EPA to promulgate many significant new regulations and include "hammer provisions" that become effective if EPA fails to act before stringent deadlines. Provisions include bans on land disposal of many wastes, more stringent technical and financial requirements for TSDFs, and extension of regulations to small-quantity generators (SQGs), facilities that generate less than 1,000 kg of hazardous wastes per month. Very-small-quantity generators (VSQGs), generating less than 100 kg/month, remain exempt from federal regulations, although they are covered by some state laws.

Largely as a result of the new statutes the costs of hazardous-waste disposal have increased manyfold since the 1970s, and may continue to increase. Cost

increases reflect not only the increasingly stringent regulations themselves but also the difficulty of siting or expanding treatment and disposal facilities and insurer fears of potential Superfund or other civil liability.

A particular concern arising from the increasing costs of legal disposal is that firms will resort to improper and illegal disposal methods. Waste generators face an array of options for responding to disposal-price increases, including illegal disposal. As costs of legal disposal rise, the financial incentive for illegal disposal also increases, possibly leading to more disposal in sewers or storm drains, evaporation, burial, or abandonment on land.

*How serious is the problem of improper disposal?*

Incentives to dispose illegally are significant and growing. As described in Section 2, however, there are additional factors that affect compliance with disposal regulations and these have also changed as the incentives for improper disposal have risen. Enforcement pressure has also increased. As a result, we cannot infer that the rising costs have led to a large increase in illegal disposal. In fact, very little is known about the extent or nature of improper hazardous-waste disposal.

One might attempt to estimate the extent of illegal disposal as the difference between the quantities of waste generated and legally disposed. Estimates of total legal disposals appear reliable, since disposal facilities must report to EPA [2], but generation is not well estimated. Nationwide estimates are inconsistent and state-level estimates vary by an order of magnitude [3].

It seems unlikely that generation estimates will ever approach the accuracy needed for this type of estimate. There are at least four basic problems: (1) Hazardous waste is an extremely heterogeneous set of materials, including liquids and solids of enormously varying chemical composition. Changes in dilution practices alone can dramatically affect the total. (2) Definitions of waste and of what part is hazardous vary across levels of government and over time. Many wastes that would be hazardous if produced by an LQG would not be legally hazardous if generated by a household or VSQG (in most states), or if discharged to surface waters under a Clean Water Act permit. (3) The universe of generators is large, heterogeneous and difficult to identify. (4) The data systems that are available for measuring generation use varying conceptual definitions. Some trap quantities that move through legal recording systems and thus inevitably miss quantities improperly disposed, while others do not take account of on-site disposal, which may be legal or illegal.

To our knowledge, no significant effort has been made to develop an estimate of the national quantity of hazardous waste disposed illegally. Laws have been enacted and are to be enforced, but enforcement is not complete; no one expects it to be and society cannot afford to make it so. Measuring the extent of crime is always difficult, expensive, and intrusive. It is particularly so for of-

fenses like these that may not become apparent for some time after they have occurred. Agencies have not been motivated to take responsibility for measuring the problem.

It is difficult then to determine how well agencies are doing in their basic task of enforcing the laws. In Section 3, we describe how a few agencies are undertaking this responsibility, and make some judgments about how well they are doing it. But those judgments are tentative, for we are unable to say anything definite about the social costs arising from any failure on the agencies' part. We suspect that the law is under-enforced; that society would be better off if more resources were devoted to enforcement. We do not claim to be able to persuade a skeptic of that view, however, for we cannot even say how much is being improperly disposed. Moreover, our knowledge of the other factors necessary to calculate the optimal degree of enforcement — the environmental, health, and other costs that illegal disposal imposes on society, and the marginal efficacy of enforcement resources — is even less complete.

## **2. Factors affecting compliance with hazardous-waste-disposal regulations**

Hazardous-waste generators may choose from a large array of possible responses to the increased costs of legal waste disposal, including (1) paying the higher costs of legal treatment and disposal; (2) reducing the quantities of wastes generated; (3) recycling wastes or selling them to other firms; (4) treating and/or disposing of wastes in legal on-site facilities; and (5) disposing of wastes illegally, by depositing them in sewers or storm drains, on land and/or off site, or allowing them to evaporate. A firm may use more than one of these options. Its choice is likely to be affected by the cost and technical feasibility of each alternative, knowledge and understanding of the regulations, technical expertise in waste management, difficulty in siting and permitting treatment facilities, and the perceived threat of legal liability for cleanup or damages. Similarly, waste haulers can choose among various alternatives, legal or illegal, for disposal of wastes they accept from generators.

