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Environmental Risk

Collecting soil samples to measure possible dioxin contamination. Even though EPA is reassessing its original dioxin cancer risk estimates, dioxin is still considered to be a highly toxic cancer-linked compound. A modern, affluent society offers many benefits, but also presents risks.

Environmental Risk

How is it possible to make decisions dealing with environmental risks from pesticides to air pollution in a complex society with competing interests and viewpoints, limited financial resources, and a lay public that is deeply concerned about the risks of cancer and other illness? EPA advocates risk assessment and risk management as a decision-making approach that can avoid stalemate and enable the society to work out its environmental problems rationally and with good results. This issue of *EPA Journal* explores the theory and practice of risk assessment/risk management, attempts to put this problem-solving approach in the context of today's environmental challenges, and includes comments from industry and environmentalist viewpoints on the viability of the approach.

This issue begins with an interview with Lee M. Thomas, EPA's Administrator, providing an overall perspective and answering questions about the risk assessment/risk management approach. Then two articles describe some of the challenges to environmental decision-making today, including a national tradition of focusing narrowly on separate environmental problems, the danger of stalemate on crucial environmental issues, and a divergence of public and scientific views on what are the most risky environmental problems.

Then several articles explain the risk assessment/risk management decision-making approach. They deal with its relevance to today's environmental needs; how it works, generally and in specific situations; and how it can be improved. Included are pieces specifically on risk assessment; risk management, with EPA action on the pesticide dinoseb as an example; and on risk communication, a term widely used to refer to public discussion about environmental risks.

Risk communication articles include an explanation of why this tool is important; a piece describing how it works; and two "case" stories. One of these describes how EPA is gearing up to help the public deal with an influx of information about chemicals and their environmental impacts under Right-to-Know provisions in recent law; the other is on efforts to help people make wise decisions of their own about the risk that radon may pose in some homes.

Then two articles feature the risk assessment/risk management approach on the firing line—one report is on the experience of using it in an EPA regional office, and the other article is on applying it to help deal with the environmental impact of high-tech industry in California's Santa Clara Valley.

The next section includes articles by two outside observers expressing their views about EPA's risk assessment/risk management approach. One is by a scientist from an environmental group; the other is by a representative from an industrial group.

This issue's coverage of environmental risks concludes with an *EPA Journal* Forum. In this feature, five journalists and three journalism professors were asked whether they believe recent media coverage of environmental issues such as the pesticide EDB and the chemical dioxin has served to inform or inflame the public.

Two articles outside this *Journal* theme on risk include a feature on the environmental potential of the Lower Hudson River, despite the fact that it flows through a big city, and a piece on the effort to protect Cape Cod's ground water.

The issue concludes with two regular features—Update and Appointments. □

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EPA is charged by Congress to protect the nation's land, air, and water systems. Under a mandate of national environmental laws, the agency strives to formulate and implement actions which lead to a compatible balance between human activities and the ability of natural systems to support and nurture life.

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Front Cover: Risk. How serious are the problems in our water, air, and land? What should we do about them? How should the society discuss and debate these issues? Risk assessment, risk management, and risk communication are being utilized by EPA as it attempts to find solutions to such problems.

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Environmental Decision-Making Today

An Interview with Lee M. Thomas

Steve Wurtz

A public meeting, a frequent occurrence as EPA explains environmental problems and policies and hears questions and views from the grass roots.

For a perspective on environmental risks as they are being addressed by EPA, the Journal interviewed Lee M. Thomas, the Administrator of the Agency. The text of the interview follows:

Q Why are risk assessment and risk management important to EPA and the nation's environmental protection efforts?

A Risk assessment and risk management give us a framework for setting regulatory priorities and for making decisions that cut across different environmental program areas. This kind of framework has become increasingly important to EPA in recent years for several reasons, one of which is the considerable progress we have made in pollution control in this country. Fifteen years ago, it wasn't hard to figure out where our first priorities should be. The worst pollution problems were all too obvious. Now that we are moving toward final control stages in a number of program areas, the real priority problems and their solutions are not so obvious.

As a practical matter, we often come down to the question whether the final increment of a control program is cost-effective, given the resources available, or whether those same resources would be better spent on other, more pressing environmental problems. For example, we know that the last five percent of pollution control is usually the most difficult and the most costly on a percentage basis. Is it worth it? Risk assessment and risk management help us answer such pragmatic questions—and also enable us to evaluate our regulatory efforts to ensure that we are making the environment safer, not just moving pollution from one place to another.

Q What progress has EPA made over the last several years in actually implementing risk assessment and risk management approaches?

A There's been a tremendous amount of progress in the five years I've been associated with EPA. Risk assessment and risk management are becoming institutionalized at EPA, and we're making increased use of them nationally and at the regional level to work through environmental and health issues. For example, here at headquarters, the Agency's Risk Assessment Council is doing important work on science policy issues that require coordination across programs within EPA, and may involve other regulatory agencies as well. The Council works in close concert with the Risk Assessment Forum, which reviews specific scientific and technical issues and refers broad science policy questions for the Council's consideration.

There is still much to be done—in terms of incorporating risk assessment and risk management concepts into all our programs, as well as refining the

risk assessment process and its underlying assumptions. But overall we have made great strides in the last five years.

Q In a study completed earlier this year, EPA used risk assessment to rank environmental problems ranging from underground storage tanks to indoor air pollution to global warming. The Agency's own report from this study, entitled *Unfinished Business*, points out that the environmental issues of greatest concern in public opinion polls do not correlate well with EPA's findings on relative risks. Why this discrepancy?

A I think EPA needs to do a better job of getting across to the public what we know about the risks associated with particular environmental problems, and how these risks compare from one source to another. The comparative risk report, *Unfinished Business*, is a step in that direction.

We initiated the comparative risk project to gain a systematic overview on our environmental objectives—where we can go from here. In the process, it became apparent that our findings were at variance with public perception. It is also apparent that the public places great weight on certain qualitative aspects of risk, such as the degree to which risk may be voluntary, familiar, or equitable, that were not included in the Agency's comparative assessment. We need to keep such qualitative factors in mind as we shape our programs.

Q How extensively do you see comparative risk being used for broad management decisions such as setting budget priorities?

A I feel certain that comparative risk assessment will play an increasingly integral role in major policy-setting decisions including budget priorities. However, it cannot be the sole factor considered in such decisions. With budget priorities, for example, there are other considerations including specific mandates established by law. Clearly, our budget priorities must enable us to meet our statutory mandates, and it is also necessary to consider such factors as costs and available technology. Nevertheless, in this context, I do see comparative risk becoming more important in the future for EPA and other regulatory agencies.

Q The basis for risk management decisions is defined differently in the various statutes that EPA administers. Is it possible to have a uniform environmental protection policy when such differences exist?

A First of all, I believe it is possible to have a uniform policy as far as risk assessment is concerned. You asked about risk management. Clearly there are differences among our statutory mandates for making risk management decisions. Some call for cost-benefit analysis as a component of decision-making. Some specifically do not allow us to make cost analysis a part of the decision process.

I would like to see consistency in risk assessment fully institutionalized across all our programs. I also think we need to take a critical look at the consistency of our risk management decision processes in our different program areas to ensure that we are as consistent as possible under existing laws. Where we do not have sufficient statutory flexibility to achieve a workable consistency in risk management decisions, it will be our responsibility to work with Congress on possible legislative solutions.

Q What do you see as the strengths and disadvantages of the different statutes from a risk management standpoint?

A In my view, those statutes which allow us the flexibility to take into account a broad range of factors in making risk management decisions best enable us to manage environmental programs. I say this because there are a broad range of regulatory problems to be dealt with in this country, all of which have resource implications. I believe EPA should have the authority and flexibility to look across the spectrum of environmental problems and make decisions to ensure that we are getting the most environmental protection for the resources we spend.

Definitions

Environmental **risk assessment** may be broadly defined as a scientific enterprise in which facts and assumptions are used to estimate the potential for adverse effects on human health or the environment that may result from exposures to specific pollutants or other toxic agents.

Risk management, as the term is used by EPA and other regulatory agencies, refers to a decision-making process which involves such considerations as risk assessment, technological feasibility, economic information about costs and benefits, statutory requirements, public concerns, and other factors.

Risk communication is the exchange of information about risk.

Q **Doesn't the trend seem to be going in the opposite direction, with legislation becoming more prescriptive?**

A In some respects, the recent legislation has become more prescriptive, but not necessarily with respect to the risk management decision process. Consider the new Superfund law, for example, which was passed in the wake of extensive debate on cleanup standards and schedules. Congress ultimately gave us a good deal of flexibility so that we can take a broad range of factors into account in establishing cleanup standards under the new Superfund. On the other hand, Congress has recently given us some very prescriptive time frames for taking specific actions, and unfortunately this does take away the flexibility to look across comparative risk scenarios and say, let's work first on controlling those that present the greatest risk.

Q **When you look at risk, how do you decide how safe is safe, or how clean is clean?**

A To begin with, you have to look at both sides of the risk equation—both the toxicity of a pollutant and the extent of public exposure. You need to look at both current and potential exposure, considering all possible exposure pathways. In addition to human health risks, you need to look at potential ecological or other environmental effects. You conduct the most comprehensive risk assessment you can, but there are always uncertainties, and you must make assumptions.

From a risk management standpoint, whether you are dealing with a site-specific situation or a national standard, the deciding question is ultimately: What degree of risk is acceptable? In general, we are not talking about a "zero risk" standard, but rather a concept of negligible risk: At what point is there really no significant health or environmental risk; at what point is there an adequate safety margin to protect public health and the environment. In addition, some of our environmental statutes require us to consider benefits together with risks in making risk management decisions.

Q **Large segments of the public and Congress seem to view environmental protection as essentially a moral issue with zero risk as a goal. How can risk management take this into account?**

A Well, in one respect, it is possible for EPA to promote the goal of zero risk by emphasizing preventive regulatory policies so that pollution does not occur in the first place. For example, we can strive to ensure that the pesticides we register under our pesticide program do not have the potential to leach to ground water.

On the other hand, I think your question raises a dilemma that we face in that it is simply not possible to develop "zero risk" environmental programs across the board. Certainly public health and environmental risks can be minimized, but I don't believe we can eliminate all such risks. Ours is not a risk-free society.

Q **Some people believe that risk management is really just a code word for cost-benefit analysis. They contend that because we know how to calculate costs better than we can project benefits, risk management is always going to be on the negative side of environmental protection.**

A Cost-benefit analysis is sometimes a component in making risk management decisions, but it is only one component. Frankly, I think it is a legitimate consideration, particularly when you are concerned about getting the most environmental protection you can from the resources you spend. But clearly, risk management goes far beyond cost-benefit analysis.

Q **The term "risk communication" has been bandied about quite a bit lately. What does it really mean, and what is EPA trying to accomplish with risk communication?**

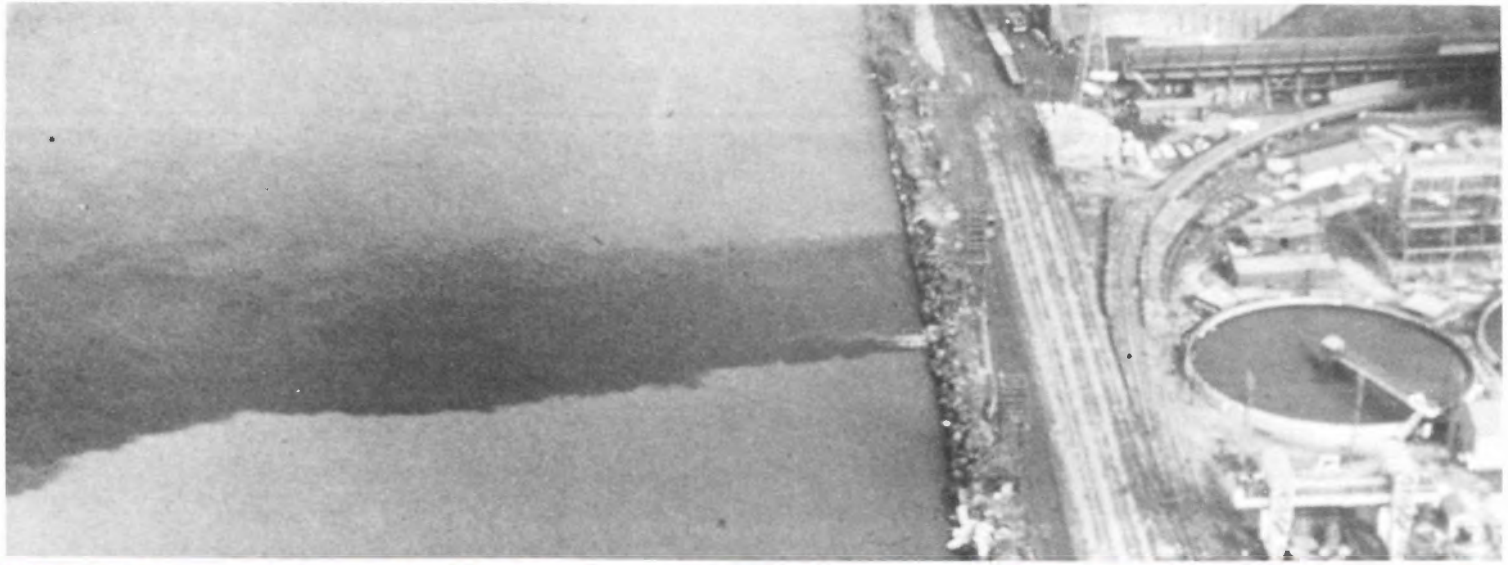
A Basically, risk communication means talking and listening to the public on three essential factors pertaining to risk. These are: (1) the environmental and health risks we are trying to deal with in a given situation, (2) the specific decision(s) we have made, or are considering making, in this situation, and (3) the reasons for our proposed or final course of action. I believe these factors are central to all our risk communications, whether they involve national policy-making or the specific risks at a particular Superfund site.

I see risk communication as an important part of EPA's responsibility. It is a tool for educating the public on the nature of the risks the Agency is trying to deal with, and how and why we make our risk management decisions. It is also a tool for us to get feedback from the public on issues that concern them. Beyond that, risk communication can also serve to educate the public as to what decisions they, as individuals, can make to help manage risks in their environment. The latter is an aspect of risk communication the Agency has begun to focus on just in the last couple of years.

Q **But there seems to be a suspicion in some sectors that EPA is trying to persuade the public to accept risks that they might not otherwise go along with.**

A I think this perception relates to the understandable reluctance of the public to accept any risk. This point strikes home to the most difficult challenge of risk communication. Our job is to explain what risks we are dealing with, in a context that is comprehensible to the public. But the nature of risk is often difficult for us to communicate, and difficult for the public to understand.

Putting risks in an understandable context is very important. The polls show that the vast majority of the public supports strong environmental protection. Yet in the same cities where we find strong support for the environment, frequently we also find strong opposition to air pollution control programs such as an inspection and maintenance program for automobiles. Why is that? I think one major reason is that people do not fully understand or appreciate the risks associated with air pollution in their city, and do not see the direct tradeoff between the inconvenience of complying with inspection/maintenance requirements and the quality of the air they breathe. Effective risk communication can give the public a perspective for understanding risks and also help people understand why the part they are being asked to play in risk management is important.



Water pollution, one of the risks that EPA has major responsibilities for regulating. Such visible environmental problems are becoming less frequent.

Q As you see it, what is the best medium for communicating risk?

A I think the best long-range strategy for risk communication is what I would call a grass-roots effort, carried out on all levels—federal, state, and local. Risk communication needs to be an ongoing effort, so that you keep people informed at the various stages of a decision-making process, whether you are dealing with air pollution in a city, water pollution in a community, a Superfund site cleanup, or any other environmental issue. It is important to build understanding "from the bottom up."

Generally, the public gets most of its information on environmental issues through the mass media—newspapers, radio, television. For this reason, working with media representatives to ensure that they understand the assumptions behind risk assessments and the rationale for risk management decisions is an extremely important part of EPA's responsibility. Obviously, news coverage of environmental issues has a big impact on public perception. I have seen articles that have not reported risk well at all. On the other hand, I see a lot of reports that I think are well done—articles that do in fact explain assumptions and place particular risks in proper perspective. On the whole, I think that if reporters are given all the facts and the rationale for a risk management decision, the majority do a pretty good job in their coverage.

