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The Temporal Dimension of Land Pollution: Another Perspective on Applying the Breaking the Logjam Principles to Waste Management

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THE TEMPORAL DIMENSION OF LAND POLLUTION: ANOTHER PERSPECTIVE ON APPLYING THE BREAKING THE LOGJAM PRINCIPLES TO WASTE MANAGEMENT

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INTRODUCTION

Professors Stewart and Adler have written thoughtfully of the challenges of regulating, respectively, nuclear and hazardous waste in an effective and efficient manner. Each points to ways in which application of the Breaking the Logjam principles could make valuable improvements in the legal regimes for these categories of dangerous, land-disposed waste. Stewart seeks to repair a system for managing numerous types of nuclear waste, which he regards—with justification—as largely dysfunctional.[1] Adler argues that the system for the management of hazardous waste is unduly centralized and inflexible, especially since hazardous waste is, in his view, an essentially local and relatively contained environmental problem.[2] This comment adds a temporal dimension to the consideration of both waste types.

Unlike air and water pollution, land pollution (that is, the management of dangerous solid and liquid wastes on land) remains a relatively concentrated, active hazard for long periods of time. Uncontrolled, land pollution moves through the environment slowly and often without significant diminution of toxicity. Persistence, in fact, is often regarded as the defining quality of dangerous land pollutants.[3] Even controlled, which is to say

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1 Richard B. Stewart, *U.S. Nuclear Waste Law and Policy: Fixing a Bankrupt System*, 17 N.Y.U. ENVTL. L.J. 783 (2008).

2 Jonathan H. Adler, *Reforming our Wasteful Hazardous Waste Policy*, 17 N.Y.U. ENVTL. L.J. 724 (2008).

3 *E.g.,* Stockholm Convention on Persistent Organic Pollutants, May 23,

isolated from the environment, land pollution retains its hazardous qualities for long periods of time. Indeed, one of the ironies of hazardous waste management is that the more effectively the waste is isolated, the more effectively its hazardous qualities are protected: it can neither degrade nor disperse. (Radioactive decay is not slowed by isolation, of course, but neither can it be accelerated by natural processes.[4]) It is true that water pollutants can be deposited in sediments, that contaminants in aquifers often move slowly, and that air pollutants can remain in the stratosphere for decades—but none poses a focused threat for as long as hazardous and nuclear waste. Accordingly, there is no notable temporal dimension to air and water pollution laws or regulations, but hazardous and nuclear waste regulation is very much concerned with the problem of maintaining the isolation of solid and liquid materials over decades, centuries, and even millennia.[5]

To say that time is a concern of hazardous and nuclear waste regulation is not to say, however, that regulation is particularly successful in addressing that concern. In fact, there is good reason to believe that waste management practices and institutions are not well designed to perform over the time periods during which the waste remains dangerous. In particular, institutions do not exist that have any kind of record of ability to monitor and safeguard waste material over decades, centuries, or millenia.[6] The temporal

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2001, *reprinted in* 40 I.L.M. 532 (2001), *available at* http://www.pops.int/documents/convtext/convtext_en.pdf.

[4] Techniques for transmuting radioactive waste into less dangerous isotopes have been suggested, but they are in the earliest stages of development. "It is generally agreed that it is not feasible to deal with existing waste by this process; the technology, if feasible, would form an intrinsic part of the fuel cycle of future programmes." PETER RILEY, NUCLEAR WASTE: LAW, POLICY AND PRAGMATISM 45 (Ashgate 2004).

[5] *See, e.g.*, 10 C.F.R. § 60.113 (2008) (requiring 300 years for package integrity, 1000 years for radiation leaks); 40 C.F.R. §§ 191.13–119.15 (2006) (requiring 10,000 years for surrounding areas for high-level waste); *see also* Nuclear Energy Inst., Inc. v. EPA, 373 F.3d 1251, 1267 (D.C. Cir. 2004) (requiring a greater than 10,000 year compliance period for the Yucca Mountain deep geologic repository).

[6] John S. Applegate & Stephen Dycus, *Institutional Controls or Emperor's Clothes? Long-Term Stewardship of the Nuclear Weapons Complex*, 28 ENVTL. L. REP. 10631, 10639 (1998); Katherine N. Probst, *Long-Term Stewardship and the Nuclear Weapons Complex: The Challenge Ahead*, 131 RESOURCES 14, 15 (1998); NAT'L RESEARCH COUNCIL, LONG-TERM INSTITUTIONAL MANAGEMENT OF U.S. DEPARTMENT OF ENERGY LEGACY WASTE SITES (2000). The track record

dimension of waste management thus presents a particularly interesting occasion to apply the Breaking the Logjam regulatory principles that Professors Stewart, Schoenbrod, and Wyman have developed.[7] Specifically, consideration of the long-term nature of waste disposal offers important *opportunities to apply cross-cutting regulatory approaches that address underlying causes*. The principle of *expanding the use of market incentives and information* may be particularly useful in accomplishing this objective. The temporal dimension also offers an opportunity to insist on *openness about trade-offs*, and decision making will undoubtedly benefit from an informed, transparent, and deliberative approach. The temporal aspect presents a conceptual challenge, however, to *scaling regulatory authority to the problem*. These comments conclude with the suggestion of an additional principle of *institutional learning and the conservation of options*. In any long-term effort one must expect that over time we will come to understand a problem better and so develop better ideas for addressing it. These improvements can only be implemented if the regulatory system is capable of learning and if decisions now leave open options for the future.

I. RISK, COST, AND TIME

The salience of temporal concerns in the management of nuclear and hazardous waste has important consequences for their management. These wastes not only pose risks of various kinds and to various groups of people in the present, but also far into the future. The challenges of long-term management of waste have been most extensively explored in the context of nuclear waste, perhaps because we are accustomed to thinking about nuclear waste in terms of time, that is, half lives. However, time is at least as important to other hazardous wastes. Radioactive substances decay—albeit usually over centuries or millennia—but other elements do not. As a result, toxic metals like nickel, mercury, arsenic, and lead are, for all practical purposes, forever. There are thousands of sites containing such "ordinary" toxic materials in

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of institutions in protecting even items of great value, such as texts, jewels, records, and artwork, is minimal, and preservation has depended primarily on luck. Applegate & Dycus, *supra* at 10645.

[7] *Breaking the Logjam: Environmental Reform for the New Congress and Administration,* 17 N.Y.U. ENVTL. L.J. 1, 1 (2008).

significant quantities, and their long-term management receives almost no attention. Indeed, the Resource Conservation and Recovery Act (RCRA), the primary regulator of such wastes, in effect washes its hands of these sites a mere thirty years after closure.[8] In sum, the longevity of both nuclear and hazardous waste poses serious and unique challenges to its proper management.