The relative costs of alternative disposal methods, and particularly the costs of legal as opposed to illegal methods, vary systematically and significantly among firms. Relative costs may be affected by the firm's location; technical sophistication; size; industry; cost of waste disposal relative to profits, revenues, or other economic measures; the extent to which the firm's assets are at risk or are salvageable if it is caught disposing wastes illegally; the specific wastes produced; and other factors. In this section, we analyze some of the factors that are likely to influence a firm's compliance.

We restrict our analysis to hazardous-waste generators and haulers, since these appear more likely than TSDFs to dispose of wastes outside of hazardous-waste facilities. Moreover, ensuring TSDF compliance is probably much easier than ensuring generator and hauler compliance, and it requires different

strategies. This follows since there are comparatively few TSDFs and they operate under stringent permits<sup>1</sup>.

### *Incentives to Illegal Disposal*

The primary factors encouraging illegal disposal appear to be economic and informational. Firms may dispose illegally to save disposal costs, because they are not aware of the regulations and their responsibility to comply, and/or because they do not know how to comply with the regulations.

#### *Knowledge of regulations and technical expertise*

Hazardous-waste management is usually a small part of a firm's operations. It may not attract the attention of senior management; indeed, it may receive little attention from anyone. Lack of concern about the dangers of familiar chemicals; delay in disposal (leading to accumulation of illegal quantities); and the novelty of regulations are just some of the factors in this category.

#### *Disposal-cost savings*

The cost savings a generator or hauler can achieve by disposing illegally depend on the type and quantity of wastes and the accessibility and cost of legal disposal methods. This cost can vary substantially among firms, by industry and location. Increases of 200 percent in the last five years are not uncommon, but increases have been highly variable [3]. Legally disposed wastes are also taxed in many states. Small Quantity Generators may be disadvantaged because shipping rates for partial loads may be much higher per unit; testing costs can also be substantial and are essentially independent of waste quantity.

#### *Competitive significance of disposal costs*

Firms that dispose of their wastes illegally can gain a competitive advantage. In industries where legal disposal costs are large relative to profits this advantage may be so significant that legal disposers cannot compete. For example, according to a waste hauler we interviewed, legal disposal may cost a small dry cleaner \$200/month, a substantial share of its typical \$2,000/month net revenues. A small metal cleaner with similar profits might face \$2,000/month disposal costs. In cases like these, nearly all competing firms must comply with disposal restrictions, or none can comply and survive.

#### *Cost and feasibility of alternative technologies*

The costs of alternative waste-management techniques, such as on-site recycling and source reduction, can vary among themselves and from those of

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<sup>1</sup>There are approximately 3,000 active TSDFs nationwide subject to permitting [2], of which most are captive facilities; 508 are commercial facilities that accept wastes from other firms [4].

legal off-site disposal. Differences in both fixed and variable costs may be important. Often these alternative waste-management approaches will pose increased fixed costs that capital-constrained firms may be unable to bear. Difficulties in siting and permitting new treatment units can add substantially to the costs of adopting alternative waste-management practices.

#### *Deterrents to illegal disposal*

Waste-law violators risk both legal and business penalties. Government-imposed legal penalties (including fines, imprisonment, permit revocation, or payment for site cleanup or civil damages) are discussed in Section 3.

#### *Business penalties*

Because generators remain liable for cleanup of sites in which their wastes were deposited, they may be unwilling to contract with haulers or TSDFs of uncertain reliability. The associated loss of business by unreliable haulers or TSDFs constitutes a business penalty. Because of joint and several liability, large firms that believe they are prominent targets for cleanup suits because of their "deep pockets" may be particularly anxious to enforce compliance by haulers and TSDFs with which they contract.