Q One more risk communication question: what sort of lessons did we learn from the Chernobyl incident about risk communication?

A One major lesson we learned has to do with being able to put risks in context, and that is the importance of collecting as much basic information about a given risk as possible over a substantial period of time. Fortunately, in this instance, we had been collecting information on radiation risk for years in this country. We had a good base line of data, so that we were able to explain to the public what the normal readings were for water and milk, for example. Then when we did see increases in radiation levels, we were able to compare these increases with levels that we would consider to present any significant risk. We would have been in still a better position if we had communicated basic radiation information to the public beforehand.

Another lesson we learned from Chernobyl is the imperative of responding quickly and openly to public concerns about an emergency situation.

Q Are you optimistic that the risk approach has enough momentum to go on through the next administration?

A I don't think there is any question about that. We have to set drinking water standards, air standards, and many other standards, and our ability to do that is based on our assessments of risks. Our job is to protect public health and the environment, and that puts us in the business of making risk management decisions. We have to be able to characterize the environmental problems that confront us, whether you call it risk assessment or something else.

Q Is EPA unique in its use of risk assessment and risk management?

A Not at all. Essentially the same concepts are being applied by other regulatory agencies including the Food and Drug Administration, the Consumer Product Safety Commission, the Nuclear Regulatory Commission, and the Department of Labor's Occupational Safety and Health Administration, among others. I personally used risk assessment and risk management approaches and methodologies during my tenure at the Federal Emergency Management Agency. The technical aspects were somewhat different from the ones EPA is using, but the concepts of assessing and managing risk were similar. Risk criteria are also being used increasingly at state and local levels, and in the international arena as well.

Q What are some examples of how risk assessment and management approaches are being used internationally?

A One of the best examples of risk assessment and risk management at the international level is the work we have done with other countries on stratospheric ozone depletion. Scientists from EPA and around the world collaborated in an effort to reach a consensus on the risks of depletion of the stratospheric ozone layer, and the potential effects of that depletion. And we were able to reach a broad consensus of the international scientific community. Based on that consensus, we were then able to frame policy decisions for risk management on an international scale. I think this accomplishment has established a clear precedent for dealing with international environmental issues in the future. □

Richard Frear, National Park Service

The Situation: Institutional Problems

by Terry Davies

The United States is not well prepared to deal with the current environmental agenda, much less with the agenda of the future. There has been progress on some problems and in some geographical areas, but currently, stalemate and inaction characterize much of the environmental policy scene.

What we need is a better way of understanding these problems, which involves risk assessment; a better understanding of the process of doing something about these problems, which includes risk management; and a better way to carry on the public debate regarding these problems, which involves risk communication.

Consider the environmental problems that are now on the agenda. Even a brief list is sufficient to show how much remains to be done: acid rain, pesticides in food and water, too much ozone at ground level and too little in the

Isle Royale National Park in Lake Superior. Now that extensive water pollution controls are in place for the Great Lakes, it has been learned that pollutants are also being deposited in the lakes from the air. It is an example of the complex problems now facing the nation's environmental cleanup drive.

stratosphere, global temperature warming, draining of wetlands, slow implementation of the Superfund program, extinction of species, toxic substances in all parts of the environment. But to really understand what's broken, it is necessary to penetrate behind the myriad of specific problems and examine what's wrong with the institutions and processes the nation relies on for environmental protection.

Environmental policies are formulated and implemented in the context of pervasive mistrust, alienation, and conflict. The problems of risk communication described elsewhere in this issue have their roots in the alienation of the American people from their government, and from other basic institutions in society.

After 25 years of being told, and too often shown, that government is part of the problem, not part of the solution, the American people have, not surprisingly, come to believe it. The belief not only poisons communication, it also creates a vicious cycle: the individuals and institutions of government are held in low esteem; government therefore has trouble attracting qualified people and is increasingly handicapped in implementing programs, which results in less effective and efficient government. This in turn lowers the public's respect for government still more. Obviously, this problem affects all public policies, not just environmental policies, but until the advance of alienation is reversed, we will not be successful in protecting the quality of the environment.

The gap in understanding and communication between the public and the pollution control agencies has deep roots, which now include the very conception of pollution itself. As Peter Sandman has noted, "Over the past several decades our society has reached near-consensus that pollution is morally wrong—not just harmful or dangerous, not just worth preventing where practical, but *wrong*." This view is not shared by many in pollution control agencies who must operate with limited resources and who witness segments of the public becoming agitated over environmental problems which in the view of the agency experts do not pose serious dangers.

Congress is responsive to the public's view that pollution is inherently evil. The widening gap in understanding between Congress and the Executive agencies is aggravated and reinforced by other factors. Congress expresses its power through legislation, but most members have no experience in the problems of actually implementing laws. Agency staff, on the other hand, spend their entire working days wrestling with implementation problems, but have little experience with balancing the types of political pressures which make or break a member of Congress.

The result is two very different pictures of what needs to be done to protect the environment and increasing difficulty in communications between the two branches of government. Congress, not understanding implementation, thinks that agencies such as EPA are delaying taking action for lack of commitment to the law. Agency personnel, not appreciating political pressures, think that Congress is putting unrealistic and unworkable provisions into law simply to win the next election, not with any expectation that the provisions will help the environment.

After 25 years of being told, and too often shown, that government is part of the problem, the American people have, not surprisingly, come to believe it.

As with our views of government competence, the result of the Congress-Executive split is a vicious cycle. The laws are made increasingly detailed and specific because Congress believes the agencies won't take action unless the laws are written this way. Because the details and specifics do not reflect a realistic understanding of implementation requirements, each new law seems more poorly implemented than the last, feeding the mistrust of Congress and resulting in still more unrealistic laws.

The fragmented committee structure within Congress and the fragmented bureaucratic structure in the executive branch also hamper environmental protection. The narrow focus of environmental programs is now a major impediment to dealing with environmental problems. Each of the dozens of programs—underground storage tanks, old hazardous waste sites, new hazardous waste sites, indoor air pollution, outdoor air pollution, occupational air pollution, etc., etc.—concentrates only on its narrowly defined tasks, generally ignoring the often critical interrelationships among programs. Because these interrelationships are ignored, much of what passes for pollution control is, in reality, simply shifting the pollution somewhere else.

It is no accident that a large portion of the current environmental problems defies traditional categorization into air, water, or land pollution. Acid rain, global climate change, ground-water contamination, toxic substances, hazardous waste, and other problems do not fit into the traditional way pollution control programs have been organized. The creation of new single-focus programs only exacerbates the fragmentation and the failure to recognize the key importance of ecological interrelationships.

The Office of Policy Analysis and some other parts of EPA have tried to overcome the self-defeating maze that now exists. Utilizing the common metric of risk is an important step forward in overcoming the current fragmented approach. The EPA staff report on *Unfinished Business*, released earlier this year, found serious mismatches between Agency priorities and the degree of risk to the environment and human health. But analytical approaches by themselves will not bring about more integration. Fundamental changes in concepts, in laws, and in the organization of both the legislative and executive branches will be required to deal adequately with current and future environmental problems. These changes will not be easy to effect, but they are absolutely essential.

Increasing numbers of environmental problems require international cooperation for their solution. Some of these problems, like stratospheric ozone depletion and climate warming, are obviously global in scope. Some, such as pesticides and acid rain, arise because we are discovering that substances can be carried much longer distances than previously thought. And, not least, the growing extent of international trade and the spread of

sophisticated technology turn what were once local or national problems into international ones.

It is much more difficult to deal with international problems than with national ones. Unfortunately, the weakness of international institutions to protect the environment and the jealous defense of national sovereignty mean that even if nations can agree on cooperative measures, it will be very difficult to implement such measures.

The worst environmental conditions are to be found in the developing countries. The United States and other developed nations cannot ignore these conditions, for national security and humanitarian reasons. A degraded environment in any one country can pose a threat to the environment of other countries. Misuse of pesticides in Central America can result in contaminated food on American tables. Loss of tropical forests can deprive the world of potentially valuable species.

Increased knowledge about the long-range transport of pollution also poses problems among the 50 states. The basic U.S. pollution control laws rely on the states for their implementation, and they are premised on the damage caused by pollution being felt mostly by the state in which the pollution arises. Acid rain clearly violates this premise, which is one reason that it has been so difficult to reach agreement on control measures. But acid rain is not unique. More likely it is the prototype of the environmental problems of the future. The disparity between the scope of environmental problems and the jurisdiction of the governments that must deal with the problems will become an increasingly acute weakness in our attempts to improve environmental quality.

The federal government has increasingly turned over to the states responsibility for dealing with environmental problems. In recent years we have been in one of our periodic pendulum swings toward greater decentralization and state power. That the pendulum will swing the other way can be predicted with near certainty. But the scarcity of money, which has driven much of the current swing to the states, will not be so easily reversed. The federal budget has been "busted" by the past six years of huge increases in government expenditures combined with the failure to raise taxes to pay for the increases. Dealing with environmental problems takes money, and if the economic system is broke, then the environmental control system will likely be broken.

All of the weaknesses described above are affected and made worse by an underlying problem—the lack of scientific knowledge about the causes and effects of environmental degradation. Scientific knowledge does not determine environmental policy decisions—economic and political factors are likely to be equally or more important. But the political and economic factors themselves derive from an understanding of the nature of the problem, an understanding that is, or at least should be, based on science. It is hard to exaggerate the extent of our ignorance about environmental problems, and current research efforts are woefully inadequate.

This article has dwelt on "what's wrong." There are also aspects of current environmental efforts that work, but description of these was not part of the author's assignment. Unfortunately, those aspects of our efforts that are wrong are quite fundamental, and until they are fixed we cannot expect to be successful in protecting environmental quality. □

(Dr. Davies is Executive Vice President of The Conservation Foundation.)

The U.S. Congress. This body and EPA each play key roles in determining how environmental risks are addressed.

The Situation:
What The Public Believes; How The Experts See It

by Frederick W. Allen

Kenneth Garrett, Woodfin Camp Inc.

Spraying pesticides on a crop. Consumer risks from pesticides were given a high ranking by EPA experts in the Agency's comparative risk report, but received a lesser ranking by the public in polls.

People often overestimate the frequency and seriousness of dramatic, sensational, dreaded, well-publicized causes of death and underestimate the risks from more familiar, accepted causes that claim lives one by one. Indeed, risk estimates by "experts" and lay people (or "the public") on many key environmental problems differ significantly.

This problem and the reasons for it are extremely important, because in our society the public generally does not trust experts to make important risk decisions alone. As former EPA Administrator William D. Ruckelshaus has said, "We have decided, in an unprecedented way, that the decision-making responsibility involving risk issues must be shared with the American people, and we are very unlikely to back away from that decision. "The policy questions at stake are critical, affecting not only public and ecological health and welfare, but also massive amounts of public and private resources."

This situation was illustrated by a recent EPA study. In February 1987, EPA released a report entitled *Unfinished Business: A Comparative Assessment of Environmental Problems.* (See *EPA Journal*, May 1987.) EPA Administrator Lee M. Thomas had commissioned this study nearly a year earlier to "compare the risks currently associated with major environmental problems, given existing levels of control." Thomas' explicit premise was that "in a world of limited resources, it may be wise to give priority attention to those pollutants and problems that pose the greatest risks to our society."

To assess and compare these problems, EPA created a special task force of about 75 career managers and experts from all Agency programs. The task force compared four different types of risks existing now for each of 31 environmental problem areas: cancer risk, non-cancer health risks, ecological effects, and welfare effects (e.g., materials damage). While the task force did not try to "weight" or "add" the different types of risks for problem areas, they did develop rough rankings of problems within risk types. (See box on page 11.)

People often overestimate the frequency and seriousness of dramatic, sensational, dreaded, well-publicized causes of death and underestimate the risk from more familiar, accepted causes.

Beyond these rankings, the task force made no assertions about what EPA's priorities ought to be, noting that policymakers must consider many other factors besides risk when they set priorities, such as legislation, economics, technology, and public mandate.

The examination of public mandate raised some interesting issues. A rough analysis of recent public polling data by the Roper Organization on environmental problems made it clear that EPA's actual priorities and legislative authorities correspond more closely with public opinion than they do with the EPA task force's estimates of the relative risk. (See Box.) The most significant differences concern hazardous waste and chemical plant accidents (high public concern, medium/low risk ranking by the task force) and pesticides, indoor air pollution, consumer product exposure, worker exposure to chemicals, and global warming (medium/low public concern, relatively high risk ranking by the task force).

Why The Differences?

The most obvious reason for the differences is that the general public simply does not have all the information that was available to the task force experts. The subject is vast and it is hard for anyone to have full knowledge of the information. Indeed, the experts themselves had to go to considerable effort to develop their rankings, and all of them were surprised by at least some of the findings.

Beyond this fact, it is interesting to observe that the judgments expressed in the polling data are consistent with an important finding by various researchers: as mentioned at the beginning of this article, people often overestimate the frequency and seriousness of dramatic, sensational, dreaded, well-publicized causes of death and underestimate the risks from more familiar, accepted causes that claim lives one by one. The EPA report should help people gain a better knowledge of the information and help close the gap between the experts and the public.

It is also important to note that the experts and the public were answering somewhat different questions. The EPA task force purposely dealt with a limited number of dimensions of risks, ignoring most of the intangible aspects that are of great value to the public: the degree to which risks are familiar, generally accepted, voluntary, controllable by the individual, etc. These differences reflect a more general pattern of experts taking a societal (macro) perspective, while the lay public usually takes a more individual or personal (micro) perspective.

These factors provide important additional insights in explaining the differences between the task force's relative rankings and the public's. Hazardous waste disposal provides the most dramatic illustration. Recognizing the degree of public concern on this issue, the task force double-checked its rankings of active and inactive hazardous waste sites. The task force noted that in certain locations hazardous waste does pose a very serious risk, but relatively few people live near enough to be directly affected. Thus the total national impacts on public health and welfare and environment do not match the national concern. The intrusive, involuntary nature of the risk, the fact that slow-moving ground water can stay polluted for a very long time, the presence of any identifiable "scapegoat," and the difficulty many people have in seeing any overriding benefit to having a hazardous waste site nearby are also important factors.

Interestingly enough, the fact that hazardous waste is only a problem in some locations has not been lost on the public. While 76 percent of the people interviewed by Roper called chemical waste disposal a "most serious" environmental problem and the same percentage said there is not enough regulation of industrial toxic waste, only 36 percent were aware of toxic waste problems in their own communities and only 16 percent considered toxic wastes to be near enough to their homes to be a threat to their personal health.

In contrast, indoor air pollution, consumer product exposure, and, to some extent, pesticides problems and worker exposure to chemicals are risks to which nearly everyone is exposed. The task force ranked these risks relatively high, yet the public ranked them medium/low. These risks are not dramatic and come from familiar, diffuse, generally accepted sources; it is usually difficult, if not impossible, in these cases to finger a "scapegoat"; and the benefits from the substances causing each of these problems are clear.

Global warming was also ranked low by the public and relatively high by the task force. However, this appears to be a somewhat special case. The task force ranked it high because of the massive potential implications for the entire world. The most probable explanation of the low public ranking is threefold: (1) the consequences are very much in the future and hard for many to imagine because they extend beyond ordinary experience, (2) the problem is diffuse and there are many causes (the "scapegoat" problem), and (3) there is simply a general lack of public

The Valley of the Drums in Kentucky, one of the hazardous waste sites that gained early renown. Hazardous waste ranks high in public concern in polls. EPA experts agreed that it poses serious risks at various locations, but ranked it as a relatively medium to low risk to the population at large.