A. *The Life Cycle of Hazardous and Nuclear Waste*

Industrial waste has a life cycle that begins with the raw materials that go into a manufacturing or other industrial process, continues through the design and operation of the process itself, then the generation of the waste products, the treatment (if any) of the waste, the storage and transportation of the waste, disposal on land, and finally remediation of ineffective disposal.[9] Adjustments at any of these phases of the life cycle can have important downstream effects on the volume and characteristics—indeed, on the existence—of the resulting waste and its human health and environmental consequences. For example, choice of raw materials or process design changes can eliminate a component that contributes to the hazard of the resulting waste. Minimization of the use of chlorine is often advocated for precisely this reason, since chlorine is a kind of *radix malorum* of many persistent hazardous pollutants. Likewise, more efficient use of raw materials in the production process itself can reduce their presence in waste, as many companies have found by doing careful analyses of inputs, processes, and wastes.[10] Moreover, it is universally agreed that, all other things being equal, it is both cheaper and more effective to avoid creation of the waste in the first place than to manage it after it has been created.

Federal and state waste management laws and regulations are overwhelmingly concerned with the phases of the life cycle *after*

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[8] 40 C.F.R. § 264.117(a) (2007).

[9] Our present concern is disposal on land. *See generally* JOHN S. APPLEGATE & JAN G. LAITOS, ENVIRONMENTAL LAW: RCRA, CERCLA, AND THE MANAGEMENT OF HAZARDOUS WASTE 18–20 (Foundation Press 2006).

[10] *See generally* Paulette L. Stenzel, *Can the ISO 14000 Series Environmental Management Standards Provide a Viable Alternative to Government Regulation?*, 37 AM. BUS. L.J. 237 (2000) (describing the use of an international standard for measuring inputs and waste outputs).

the waste is generated. With the exception of the voluntary programs under the Pollution Prevention Act[11] and the occasional state law,[12] they are concerned with the fate of wastes that already exist. The management system under RCRA[13] often styles itself as cradle-to-grave regulation, because it tracks *waste* from its creation to disposal. However, Professor Gaba has correctly observed that this is really "deathbed to grave" regulation, because early opportunities to reduce or eliminate the generation of the waste are almost entirely ignored.[14]

To extend the metaphor, the afterlife of waste—remediation—is addressed in great detail and at enormous expense in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund).[15] CERCLA's prehistory is the disposal of hazardous waste on land in a way that did not, as it turns out, effectively isolate it.[16] This leads to a polluted present in which the current condition of the land includes the presence of non-isolated wastes. In CERCLA terminology, this constitutes a "release" of a hazardous substance, which triggers response authorities.[17] The response authorities include a range of activities of shorter or longer duration and short- or long-term objectives, which are needed to destroy, isolate, or re-isolate the waste. The objectives are established with reference to the expected condition and use of the land immediately *following* remediation and for the near-term future. Thus, EPA and other agencies consider the extent of predicted future human exposure patterns in assessing the appropriate nature and extent of remediation. For example, industrial re-use ("brownfields") necessitates a less extensive clean-up because such a use results in lower exposure levels to persons at the site and thus lower risks to

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[11] 42 U.S.C. §§ 13101–13109 (2000).

[12] *E.g.*, Massachusetts Toxics Use Reduction Act, MASS. GEN. LAWS ch. 21I, §§ 1–23 (2004 & Supp. 2006).

[13] *See* 42 U.S.C. §§ 6901–6992(k) (2000).

[14] Jeffrey M. Gaba, *Solid Waste and Recycled Materials Under RCRA: Separating Chaff from Wheat*, 16 ECOLOGY L.Q. 623, 651 (1989).

[15] 42 U.S.C. §§ 9601–9675 (2000).

[16] *See* Applegate & Dycus, *supra* note 6; John S. Applegate & Steven M. Wesloh, *Short Changing Short-Term Risk: A Study of Superfund Remedy Selection*, 15 YALE J. ON REG. 269, 270 (1998).

[17] 42 U.S.C. §§ 9601(22) (2000) (definition of "release"); 42 U.S.C. § 9604(a)(1) (2000) (response authorities).

them.[18] Finally, "long-term stewardship" means long-term management of the remaining contamination or waste to assure its continuing isolation to protect human health and the environment.

The general rule also applies to the grave and afterlife, that it is both cheaper and more effective to avoid waste production in the first place. Waste that does not escape does not have to be cleaned up, and so better management and control practices at the earlier stages are greatly preferred to remediation. Even though most wastes cannot be made to disappear entirely, because elements cannot practically be destroyed, isolating them, gathering them into a well defined location, treating them for stability, and controlling access will result in a safer near-term and more reliable long-term future.

B. *Waste Management Options*

One of the strongest arguments for addressing waste early in its life cycle is that the basic options for managing waste are actually quite limited. In contrast, reformulating products, redesigning processes, finding substitute inputs, and finding substitute products can all eliminate or reduce the generation or degree of hazard from waste. Thus, waste minimization at the earliest phases of the life cycle—selection of raw materials and design of production processes—can be the most cost-effective methods of reducing risk from waste management, even though it has little to do with waste management *per se*. (Control at the back-end of the cycle only indirectly encourages waste minimization by raising the cost of management.) However, direct control of the early life cycle stages would involve a level of detailed involvement in production processes that is rare in American environmental regulation.

Once the waste is generated, the first-order options consist of isolation, treatment, and release into the environment (without treatment). Isolation can involve anything from dumping in a trench behind the factory (as described in *A Civil Action*,[19] for example), to dumping in an apparently suitable location (*e.g.*, Love

[18] *See generally* John S. Applegate, *Risk Assessment, Redevelopment, and Environmental Justice: Evaluating the Brownfields Bargain*, 13 J. NAT. RESOURCES & ENVTL. L. 243 (1997–98).

[19] JONATHAN HARR, A CIVIL ACTION (Vintage Books 1995).