The form of contract between generator and hauler can strongly influence the hauler's incentives. If the generator pays the hauler for transport and disposal, the hauler can potentially retain the entire disposal fee by dumping the wastes illegally. If the generator pays the TSDF directly and pays the hauler for transport alone, the hauler's profit from illegal dumping is smaller.

Similarly, liability insurers may influence generator (as well as hauler and TSDF) compliance. The possibility of varying insurance rates in proportion to a firm's chance of violation appears limited, however, because of extreme uncertainty about expected insurance losses.

#### *Other determinants of behavior*

In addition to economic incentives, much evidence suggests that a firm's internal values and organizational structure (its "corporate culture") can affect the firm's compliance and other behavior [5]. Further complicating matters, individuals within firms have their own interests and one of the goals of management, never fully achieved, is harmonizing the interests of employees and those of the corporation.

The significance of adverse publicity as a method for controlling corporate behavior may hinge on these factors. One study [6] found significant differences among major corporations in their responses to publicity about regulatory violations. Some made major changes in personnel or structure, others did little. All did something, which is itself a remarkable finding given the depressing literature on individual rehabilitation. Moreover, it was not the financial cost of the violation and accompanying publicity but precisely the "loss of

corporate and individual prestige, decline in morale, distraction from getting on with the job, and humiliation in the witness box” that had most effect [6]. If corporate prestige is associated with size, large corporations may be more sensitive to adverse publicity than are small corporations.

### *Small quantity generators (SQG)*

Although systematic data on the types of firms most likely to violate waste-disposal regulations are lacking, SQGs are widely believed to be more likely than Large Quantity Generator (LQGs) to violate [7–10]. SQGs are believed to generate only a small fraction of hazardous wastes, perhaps only one percent of total hazardous waste or less [11]. But if they are more likely to dispose of those wastes illegally, their share of illegally disposed wastes may be much greater. In addition, SQGs are believed to be more frequently located near residential areas, increasing the likelihood of human exposure to illegally disposed wastes [11].

SQGs are often assumed to be small businesses, although this need not be correct. SQG status is determined by facility generating level, so a firm that would qualify as an LQG if all its activities were considered as a whole may be comprised of many distinct SQGs. Moreover, large firms in many industries produce little hazardous waste and may be SQGs. Estimates of the fraction of SQGs that are small businesses are apparently not available.

The claim that SQGs are more likely than LQGs to dispose of their wastes improperly is credible, but evidence is limited. The common wisdom holds that LQGs have largely been identified, are inspected, and manifest their wastes. In contrast, it is widely held that: many SQGs have not been identified; SQGs perceive only a minimal threat of legal enforcement; SQGs can face disproportionately high costs for legal disposal; and SQG personnel more often hold negative views of regulators and the need to comply with regulations [10]. Opportunities for clandestine disposal are likely to be greater for SQGs, because of the smaller quantities involved. SQGs that are also small firms will often have fewer of the internal paper controls that permit detection through audit.

SQGs are also believed to be less likely to be aware of, and to understand, the relevant regulations. At the same time several of our sources indicated that SQGs can quickly learn to defeat the regulations. One trick is to legally dispose of only part of the firm’s wastes, in order to obtain the required documents to show in case of inspection. The remaining wastes are dumped illegally [8]. Several sources report that when waste haulers serving SQGs increase their fees or change from a flat rate for collecting all of a generators’ wastes to a per-unit charge, the quantities hauled drop dramatically, suggesting diversion to illegal alternatives. Other explanations (such as process changes) are possible, of course, but were not considered likely.

*Estimates of compliance*

Estimates of the share of firms that dispose of their hazardous wastes illegally, and of the quantities illegally disposed, are few and of limited reliability. However, they support the claim that SQGs are more likely than LQGs to fail to comply with disposal regulations.

A survey in North Hollywood, California estimated 5–28% of SQG wastes are improperly disposed there, most going to sewers, sanitary (nonhazardous-waste) landfills, buried on site, or evaporated [12]. A New Jersey survey estimated that about 30–50% of SQGs do not use required manifests [7]. In Massachusetts, only 25 of the 36 SQGs surveyed had EPA identification numbers required for manifesting wastes, compared with 21 out of 22 LQGs [8].