How EPA Experts Rank Environmental Risks—Highlights

Overall High/Medium Risk

- "Criteria" air pollution from mobile and stationary sources (includes acid precipitation)
- Stratospheric ozone depletion
- Pesticide residues in or on foods
- Runoff and air deposition of pesticides

High Health; Low Ecological and Welfare Risk

- Hazardous/toxic air pollutants
- Indoor radon
- Indoor air pollution other than radon
- Drinking water as it arrives at the tap
- Exposure to consumer products
- Worker exposures to chemicals

Low Health; High Ecological and Welfare Risk

- Global warming
- Point and nonpoint sources of surface water pollution
- Physical alteration of aquatic habitat (including estuaries and wetlands) and mining waste

Overall Medium/Low Risk (Ground-Water-Related Problems)

- Hazardous waste sites—active (RCRA)
- Hazardous waste sites—inactive (Superfund)
- Other municipal and industrial waste sites
- Underground storage tanks

Mixed and/or Medium/Low Risk

- Contaminated sludge
- Accidental releases of toxic chemicals
- Accidental oil spills
- Biotechnology (environmental releases of genetically altered materials)

Source: *Unfinished Business: A Comparative Assessment of Environmental Problems (EPA 1987)*

How the Public Ranks Selected Environmental Risks

High Risk

- (1) Chemical waste disposal
- (2) Water pollution
- (3) Chemical plant accidents
- (4) Outdoor air pollution

Medium Risk

- (5) Oil tanker spills
- (6) Exposure to pollutants on the job
- (7) Eating pesticide-treated food
- (8) Other pesticide risks
- (9) Contaminated drinking water

Low Risk

- (10) Indoor air pollution
- (11) Exposure to chemicals in consumer products
- (12) Genetic engineering (biotechnology)
- (13) Waste from strip mining
- (14) Non-nuclear radiation
- (15) "Greenhouse effect" (CO_2 and global warming)

Source: Original data drawn from 1984-86 polls conducted by the Roper Organization, Inc.

Should the government focus available resources and technology where they can have the greatest tangible impact or should it focus them on those problems about which the public is most upset?

familiarity with the issue. If more people knew about global warming, its implications would probably cause them to rank it much higher. This is a "new" issue and although polling data are not yet available to confirm it, the level of concern appears to be rising.

What are the implications?

The most obvious message for those involved in environmental problems—representatives of government, industry, public interest groups, and the science community—is to recognize how people may react to the risks, to understand why the risks have been assessed technically as high or low, and to tailor policies and communications to accommodate differing perspectives.

Issues of high risk/high public concern and low risk/low public concern are issues of general agreement. But the high/low combinations can present challenges of leadership, values, and ethics to all involved.

The high-risk/low-concern problems tend not to excite the public, in seeming contradiction of the data developed by the experts. These are hard cases for government officials, where the experts are suggesting they act on the basis of facts or scientific projections, rather than on public mandate. The situation can be especially difficult when the remedies are complicated and expensive and there are other competing demands for resources. As it turns out, experts from the science community often have a special credibility in these cases, particularly when the problem is "new" to the public agenda. Public interest groups and the press can also play an important role. In these instances, clearly presented facts that are relevant to individual circumstances are essential. At the same time, however, those presenting the facts in the hope of raising public interest have a responsibility not to raise anxiety to an unjustified level.

On the other hand, the low-risk/high-concern problems present different issues, especially to those considering national priorities. The first issue to confront is how many individuals are in the high-risk category and how high is the risk? The next issue concerns equity. We must ask whether the hazard to a relative few from an identifiable source(s) is justification enough to give the problem high priority and a generous share of resources. The answer may be yes or no. A third issue is how to reply to people who are concerned about a problem that the experts claim presents relatively less hazard than another, especially when resources to deal with both are limited.

There is always a temptation not to face these issues. It is hard to ignore the will of the people, particularly when the sentiments are firmly held and not easily changed. Indeed, they raise some even more fundamental issues concerning the proper role of a democratic government (and other organizations in a democracy) when it comes to issues of risk. Put crudely, should the government focus available resources and technology where they can have the greatest tangible impact on human and ecological health and welfare, or should it focus them on those problems about which the public is most upset? (After all, anxiety and fear are very real to those who are affected.) Put more pragmatically, what is the proper balance? Does the severity of the problem make a difference? How about the qualitative aspects of the risk? (For that matter, is the answer the same for different qualitative aspects: individual vs. population risk; dread of the unknown vs. acceptance of the commonplace; presence of a "scapegoat"; voluntariness of exposure; equity in incidences of harm or cost, etc.?) Is the answer the same for the legislative and executive branches? Is the answer the same at the site-specific and national levels?

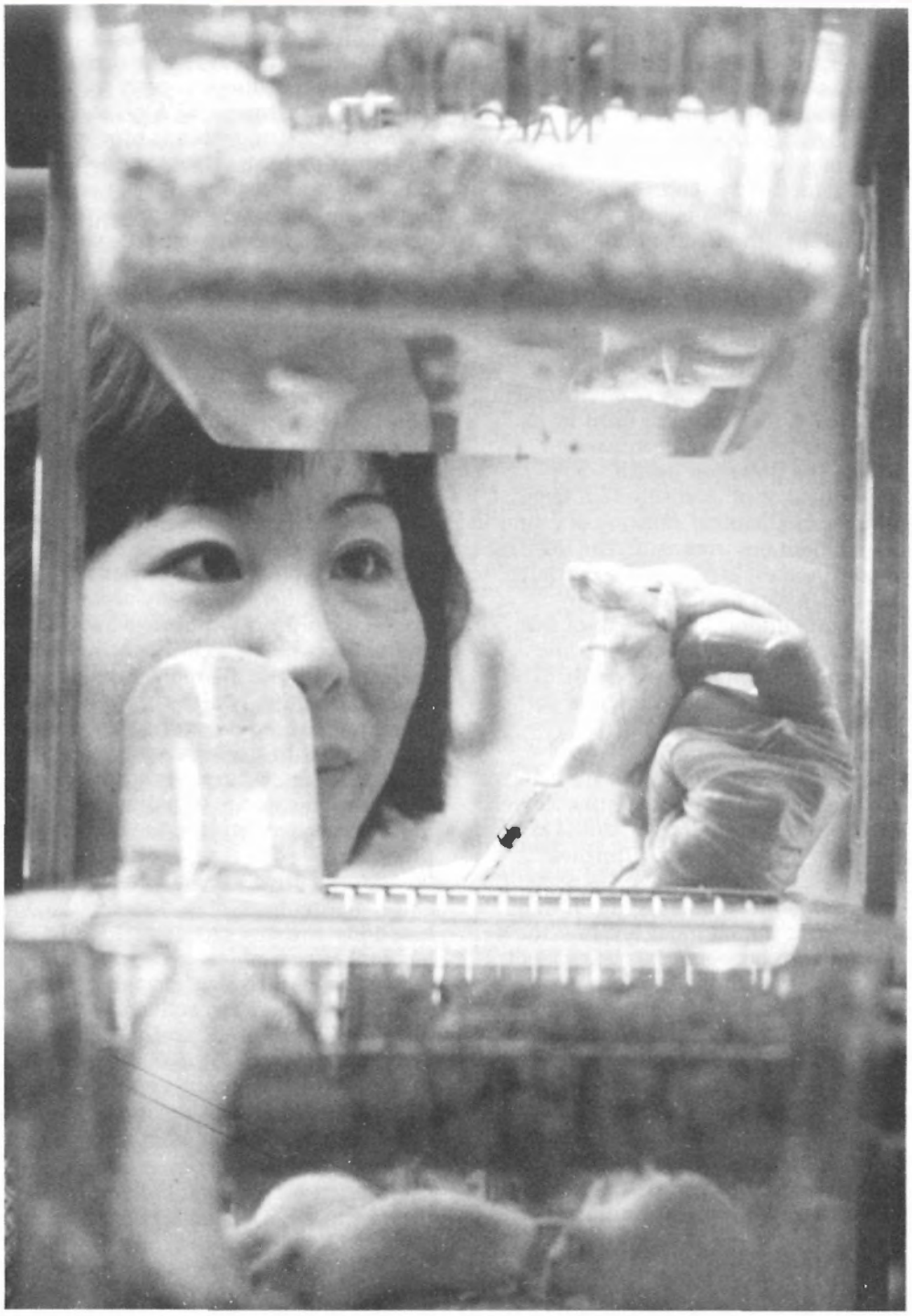
Obviously there are no clear answers to these questions. However, it is becoming clear to both experts and the public that they each have something to offer concerning how we view risk. Many risk experts who have been accustomed to looking at numbers and probabilities are now conceding that it is clearly rational to look at risk in broader terms. At the same time, the public is being supplied with more risk data to enable them to make more informed judgments.

What is happening now is that the concepts and tools are being developed to understand and communicate both tangible and intangible aspects of risk more explicitly so that people who begin with different viewpoints can come to a common understanding more easily. This is where the recent emphasis on risk assessment, risk management, and risk communication, the EPA project described in this article, and indeed this whole issue of *EPA Journal* come together. Together they make it easier to deal with issues that hinge on data, probabilities, assumptions, and tradeoffs, and in turn make it easier to frame issues of social values for real public discussion. Achieving this goal is not an easy or short-term task, but the stakes—health, welfare and society's resources— make it worth the effort. □

(Allen is Associate Director of EPA's Office of Policy Analysis. He was a member of the EPA task force described in this article.)

Risk Assessment: What It Is; How It Works

by Warner North and Terry F. Yosie



Test being performed on a laboratory rat. Animal tests provide much of the data that EPA uses in assessing environmental risks.

Risk assessment has emerged as a major, if not the dominant, analytical tool in supporting environmental decision-making within EPA. The growth in the use of risk assessment has resulted from EPA's need for increased sophistication in developing regulations mandated by statute, and improved ways to communicate the scientific basis for decisions to the public. While EPA's use of risk assessment has accomplished some major successes, it should be anticipated that risk assessment methods and practice will undergo considerable expansion and refinement in the coming years.

Risk assessment may be defined as the characterization of potential adverse effects to humans or to an ecosystem resulting from exposure to environmental hazards. Risk assessment supports risk management, the choices on whether and how much to control future exposure to the suspected hazards. Risk managers face the necessity of making difficult decisions involving uncertain science, potentially grave consequences to health or the environment, and large economic effects on industry and consumers. What risk assessment provides is an orderly, explicit, and consistent way to deal with scientific issues in evaluating whether a hazard exists and what the magnitude of the hazard may be. This evaluation typically involves large uncertainties, because the available scientific data are limited, and the mechanisms for adverse health impacts or environmental damage are only imperfectly understood.

Over the past decade risk assessment has had its largest impact in regulatory practices with respect to carcinogens. As we have accumulated evidence that a large number of common chemicals are mutagenic or give positive results in rodent bioassays, a regulatory

Despite the expanded use and increased sophistication of risk assessment, there are many areas where research can lead to improved methods and practices.

philosophy based on banning such substances from the ambient environment has become less and less feasible. Risk assessment for carcinogens has provided a means to evaluate and compare the magnitude of the threat to health posed by a large number of suspected carcinogens present at low levels in air, water, and soil.

EPA has played an important leadership role among federal agencies in pioneering methods to categorize the evidence that a chemical substance is carcinogenic in humans and to make quantitative estimates of the extent of cancer that could result from a given level of exposure. EPA's methods for carcinogen risk assessment were first published in the scientific literature more than a decade ago. These methods were important influences on federal interagency efforts to establish regulatory practices for carcinogens. The National Academy of Sciences' (NAS) widely cited 1983 Report, *Risk Assessment in the Federal Government: Managing the Process*, endorsed many of the practices that EPA had evolved for carcinogen risk assessment, such as the preparation of formal scientific documents summarizing the available scientific information and the practice of having such documents undergo peer review by an outside group of scientific experts.

As a means of facilitating uniform practices for using available scientific information and for increasing public credibility of a process that requires extensive reliance on judgment in the absence of data, the NAS recommended that uniform guidelines be established for risk assessment. Interagency principles for carcinogen risk assessment have subsequently been developed under the leadership of the Office of Science and Technology Policy of the Executive Office of the President. EPA has published its own guidelines in the *Federal Register*, not just for carcinogenicity, but also for the assessment of other health effects (mutagenicity, developmental effects), for exposure assessment, and for dealing with the health effects of chemical mixtures.

Risk assessment methods for carcinogens and other chemicals suspected of causing adverse human health effects are now widely used within EPA and by many environmental agencies at the state and local levels. These methods have been used to project the potential health consequences of exposure to a large number of chemical substances found in the ambient environment. The decisions to continue registration of a pesticide, to list substances as hazardous air pollutants under Section 112 of the Clean Air Act, or to regulate water contaminants under the Safe Drinking Water Act now depend in large part on EPA's risk assessments for the substances in question.

Risk assessment methods are being used to set regulatory priorities as well as to support regulatory actions. EPA's February 1987 report, *Unfinished Business: A Comparative Assessment of Environmental Problems*, has initiated a dialogue at the national level on the relationship between risk assessment and priority setting. The Integrated Environmental Management Program within EPA's Office of Policy Analysis has worked with state, local, and citizen groups to apply risk assessment to air toxics, indoor radon, ground-water contamination, and drinking water supplies in areas as diverse as Philadelphia, Denver, Baltimore, and Santa Clara Valley, California.

Assessment of exposure is an important component of risk assessment, and EPA is evolving improved procedures to carry out exposure assessment. EPA's Total Human Exposure research program has provided important new information concerning human activity patterns in indoor and ambient environments and new insights into the importance of pollutant exposure indoors and outdoors. There is also a growing appreciation within the scientific community of the role of indirect pathways as a means of human exposure. For example, deposition of lead particles in dust or soil and subsequent ingestion through hand-to-mouth contact is a major exposure pathway and, therefore, health risk, especially for children.

Despite the expanded use and increased sophistication of risk assessment, there are many areas where research can lead to improved methods and practices. The rapidly expanding understanding of the molecular basis of cancer and other health effects offers the potential that the large uncertainties now present in risk assessment may be reduced. More accurate procedures based on knowledge of biological mechanism may replace the current procedures for scaling doses from laboratory animals to humans and for extrapolating from high doses to the much lower doses characteristic of ambient exposure levels.

The scope of risk assessment is also expanding. There are active efforts underway in EPA and in the scientific community to expand risk assessment to include health endpoints such as immunotoxicity, neurotoxicity, reproductive effects, and adverse

Risk assessment can play an increasingly important role in educating the public on the nature and degree of environmental risks that confront them.

changes in specific organs, such as the kidney, liver, and lung. The Office of Air Quality Planning and Standards has developed the use of probability methods to assess the judgment of scientific experts on uncertainties regarding the health effects of low levels of lead in children. Such methods for characterizing uncertainty explicitly are a promising alternative to the use of conservative or plausible upper-bound estimates for uncertain quantities.

Other examples of research conducted by EPA and other research institutions to improve scientific data and methods include the following:

- Extrapolation modeling—the process of projecting effects in humans based upon observations derived from controlled animal studies. Examples of work underway include: extrapolation between species, testing subpopulations of differing sensitivity, interpolation between doses, extrapolation across durations of exposure and between developmental stages.

- Pharmacokinetics—the study of the absorption, metabolism, distribution, and elimination of foreign substances from the body. EPA's inhalation toxicology research program has developed ozone dosimetry models to simulate local absorption of ozone in the lower respiratory tract. Agency researchers are also presently investigating pharmacokinetic analysis to analyze the consequences of changes in the cadmium level in the food supply.

- Development of toxic equivalency factor (TEF) methodologies for assessing mixtures of untested (or incompletely tested) compounds on the basis of structure-activity relationships. EPA has developed a peer-reviewed interim methodology for assessing the health risks of dibenzo-p-dioxins and dibenzofurans.

- Ecological risk assessment—the development of a formal approach to characterize scientific knowledge of the risk to ecological systems following exposure to environmental contaminants.

- Assessment of the consequences of stratospheric ozone depletion. EPA staff developed a summary of applicable scientific data and a quantitative integrating model for projecting human health and ecological impacts from changes in ultraviolet radiation that could result from changes in the ozone layer of the stratosphere. This risk assessment supported the EPA and other U.S. representatives in the negotiation of the recent Montreal treaty for worldwide limitation of chlorofluorocarbon emissions to protect the stratosphere.

Risk assessment can play an increasingly important role in educating the public on the nature and degree of environmental risks that confront them. Over the past 25 years the public awareness of environmental risks has risen dramatically, and the scope of the public concern extends across the nation and the range of EPA's regulatory activities. It applies to hazardous waste sites in New Jersey, to pesticide applications in Kansas, and to the issuing of permits to biotechnology companies in California.