Canal[20]), to disposal in a state-of-the-art waste disposal facility. In all cases, the objective is to keep the waste in place and away from humans and the ambient environment for as long as it remains hazardous. Untreated release is the opposite of isolation, and it covers a range of activities from careless or willfully irresponsible disposal (as alleged in *A Civil Action*) to a deliberate effort to manage safely through dilution. A septic field is an example of the latter, but the safety of this technique for biological hazards contrasts with the use of a similar method for diluting radioactive waste, which left a legacy of widespread contamination of soil and groundwater.[21]

Treatment encompasses a wider array of physical techniques. Many, many treatment technologies exist, but all are designed to accomplish one of three second-order objectives: to destroy the waste, to render it safe for release into the environment, or to render it more capable of effective isolation. Destruction of waste usually means changing its physical form so that it is separated into non-toxic constituent parts. Incineration, for example, results in air emissions and ash, which are supposed to pose no further (or more controllable) hazard. Rendering safe for release into the environment often overlaps with destruction. Destructive treatment typically results in hazardous and non-hazardous fractions. The non-hazardous fraction can be released to the environment, and the hazardous fraction is isolated. Treatment is also used to change the form or characteristics of waste so that it (or some fraction of it) is suitable for isolation, that is, so that it will stay put. This involves treatment to reduce volume, mobility, or a hazardous characteristic (e.g., toxicity) of the waste, with the objective that it would be easier to isolate (for example, there is less of it) and, if isolation failed, would either move slowly through the environment (less mobile) or would be less dangerous to health or the environment (less toxic). This is the philosophy behind the 1984 "land ban" amendments to RCRA, which prohibit land disposal of hazardous waste unless it has been treated to reduce volume, mobility, or toxicity.[22]

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[20] United States v. Hooker Chem. & Plastics Corp., 850 F. Supp. 993, 997 (W.D.N.Y. 1994).

[21] ROY E. GEPHART, HANFORD: A CONVERSATION ABOUT NUCLEAR WASTE AND CLEANUP 5.26–5.30 (Battelle Press 2003).

[22] 42 U.S.C. § 6924(c)–(g).

Waste management always involves one or more of the first-order options, often in combination, and deploys a wide range of second-order physical techniques. The essential point is that total destruction is relatively rare (thanks to the physical laws of conservation of matter), and so it is more common to use methods that reduce the volume or the mobility or the toxicity of a hazardous fraction of the wastes in order to render isolation of the hazardous fraction more secure. The latter methods improve safety, but they leave a legacy for future generations.

C. *Isolation Over Time*

Unless a waste can be treated in a way that destroys it or allows it to be freely released into the environment, it must be isolated, and isolation is the primary focus of the current regulatory schemes for hazardous and nuclear waste. They specify the kinds of wastes that can be isolated (*e.g.*, only *after* treatment),[23] the locations where they may be isolated,[24] and the specifications of the facilities where they may be isolated.[25] (They also address intermediate management activities such as transportation and temporary storage.) Since isolation only works if it is effective over the period of time during which the waste material remains dangerous, the problem of long-term isolation drove the 1984 RCRA "land ban" for hazardous waste. EPA and the Office of Technology Assessment (OTA) took the view, and Congress agreed, that it is only a matter of time before virtually all isolation systems fail and the hazardous materials in them are released into the environment.[26] Worse, such releases are likely to be unplanned and even undetected at the time. The land ban's

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[23] *E.g.*, 40 C.F.R. pt. 268 (2007) (land disposal restrictions);10 C.F.R. § 61.1 (2008) (applicability); 10 C.F.R. § 61.55 (2008) (waste classification).

[24] *E.g.*, 40 C.F.R. § 264.18 (2007) (general standards; specific standards in following sections of pt. 264; 10 C.F.R. §§ 60.121, 60.122, 61.50–61.59 (2008) (high-level waste, ownership of high-level waste and other radioactive waste, respectively).

[25] *E.g.*, 42 U.S.C. § 6924(o) (2000) (minimum technological requirements); 40 C.F.R. §§ 264.300–264.317 (2007) (same; hazardous waste landfills); 10 C.F.R. §§ 60.111–60.113 (2008) (high-level waste); 10 C.F.R. § 61.51 (2008) (design standards).

[26] APPLEGATE & LAITOS, *supra* note 9, at 12–16, 75–83; OFFICE OF TECHNOLOGY ASSESSMENT, TECHNOLOGIES AND MANAGEMENT STRATEGIES FOR HAZARDOUS WASTE (1983) [hereinafter OTA].

treatment requirement was intended to reduce toxicity and/or exposure (*i.e.*, mobility) of such releases, thereby reducing risks when such releases inevitably occur. The 1986 amendments to CERCLA provide a litany of similar concerns:

> In assessing alternative remedial actions, the President shall, at a minimum, take into account:
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> (A) the long-term uncertainties associated with land disposal;
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> (B) the goals, objectives, and requirements of the Solid Waste Disposal Act [RCRA];
>
> (C) the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents;
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> (D) short- and long-term potential for adverse health effects from human exposure;
>
> (E) long-term maintenance costs;
>
> (F) the potential for future remedial action costs if the alternative remedial action in question were to fail; and
>
> (G) the potential threat to human health and the environment associated with excavation, transportation, and redisposal, or containment.
>
> The President shall select a remedial action that is protective of human health and the environment, that is cost effective, and that utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.[27]

Since CERCLA is by definition all about *failed* isolation, it is no surprise that Congress, in establishing clean-up standards under CERCLA, made avoiding future failures its central concern.[28]

The length of time that an isolation system retains its integrity depends on several factors: the characteristics of the waste (a corrosive waste would degrade containers more quickly), the initial design and construction of the isolation system, and the continuing monitoring and repair of the isolation system. Deep

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[27] 42 U.S.C. § 9621(b)(1).

[28] *See generally* OFFICE OF TECHNOLOGY ASSESSMENT, SUPERFUND STRATEGY (1985) (criticizing a policy of containing rather than treating hazardous wastes to avoid future clean-up sites).

geologic repositories like Yucca Mountain and the Waste Isolation Pilot Plant (WIPP), for example, are or will be constructed in such a way that no further human interaction will ever be necessary (or even feasible).[29] An alternative strategy, monitored retrievable storage, assumes a constant low level of monitoring activity and regular human intervention (at about century-long intervals) over the course of millennia to repackage the material.[30] Even aspirationally permanent solutions like Yucca Mountain and WIPP will require very long-term stewardship arrangements to prevent intrusion through, for example, mining.[31]

There is, generally speaking, an inverse relationship between the resources invested in the early management of waste and the resources required to maintain isolation. As with so much in life, it is a matter of paying now or paying later. At the simplest level, investment in an elaborate, RCRA-compliant hazardous waste facility now will reduce the likelihood of leakage, extend the effective life of the facility, and alert watchers to leakage shortly after it occurs—all of which will minimize the costs of responding to the eventual loss of integrity of the facility. In 1983, OTA estimated that "years or decades from now, cleaning up a site from which there are hazardous releases, and compensating victims, might cost 10 to 100 times the additional costs incurred today to prevent releases."[32] Likewise, the better designed and constructed the isolation system is, the less or less frequent ongoing care—monitoring, repair, clean-up, re-isolation—will be required. Nevertheless, even the most elaborately designed system will require some minimal attention as long as the waste is dangerous, if only to prevent intrusion by animals, plants, geologic events, hydrologic events, or human activity. An analogy to preventive maintenance is apt: it is far less expensive in the long run to keep up with the needed maintenance, than to let the facility get to the point of structural damage.