A survey of San Francisco Bay Area SQGs found that 57% dispose of at least some of their waste illegally. Half of the firms surveyed claimed not to be familiar with the rules. When asked the maximum amount they would pay for proper disposal, half the firms said zero and a total of 85% stated less than \$50 per month, suggesting little demand for legal disposal services [9].

The only published study of LQG compliance [13] is now somewhat dated. It found that, in a period of less stringent enforcement, about 10–15% of firms had “disposed some of their wastes illegally in the previous two years.” The study also produced evidence of over-compliance to avoid inadvertent violations: one fifth of the generators reported treating as hazardous some wastes that were not regarded as such by EPA.

*Potential indicators of non-compliance risk*

Theoretical considerations suggest that incentives and deterrents to illegal disposal differ systematically by observable characteristics of firms. These differential incentives should lead to varying rates of compliance among firms, and may be useful in targeting enforcement actions.

One potentially important characteristic is the ratio of legal disposal costs to profits. As described above, in industries where the costs of legal disposal are large relative to profits, it may not be possible for firms to bear these costs and remain in business unless almost all firms comply. In such markets, there are strong incentives to dispose illegally.

A related point involves the ratio of fixed to variable legal-disposal costs. Where the variable costs are small, the incentives for noncompliance are also small. Thus, a hauler that is paid both for transport and disposal has a greater incentive to dump than one who contracts only for transport, since he can retain the entire disposal fee by dumping the waste.

The extent to which a firm's value can be salvaged, if it is forced to shut down as a result of legal or business penalties, may also be important. If a large part of the firm's value is in assets with ready resale markets, such as a hauler's trucks, the owner may lose relatively little if he is caught disposing illegally. In contrast, TSDf owners may lose a large share of their assets if forced to shut



down, since the physical facility may not be readily transferred to another operator without significant delay.

Firm size can affect the magnitude of business penalties resulting from disclosure that a firm violated a disposal standard. The effect of a single disclosure on other firms' estimates of the reliability of a hauler, for example, may not be properly adjusted for the hauler's size. That is, if the probability of violating a standard and being caught is proportional to the amount of waste hauled, firms that haul large amounts are more likely to be caught than other firms. If generators do not properly account for this effect, their estimates of the comparative reliability of haulers may be biased against the larger-volume firms<sup>2</sup>. This suggests the threat of business penalties will be more important for large- than small-volume firms.

The amount of waste a firm generates or handles can also affect its opportunities for illegal disposal. It is surely easier to illicitly dispose of a small amount than a large amount, although the larger generator may face different opportunities and may be able to illegally dump a proportionately small, but absolutely large, quantity of hazardous waste.

### *Conclusions*

Given the scanty evidence available concerning the extent of illegal disposal by different classes of firms, we are forced to rely on *a priori* theorizing, stressing the costs, knowledge, and incentives of each class of firm. Combining this with the available empirical evidence suggests that SQGs are very likely to dispose of a larger share of their hazardous wastes illicitly than are LQGs or TSDFs. Similarly, it would appear that haulers are more likely than TSDFs to dispose of others' wastes illegally. To assess the social cost of illegal disposal by each class of firm requires additional information on the quantities and types of wastes involved and their ultimate disposition.

### **3. Current monitoring and enforcement practices**

Monitoring and enforcement of hazardous-waste-disposal laws and regulations are carried out in quite different ways in different jurisdictions. There is also considerable variation in enforcement agencies' perceptions of the extent and character of illegal activities they seek to control. Although EPA and other federal agencies help to shape enforcement strategies, the actual monitoring, investigation, and prosecution of violators are largely performed by state and local agencies.

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<sup>2</sup>Experimental evidence suggests that individuals often fail to give adequate weight to prior probabilities [14].

*Inspection and enforcement resources*

EPA rated hazardous-waste enforcement as the third most important of 31 enforcement areas [15]. Similarly, state and local environmental and law-enforcement agencies nominally give high priority to enforcement against illegal hazardous-waste disposal. Attention and resources assigned to this area have increased significantly in recent years. Yet in the jurisdictions we studied (Massachusetts, Pennsylvania, and Los Angeles County), resources devoted to inspection and enforcement seem modest in comparison with the likely extent of illegal disposal. In part, this reflects the fact that the responsibility is a new one and the programs are just developing. There is a great deal of uncertainty about how to proceed best. Standard monitoring, surveillance, and inspection procedures have not been well developed and experienced personnel are few in number. The universe of generators, especially SQGs, has not been identified, which hinders the development of generator-inspection and monitoring programs.