EPA is taking actions in an attempt to improve understanding of the public's perceptions about risk. The Agency is also using risk assessment as a way to articulate the scientific basis for its actions to reduce risks. Such efforts include a trend toward greater involvement of EPA scientists and analysts in working directly with affected communities and groups. The Agency has sponsored meetings to encourage Pennsylvania citizens to inform themselves about indoor radon, and to express their perceptions regarding what actions they and government agencies might take to reduce this hazard. Risk communication conferences are used to explain to representatives of the media, to environmental and industry groups, to members of the scientific community, to Congress, and to individual citizens how EPA uses scientific data in making regulatory decisions.

Risk assessment provides a means of presenting and evaluating scientific information and uncertainties, so that both decision-makers and the affected public can better understand the basis for environmental risk management decisions that EPA and other regulatory agencies are charged with making under existing environmental statutes. The science supporting environmental regulatory decisions is complex and evolving rapidly, and many of the most important threats to human health and the environment are highly uncertain. Risk assessment can help in establishing a common basis of knowledge and uncertainty, so that EPA and other institutions can carry out the needed research, planning, and decision-making in a way that is consistent with both science and the public's concern for environmental protection. □

(Dr. North is Principal of Decision Focus, Inc., and a member of the Environmental Health Committee of EPA's Science Advisory Board and Dr. Yosie is Director of the Science Advisory Board.).

Risk Management:
FIFRA and the Dinoseb Case

by Karen Flagstad

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), which governs EPA's regulation of pesticides, is often called a "balancing" statute because it requires the Agency to weigh the risks of pesticides against their economic and social benefits when making regulatory decisions. Under FIFRA, all pesticides intended for use in the United States must be registered (licensed) by EPA to ensure that they do not cause "unreasonable adverse effects on the environment." In the context of FIFRA, unreasonable adverse effects are defined to mean: "any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide."

The risk/benefit mandate of FIFRA makes pragmatic sense when you consider that pesticides, almost by definition, yield risks as well as agricultural and other pest-control benefits. Since pesticides typically perform their intended function *because* they are toxic to something, there is generally no such thing as a "zero risk" pesticide. Reflecting Congress' recognition that pesticide uses involve tradeoffs between benefits and risks, FIFRA calls upon EPA to make administrative judgments as to how much risk is reasonable in light of the specific benefits to be obtained from pesticide uses.

Registration under FIFRA is a license for the sale of a pesticide for use on a specific crop or other site under the circumstances prescribed by its approved labeling. Pesticide registration is *not* an "either/or" proposition whereby EPA either gives blanket approval to the sale and use of a pesticide, or else disapproves its registration. On the contrary, in cases where proposed or continued uses of a pesticide raise risk concerns, FIFRA affords EPA a spectrum of risk management options to bring down risks, wherever possible, with limited impacts on benefits. Depending on the nature of EPA's concerns, such options might include: requiring protective apparel and/or equipment to minimize risks to pesticide applicators; reducing the rate or frequency of application or otherwise modifying application practices to lower pesticide residue levels on harvested crops; or imposing regional restrictions against using a pesticide in areas where it could leach into ground water.

On a graduated scale of risk management options available under FIFRA, regulatory action by EPA to remove some or all uses of a pesticide from commerce by initiating cancellation proceedings is an option of last resort. Yet there are cases where EPA does opt to cancel a pesticide, or even call an immediate halt to its use for the duration of formal cancellation proceedings—most recently in the case of dinoseb, a chemical with herbicidal, fungicidal, insecticidal, and desiccant properties that has been widely used in recent decades, primarily in agriculture.

On October 7, 1986, the Agency issued a formal notice of intent to cancel and deny all registrations for pesticide products containing dinoseb, citing evidence that it may cause birth defects in children born to women exposed to dinoseb during pregnancy, and may also cause sterility or decreased fertility in males, acute toxic poisoning, and other potential adverse effects on health and the environment. On the same day, EPA issued an emergency suspension order effecting an immediate stop to dinoseb use during the time required to complete cancellation proceedings on the pesticide. (Under FIFRA, an "emergency suspension" takes effect immediately, whereas under an "ordinary suspension," pesticide registrants may request an expedited hearing *before* the suspension takes effect.) The dinoseb order was the third such emergency suspension order EPA has issued under FIFRA.

Let's consider the case of dinoseb in the context of EPA's pesticide risk assessment and risk/benefit "balancing" process.

Dinoseb Risk Assessment

What were the studies that led to EPA's emergency suspension and cancellation initiatives on dinoseb, and how did EPA use these studies for risk assessment?

- *Birth Defects.* In recent laboratory studies, dinoseb has caused birth defects in the offspring of three test animal species (rabbits, rats, and mice). Based on this multi-test evidence from studies using several different routes of exposure, EPA scientists concluded that dinoseb causes birth defects in laboratory animals and has the potential to cause birth defects in humans. Based on statistical data from the rabbit study (an oral feeding study), a "No Observed Effects Level" (NOEL) was provisionally set at 3 milligrams per kilogram of body weight per day (mg/kg/day)—meaning that adverse effects in test animal offspring were apparent at all oral exposure levels higher than 3 mg/kg/day.

- *Male Reproductive Effects.* In rodent feeding studies, dinoseb has caused adverse reproductive effects in males. Based on the evidence in mice and rats, EPA scientists concluded that dinoseb causes adverse reproductive effects in laboratory animals and should be

considered a potential cause of human male reproductive disorders.

• *Acute Toxicity.* The LD50 of a pesticide (the dose at which 50 percent of test animals succumb to the toxicity of the chemical) is typically used as a measure of its acute toxicity. Test data cited by EPA in its dinoseb suspension and cancellation notices showed the dinoseb LD50 by dermal exposure to be approximately 75 mg/kg—an LD50 low enough to be considered indicative of very high toxicity. There is also direct evidence of the acute toxicity of dinoseb in humans, including at least one human fatality attributed to accidental exposure to dinoseb during spray application.

In addition to the effects just described, dinoseb belongs to a class of chemicals (dinitrophenols) known to induce cataracts in humans, and cataracts have been observed in the eyes of three species of laboratory animals following dinoseb exposure. Dinoseb has also induced tumors in female mice and may have the potential to affect the immunological system. Apart from its potential human health effects, dinoseb also has the potential to adversely affect wildlife.

The toxicity profile just outlined raises very significant concerns regarding the teratogenicity (birth defects) and other hazards of dinoseb. On the other hand, from the standpoint of pesticide risk assessment, the toxicological characteristics of a pesticide chemical are only half the picture. The second basic component of risk is the extent to which people and the environment are actually exposed to the pesticide when it is used in accordance with widespread and commonly recognized practice.

FIFRA affords EPA a spectrum of risk management options to bring down risks, wherever possible, with limited impacts on benefits.

In the case of dinoseb, three basic exposure scenarios were identified:

• Possible dietary exposure to the public through consumption of food or drinking water containing residues of dinoseb.

• Occupational exposures to workers who mix, load, or apply dinoseb.

• Secondary or "coincidental" exposures to bystanders, farmworkers, and others who could be exposed to dinoseb through spray drift, contact with residues in treated fields, or even contact with contaminated clothing or farm equipment immediately after dinoseb application.

In conducting pesticide risk assessments, as in the case of dinoseb, EPA makes a practice of evaluating all potential toxic effects, but generally focuses its quantitative risk assessment and risk/benefit balancing process on the effect observed at the lowest dose level. For dinoseb, this was the 3 mg/kg/day NOEL cited earlier for dinoseb-induced birth defects in rabbit offspring. In quantitative calculations, EPA scientists compare this NOEL from laboratory studies with expected human exposure levels to obtain numerical "margins of safety" (NOEL divided by exposure equals margin of safety, or MOS). To protect people from significant health risks, EPA generally considers an MOS greater than 100 to be acceptable when calculated from animal data. Where an MOS is less than 100, the Agency typically considers the comparative impacts of possible risk management measures.

• *Risks from Dietary Exposure.* EPA scientists calculated MOS values for risks of birth defects from potential dietary exposure to dinoseb residues in food and drinking water. Even when certain "worst case" assumptions regarding dietary exposure levels were factored into these calculations, the MOS for the risk of birth defects occurring from consumption of foods from crops treated with dinoseb was found to be ample—over 2700. Similarly, from consumption of drinking water in areas where dinoseb may have leached to underground aquifers, the MOS was roughly 2450.

• *Risks from Occupational Exposures to Dinoseb.* Based on experimental data from field studies performed with dinoseb and other agricultural pesticides, exposure levels were estimated for the various kinds of workers involved in the use of dinoseb on various crops sites: mixer/loaders, pilots, airplane flaggers, "ground boom" applicators, and hand-sprayers. For these various kinds of workers, exposure levels were estimated for a range of plausible exposure conditions.

In many instances, estimated worker exposure levels were *equal to or greater than* the NOEL of 3 mg/kg/day for birth defects in test animals treated with dinoseb. If a worker is exposed to a pesticide at a level that is equal to its NOEL in laboratory animals, he or she is said to have an MOS of 1. Thus, in

For all crops and use sites, based on all available risk data and benefits information, the risks of continued use of dinoseb were deemed to outweigh the benefits.

the case of dinoseb, the Agency found virtually no MOS against the occurrence of birth defects in pregnant workers handling the pesticide.

- *Risks from Secondary Exposure to Dinoseb.* EPA did not have adequate exposure data to calculate MOS values for secondary exposures to dinoseb. However, there are grounds for inferring that significant secondary exposures do occur, including data from the State of California revealing that acute poisonings from spray drift of dinitrophenol pesticides occur annually.

Dinoseb Benefit Assessment

Based on data from the U.S. Department of Agriculture and other sources, EPA conducted an assessment of the benefits of dinoseb by calculating the short-term and long-term economic impacts expected to occur if dinoseb were unavailable for registered uses. Dinoseb use sites included soybeans, peanuts, cotton, snap beans, potatoes, green peas, grapes, alfalfa, almonds and walnuts, berries, hops, non-crop areas, and a variety of "minor use" crops and sites.

For both short- and long-term scenarios, estimated economic losses were due mainly to increased pest control costs and expected yield losses for some crop sites. For both scenarios, the largest user impacts were projected for potato and peanut growers, while the extent of impacts on the production of green peas, snap beans, caneberries, and hops were uncertain. Apart from these uncertainties, the overall annual impacts of removing dinoseb from the marketplace were estimated at the user level in the range of $80 to $90 million. The information available to EPA did not point to significant market and consumer impacts, except for possible short-term peanut price increases.

Regulatory Options Considered

In the case of dinoseb, EPA was satisfied that there were adequate margins of safety to protect public health from any risks due to dietary and drinking-water exposures to the pesticide. On the other hand, the Agency's MOS calculations pointed to extraordinarily high risks of birth defects from occupational exposures to dinoseb, and there was reason to believe that secondary exposures to dinoseb also presented significant risks to unborn children. The evidence available to EPA also indicated that occupational and secondary exposures to dinoseb posed additional risks of adverse reproductive effects in males and acute toxic poisoning. Focusing on these exposure routes, EPA considered a number of possible risk management options to determine whether such measures could reduce the risks of birth defects and other potential adverse effects to acceptable levels in view of the known benefits of dinoseb.

- *Additional Protective Clothing.* The risks of birth defects in children born to workers involved in the use of dinoseb were found to be unacceptable even with the protection afforded by the requisite apparel specified by dinoseb product labels: goggles or a face shield, impermeable gloves, and an apron when handling dinoseb concentrate; and long-sleeved shirts, long-legged pants, and shoes and socks when handling the concentrate or spraying the prepared formula. To further minimize worker exposure, the Agency considered the possible additional requirement of Tyvek® suits (synthetic, disposable coveralls) for workers who handle dinoseb. However, EPA decided against this special requirement, due in part to practicality and enforcement problems. In addition, the Agency had concerns about the hazards of heat stress that may result when this type of synthetic clothing is worn in temperatures above 80 degrees Fahrenheit.

- *Protective Farm Equipment.* As part of the exposure and risk assessment of dinoseb, EPA scientists calculated MOS values for workers with and without the use of such protective farm equipment as closed loading systems and enclosed tractor cabs. Although MOS values were higher with the use of this equipment, they were still below 100. Consequently, this option was deemed ineffective to mitigate the risks of dinoseb use.

- *Lower Application Rates.* The Agency also calculated comparative MOS values for low dinoseb application rates (0.625 pounds active ingredient per acre, as directed by the label for some fungicidal uses) versus high application rates (9 to 12 pounds per acre, as recommended by labels for certain herbicidal uses). MOS values were comparatively higher for the lower application rates, but still well below 100 and therefore unacceptable.

• *Gender-Based Restrictions.* EPA considered a number of gender-based restrictions to reduce the risks of birth defects associated with exposure to dinoseb. Among other things, the Agency considered label changes to prohibit women of childbearing age from mixing, applying, or handling dinoseb in any way, or to alert pregnant women to the risks of dinoseb exposure. For the purposes of risk management, the impact of such restrictions is limited to direct occupational exposures to dinoseb. As a practical matter, gender-based restrictions were considered inadequate to control secondary exposures to female bystanders, farmworkers, and others. Moreover, such restrictions could not mitigate dinoseb-related risks of male reproductive effects or acute toxicity.

• *Reformulation.* Through comparative MOS calculations, EPA considered the risk management impacts of reformulating dinoseb to reduce worker exposure. None of the available technologies was found to reduce dinoseb risks to acceptable levels for workers performing the various tasks involved in dinoseb application.

Suspension and Cancellation Initiatives

In the case of dinoseb, EPA's risk assessment and risk/benefit balancing processes led the Agency to conclude that the risks associated with registered uses of the pesticide could not be reduced to reasonable levels by any means short of immediately removing the pesticide from the marketplace. For all crops and use sites, based on all available risk data and benefits information, the risks of continued use of dinoseb were deemed to outweigh the benefits—not only in the long term, but also during the interval of time required to conduct "ordinary" suspension and cancellation hearings under FIFRA. Thus, the Agency opted for the most drastic remedial option available under FIFRA: emergency suspension calling an immediate halt to the sale and use of a pesticide while cancellation proceedings are conducted. □

Jon Brunk

Applying dinoseb in Skagit County, Washington. Making decisions on regulating pesticides is an example of the risk management process at EPA.

Editor's note: The dinoseb case, which is used for illustration purposes in this article, is traced only up to the point of EPA's October 7, 1986, cancellation and emergency suspension notices. Subsequent developments in the dinoseb proceedings are beyond the scope of the article.

(Flagstad is an assistant editor of EPA Journal.*)*

Risk Communication: Informing Public Opinion

by Milton Russell

Scientific risk assessments were not enshrined in the 200-year-old Constitution and Bill of Rights celebrated this year; the guiding force of the will of the people was. The institutions that have evolved from this constitutional base assure that when it comes to protecting health and the environment, it is public, not expert, opinion that counts. On reflection, few would have it any other way.

Yet, for those schooled in science and in the rationalistic utilitarian underpinnings of public policy, frustrations abound when it comes to the way public opinion regards environmental risks and drives environmental protection.

Some risks are large, sometimes frighteningly large, and others small, sometimes vanishingly small. This is so whether they are placed on the measuring rod of total population life expectancy or on that of the probability of premature death for small numbers of exposed people. The same holds true of non-fatal disease and ecological harm. At least this is what available scientific evidence suggests.