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[29] For more about these repositories, see sources cited in Applegate & Dycus, *supra* note 6, at 10634 n.17 (citing sources).

[30] *Id.*

[31] Figuring out how to warn people thousands of years in the future is a fascinating endeavor. An excellent, accessible account of the issues can be found in GREGORY BENFORD, DEEP TIME: HOW HUMANITY COMMUNICATES ACROSS MILLENNIA (Avon 1999).

[32] OTA, *supra* note 26, at 6.

D. *Hazardous and Nuclear Waste Management Decisions*

The foregoing discussion has fundamental implications for the management of hazardous and nuclear waste. First, the advantages in cost and environmental protection of reducing waste at or close to the source—that is, as early in the life cycle as possible—are, if anything, understated by the common wisdom. Hazardous and nuclear wastes are forever, and without some level of long-term monitoring and control, they will simply reappear again (and again) as a problem for future generations.

Second, we cannot make the wastes that have already been generated entirely disappear. We must in candor recognize that irretrievable decisions have been made, which take contaminated land and waste disposal areas out of productive circulation for many uses, also forever. Any waste that we leave behind, in whatever configuration, imposes some level of burden on future generations at least to monitor and isolate it, and perhaps to manage it actively.

Third, there are, however, opportunities to limit the burden in the waste management choices that we make now. Investments in aggressive management will, as a general rule, result in lower long-term costs and less burden on future generations.

Fourth, these are not simple decisions. A thoughtful approach to waste management policy must consider opportunities to minimize the problem, current risks and costs, and effects far into the future. Hazardous and nuclear waste does not lend itself to absolute rules, nor does it lend itself to simple formulas for arriving at appropriate solutions. There are trade-offs aplenty—among future land uses, types of risks, persons at risk, and above all the timing of risks—and none are subject to simple quantification or comparison. The management of these wastes is, in short, an excellent candidate for applying and assessing the Breaking the Logjam principles.

II. TIME AND THE BREAKING THE LOGJAM PRINCIPLES

The safe management of hazardous and nuclear waste implicates several of the Breaking the Logjam principles, as Professors Stewart and Adler explain in their papers. The principles have additional implications when the temporal dimension of waste management is considered. In addition, the temporal dimension suggests the value of an additional principle, institutional learning and the conservation of options, for regulatory decision making.

A. *Cross-Cutting Regulatory Approaches that Address Underlying Causes*

The principle that "existing statutes must be restructured to match the true character of environmental problems and their underlying causes" matches perfectly the observation that the best way to deal with wastes is not to generate them in the first place. An effective hazardous waste policy must focus on the true cradle of the waste, its underlying cause: the decisions that led to its creation in the first place. The decisions to make a product or to perform an activity at all (or in a certain amount), to formulate the product or to design the activity in a certain way, and to design the production process in a particular way, all affect the volume and nature of the resulting waste streams. Such changes to the early parts of the life cycle will not eliminate all hazardous and nuclear waste, of course, but waste minimization must be the foundation of the regulatory scheme.

The fundamental difficulty in developing effective waste minimization programs is gaining regulatory access, so to speak, to the early production decisions. In general, governmental regulation focuses on the *externalities* of enterprises. Externalities offer the best justification for imposing collective public controls, and they are the most politically acceptable interventions. For example, much of the resistance to the Occupational Safety and Health Act, which has left it largely inactive,[33] is founded on the idea that government should not regularly go "inside" business operations; its focus should be on controlling external effects. Whatever the merits of this view, it was implicitly supported by the differential treatment of workplace inspections and ambient pollution: the former requires a warrant, and the latter can be warrantlessly observed and sampled at the fenceline.[34] Moreover, the internal

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[33] *See* THOMAS O. MCGARITY AND SIDNEY A. SHAPIRO, WORKERS AT RISK: THE FAILED PROMISE OF THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION 3–30 (Praeger 1993).

[34] Dow Chem. Co. v. United States, 476 U.S. 227, 237–38 (1986); Marshall v. Barlow's, Inc., 436 U.S. 307, 315 (1978); Air Pollution Variance Bd. of Colorado v. Western Alfalfa Corp., 416 U.S. 861, 865 (1974); *see also* Cary

operations of economic enterprises are extremely various. The familiarity of the enterprise's management is particularly valuable with respect to operational choices and designs; conversely, external regulators are most likely to err in creating detailed requirements in these areas. It would be silly to abjure all regulation of enterprises' internal operations—and environmental, health, and safety laws wisely do not do so—but the internal-external divide poses a real challenge for addressing "underlying causes" of hazardous waste disposal on land.

As a result, federal legislation on waste minimization and pollution prevention is basically voluntary. The Pollution Prevention Act,[35] for example, recognizes the value of addressing the early life cycle of pollutants, but does little more than offer weak incentives to develop and implement waste minimization.[36] RCRA requires certain waste generators to have waste minimization *plans* in place.[37] The most effective systems have instead attacked the problem indirectly—from the outside, so to speak. "Reputation tax"[38] systems publicize the hazardous emissions of a facility or hazardous contents of a product, with the expectation that such publicity will create a strong incentive to eliminate or reduce the hazardous discharges or contents. The Toxics Release Inventory established by the 1986 amendments to CERCLA (the Emergency Planning and Community Right-to-Know Act (EPCRA)) required industrial facilities to disclose their releases of significant amounts of designated hazardous substances into any medium,[39] and industry reacted to the publicity by reducing such releases.[40] The *means* of achieving the reductions

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Coglianese & David Lazer, *Management-Based Regulation: Prescribing Private Management to Achieve Public Goals*, 37 L. & SOCIETY REV. 691 (2003) (describing the difficulties of regulating "inside" an enterprise).

[35] 42 U.S.C. §§ 13101–13109 (2000).

[36] *See* Stephen M. Johnson, *From Reaction to Proaction: The 1990 Pollution Prevention Act*, 17 COLUM. J. ENVTL. L. 153, 170–174, 188–189 (1992).

[37] 42 U.S.C. §§ 6922(b), 6925(h).

[38] *See* John S. Applegate, *Bridging the Data Gap: Balancing the Supply and Demand for Chemical Information*, 86 TEX. L. REV. (forthcoming 2008).

[39] 42 U.S.C. § 11023.

[40] *See* JAMES T. HAMILTON, REGULATION THROUGH REVELATION: THE ORIGIN, POLITICS, AND IMPACTS OF THE TOXICS RELEASE INVENTORY PROGRAM 225–26 (Cambridge U. Press 2005); David W. Case, *Corporate Environmental Reporting as Informational Regulation: A Law and Economics Perspective*, 76 U. COLO. L. REV. 379, 381–82 (2005).

are nowhere stated in the statute or regulations; they were entirely in the hands of the enterprises themselves.