Compared with the number of hazardous-waste generators and the plausible extent of illegal disposal, the number of federal enforcement cases is modest. The EPA National Enforcement Investigations Center (NEIC) received 240 allegations that were categorized as having good potential for criminal prosecution during Fiscal Year 1982 (FY82) through FY84. Of these it could investigate only 70 because of limited resources [16].

In FY83 and the first half of FY84, EPA referred 14 illegal-disposal cases to the Department of Justice (DOJ) for criminal prosecution [16]. (DOJ has jurisdiction over cases which require appearance in court.) EPA referred 20 criminal and 66 civil cases in FY86, but most of the civil cases apparently reflect prosecution of TSDFs under interim permit provisions [17]. In addition, EPA enforcement officials issued 235 administrative complaints, consent agreements, and final orders in FY86 [17].

In most states, EPA has delegated primary enforcement responsibility for the basic RCRA program to state agencies, although only one state is authorized to administer the HSWA program that includes the federal SQG regulations. Many states, including California and Massachusetts, regulate SQGs under state law, however.

Published analyses of state-level enforcement have found small numbers of prosecutions. These studies are somewhat dated, however, and may not accurately represent current enforcement efforts. A study of enforcement in Maine, Maryland, New Jersey, and Pennsylvania found that only 71 criminal cases had been filed between 1977 and 1984, the majority in one state, New Jersey [18]. From December 1980 to December 1983, before its strike force was established, Los Angeles County prosecuted 24 cases; the states of Illinois and New Jersey each had a total of six prosecutions during this period [16].

State enforcement efforts may virtually ignore whole classes of businesses. For example, Pennsylvania does not routinely inspect SQGs, claiming this to

be EPA's responsibility since Pennsylvania has not been authorized to administer the HSWA program. Similarly, although Massachusetts regulated SQGs under state law before HSWA, 75% of inspection resources were devoted to the 115 largest LQGs, each of which was inspected four times annually; another 12% went to inspect smaller LQGs an average of only once every 15 years, and no resources were allocated to inspect SQGs (the remaining 13% went to small TSDFs) [8].

#### *Dependence on tips*

In light of the limited inspection resources and uncertainty about the number and location of generators, it is not surprising that our interviews and other sources suggest that about half or more of the criminal cases originate through tips rather than regulatory inspections. Thirty-four of 36 cases analyzed by GAO [16] came from tips. The other two were developed incidentally by investigators assigned to other cases. Rebovich [18] reports a smaller fraction, but still a majority: of the 87% of all cases he examined where the source could be determined, 53% originated from tips by unrelated citizens or by current or former employees of the offending firm. Twenty-three percent came from state regulatory inspections, 18% from local enforcement and regulatory agencies, and 6% were discovered as a result of industrial accident, such as an explosion or injury to a worker.

Tips are typically unsolicited and come from a variety of sources: disgruntled current or former employees, business competitors, and unrelated citizens who observe suspicious activity or abandoned drums [16,18]. Regular informants do not appear to be particularly valuable, although a few agents claim to use such informants. Some prosecutors develop strings of cases by using information obtained from one violator to apprehend the next [18].

Frequent inspections may increase the number of useful tips received, at least from employees, by increasing employee awareness of government concern and potentially providing employees with improved access to regulators. However, there appears to be no systematic evidence on this point.

The majority of tips received are of low quality, however. Many agencies are overwhelmed with citizen complaints or reports to toll-free telephone tip systems. Most of these tips are believed to concern unimportant violations, and they provide too little information to identify any that may be important cases.

Other cases derive from regulatory inspections, surveillance, and emergency-response operations. Trash collectors on occasion find hazardous waste mingled with other solid waste; workers have been injured when these wastes spill, ignite, or explode during compaction [19]. (Note that these injuries may have been caused by wastes legally disposed by households or VSQGs.) The manifest system has not proven useful for developing cases, in part because most states have apparently not yet developed adequate data-processing procedures. Where the system is operating smoothly it can be useful for confir-

mation and development of cases, but rarely for initiation. Moreover, some prosecutors are concerned about the evidentiary value of the system, fearing defense lawyers could easily show it to be error-prone.