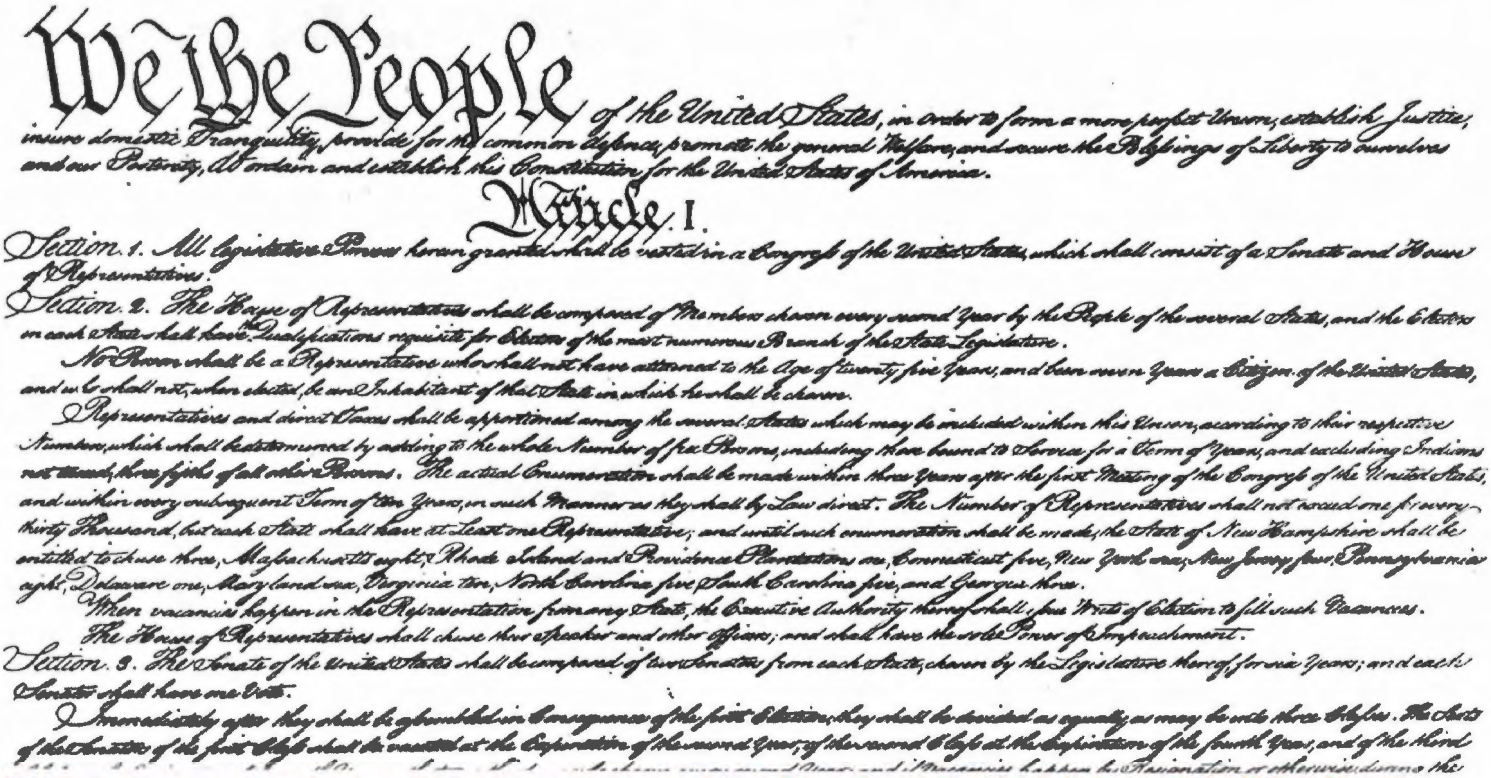
Given limited resources, those who "hold these (rationalistic, utilitarian) truths to be self-evident" would have the nation remedy the most severe risks first, leaving the others to later, or maybe, if small enough, to never. But the political system sometimes sends different orders, and the behavior of individuals in everyday life often does not comport with this view.

For example, there are toxic waste dumps where on all evidence risks are minimal. Yet, the presence of such dumps can lead to numbing anxiety on the part of some, to loss of property values, and to disruption of communities. Elsewhere, facilities to dispose safely of similar wastes may be resisted by all means possible, including threats of civil disobedience. And at the same time, individuals may show little concern for hazardous products in ordinary commerce, resist efforts to protect wetlands vital to ecological integrity, not choose to test their homes for naturally occurring radon, and ignore safe-use labels for pesticides in home use. Examples of hysteria in the face of apparently trivial risks and of apathy before apparently serious ones form an unsettling litany to risk managers.

It is also a depressing litany, because the practical result is a pattern of national expenditures and of individual behavior that leaves the country poorer, sicker, and less ecologically secure than it could be. This is surely an outcome no one could knowingly choose. Or could they?

Research has demonstrated that it is simplistic to believe that people have only one goal in protecting the environment—to reduce calculated risk. They are also concerned about the physical characteristics of the risk, its source, how it is distributed, and whether it is fairly imposed upon them. They also have a healthy skepticism about the certainty of those risk calculations, and a gnawing anxiety about what future evidence may bring. Taking the complex of values that real people bring to decisions and opinions, they may well choose to be "poorer, sicker, and less ecologically secure than they could be," at least as measured against expert opinion. And tellingly, our system of government gives them the right to make that call.

But to make this judgment wisely requires that individuals know what experts' estimates of the risks are, what it would cost in terms of their other values to reduce them, and how certain and free of bias all of this is. Mostly


We the People of the United States, in order to form a more perfect Union, establish Justice, insure domestic Tranquility, provide for the common defence, promote the general Welfare, and secure the Blessings of Liberty to ourselves and our Posterity, do ordain and establish this Constitution for the United States of America.

Article. I.

Section. 1. All legislative Powers herein granted shall be vested in a Congress of the United States, which shall consist of a Senate and House of Representatives.

Section. 2. The House of Representatives shall be composed of Members chosen every second Year by the People of the several States, and the Electors in each State shall have the Qualifications requisite for Electors of the most numerous Branch of the State Legislature.

No Person shall be a Representative who shall not have attained to the Age of twenty five Years, and been seven Years a Citizen of the United States, and who shall not, when elected, be an Inhabitant of that State in which he shall be chosen.

Representatives and direct Taxes shall be apportioned among the several States which may be included within this Union, according to their respective Numbers, which shall be determined by adding to the whole Number of free Persons, including those bound to Service for a Term of Years, and excluding Indians not taxed, three fifths of all other Persons. The actual Enumeration shall be made within three Years after the first Meeting of the Congress of the United States, and within every subsequent Term of ten Years, in such Manner as they shall by Law direct. The Number of Representatives shall not exceed one for every thirty Thousand, but each State shall have at least one Representative; and until such enumeration shall be made, the State of New Hampshire shall be entitled to chuse three, Massachusetts eight, Rhode Island and Providence Plantations one, Connecticut five, New York six, New Jersey four, Pennsylvania eight, Delaware one, Maryland six, Virginia ten, North Carolina five, South Carolina five, and Georgia three.

When vacancies happen in the Representation from any State, the Executive Authority thereof shall issue Writs of Election to fill such Vacancies.

The House of Representatives shall chuse their Speaker and other Officers; and shall have the sole Power of Impeachment.

Section. 3. The Senate of the United States shall be composed of two Senators from each State, chosen by the Legislature thereof, for six Years; and each Senator shall have one Vote.

Immediately after they shall be assembled in Consequence of the first Election, they shall be divided as equally as may be into three Classes. The Seats of the Senators of the first Class shall be vacated at the Expiration of the second Year, of the second Class at the Expiration of the fourth Year, and of the third

Wide World Photos

"When it comes to protecting health and the environment, it is public, not expert, opinion that counts."—Milton Russell.

illusory scientific precision is not needed, but a sense of "big," "medium," "small," or "infinitesimal" is.

The challenge of risk communication is to provide this information in ways that it can be incorporated in the views of common citizens who have little time or patience for arcane scientific discourse.

Success in risk communication is not to be measured by whether the public chooses the set of outcomes that minimizes risk as estimated by the experts. It is achieved instead when those outcomes are knowingly chosen by a well-informed public.

Thomas Jefferson said it best:

> I know no safe depository of the ultimate powers of the society but the people themselves; and if we think them not enlightened enough to exercise their control with a wholesome discretion, the remedy is not to take it from them, but to inform their discretion.

Two hundred years of constitutional history has left those ultimate powers with the people, not the environmental experts, so one part of Jefferson's vision has been realized.

The evidence is that the other hasn't. Communicating environmental risk is a formidable, continuing task whose effective pursuit is only now beginning to emerge from research. Practice lags still further behind.

Rather than bemoaning the views of the public when it comes to risks, environmental professionals could better look to providing information in a usable form that might "inform their discretion."

And their frustrations will be relieved as they come to understand that values embodied in environmental judgments are richer and more complex than those encapsulated in technical estimates of risk. □

(Dr. Russell holds joint appointments at Oak Ridge National Laboratory as a Senior Economist and at the University of Tennessee as Professor of Economics and Senior Fellow in the Energy, Environment, and Resources Center and in the Waste Management Institute. Until March 1987, he was EPA's Assistant Administrator for Policy, Planning, and Evaluation.)

Risk Communication: Facing Public Outrage

by Peter M. Sandman

If you make a list of environmental risks in order of how many people they kill each year, then list them again in order of how alarming they are to the general public, the two lists will be very different. The first list will also be very debatable, of course; we don't really know how many deaths are attributable to, say, geological radon or toxic wastes. But we do know enough to be nearly certain that radon kills more Americans each year than all our Superfund sites combined. Yet, as Milton Russell points out (see preceeding article), millions who choose not to test their homes for radon are deeply worried about toxic wastes. The conclusion is inescapable: the risks that kill you are not necessarily the risks that anger and frighten you.

To bridge the gap between the two, risk managers in government and industry have started turning to risk communication. They want help convincing the public that one part per million of dimethylmeatloaf in the air or water may not be such a serious hazard after all. Sometimes they want this help even when one part per million of dimethylmeatloaf is a serious hazard, hoping that clever risk communication can somehow replace effective risk management. But often the best evidence suggests that the dimethylmeatloaf really does endanger our health less than, say, eating peanut butter (not to mention the really big hazards, like cigarette smoking). Can risk communication get people to ease off on the dimethylmeatloaf and worry instead about their peanut butter consumption?

No. What risk communication can do is help risk managers understand why the public properly takes dimethylmeatloaf more seriously than peanut butter. This understanding, in turn, can lead to changes in dimethylmeatloaf policy that will help bring the public and expert assessments of the risk closer together.

The core problem is a definition. To the experts, risk means expected annual mortality. But to the public (and even the experts when they go home at night), risk means much more than that. Let's redefine terms. Call the death rate (what the experts mean by risk) "hazard." Call all the other factors, collectively, "outrage." Risk, then, is the sum of hazard and outrage. The public pays too little attention to hazard; the experts pay absolutely no attention to outrage. Not surprisingly, they rank risks differently.

Risk perception scholars have identified more than 20 "outrage factors." Here are a few of the main ones:

- *Voluntariness*: A voluntary risk is much more acceptable to people than a coerced risk, because it generates no outrage. Consider the difference between getting pushed down a mountain on slippery sticks and deciding to go skiing.

- *Control*: Almost everybody feels safer driving than riding shotgun. When prevention and mitigation are in the individual's hands, the risk (though not the hazard) is much lower than when they are in the hands of a government agency.

- *Fairness*: People who must endure greater risks than their neighbors, without access to greater benefits, are naturally outraged—especially if the rationale for so burdening them looks more like politics than science. Greater outrage, of course, means greater risk.

- *Process*: Does the agency come across as trustworthy or dishonest, concerned or arrogant? Does it tell the community what's going on before the real decisions are made? Does it listen and respond to community concerns?

- *Morality*: American society has decided over the last two decades that pollution isn't just harmful—it's evil. But talking about cost-risk tradeoffs sounds very callous when the risk is morally relevant. Imagine a police chief insisting that an occasional child-molester is an "acceptable risk."

- *Familiarity*: Exotic, high-tech facilities provoke more outrage than

Bill Ross, Woodfin Camp Inc.

People often display less concern about risks from voluntary activities, such as skiing or smoking, than from equally hazardous involuntary exposures, such as from chemicals in food or in other products.

familiar risks (your home, your car, your jar of peanut butter).

- *Memorability*: A memorable accident—Love Canal, Bhopal, Times Beach—makes the risk easier to imagine, and thus (as we have defined the term) more risky. A potent symbol—the 55-gallon drum—can do the same thing.

- *Dread*: Some illnesses are more dreaded than others; compare AIDS and cancer with, say, emphysema. The long latency of most cancers and the undetectability of most carcinogens add to the dread.

- *Diffusion in time and space*: Hazard A kills 50 anonymous people a year across the country. Hazard B has one chance in 10 of wiping out its neighborhood of 5,000 people sometime in the next decade. Risk assessment tells us the two have the same expected annual mortality: 50. "Outrage assessment" tells us A is probably acceptable and B is certainly not.

These "outrage factors" are *not* distortions in the public's perception of risk. Rather, they are intrinsic parts of what we mean by risk. They explain why people worry more about Superfund sites than geological radon, more about industrial emissions of dimethylmeatloaf than aflatoxin in peanut butter.

There is a peculiar paradox here. Many risk experts resist the pressure to consider outrage in making risk management decisions; they insist that "the data" alone, not the "irrational" public, should determine policy. But we have *two decades of data* indicating that voluntariness, control, fairness, and the rest are important components of our society's definition of risk. When a risk manager continues to ignore these factors—and continues to be surprised by the public's response of outrage—it is worth asking just whose behavior is irrational.

The solution is implicit in this reframing of the problem. Since the public responds more to outrage than to hazard, risk managers must work to make serious hazards more outrageous, and modest hazards less outrageous. Recent campaigns against drunk driving and sidestream cigarette smoke provide two models of successful efforts to increase public concern about serious hazards by feeding the outrage.

Similarly, to decrease public concern about modest hazards, risk managers must work to diminish the outrage. When people are treated with fairness and honesty and respect for their right to make their own decisions, they are a lot less likely to overestimate small hazards. At that point risk communication can help explain the hazard. But when people are *not* treated with fairness and honesty and respect for their right to make their own decisions, there is little risk communication can do to keep them from raising hell—regardless of the extent of the hazard. Most of us wouldn't have it any other way. □

(Dr. Sandman is Professor of Environmental Journalism at Rutgers University, and Director of the Environmental Communication Research Program there.)

Risk Communication:
Getting Ready for 'Right-to-Know'

by Charles L. Elkins

"We are drowning in information and starved for knowledge." —John Naisbitt, *Megatrends*

During the next two years, a tidal wave of new information on hazardous chemicals will wash over thousands of communities across the United States. The "wave" will consist of reports to the public on the amount of hazardous chemicals stored in and released to the air, water, and soil of those communities—reports required by the Emergency Planning and Community Right-to-Know Act of 1986 (Title III of the Superfund Amendments and Reauthorization Act of 1986).

The Community Right-to-Know law is an exciting new approach to environmental protection. It is based on the belief that the more information citizens have about environmental conditions in their communities, the better equipped they will be to ensure their own protection from unacceptable risks to their health and safety. The law requires disclosure by industry of both the presence and release into the environment—including both accidental and "routine" releases—of hazardous substances. The information will be available not only to government regulators, but also to the people most directly affected—the residents of the communities where the substances are located.

From EPA's point of view, Title III presents both great opportunities and great challenges. Its promise lies in the wealth of new data on levels and sources of hazardous substances in the environment that the law eventually will provide. As the program matures and the data become more and more reliable, information from the Title III reports could become the "front end" of the Agency's toxic substances and other regulatory programs. Title III data could help EPA, as well as state and local authorities, set regulatory and enforcement priorities to control hazardous substances in all environmental media—air, water, and soil.

The law also could become a driving force for the development of new industrial processes and techniques to eliminate hazardous wastes at their source—before they are produced and either released into the environment or trucked away for expensive, and not always effective, treatment and disposal.

But the promise of the community right-to-know information over the long run is equalled by the problems it could cause, if not properly understood and used, in the short run. Except in a handful of states that already have community right-to-know laws, businesses have little or no experience in reporting this kind of data. Consequently some reports—especially the reports of annual "routine" emissions of toxic chemicals required by Section 313 of Title III—are likely to be very rough estimates of actual releases. The value of the emissions data in the first years of the program probably will be limited to helping EPA and other authorities identify potential "hot spots"—areas with apparently high levels of toxic emissions—for careful monitoring and evaluation to determine if an environmental hazard may be present that requires immediate attention.

Despite the limited reliability and value of some Title III reports in the early years, however, the information collected from more than one million industrial facilities, farms, small businesses, and other chemical users around the nation will be immediately available to the public. The Community Right-to-Know law requires the states in which the facilities are located to release the information to anyone who requests it, either in printed form or—in the case of the annual emissions reports by EPA—on a national computerized database called the Toxic Release Inventory (TRI). Title III's requirements for reporting on the storage and accidental release of hazardous chemicals are already in effect; the first round of annual emissions reports must be submitted by July 1, 1988. EPA expects the national database to be ready for public access by the spring of 1989.