California's Proposition 65[41] imposes a similar notification requirement for chemicals "known to the state to cause cancer or reproductive toxicity" when they are released to the air, groundwater, or contained in products. Even though it, too, does not mandate any production process or input, the enactment of Proposition 65 has resulted in abandonment of marginal products, reformulations, and dramatic reductions in emissions and contents—exactly the kinds of decisions that waste minimization programs hope to affect.[42] The Massachusetts Toxics Use Reduction Act addresses planning more directly by requiring the manufacturers and users of toxic chemicals to generate use-reduction plans. While the plans need neither be followed nor publicly disclosed, the investment in the development of the plans is expected to encourage their implementation.[43]

Breaking the Logjam. Two specific policy devices can be deployed to encourage addressing hazardous waste at its source or as far upstream as possible. The first and more aggressive is an outright ban on the substances that constitute or contribute to much of the hazardous waste problem. Despairing of the "fine-tuning" approach to toxic water pollutants, Professor Oliver Houck concluded:

> The near-routine predictions of layoffs, plant closings, and economic ruin notwithstanding, when the paper industry has had, at last, to convert to a less polluting process, it has done so. At bottom, the struggle is not over the ability not to pollute, but over lead time and competitiveness. Any solution to toxic pollution will have to accommodate these legitimate industry needs. A solution, on the other hand, that fosters differing state standards and differing state applications of these standards breeds uncertainty, contention, unfairness, and endless

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[41] Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65), CAL. HEALTH & SAFETY CODE §§ 25249.5–25249.13 (West 2006).

[42] *See* Carl Cranor, *Information Generation and Use Under Proposition 65: Model Provisions for Other Postmarket Laws?*, 83 IND. L.J. 609, 613 (2008); Clifford Rechtschaffen & Patrick Williams, *The Continued Success of Proposition 65 in Reducing Toxic Exposures*, 35 ENVTL. L. REP. 10,850 (ENVTL. L. INST. 2005); David Roe, *Toxic Chemical Control Policy: Three Unabsorbed Facts*, 32 ENVTL. L. REP. 10,232 (2002).

[43] Coglianese & Lazer, *supra* note 34, at 700.

opposition.[44]

The device of prohibition with lead time for adjustment is responsible for two of the most celebrated successes of environmental regulation: lead in gasoline and ozone depleting substances. The choice of target substances must be a careful one, of course. For example, the Stockholm Convention on Persistent Organic Pollutants (POPs) adopts an outright ban on eleven of the so-called Dirty Dozen, which reflects steps already taken in most industrialized countries. However, it extends (indefinitely with regular review) the lead time for a total phase-out of DDT which, despite its notoriety, remains an essential element of the fight against malaria in the developing world.[45] A place to begin the process of identifying phase-out candidates for hazardous waste would be the substances (primarily chemical and petroleum feedstocks) targeted by the tax that originally created the Superfund,[46] because that list was designed to match (roughly) clean-up expenditures—that is, the very last stage of the hazardous waste life cycle—with their ultimate sources.[47]

A second and less aggressive approach would be a direct monetary tax on the model of the reputation tax described above. Numerous observers have advocated a "tail-end" waste tax as a way to reduce upstream waste generation. Twenty-five years ago, the OTA suggested a variable fee (based on the likelihood of requiring later clean-up) as a way to reduce Superfund expenditures.[48] Subsequent commentators have noted that tax systems are relatively simple and cheap to operate, they afford nearly total flexibility to generators to determine how and how much to reduce waste generation, they provide a continuing incentive to reduce and innovate, and the tax rates can be adjusted

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[44] Oliver A. Houck, *The Regulation of Toxic Pollutants Under the Clean Water Act*, 21 ENVTL. L. REP. 10,528, 10,554 (1991); *see also* SIDNEY A. SHAPIRO & ROBERT L. GLICKSMAN, RISK REGULATION AT RISK: RESTORING A PRAGMATIC APPROACH 158–72 (Stanford U. Press 2003) (recommending "back-end adjustments," rigorous general controls subject to specific modification as needed).

[45] Stockholm Convention on Persistent Organic Pollutants, *supra* note 3, at annex B, part II.

[46] *See* 26 U.S.C. §§ 4611, 4661, 9507. The taxes have since expired.

[47] *See generally* Exxon Corp. v. Hunt, 475 U.S. 355, 376 (1986) (holding that the Superfund tax preempts certain state clean-up taxes).

[48] OTA, *supra* note 26, at 30–33.

over time to respond to the system's success *vel non* in reducing waste.[49] Moreover, a tax system can be combined effectively with other techniques. For example, the effect of a tax could be intensified by offering "rebates" for preferred or demonstrably superior forms of treatment and disposal.[50] Combinations can also remedy problems that taxes are *not* good at achieving, such as avoidance of concentrations of risk[51] and establishing minimum standards for disposal (which are related problems), and it is entirely possible to combine systems to address these problems. For example, it is entirely feasible to establish "command and control" disposal technology standards, while relying on a tax system to reduce waste generation.

The waste or reputation tax approach not only implements the Breaking the Logjam principle of addressing underlying causes, but it also exemplifies the principle that "new statutes and regulatory programs need to harness the power of markets and information disclosure to increase environmental protection." Like taxes, the EPCRA and California disclosure systems allow the underlying activity to continue at any level (or none) that the enterprise chooses, but there is a distinct cost (in reputation) associated with it. Acceptable products, appropriate raw materials, and production process are all left to the individual enterprise, giving them the maximum flexibility to organize their operations most efficiently.

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[49] *See* Reuven S. Avi-Yonah & David M. Uhlman, *Combating Global Climate Change: Why a Carbon Tax is a Better Response to Global Warming than Cap and Trade* 37–47 (Univ. Mich. Law Sch. Pub. Law & Legal Theory Working Paper Series, Working Paper No. 117, 2008), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1109167; Robert W. Hahn, *An Evaluation of Options for Reducing Hazardous Waste*, 12 HARV. ENVTL. L. REV. 201, 219 (1988); Clifford S. Russell, *Economic Incentives in the Management of Hazardous Waste*, 13 COLUM. J. ENVTL. L. 257 (1988); Richard B. Stewart, *A New Generation of Environmental Regulation?*, 29 CAP. U. L. REV. 21, 99–100 (2001); *see also* Amy Sinden, *The Tragedy of the Commons and the Myth of a Private Property Solution*, 78 U. COLO. L. REV. 533, 566–76 (2007) (pointing out that tax systems are not purely market mechanisms, because they require governmental decisions concerning appropriate rates).