Neither our interviews nor the literature point to a discernable pattern in the types of firms that are most likely to violate rules. Violators include generators and haulers of all sizes, representing a broad range of industries. Rebovich [18] reports that almost two-thirds of the firms prosecuted in his four-state sample had no more than 50 employees. For comparison, according to the Small Business Administration about 95% of U.S. firms have no more than 50 employees, but we do not know the corresponding figure for firms that generate hazardous waste. Rebovich suggests that larger firms' illegal activities are under-represented among prosecutions because they are more likely to occur on site where they are more difficult to detect. Larger firms may also shelter their officers from prosecution more effectively than smaller firms. The lack of an apparent pattern may also reflect the relatively limited numbers of cases brought, sample-selection effects that result from largely tip-driven prosecution, and the paucity of systematic analyses of cases.

#### *Diversity of agencies involved*

Enforcement can be diffuse, involving state and local prosecutors, state environmental agencies, state and county health agencies, and local police and fire departments. There is, even in the three states we studied, a striking diversity of arrangements: Massachusetts and Pennsylvania have highly centralized systems, while (in the major counties) California enforcement is dominated by local agencies. The variety of agencies that can be involved, even if only peripherally, may increase effectiveness by expanding the domain of sources from which enforcers can obtain information, but it can also create difficulties in coordination.

Transportation of hazardous wastes across jurisdictional boundaries can further fragment enforcement, because of the need to coordinate efforts between jurisdictions. Interstate shipment of wastes is quite common: the majority of hazardous wastes generated in Massachusetts and Pennsylvania are disposed in other states because of a lack of disposal facilities in the originating states. Transportation may cross national boundaries as well: some California wastes are disposed in Mexico, and enforcement agents we interviewed suggest Mexican wastes are disposed in California. State records reportedly show 360 legal waste shipments to Mexico in the first half of 1986, but some journalists report that illegal shipments to Mexico, Latin America, and even the South Pacific are significant [20]. Illegal disposal in West Africa by European firms has also been reported [21].

#### *Ambiguities in legal interpretation*

Some enforcement problems arise from ambiguity about the status of particular wastes under different laws, and changes over time. For example, infec-

tious wastes discharged to waterways may be considered hazardous under California law, but allowed by a federal permit under the Clean Water Act.

Confusion about legal obligations should diminish with time, as firms and government agencies gain experience and any conflicts are resolved. Continued major revision of the laws will sustain confusion about proper behavior, however. At present, these uncertainties appear to have a significant effect on many firms' activities.

### *Staff turnover*

Part of the difficulty with hazardous-waste enforcement is that the programs are new and developing. Standard procedures have not been well developed, and experienced personnel are few. Aggravating this situation is a substantial turnover in personnel. Inspectors and investigators are often hired away by industry after they are trained by government. In both California and Massachusetts we found agencies that were unable to keep available positions filled with appropriately trained personnel.

Typically in their first professional job, many inspectors have master's degrees or are working toward them. It is scarcely surprising that these jobs become a revolving door as many inspectors move to industry and environmental-consulting firms after training.

### *Penalties*

Agencies often have severe penalties available; RCRA allows for fines of up to \$25,000/day per violation. Some state laws are even more severe, with the prospect of felony charges where the violation is deliberate and significant. In California, a defendant can be convicted of a felony based on a "should have known" or negligence standard. Ambiguities of the law can make it difficult to enforce these penalties, however, and enforcement personnel may be unwilling to seek such severe sanctions in cases that are not perceived to be egregious. But the value of a felony prosecution for attracting the attention of the corporate community, and presumably improving compliance, is widely acknowledged.

There is a perceived need for, and movement toward, use of administrative penalties. These are more severe than the Notices of Violation (NOV) typically issued by administrative agencies but less demanding in time and evidence than criminal actions. They can be particularly important given that criminal conviction may be difficult to obtain with all the ambiguities in the law. Such administrative penalties have recently been authorized in Massachusetts, where they can be assessed by inspectors.