How prepared are America's communities to receive, understand, and act on this unprecedented deluge of information about hazardous chemicals? That question has been a central concern to EPA since the law was passed. And the answer, unfortunately, seems to be: not very.

Public opinion polls such as those taken by the Roper Organization during the past few years show that most Americans believe that toxic chemicals can be found in the air, water, and soil in the United States—but not in their own neighborhoods. Except in industrialized regions or areas where hazardous substances are known to have been dumped or buried—the "Superfund" sites—toxic chemicals seem to be, for most Americans, "somebody else's" problem.

But some people who hold this view could be in for a surprise as the first Title III reports become public knowledge—especially if they indicate that substantial amounts of hazardous chemicals are stored and routinely released into the environment in their particular neighborhoods.

The routine emissions reports, which will show estimated or actual toxic releases on an annual basis, could be especially alarming.

Continued on next page

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For example, a newspaper article based on the Section 313 reports might look like this:

Local Plant Dumps Toxic Chemicals in Crystal River

The ABC Manufacturing Co. in downtown River City dumped more than 200 tons of toxic chemicals, including several cancer-causing substances, into the Crystal River last year, according to reports made public yesterday by the U.S. Environmental Protection Agency.

The river is the major source of drinking water for River City and most of surrounding Utopia County.

The reports also show that ABC, a leading producer of chrome-plated industrial widgets, released nearly 50 tons of toxins into River City's air in 1987, and sent another 300 tons of potentially poisonous material to the Utopia waste-treatment plant for disposal.

Last year, the plant reported to EPA that it stores more than 1,000 tons of hazardous substances within a few blocks of River City High School. On three different occasions over the past six months, plant accidents have released clouds of hazardous and toxic chemicals into the surrounding neighborhoods.

Now, if you were a resident of River City, what would your reaction be? Outrage? Skepticism? Concern for your family's well-being? A heated phone call to the Mayor or the company president, demanding an explanation or an immediate shut-down of the plant?

The question is not altogether hypothetical. Articles similar to this could begin popping up in the news media around the country as the Title III reports become available. Such news stories, based on accidental release or annual missions reports of questionable accuracy and written out of context, could be extremely misleading. And even accurate reports, by themselves, simply will not provide enough information for citizens or government officials to reach informed conclusions about whether hazardous chemicals actually pose a serious health risk in their communities.

In some instances, in fact, public concern over Title III reports could be entirely justified; toxic emissions into the air, water, or soil, for example, could endanger the health of citizens or the welfare of the environment.

The key word, however, is "could." The simple fact that toxic chemicals are released doesn't necessarily mean that public health and environmental quality are threatened. The fact that Company A says it released 50 tons of chemical X while Company B reports releasing 100 tons of chemical Y doesn't necessarily mean that Company B's emissions are twice as big a problem as Company A's. Much more than raw, unverified release information is needed to determine the risk in a given situation. And that's where the Community Right-to-Know law creates a major challenge for those whose job it is to assess and manage environmental risks to human health.

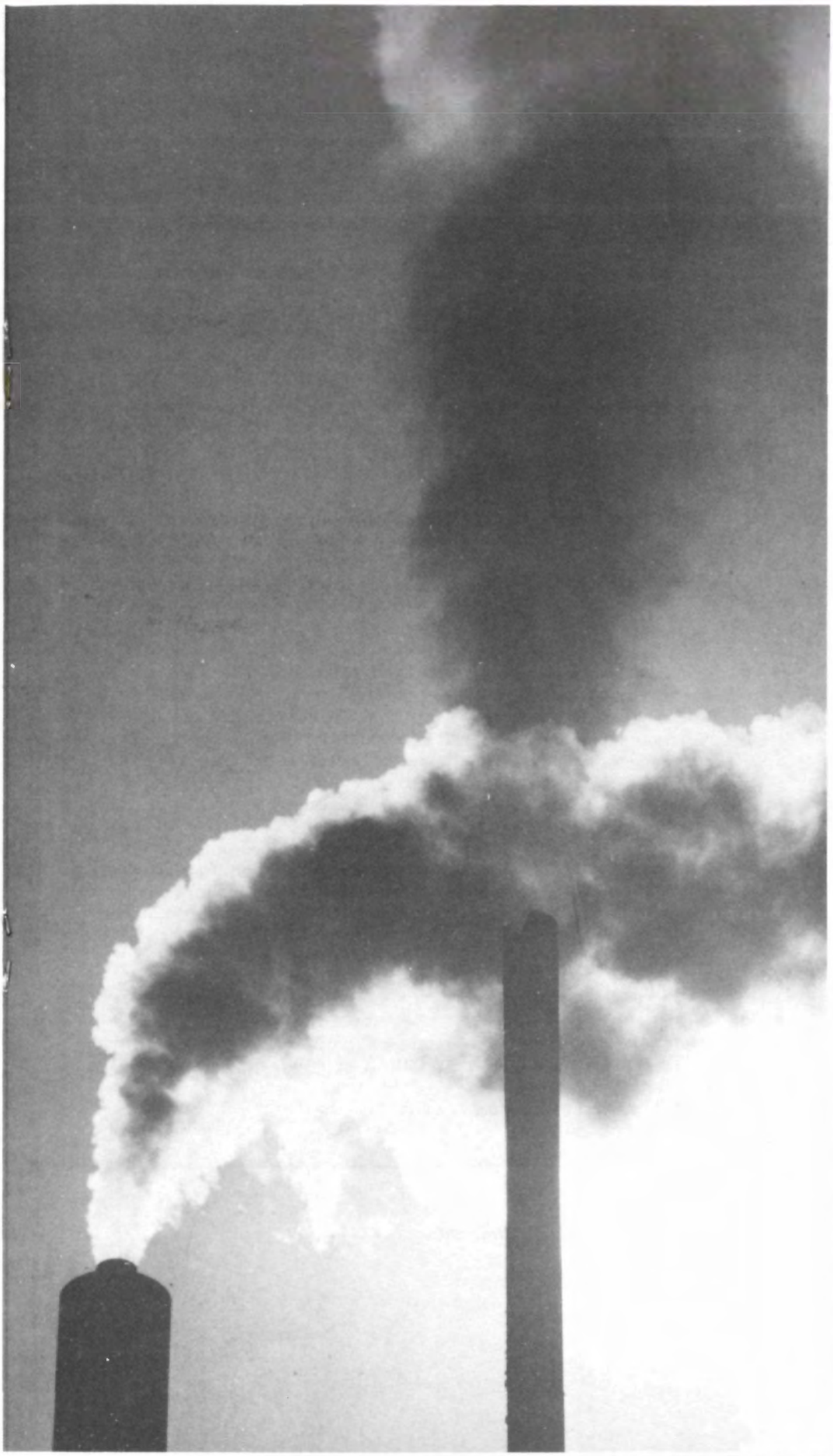
EPA management believes that the Agency, along with industry, environmental groups, and state and local governments, has a responsibility to help the public understand the significance of hazardous substances in the environment. We must do more than simply collect and verify the information and make it available.

Under Sections 301-303 of Title III, states and localities have established state emergency response commissions and local emergency planning committees to receive and handle community right-to-know information required by the law. Section 302 requires facilities (manufacturing plants, distributors, farmers—anyone storing more than a specified quantity of any of 406 chemicals listed as "extremely hazardous" by EPA) to report the presence of those chemicals to their local emergency planning commission. Thousands of facilities will be reporting this year. They must also report accidental releases of hazardous chemicals under Section 304, provide on-site inventories of hazardous chemicals under Sections 311 and 312, and provide other chemical-specific information.

The local committees are required to make the information available to the public and to develop emergency plans in the event of a chemical accident. EPA is working closely with the state commissions and local committees to provide guidance for interpreting and understanding the meaning of all of the information reported under Title III.

Communicating information on the risks posed by hazardous chemicals, however—in toxic waste dumps, in consumer products, or in the air, water, and soil from industrial emissions—is not easy. Different perceptions of risk, conflicts between new information and existing beliefs, and mistrust of the people or institutions doing the communicating can be extremely difficult to overcome.

To meet these communications challenges, EPA is developing a number of programs to help inform and educate community leaders, the news media, and citizens about the relationship between toxic substances in the environment and human health. For example, in keeping with the Right-to-Know law's emphasis on community awareness and decision-making, EPA, through its regional offices around the country, is attempting to provide states—and ultimately local health agencies and other public officials—with technical tools and training to help them evaluate public exposure to toxic chemicals. This is intended to help them estimate the degree to which toxic releases may pose a threat to their state's or community's well-being; rank the problems in order



James Douglas, Woodfir Camp Inc.

Under Right-to-Know provisions in a new law, people will receive a lot of information about discharges of hazardous chemicals in their communities.

of priority; and then make informed choices about courses of action based on the values and needs of their citizens.

By itself, hazardous release data from the Title III reports means very little in terms of human health. Along with emissions information, at least two other sets of data are needed to set priorities for managing risk. They are a chemical's toxicity—its ability to cause adverse health effects at specific concentrations—and the degree of public exposure to the chemical—in air, water, or food. Some toxicity information is already available on many of the chemicals and chemical categories whose presence and release must be reported under Title III. EPA will make that information available to state and local officials and the public as quickly as possible. At the same time, EPA plans to step up its efforts to define the toxicity of other substances which have not yet been thoroughly evaluated.

Determining the level of exposure to particular chemicals is, in some ways, even more difficult than assessing their toxicity. One method is to take measurements at various points near a known or suspected emissions source, and then relate the results to the size of the local population. This kind of monitoring, however, is expensive and time-consuming. Many measurements must be taken because exposure levels can vary under different atmospheric conditions or at different times of the year.

Another method of determining exposure involves computer modeling. Here sophisticated techniques are employed to relate reported or measured emissions to atmospheric, climatological, demographic, geographic, and other data in order to predict a population's potential exposure to a given chemical. EPA has been working for many years to develop, refine, and expand these computer modeling programs. One system developed by EPA's Office of

Determining the level of exposure to particular chemicals is, in some ways, even more difficult than assessing their toxicity.

Toxic Substances, the Graphical Exposure Modeling System (GEMS), integrates many other modeling programs in a single "user-friendly" package, complete with graphics and mapping capabilities. GEMS, already in use throughout EPA, in 21 states, and in two European countries, shows promise for application to the toxic emissions data—especially after the data have been evaluated and steps taken to improve their reliability. We are now considering ways that GEMS (or a similar system) might be used, at least initially, as a broad screening tool to identify areas that might warrant closer scrutiny by state and local officials.

Like emissions data, chemical toxicity information, exposure estimates, and risk evaluations are subject to many uncertainties. But by making technical tools like GEMS and chemical toxicity information available to state and local authorities, and by conducting a public education effort to inform the American people about the relationship between toxic chemicals and human health, EPA hopes that public concern and attention will begin to focus on the particular chemical hazards that pose the most serious threats.

Armed with the information required by the Community Right-to-Know law, including the emergency preparedness plans required by sections 302 and 303 and bolstered by a better public understanding of the significance of toxic chemicals in the environment, America's communities should be much better prepared than they have been in the past to make informed, reasoned risk management decisions that will best reflect the needs and values of their citizens. □

(Elkins is Director of EPA's Office of Toxic Substances.)

Who Must Report?

Title III, or the Emergency Planning and Community Right-to-Know Act of 1986, requires a variety of reports to citizens on the chemicals being produced, used, or stored in their communities—including releases of hazardous chemicals into the environment.

Here is a brief summary of Title III reporting requirements:

- All facilities that have on their premises specified quantities of chemicals designated under Title III as "extremely hazardous substances" must cooperate with state and local planning officials in preparing comprehensive emergency plans (Sections 302 and 303).
- Facilities that produce, use, or store specified hazardous substances must report accidental releases of those substances above certain quantities to state and local response officials (Section 304).
- All facilities that are required to prepare Material Safety Data Sheets (MSDSs) must make them available to state and local authorities. They must also report to local and state officials on inventories (including locations) of chemicals on their premises for which MSDSs exist (Sections 311 and 312).
- Some facilities must file annual reports on industrial releases of toxic chemicals into the environment. A facility is covered by this requirement if it is a manufacturing facility in Standard Industrial Classification (SIC) codes 20 through 39; has ten or more full-time employees; and either used more than 10,000 pounds of one of 329 chemicals and chemical categories during the previous year, or manufactured or processed more than 75,000 pounds of a listed chemical during the year. (The reporting threshold for manufacturing and processing drops to 50,000 pounds for reports covering 1988 and to 25,000 pounds for 1989 and thereafter). (Section 313)

To obtain more information about reporting requirements under Title III, call EPA's Title III Hotline, 800-535-0202

Peter Garfield, Folio Inc.

The possibility of health-threatening radon concentrations in some homes presents EPA with a major challenge to communicate information that will help people make their own risk management decisions.

Risk Communication: Getting Out the Message about Radon

by Ann Fisher

EPA cannot use its traditional regulatory tools for some environmental risks. Instead, the Agency has to explain the risks that people face so that, as individuals, they can make their own risk management decisions. Radon is one of these cases. The radon example illustrates many of the difficulties that individuals face in dealing with risk and that agencies, including EPA, have in communicating effectively about risks.

EPA's Office of Radiation Programs estimates that radon causes 5,000 to 20,000 lung cancer deaths each year in the United States. Radon is a colorless, odorless gas that seeps into homes from the soil beneath them and sometimes from the water coming out of faucets. EPA has no regulatory authority over

People can be expected to take action only if they know about their risks and what they can do to protect themselves.

radon in homes, so the Agency's program has relied primarily on a strategy that encourages voluntary risk reductions by individual homeowners. The radon program is one of several nonregulatory EPA programs that are encouraging voluntary actions to reduce risk.

But people can be expected to take action only if they know about their risks and what they can do to protect themselves. In the case of radon, we must alert people to the possibility that they *may* be at risk, and the only way they can find out is to have their homes tested. People also need to know *how* to test their homes and *what* they can do to reduce risk if test results show elevated radon levels.

It is not always clear what strategy will be best for communicating such information. For instance, the state of Maine distributed pamphlets about radon to people who had their homes tested. Most of these homes had radon levels below those where EPA recommends taking action, and a follow-up showed that many residents perceived their risk to be even lower. Paradoxically, nearly half of them had done something to reduce their radon exposures. However, just as many people with low radon levels were taking remedial stops as were these with houses having high radon levels. This means that some people were spending money to reduce very low risks, while others were not doing anything about very high risks from radon.

New Jersey feared that its Department of Environmental Protection would be overwhelmed by requests for information and assistance because of extensive media coverage about radon in the Reading Prong (which includes part of New Jersey). However, a study there showed that very few people had even considered testing; apathy was much more of a problem than undue concern.

EPA has faced real difficulties in attempting to reduce radon's health threat. The Agency lacks regulatory authority in this area, and evidence about the effectiveness of existing information programs has been discouraging. The urgency of the public health threat led to EPA's accelerated development of a booklet called *A Citizen's Guide to Radon* (OPA-86-004). This publication was designed to raise awareness and explain how people could test their homes. EPA also published three booklets about mitigating risk: *Radon Reduction Methods* (OPA-87-010), for the general user; *Radon Reduction Techniques for Detached Houses: Technical Guidance* (EPA/625/5-86/019), for those who want more detail; and *Removal of Radon from Household Water* (OPA-87-011), for the relatively small share of homes where elevated radon comes from water.

Recognizing the uncertainties about how to set up an effective information program, staff at EPA headquarters, several EPA regional offices, and state environmental agencies have been evaluating different approaches for communicating about radon risk. For a monitoring study in New York, EPA developed four experimental booklets that express radon risk in different ways. Along with their home's radon test results, homeowners participating in the study were sent one of these booklets, an EPA's *Citizen's Guide*, or a single-page fact sheet.

The homeowners are being interviewed both before and after receiving the risk information. These "before and after" interviews are intended to assess what people know about radon, their perceived radon risk, their desire for additional information, and ultimately their decisions about reducing their radon exposure. Preliminary results show that the *Citizen's Guide* performs reasonably well, but can be improved. The fact sheet caused undue concern, and no longer is being used. The final data set concerning these homeowners will be gathered next summer and will be used in revising the *Citizen's Guide*.