[50] *See* Stewart, *supra* note 49; Russell, *supra* note 49. The tax-rebate proposal parallels Professor Karkkainen's "flip" strategy described in his contribution to this symposium. Bradley C. Karkkainen, *Framing Rules: Breaking the Information Bottleneck*, 17 N.Y.U. ENVTL. L.J. 75 (2008).

[51] Stewart, *supra* note 49, at 101.

B. *Openness About Trade-Offs*

The temporal dimension also implicates the principle that "[n]ew statutes must acknowledge that trade-offs are inevitable and ensure that they are made in public view based on reliable information." In addition to the contemporary trade-offs that Professors Stewart and Adler identify, hazardous and nuclear waste management involves trade-offs among the present and the multiple futures: waste elimination or minimization through changes in inputs and processes; initial treatment, storage, and disposal; the remediation period; the foreseeable future at which disposal decisions are aimed; and the long-term future of monitoring, repair, prepackaging, or clean-up. Decisions made now, or postponed now, will determine who will be exposed to risks, which risks, and at what scale. For costs, the questions are who will pay and how much.

The remediation of failed waste management is a particularly compelling example of trade-offs across time. EPA is required to balance the risks of remediation itself against eight other criteria in determining an appropriate clean-up remedy,[52] but EPA rarely gives remediation risks the kind of thorough consideration that it does many of the other CERCLA decision making criteria.[53] There are several likely reasons for this, such as a tendency to think of pollution control as a fairly simple and straightforward (if expensive) operation, even though that is demonstrably untrue of waste management. The risks to humans arise from direct exposure to the dangerous materials themselves (the extreme case is the firefighters at Chernobyl). In most cases, these exposures can be limited to reasonably safe levels, but at the substantial cost of protective equipment and work procedures that extend the length and complexity of the clean-up effort. Perhaps the most serious remediation risk, though, is participation in the ordinary construction and transportation activities of clean-up itself—digging, driving, and so on. There are many valid reasons why we might not consider the magnitude of these risks to outweigh environmental harm, even if they are statistically higher than the toxic risk—they are voluntarily undertaken by workers, they are not different in kind or degree from other construction and

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[52] 40 C.F.R. § 300.430(e)(9)(iii).

[53] Applegate & Wesloh, *supra* note 16.

transportation risks, the present generation should restore the planet for future generations—but they are hardly irrelevant to clean-up decisions. Likewise, remediation harm to ecosystems, such as removing contaminated topsoil or sediments, is also substantial in many cases, and again there is no simple formula balancing them against present and future risks. The factual and normative complexity of these trade-offs cries out for transparent and well informed decisions—"made in public view based on reliable information," as the Breaking the Logjam principle puts it.

Waste management statutes like CERCLA, RCRA, and the Nuclear Waste Policy Act tend to marginalize remediation risks, because the statutes themselves represent a firm commitment to the active management of present wastes with the objective of protecting future generations from the mistakes of the present and past generations. Turning our attention, then, to the multiple futures of hazardous waste, the principle trade-off is the familiar one that the more we do now, the less we will have to do in the future. Put another way, there is a direct trade-off between long-term assurance of isolation and short-term cost.[54] Aggressive isolation and stabilization of wastes and contamination will undoubtedly be more costly, but they will spare future generations from the necessity of themselves dealing with the waste (beyond, say, maintenance and monitoring of disposal facilities). By contrast, remedial plans that depend heavily on so-called institutional controls (land use controls or deed restrictions, for example) will require active long-term stewardship to ensure that the controls remain effective. Similarly, doing no more than capping contaminated soils in place will slow migration of contaminants, even substantially, but the cap not only must be maintained intact, but migration will ultimately require more aggressive measures. "Attempting to minimize present costs will almost certainly lead to a transfer of greater costs to the future."[55]

As with remediation risks, the foregoing are real and inevitable trade-offs, and one cannot say *a priori* that a particular result (now or later) is always more appropriate. Statutes like RCRA and CERCLA sensibly privilege long-term solutions, but that is mainly in order to counteract the tendency to impose risks

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[54] *See* Applegate, *supra* note 18.
[55] OTA, *supra* note 26, at 5.

and costs on future generations, whether through the formal use of discounting procedures or the all too human temptation to put off today what others can do tomorrow. Professor Brown Weiss has written compellingly of "fairness to future generations."[56] She begins with the equality of generations, such that no generation (present or future) suffers undue hardship on account of others, and no generation is expected to predict the goals and values of others. These lead her to substantive principles of conservation of options, conservation of quality, and conservation of access to resources.[57] The fundamental choices are therefore normative—who is at risk and how much, who pays and how much. They can and should be informed by available information, but information and analytical tools will not make decisions for us. Professors Farber and Hemmersbaugh add the important observation that consideration of effects on future generations is essential to the long-term sustainability of current decisions.[58]

Breaking the Logjam. Breaking the logjam will require statutory frameworks that permit the trade-off of present and future to be frankly considered and resolved, as well as institutions that are capable of addressing long-term consequences. Of the relevant statutes, CERCLA does the best job of expressly identifying the relevant criteria and giving an indication of their relative priority.[59] RCRA and the Nuclear Regulatory Commission regulations under the Atomic Energy Act make many of these choices through treatment requirements and disposal standards, but they, too, leave some room for consideration both in the setting of general standards and in their application to individual disposal decisions. The logjam, instead, is with regulatory decision making processes. Reasonably available information concerning long-term consequences must be gathered and disclosed, affected

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[56] EDITH BROWN WEISS, IN FAIRNESS TO FUTURE GENERATIONS: INTERNATIONAL LAW, COMMON PATRIMONY, AND INTERGENERATIONAL EQUITY (1989).

[57] *Id.*; *see also* NATIONAL ACADEMY OF PUBLIC ADMINISTRATION, DECIDING FOR THE FUTURE: BALANCING RISKS, COSTS, AND BENEFITS FAIRLY ACROSS GENERATIONS 9–13 (1997) (setting out similar principles for intergenerational decision making).

[58] *See* Daniel A. Farber & Paul A. Hemmersbaugh, *The Shadow of the Future: Discount Rates, Later Generations, and the Environment*, 46 VAND. L. REV. 267, 293 (1993).

[59] 42 U.S.C. § 9621(b), (d) (2000).

stakeholders must be involved in a meaningful way, and they and the decision makers must expressly address the trade-offs between present and future in reaching a final decision.[60] A good model is the "analytic-deliberative process" advocated by the National Academy of Sciences for risk-based decisions.[61] Scientific analysis (and, in the case of future effects, predictions) are developed in consultation with stakeholders and form the basis for both public participation and administrative decisions. A robust up-front deliberative process provides the basis for legally and politically sustainable trade-off decisions.