### *Conclusions*

The monitoring and enforcement of compliance with hazardous-waste laws and regulations is a new responsibility; it should come as no surprise that there

is considerable variation in the response of state and local governments. And, given the weakness of measures of the extent of the problem and the absence of any measures of the effectiveness of different approaches, it is also not surprising that the current system in some states looks unfocused or arbitrary.

That identifies a problem. How should the experiences of the different jurisdictions be used to learn about what is an appropriate level and mix of resources and instruments? We turn to that issue in the final section.

#### **4. Policy implications**

Appropriate enforcement of hazardous-waste-disposal regulations requires an understanding of the scale and distribution of illegal disposal, to determine the level of resources that should be committed to enforcement and to efficiently target those resources. As described in Section 2, however, little is known about how much illegal disposal occurs, its composition in terms of types of wastes and disposal routes, or the characteristics of firms most likely to be involved.

Although we have no estimate of the extent of illegal disposal, there are reasons to believe it is significant. Compliance with disposal regulations is expensive for many firms. The regulations are relatively recent, technically complex, and require substantial departures from past practices in an area — waste management — that is peripheral to most firms' activities. The evidence we have accumulated suggests that enforcement programs present only a modest threat to some classes of violators. Many generators, especially SQGs, apparently face a very slight risk of being detected if they choose to dispose of their wastes improperly. From a purely profit-maximizing view they have little incentive to incur the costs of proper disposal.

Nonetheless, we cannot infer that illegal disposal is massive. The expected cost of noncompliance is only one of the factors that enters into firms' compliance decisions. On the whole citizens, even corporate citizens, prefer to comply rather than violate, if only because it is consistent with their self-image.

But even if significant quantities are disposed of illegally, it is not certain that more resources should be devoted to enforcement. Enforcement of hazardous-waste laws competes for resources directly with enforcement against a variety of white-collar or corporate crimes (such as fraud, price-fixing, and workplace-safety violations) and indirectly with other law-enforcement and government activities. Already, enforcement officials in some jurisdictions argue that the resources committed to hazardous-waste enforcement are large relative to those committed to other areas. In order to justify further increases in resources for hazardous-waste enforcement, there must be some showing that the deterrent effect of increased enforcement is sufficient, and the resulting gains in social welfare are large enough, to make reallocation worthwhile.

We have no basis for evaluating the deterrent effect of hazardous-waste enforcement.

Nor is there a literature on other kinds of corporate crime that we might use as a basis for assessing deterrence here. Measurement of the frequency of particular classes of corporate crimes reflect only what is found through enforcement. There is no equivalent to the household victimization surveys that have been so important in the measurement of violent crime and thefts against individuals or households; even the equivalent of “reports to the police” is much weaker for corporate crimes.

We start then with little understanding of the scale or importance of illegal hazardous-waste disposal and with little knowledge of how well the available instruments of control might work. Ignorance is no excuse for inaction, but it suggests that better data must be developed. We provide some preliminary suggestions about how to proceed along this path.

#### *Estimating the extent of illegal disposal*

Data on illegal disposal are inherently difficult to collect. Data from prosecuted cases [16,18] may not accurately represent the universe of hazardous-waste crime as they are filtered through the screen of past and current detection and prosecution procedures. Similarly, generator surveys may not produce reliable estimates of illegal disposal. The universe of generators is not identified; if reliable extrapolations are to be drawn from a sample, it must be carefully selected to reflect the substantial heterogeneity in incentives to dispose illegally, types of wastes generated, and sensitivity of the environments to which illegal disposal occurs. Surveyed firms may not respond accurately; those that do will be self-selected and may be unrepresentative.

One possible approach to estimate the scale and nature of illegal disposal is to conduct intensive inspections of a large random sample of generators and haulers. There is a model for this approach in the U.S. Internal Revenue Service’s (IRS) Taxpayer Compliance Measurement Program (TCMP) [22]. Approximately every third year, IRS selects a stratified random sample of income-tax returns for intensive auditing. The results are used to develop its audit strategy; those kinds of returns that TCMP finds to have a high noncompliance rate are assigned high probabilities of being selected for audit in following years. TCMP also provides the basis for IRS estimates of the overall level of noncompliance.