A study in Maryland is examining how to motivate people to test for radon in the first place. (Homeowners in the New York study had been contacted by the state, which sent free monitors to those who agreed to participate.) A multi-pronged approach is being tested in two cities. It will use posters, public service announcements on radio and television, and leaflets distributed along with utility bills and in doctors' offices, in addition to the official EPA booklets listed above. One of the cities also will have intensive public outreach, with slides and script for use by community organizations. A third city will serve as a control, with no information program. Interviews before the information program and afterward will measure increases in awareness of radon and its risks, whether people decide to have their homes tested, and their plans for mitigation. The results should indicate how effective it is to have multiple sources communicating about risk and reaching people multiple times.

These studies are focused specifically on radon, and their results will help EPA improve its radon information program as a way to reduce the health risks from this potentially dangerous gas. At the same time, the results will guide other information activities that are designed to reduce risk through voluntary action on an individual basis as an alternative to regulation. □

(Fisher is a senior economist and directs risk communication projects in EPA's Office of Policy Analysis.)

On the Firing Line:
The Challenge of Environmental Risk in Region 8

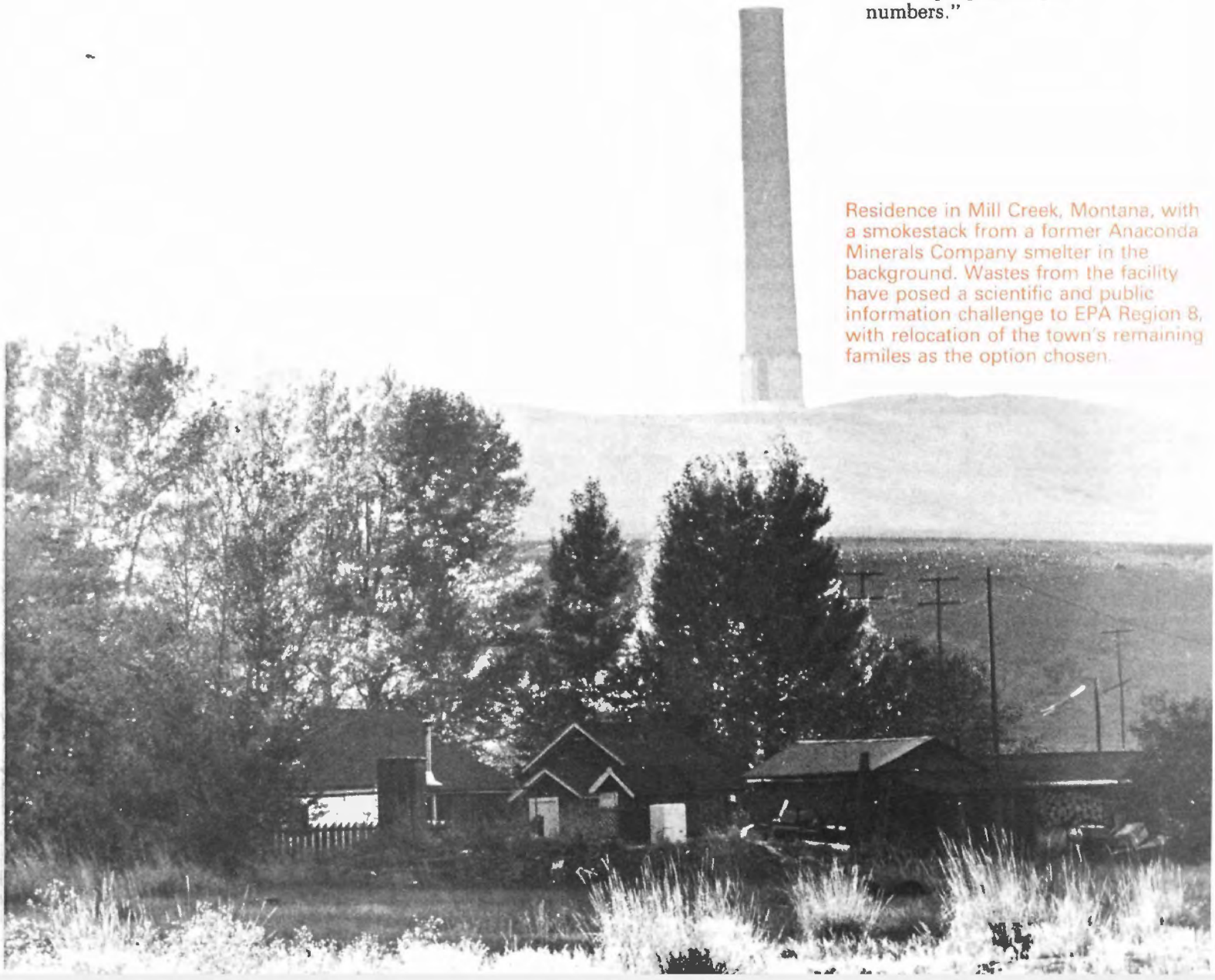
by David Wann

The telephone rings often in EPA toxicologist Suzanne Wuerthele's office in Denver. This time it's a citizen whose house was recently sprayed with the pesticide chlordane, and who has heard on the news that chlordane's use will be restricted and phased out.

"The people who call me often want yes/no answers: will substance X give me cancer or won't it?" Suzanne said. "The problem is, only God can give you zero or 100 percent probability. We try to provide the public something in between."

The caller about chlordane is one voice among many:

"Would you drink this water?"
"My constituents demand clean, healthy air."
"How can you justify closing our plant when 300 jobs will be lost?"
"We're people, not just numbers."



Residence in Mill Creek, Montana, with a smokestack from a former Anaconda Minerals Company smelter in the background. Wastes from the facility have posed a scientific and public information challenge to EPA Region 8, with relocation of the town's remaining familes as the option chosen.

Rich Simpson, The Montana Standard

"Only God can give you zero or 100 percent probability. We try to provide the public something in between."—Suzanne Wuerthele.

The common thread running through these concerns is risk, particularly risk which happens involuntarily. At the heart of environmental decision-making at EPA's regional level is the stark reality of actual people and their needs, side-by-side with an almost infinite variety of circumstances: each site or occurrence is unique.

When risk assessments are made at a national level to set guidelines, create legislation, or make management decisions on a national scale, those "five cancers in a population of a million over a 70-year period of exposure" are hypothetical and anonymous. But when applied to real-world decision-making, human faces begin to emerge from the midst of the numbers.

As Region 8 Deputy Regional Administrator Alexandra Smith puts it, "Here in the Regions is where the rubber hits the road." Decisions have to be made as quickly as possible, yet often without absolute scientific certainty. As EPA toxicologist Jim Baker explained, "Sometimes we have only two data points, sometimes 200, but we never seem to have as many as we'd like to have."

Inevitably, when the issue is a hot one, the scientific, probabilistic nature of risk assessment tends to float like a tiny boat on a sea of human emotions.

One such issue is the proposed incineration of mixed radioactive and hazardous wastes at the Department of Energy's Rocky Flats plant just north of Denver. Nat Miullo, EPA coordinator on the project, explained, "Three separate risk assessments (including the Department of Energy's assessment) are now being juggled by the public. One of them, generated by a coalition of scientists who live near the plant, disputes the point assessment made by the Centers for Disease Control (CDC) and the Colorado Department of Health (CDH), alleging that CDH's analysis underestimates risk by 160 billion times. But the coalition's assessment is based on a worst-case scenario which assumes that a 'domino effect' of nearly impossible events will occur at the same time."

Miullo continued, "The problem with this sort of assessment is that the word 'probability'—used in a statistical context—becomes a 'strong possibility' in the mind of the public. Misperception becomes reality." He emphasized the absolute importance of starting with reasonable assumptions.

"The coordination among the primary players—in this case EPA, other federal agencies, the State of Colorado, local governments, and citizens—is crucial in the beginning stages of a risk assessment. We need to know where the data are coming from—how they are gathered and how they are reported. And we have to make sure the right questions are being asked: How much air does the average person really breathe? What are the meteorological conditions? What is the probability of a worker tripping over a monkey wrench and somehow flipping the wrong switch?"

In the tiny mining town of Mill Creek, Montana—located near the Anaconda Minerals Company copper smelter—one of the more critical risk assessment variables turned out to be, "How much soil does the typical child ingest over the course of a year's play?"

Between 1884 and 1980, Anaconda produced more than 185 million cubic yards of tailings as well as other wastes such as flue dust. These wastes contained not only arsenic, which at low levels poses a clear-cut risk for producing skin and lung cancer, but also lead, cadmium, copper, and zinc. The possible interaction of these metals and their cumulative health effects posed a scientific challenge to Region 8 personnel and EPA contractors.

The fundamental question which had to be answered was, "How many are exposed to how much health risk from which interacting contaminants?" Because the area is extremely dusty, Mill Creek's houses and furniture had become contaminated, and because of the inevitability of re-contamination, the houses were judged by EPA to be uncleanable.

When lab tests revealed elevated levels of arsenic in the urine of resident pre-school children, it was indisputable that something had to be done. After cost estimates for the removal of millions of tons of soil were weighed against costs of relocating the residents of Mill Creek, relocation emerged as the best option. The management decision was a clear one, but only after an

"in-the-trenches" assessment had been carefully performed.

Jim Baker explained, "Two apparently identical mining waste piles in different towns may post completely different risks, because heavy metals in one pile are in a soluble form, while those in the other are not. Or one of the piles may be located near a school or over a groundwater source. Citizen response is also highly variable. Old-timers in a mining town which is being considered as a Superfund site may regard the tailings piles as a bit of Western history, something they played on as children. They may bitterly resent the state and federal "interference," which they feel will lower their property values.

Baker added that each geographical area has its own unique characteristics, which make a generic assessment impossible. "In the West, for example, we have arid conditions, high altitude, and a lot of mining and agriculture. On 362 days of the year, a certain lazy prairie steam may be nearly a dry creekbed, but the other three days a year it's 10 feet high and eroding everything in its path."

Exposure assessments and risk characterization are areas in which the regions' involvement is indispensable. Typically, regional risk assessors overlay site-specific data on generic dose-response data which have been generated by EPA labs, National Institute of Occupational Safety and Health labs, or CDC to arrive at an assessment for a particular site.

This approach was taken at an unorthodox Superfund site in Denver consisting of 44 separate properties contaminated by wastes from radium, vanadium, and uranium processing operations conducted early in this century. After an extensive exposure assessment, the existing risks for the sites were determined to be small. However, if the material is ever disturbed or if buildings are built and occupied on top of the tailings, those calculated risks will skyrocket. In this case, risks to future populations were heavily considered in decision-making. Removal and long-term isolation of the material has been proposed as the most protective solution, since radium has a half-life of 1,600 years, and on-site isolation of the wastes was judged to be highly uncertain in a developing urban area.

In Minot, North Dakota, in April 1987, EPA's Emergency Response Branch did not have the opportunity to deliberate over future risks. A warehouse stacked to the roof with agricultural chemicals in anticipation of the coming growing season caught fire, raging for four hours and then smoldering for the next couple of days.

Floyd Nichols, the emergency response on-scene coordinator, recalls that "Nobody got any sleep for about four days" while an inter-agency team grappled with finding the best solution. Because the receiving waterway, the Souris River, flows into Canada, the problem had international implications. EPA cooperated with the Manitoba government, the U.S. Coast Guard, OSHA, the State of North Dakota, the responsible parties, and others to bring about a swift, effective solution.

Nichols said, "Sometimes our actions had to be by trial and error as we were laying out an action plan, but we reached consensus on a containment and cleanup procedure within two days, with the responsible party agreeing to pay the bill."

He added that one of the concerns in coming up with a solution was making sure they weren't doing more than they had to. "We were very much aware of the fact that over the next several days we'd be authorizing the expenditure of two or three million dollars."

The response to the Minot fire was greatly enhanced by the work of an EPA bioassay team which happened to be in North Dakota at the time, and was dispatched to Minot. Using ceriodaphnia (a tiny, shrimp-like bioindicator), fathead minnow, and algae tests, the aquatic toxicologists pinpointed the degree of toxicity in water which had been pumped into temporary holding tanks. They also trained the State of North Dakota scientists in bioassay methods which the state has since used elsewhere.

Bioassay techniques are a valuable piece of Region 8's strategy to reduce environmental risk as well as health risk. Because of the quick, conclusive results which are possible, bioassays offer an excellent means of evaluating entire watersheds. If contamination is discovered in a river, for example, the pollution source can be traced back upstream with short-term bioassays which give definitive results within several days.

The need for techniques which steamline the complexities of risk assessment is also reflected in the Integrated Environmental Management Project (IEMP) which is now underway in Denver. This project, like its predecessors in Philadelphia, Baltimore, and Santa Clara County, California, will use risk assessment techniques to focus on the relative risks of local problems, with heavy participation from local decision-makers and leaders from Denver's business, scientific, citizen, and environmental communities.

Several of the key questions Denver's IEMP will attempt to answer are:

- Does local perception of the worst environmental problems correlate with scientific judgment of the risk?
- Are the various institutions which oversee pollution reduction coordinating their efforts effectively?
- How do cancer risks from compounds studied in the project compare to the overall risk of cancer in the metropolitan area?
- Do the relative risks from toxic air pollutants appear to be greater than the health risks from abandoned hazardous waste sites?

The conclusions reached by the Denver IEMP will help Region 8 and other EPA regions evaluate and manage risks. The cross-media and intergovernmental aspect of the project is intended to broaden agency perspectives on risk reduction by acknowledging two postulates which keep surfacing in EPA's regions: "Everything is interconnected" and "Every place is somebody's backyard."

In the regions, direct contact with the public as well as with the unique features of each site characterize risk decisions. Working "in the trenches" alongside state and local personnel, it sometimes seems to EPA scientists, engineers, and managers as if the inherent complexities result in "three steps forward and five backwards." But while risk assessment can rarely offer complete certainty on a given issue, it does help enable another three steps forward. □

(Wann is a technical writer in the Office of External Affairs, EPA Region 8.)

On the Firing Line:
Risk Management in the Santa Clara Valley

by Nancy Ianni and Keith Hinman

Residents of California's Santa Clara Valley can look forward to a better protected environment in the years ahead, thanks to alert and concerned local governments and community leaders, and to EPA's Integrated Environmental Management Program (IEMP). The IEMP combines risk assessment, management, and communication to help determine the Valley's environmental goals.

In the late 1970s the area—known as "Silicon Valley"—was blossoming under a booming high-tech economy that seemed to be free of the air and water pollution problems common to smokestack and other heavy industries. "Silicon Valley" was seen as the environmentally safe, high-tech industrial wave of the future.

Then, in 1981, the future was clouded by discovery of a serious industrial chemical leak from an underground storage tank belonging to a San Jose semi-conductor manufacturer. The tank was leaking TCA, an industrial solvent. As concern about this single incident and its potential impact on ground water mounted in the news media, other firms, directed by the Regional Water Quality Board to investigate their storage and waste disposal systems, found hundreds of other fuel and industrial contamination sites. Dozens of drinking water wells were affected.

As the Water Quality Board gathered the samples from the various locations and detected the different pollutants, EPA scientists joined in the burgeoning Valley-wide risk assessment process that grew in response to public alarm about contamination of the water supply and the possibility that drinking the contaminated water could cause birth defects. Their role was to try assessing the levels of contamination and their potential health impacts, while Santa Clara County and local municipal officials joined with citizens and industry groups to develop new local ordinances controlling the handling and storage of hazardous materials. They were among the first in the country to respond to a regional pollution risk assessment with locally developed risk management regulations governing hazardous materials.

In 1983, the EPA saw in the Santa Clara Valley a unique potential laboratory for experimenting with the Agency's new IEMP approach. The area was actively concerned with its environmental problems, and the industrial infrastructure and pollution situation were different from those to the east, where ground-water considerations were less related to industry. When EPA proposed the project, the local leaders were receptive; after all, the Valley residents had already mobilized to deal with their environmental problems in a constructive way.

EPA hoped to use the risk-based IEMP approach to foster management decisions that were more directly linked to specific *local* environmental results than traditional approaches based on state or federal regulations targeted at a single medium such as air or water. The project hoped also to compare a wide range of environmental problems and set management priorities, using a common measure of risk to human health. From the outset, the project was conducted through an open process involving an active dialogue between the community leaders and federal, state, and local regulators.