In addition, without institutions to address the long-term environmental consequences, it is unrealistic to expect that legislatures, agencies, or the general public will ever be comfortable with accepting long-term management for lower present costs—nor would that be a responsible course of action. An effective long-term stewardship program should demonstrate transparency concerning long- and short-term risks while practicing life-cycle accounting, documentation, identification of stewards, enforceability, redundancy, public involvement, sustainability, and flexibility and responsiveness to future conditions.[62] Institutions for managing long-term stewardship programs will need to identify hazardous and nuclear waste disposal sites that have potential long-term effects on the environment (that is, nearly all of them), keep track of their condition and legal status, and possess the capacity to remedy (or cause others to do so) leaks, intrusions, or other environmental effects.[63]

Few, if any, extant institutions have such capacities which can also be counted upon to last for decades or centuries into the future. At a minimum, such institutions would require a very clear sense of a long-term protective mission (like the National Park

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[60] Applegate & Dycus, *supra* note 6, at 10650–51.

[61] COMM'N ON RISK CHARACTERIZATION, NAT'L RESEARCH COUNCIL, UNDERSTANDING RISK: INFORMING DECISIONS IN A DEMOCRATIC SOCIETY 3, 6 (Paul C. Stern & Harvey V. Fineberg eds., 1996); *see* COMM. ON RISK-BASED APPROACHES FOR DISPOSITION OF TRANSURANIC AND HIGH-LEVEL RADIOACTIVE WASTE, NAT'L RESEARCH COUNCIL, RISK AND DECISIONS ABOUT DISPOSITION OF TRANSURANIC AND HIGH-LEVEL RADIOACTIVE WASTE 7 (National Academies Press 2005).

[62] Applegate & Dycus, *supra* note 7, at 10644–45.

[63] *Id.* at 10651–52.

Service, perhaps), which would provide the necessary incentive to continue stewardship activities for the long term. A clear mission might also permit such an institution plausibly to represent (loosely defined) future generations in present deliberations. Stable long-term funding, too, would be a necessity, and perhaps the waste tax suggested above could be used to create a fund for this purpose.

C. *Scaling Regulatory Authority to the Problem*

Professor Adler makes the case that the environmental effects of hazardous waste are almost entirely local.[64] Whatever our worries are about leaking waste sites and spreading contamination, the direct impact of the problem is generally quite limited in geographic terms. Adler concludes from this that decisions about the disposal of hazardous waste are essentially local land use decisions—whether to place waste in a particular location, the level of risk to which the nearby population should be exposed, the design and waste acceptance criteria for the facility, and so on.

There are several ways in which the management of hazardous waste is not simply a local problem, however. Waste is, as Professor Adler recognizes, itself an item of interstate—and, indeed, international—commerce, and he makes a special point of ensuring that interstate commerce in hazardous waste be protected against legal (the dormant Commerce Clause) and political (NIMBY) restraints. The irresponsible shipment of hazardous wastes to economically depressed parts of the United States or to developing countries that have little or no capacity for minimally appropriate management is therefore not a local problem at all, but a global problem that needs to be addressed at the national and supranational level. More closely related to the temporal issues that are our focus, efforts at waste minimization through product choice and design change will be undermined, at least to some degree, by the existence of localities which, for whatever reason, welcome substantial amounts of hazardous waste disposal. Nuclear waste policy, too, is national and international, inasmuch as efforts to encourage or discourage the use of nuclear power—to say nothing of nuclear weapons—are distinctly matters of national and international policy. Moreover, it is a cornerstone of U.S. nuclear

64 *See* Adler, *supra* note 2.

waste policy that widely distributed spent fuel is to be gathered into one or two national repositories for disposal.

A more difficult problem of scale involves the intersection of the geographic limitations of the effects of hazardous waste and their temporal extensiveness. While the geographic effects of contamination may never extend beyond the residents of River City, all of the residents of River City will change across generations. Over the millennia that hazardous and nuclear wastes remain hazardous, the social and political organization of that place will change drastically. Decisions about the location and isolation measures made by River City today are surely more remote from the people of River City in 3000 or 4000 or 10,000 C.E. than decisions made in Washington, D.C. today—and yet decisions to accept certain kinds of waste, to place them in certain locations, and to isolate them to a certain degree will directly affect those future generations. One cannot, of course, simply equate temporal and geographic distance. Nevertheless, the temporal dimension of these wastes at least suggests that a larger polity is affected by waste decisions.[65] While it is by no means obvious that the larger polity is best represented by the federal, as opposed to (say) the relevant state government, there might be some advantage in making such decisions at some remove from the most immediate local concerns.

Breaking the Logjam. As with trade-offs, the appropriate way to address the time scale of hazardous and nuclear waste management is through implementation of the principles of transparency and deliberation that the National Academy of Sciences has recommended in connection with risk regulation. In the long run, candid and complete disclosure of the known facts and uncertainties, and candid and complete acknowledgement of the relevant policy choices, will permit the kind of open deliberation that yields robust and lasting decisions. It is optimistic, but surely not utopian, to suggest that a decision making process that embodies these qualities would enjoy the kind of judicial and political deference to administrative judgment that currently eludes such judgments. A bureaucratic culture of suppressing scientific information or of dressing policy choices in

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[65] *See* Sinden, *supra* note 49, at 588–94 (describing the ways in which local land-use decisions can have wide-ranging impacts).

scientific clothing breeds the kind of distrust that causes courts, legislatures, and the general public to resist unwanted regulatory decisions to the last, and to insist on legislative directives ("substantial evidence") and judicial doctrines ("hard look") that contribute directly to the logjam. Thus, while there is much to be said for placing the essentially local aspects of hazardous waste management at the center of deliberations, the failure to acknowledge and analyze wider temporal implications—in particular, by the aggressive use of legal doctrines like the dormant Commerce Clause to foreclose legal and political objections—will only push the logjam a little farther downstream.

D. *Institutional Learning and the Conservation of Options*

The temporal dimension of hazardous and nuclear waste also suggests the utility of a new Breaking the Logjam principle. In any long-term effort, one must expect that over time we will come to understand the underlying problem better and will develop better ideas and capacities for addressing it. These improvements can only be implemented if the regulatory system is capable of learning *and* if present decisions leave options open for the future.