We suggest that EPA explore the possibility of creating a similar system to periodically measure compliance across classes of generators and haulers. Classes should be based on factors that are likely to be related to compliance rates (such as those suggested in Section 2), so that the information could be used to target enforcement efforts. Sampled establishments would be subject to a much more intensive inspection than is currently undertaken. The pur-

pose would be less to establish a legal basis for prosecution than to learn about the level and nature of violations by particular kinds of establishments.

In considering the feasibility of this system, it is important to know whether intense inspection is likely to detect illegal disposal. The offenses are not continuous (generators may cumulate waste in proper containers and dump them intermittently), but intensive record checks should have a reasonable prospect of establishing at least a *prima facie* case and the basis for a targeted investigation.

#### *Potentially effective monitoring and enforcement strategies*

Inspection or surveillance programs targeted on the most likely and dangerous violators are likely to improve on a system that relies on tips as the primary source of leads. However, targetting requires information on compliance rates such as might be obtained from the inspection program suggested above.

Routine inspections of all firms, as currently attempted, may not be as cost-effective as more extensive, random inspections of fewer firms. Meaningful inspection requires experienced inspectors who understand some of the details of industrial processes and significant analysis to correlate legal disposals with raw-material inputs or process outputs. Except as they can detect gross inadequacies in physical equipment or operating procedures, routine inspections may be inadequate to prevent episodic illegal disposal; a more continuous monitoring system may be necessary. Inspecting each generator once may be useful for educational purposes, but once hazardous-waste programs become better established, compliance may be improved by random, unannounced, and more thorough inspection of fewer firms, accompanied by vigorous enforcement of violations detected. (Abandoning a policy of universal inspection may require amendment of RCRA and state laws.)

Manifests can be used more effectively than they are at present. Once computerized manifest systems are in place, routine tracking of waste quantities shipped by a firm over time and comparison of wastes to industry norms should be relatively inexpensive. Similar programs could be used to analyze the data submitted by TSDFs in their periodic operating reports. Coordination between source and destination states will be important.

Continuous monitoring of sewers and storm-drain channels could provide evidence of the amount of hazardous wastes disposed there. We do not envision monitoring all access points to these systems, but continuous monitoring of main lines appears to be technically feasible and may not be overly expensive if automated systems for chemical analysis are feasible. Although such monitoring would not identify responsible firms, it would suggest the types of wastes, approximate location, and timing of intermittent disposals. Observers stationed at sanitary landfills (as in Los Angeles County) can also provide data on the magnitude of illegal disposals, and lead to identification and prosecution of violators.



Aerial surveillance currently appears helpful, according to our interviews and others [18]. However, if such programs spread, violators are likely to adapt by conducting their activities at night or indoors.

In addition to detection strategies, policy makers should consider the appropriate penalty schedules. These should recognize not only the potential environmental harm resulting from each crime, but also the varying detection probabilities: More severe penalties should be imposed for crimes that are less likely to be detected. However, penalties are limited by other factors. Equity considerations imply that environmental penalties must be calibrated against other offenses. The harsher the penalty the more expensive agencies will find it to administer, since detected violators will contest the matter more vigorously and courts will provide greater protections. Some jurisdictions have felt a need for easily administered enforcement penalties to avoid using the resource-intensive judicial process for many cases.

### *Conclusions*

Efficient enforcement strategies for RCRA and similar state laws cannot be developed without better information on the magnitude and character of illegal disposal. Such information might be developed through a program of intensive inspection of a stratified random sample of generators and waste haulers, perhaps accompanied by improved monitoring of sewers, storm drains, sanitary landfills, and other frequent destinations of illegally disposed wastes.

Enforcement of hazardous-waste-disposal regulations must be recognized as a dynamic enterprise. The primary legislation is relatively recent, the regulations are continually changing, legal disposal alternatives and their prices are changing, and regulatory and enforcement agencies are developing appropriate procedures and strategies. Industry is adapting to changes in waste-management opportunities, enforcement strategies, and other features of its environment. Illegal disposal is widely perceived as having become more sophisticated in recent years, because of increasing enforcement pressure. In part, it is apparently shifting on site, behind industry walls [18]. Such adaptation by violators will continue, and will require continuing monitoring and innovation by enforcement agencies.

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