Humility is the first reason to permit learning and retain options. Our ability to predict the future of physical locations or human technology is extraordinarily limited. It is hard to imagine how the human events and technologies of the Twentieth Century could have been predicted with any certainty in the Nineteenth. Indeed, it is the occasional good guess (H.G. Wells comes to mind) that stands out for its rarity. Without indulging in dystopic fantasies (*Road Warrior* scenarios in which legacy hazardous waste will be the *least* of humankind's problems), it is fair to ask whether we will be able successfully to transfer knowledge of the location and dangers of hazardous waste to the future. Likewise, while technological optimism seems amply justified in general terms (the Twentieth Century being the outstanding example), it is a different matter to count on particular solutions to particular problems as the way to preserve options or ensure safety.[66]

In addition to having humility about our ability to predict the future, we must respect the future and its inhabitants. As Professor

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[66] *See* James E. Krier & Clayton P. Gillette, *The Un-easy Case for Technological Optimism*, 84 MICH. L. REV. 405 (1985).

Brown Weiss observes, we cannot predict the values of future generations any more than we can predict their technology or situation, and so we should seek to conserve options for future generations to choose from. Irreversible decisions are unavoidable, of course, and sometimes irretrievable solutions are the most appropriate ones. Deep geological disposal of nuclear waste, for example, is intended to be irretrievable and may well be the most responsible way to address this most difficult of problems. On the other hand, advocates of monitored retrievable storage argue that there are greater advantages to being able to revisit disposal choices and technologies in the future. Brown Weiss's approach counsels caution (not inaction) in making irretrievable commitments.

Conserving options into the future is of little use if regulatory systems are incapable of responding to changed conditions. Under the rubric of "reflexive environmental law,"[67] and "adaptive management,"[68] scholars have advocated legal regimes that adjust to new conditions. Professor Driesen proposes a similar approach, which he calls "economic dynamics."[69] Accepting that our understanding of consequences in the present is constrained, which sharply limits our ability to develop an adequate long-term analysis of, say, costs and benefits, economic dynamics counsels regulatory designs that adjust to change and encourage innovation—"learning while doing," in Doremus's phrase.

Breaking the Logjam. Responses to hazardous and nuclear waste—and to any long-term environmental problem—must be adaptable wherever possible, so that we can take maximum advantage of what we *do* know now and be minimally dependent on our knowledge of the future. This calls for institutional structures that adjust and learn from experience, and for substantive decisions that conserve options to permit learning. In the depths of the Great Depression, President Franklin Roosevelt

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[67] *See generally* Eric W. Orts, *Reflexive Environmental Law*, 89 NW. U.L. REV. 1227 (1995).

[68] *See* Holly Doremus, *Precaution, Science, and Learning While Doing in Natural Resource Management*, 82 WASH. L. REV. 547, 550–57 (2007) (describing adaptive management).

[69] David M. Driesen, *The Economic Dynamics of Environmental Law: Cost-Benefit Analysis, Emissions Trading, and Priority-Setting*, 31 B.C. ENVTL AFF. L. REV. 501 (2003).

famously urged governmental experimentation: "It is common sense to take a method and try it. If it fails, admit it frankly and try another."[70] Informal rulemaking, with its basic notice-and-comment procedures,[71] may be said to embody this approach. It allows agencies the widest possible range of inputs, the greatest flexibility in considering them, and the speediest path to the implementation of agency conclusions. It also allows agencies to experiment, to change course, to admit failure and try something else—above all, to learn from experience.

This administrative process, while nominally the basis for most hazardous waste regulation, has "ossified"[72] over time as the result of formal legislative mandate (so-called hybrid rulemaking), aggressive judicial review (the "hard look" approach[73]), executive analytical requirements (for example, Office of Management and Budget review), and changing agency culture. Some procedural complexity is inevitable to achieving a well-informed, participatory system of administration, but the clear objective should be full and public consideration based on available information, followed by a prompt agency decision and deferential judicial review. As with consideration of trade-offs, confidence in agency decisions reached in a simple and (relatively) speedy process would be justified by a strong initial process of agency deliberation; by the ready ability of the agency, using informal rulemaking as originally conceived, to rectify errors and adapt to new information or circumstances; and by a firm practice or legal requirement that agencies regularly review their decisions in terms of their stated goals.[74]

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[70] "The country needs and, unless I mistake its temper, the country demands bold, persistent experimentation. It is common sense to take a method and try it. If it fails, admit it frankly and try another. But above all, try something. The millions who are in want will not stand idly by silently forever while the things to satisfy their needs are within easy reach." President Franklin Roosevelt, Commencement Address at Oglethorpe University (May 23, 1932), *available at* http://www.bartleby.com/66/19/47019.html.

[71] 5 U.S.C. § 553 (2000).

[72] *See* Thomas O. McGarity, *Some Thoughts on "Deossifying" the Rulemaking Process*, 41 DUKE L.J. 1385, 1385–86 (1992) (quoting former EPA General Counsel E. Donald Elliott).

[73] Changing course, for instance, can be considered a warning sign of agency irrationality. *See* Greater Boston Television Corp. v. FTC, 444 F.2d 841, 851 (D.C. Cir. 1970).

[74] A review requirement is capable of abuse, of course, and so it must be

In sum, a long-term approach must assume that conditions will change and understanding improve; therefore, it must also provide for an agency to return to a decision multiple times and to respond nimbly to the changed circumstances.

CONCLUSION

It is refreshing to have a discussion of environmental regulation, such as the one that Professors Stewart, Schoenbrod, and Wyman have initiated, that is couched in terms of principles—not of absolute principles of right and wrong, but of principles that, as Professor Dworkin put it, "state[] a reason that argues in one direction, but [do] not necessitate a particular decision."[75] Principles of this kind properly reflect the complexity and contingency of environmental decision making and the multiple goals that it seeks to serve. Principles remind us that simple formulas cannot provide real answers. The temporal dimension of hazardous and nuclear waste illustrates the power of principles. The Breaking the Logjam principles unquestionably have application to these wastes and point us in useful directions, but the underlying facts and the overarching goals are too complicated for formulaic application. A principle, moreover, "is flexible, interrelates with other principles, does not dictate a particular outcome, and can be subject to different interpretations."[76] The Breaking the Logjam principles do not provide *a priori* answers for every case, but instead they form the basis for a rich and deliberative analysis of what we know and do not know about a particular situation, and what we want to achieve and want to avoid.

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backed by adequate agency resources to undertake such reviews without compromising its on-going responsibilities, and it should not routinely be linked to so-called sunset provisions that terminate approaches without regard to their effectiveness.

[75] Ronald Dworkin, *The Model of Rules*, 35 U. CHI. L. REV. 14, 26 (1967).

[76] Elizabeth Fisher, *Precaution, Law and Principles of Good Administration*, 52(6) WATER SCI. & TECH. 19, 19 (2005) (discussing the precautionary principle); *see also* Elizabeth Fisher, *Precaution, Precaution Everywhere: Developing a 'Common Understanding' of the Precautionary Principle in the European Community*, 9 MAASTRICHT J. EUROPEAN & COMP. L. 9 (2002).