Among the IEMP's major successes was the integration of state, local, and federal government agencies into a common effort, although this was not one of the project's primary goals. As a result, even though the IEMP had no authority to enforce its recommendations, the implementing state, county, and regional agencies involved have taken them seriously. A number are already in the process of being implemented, and local funds have been appropriated to form a new Santa Clara Valley Toxics Policy Council to promote consistent policy, evaluate programs, target issues for attention, and serve as the unified voice of the region to state and federal agencies. This is especially important because of the large number of local governments involved.

The Council would continue many of the positive aspects of the IEMP: centralized consideration of environmental issues, an open process involving the public, and development of policy by consensus. The key difference between the Council's future role and the pre-IEMP days is that the Council will be an official, permanent body, marking the transition from a pilot project to an ongoing program.

On the other hand, one of the project's ambitious early goals—obtaining specific scientific confirmation of the potential risk of birth defects from toxics in the water supply—was not achieved. EPA laboratory tests and epidemiological studies were unable to generate the data. Scientific risk assessment could not, for example, prove that the TCA from the industrial spill that started it all would or would not cause birth defects.

This, in turn, related to another key IEMP goal, determining whether the esoteric-seeming techniques of risk assessment and risk management could be used as practical management tools. As it turned out, the sophisticated analytic approaches did not always fit local needs for quick, short-term decisions about beefing up controls or standards for environmental damage prevention, nor were the results of such studies readily understandable to participants in public hearings. They found the time required for risk assessments, cost-effectiveness analysis, and program evaluation frustrating, given what they saw as a pressing need to take action. Some were disappointed by the complexity of EPA analyses and the substantial uncertainty surrounding risk assessment estimates. They had hoped for simpler and more clear-cut findings.

Nevertheless, the IEMP has been fairly successful in combining analysis and public process to produce practical proposals for improvements in environmental management.

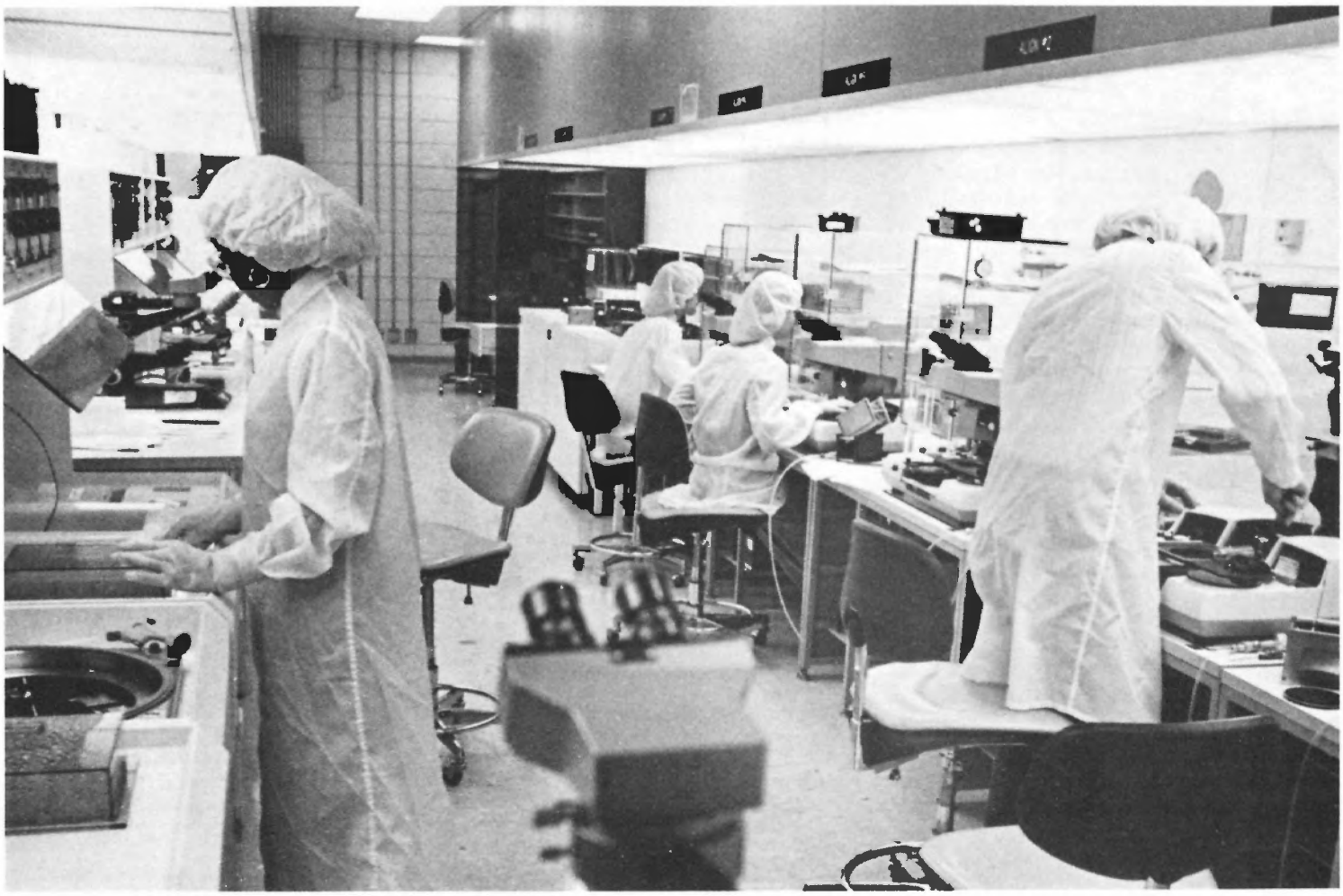
• A major project achievement has been the communication to local citizens and leaders of the best available information on health risks from toxics. As a result, area officials, community leaders, the news media, industry, and public interest groups, today have a sounder and more consistent understanding of the Valley's environmental problems than they did four years ago. While there are still debates over whether TCA causes birth defects and more controls are needed, the area has moved from policies driven by frightening newspaper headlines to more rational policies based on facts and analysis.

• The IEMP helped place ground-water contamination in perspective and refocus a general anxiety about health risks from ground water into specific areas where constructive action could be taken in relation to users of small private wells. It also emphasized the importance of ground-water protection and management so that not only health but potable future water availability is considered. The project also made recommendations for improved ground-water management through efficient and coordinated prevention, cleanup, and user-protection programs, including ground-water protection zones to restrict activities that threaten vulnerable resources, and addressing Valley-wide resource impacts and health threats while developing the cleanup policies. Strengthening the county and local toxics disposal and storage ordinances was also recommended.

• As a result of its multi-media approach, the project also focused attention on air pollution and forced the Valley to face up to the way automobiles were producing smog and creating growing health risks as ozone and carbon monoxide levels began to rise in the area. The California State Implementation Plan is being reviewed with these findings in mind, and improvements in local air pollution controls are being sought. The project also recommended that air toxics and criteria pollutants be simultaneously considered in future regulatory development.

Effective management of environmental toxics cannot take place unless the people affected are educated about risks and the trade-offs involved in controlling them, and are empowered to make their own decisions. While the IEMP has been time-consuming, at times frustrating, and often controversial, it has done the Santa Clara Valley an invaluable service. It has moved the community several steps closer to understanding and controlling its environmental destiny. □

(Ianni is a member of the San Jose City Council. She chaired the IEMP's Intergovernmental Coordinating Committee. Hinman was EPA's Project Manager for the Santa Clara Valley IEMP; he is now an Environmental Specialist in Region 10.)



Workers in a high technology industry in Santa Clara Valley, California. Often thought to be environmentally clean, some high-tech firms in the Valley were linked to ground-water contamination, which triggered an EPA-local effort to understand and manage the risks.

San Jose Mercury News

From the Outside:
An Environmentalist's View

by Ellen Silbergeld

Manufacturing paper. Recent findings that commonly used paper products could possibly contain tiny concentrations of the toxic chemical dioxin raised questions about how environmental risks in products in wide use can be assessed and managed.

Risk assessment has become an increasingly controversial subject in environmental policy. As process, it remains inaccessible and hence unintelligible to many concerned with environmental issues. To the public, risk assessment is viewed empirically, that is, in terms of the results which are associated with its application. In that setting, it suffers from the general view, among the public, that the last decade at EPA has been characterized by inaction and evasion except in those areas where legislation has compelled decision-making as in the hammer provisions of Resource Conservation and Recovery Act (RCRA) and Superfund. Risk assessment in connection with regulatory activity under the Clean Air Act, the Clean Water Act, or the Toxic Substances Control Act has certainly not been associated with a great deal of action or risk reduction using these statutory powers. Moreover, risk assessment is frequently viewed as operationally coupled with cost/benefit analysis, or the economic valuation of risk reduction actions.

Because the public in general, its doubts confirmed by several recent court decisions, does not accept an accountancy approach to environmental regulation, this joining does not help the image or acceptability of risk assessment. Industry, on the other hand, seems to be increasingly opposed to risk assessment because of its alleged extreme conservatism, and because its use appears to be a relatively inflexible source of very low regulatory numbers, which, if ever applied in regulation, would support extremely stringent control actions. State authorities are in many instances unhappy with EPA's strong endorsement of risk assessment because of fears as to the resource requirements necessary to develop, interpret, and enforce risk assessment-based regulations. These resources are not well distributed through the country; Connecticut's recent misadventures with misunderstanding the nature of cancer risk assessment demonstrates the pitfalls of uninformed decision-making.

Given this lack of acceptance, it may be surprising that the issue of risk assessment is still being discussed. At its simplest, risk assessment is no more than a consistent methodology to do two things: incorporate the results of experimental toxicology, and develop estimates of appropriate goals for regulation or cleanup. It is not clear that risk assessment can go beyond those goals. It is, moreover, extremely limited. Quantitative risk assessment, by which is meant the process of generating relatively precise dose: response information, is presently limited to assessing the risk of cancer.

All other types of risk are generally only qualitatively evaluated; in such arenas, arguments over types of models and extrapolation assumptions do not arise. Unfortunately, very little real consideration of non-cancer endpoints is undertaken and a kind of toxicological Gresham's Law operates, where bad regulatory toxicology drives out good, and other endpoints—which may be much more conclusively demonstrated for a particular chemical—are neglected in the argument over quantitative cancer risk assessment. For instance, many years have been lost debating the carcinogenic properties and quantitative risk assessment of formaldehyde and dioxin; yet these two chemicals have very clearly identified effects on the immune system (both), the nervous system (formaldehyde), and reproduction (dioxin).

Given this lack of acceptance, it may be surprising that the issue of risk assessment is still being discussed.

Currently, EPA seems to be sending mixed messages about risk assessment. On the one hand, EPA has recently promulgated Science Advisory Board-reviewed guidelines for risk assessment, which represent consensus scientific opinion as to appropriate statistical methods and interpretation; on the other hand, EPA, in specific risk assessments, inserts so much hesitation and qualification in the name of "scientific uncertainty" that it becomes impossible to determine the Agency's actual position. It is this kind of double-dealing with risk assessment—its methods and results—which keeps the public from accepting this approach.

Scientifically, the most unfortunate result of risk assessment as practiced by EPA is to make assumptions as to biological mechanisms overly rigid. For instance, in cancer assessment, demonstration of initiation properties such as mutagenesis has become all-important. Thus, for risk assessment purposes, chemicals are forced into a dichotomy of causing mutations or not (what people frequently refer to as genotoxic and non-genotoxic or epigenetic).

This dichotomy is not scientifically valid. First, chemical carcinogenesis is a complex process, involving many stages and cell events. Second, epigenetic events affect the gene, even if they do not cause mutations, and certain epigenetic effects can be inherited. Some of these current assumptions about cancer risk assessment have been made more for the convenience of computer modelers, number crunchers, and statisticians as opposed to biologists. These assumptions will have to be revised to incorporate new information on hormone-like activities of chemicals, activators of incipient cancer-causing genes known as proto-oncogenes, immune suppressants, and other complex actions that relate to the overall process of carcinogenesis in the organism.

If EPA is concerned to make risk assessment more accessible to the public, and to increase public understanding and acceptance of this methodology, the Agency should refrain from accompanying every risk assessment with the extensive litany about the risk of everyday life and uncertainty, which is currently invoked in almost all *Federal Register* notices and public statements. Second, the Agency should devote more resources to developing ways to identify and evaluate the risks of noncarcinogenic chemicals. Third, EPA should consider the gaps between its assessments of risk and its record of actions to reduce these risks. Only when these processes appear more in line can there be reasonable expectation that the public will see empirical value in the process, and only by accepting this value will the public be committed to participating in the risk assessment and risk management process. □

(Dr. Silbergeld is Chair, Toxics Program, for the Environmental Defense Fund.)

From the Outside:
An Industry View

by Robert C. Barnard

How does industry view scientific risk assessment? Industry's attitude, I believe, stems from a basic position that public health policy should be based on the use of the best and latest scientific data and understanding to identify and control health risks. This position is based on the principle that scientific evaluation of the character and magnitude of the risk—scientific risk assessment—provides the best and most informed input for regulatory decisions and for communicating with the public on risk.

We all understand that there are two basic motives for communication: one is manipulative, the other is educational. Scientific risk assessment is the basic educational tool that provides the risk manager in government and in industry with the basic information for sound decisions on how to control risks. Risk assessment is also the soundest educational tool to inform the public about risk.

Practical Considerations

There are a number of practical considerations that enter into industry's support of risk assessment and its support of efforts to improve the process.

Economic Issues: The fall 1985 issue of the National Academy of Sciences magazine *Issues* reported a study showing that the cost of managing risk in the United States in 1978 amounted to seven percent to 12 percent of the gross national product. Half that cost reflected damages or injury compensation; the balance was the cost of controlling risks. In real terms, many companies are devoting 10 percent of capital budgets and equivalent proportions of research budgets and technical personnel to deal with risk management problems.

These figures are not cited because they are too low or too high. Costs of this magnitude—and they have increased significantly since 1978—explain why industry supports efforts to ensure that the best scientific data are used so that controls are appropriate—that is, reasonably related to the true magnitude of the risk involved.

Communication Issues: The soundness of both the public perception and the risk manager's decision on products and controls depends on whether the risk assessment gives the best and most complete information science can provide on the potential risk. Arthur Hays Sulzberger, former publisher of the *New York Times*, put the matter very bluntly in a comment that applies to both newspaper and scientific risk assessment:

> A man's judgment cannot be better than the information upon which he based it. Give him the truth and he may still go wrong, but give him no news or present him only with distorted data, with ignorant, sloppy or biased reporting, with propaganda and deliberate falsehoods, and you destroy his whole reasoning process.

Some Background

These general concepts can be brought down to earth if we look at the process for assessing potential human cancer risk.

The science of carcinogenesis is a young science. Dr. Lewis Thomas, Chancellor of the Sloan-Kettering Cancer Center, called his magnificent book *The Youngest Science*.

Since the early 1970s, when the "war on cancer" was announced, there has been a spectacular growth in cancer research in government, academia, and industry. Although the data base has grown exponentially, the list of human carcinogens has remained virtually the same over the past decade. What has grown are the number of substances that cause cancer at some dose in some species of animals.

Scientific understanding of the biological processes that lead to cancer has grown markedly at the same time the animal data base has grown.

Our understanding of how a substance is handled in the body—transported, changed, and excreted—and the response of both animals and man has advanced remarkably. The simple yes/no approach—an animal carcinogen is a human carcinogen—has been replaced by an increasingly sophisticated analysis to determine the relevance of the huge volume of experimental animal data to human risk.

To take advantage of the new scientific developments the analysis becomes more complicated:

- Does the animal data provide insight on the biological process that produced the cancer: mechanism, pharmacokinetics, or metabolism?
- In light of the animal data and comparative human metabolic and pharmacokinetic data, which animal study is the best surrogate for man?
- Since even the best available surrogate is not perfect, in what respects does the surrogate fall short or differ biologically from man?
- What combination of scientific judgment and risk assessment

Chemical analysis in a laboratory of the Minnesota Mining and Manufacturing Company. The lab performs assessment services that help determine the environmental impact of products and processes.

Although the data base has grown exponentially, the list of human carcinogens has remained virtually the same over the past decade.

Minnesota Mining and Manufacturing Company

The bottom line is how we can improve scientific risk assessment so that we make best use of the rapid advances in science.

methodology best uses these scientific insights to provide the "best" or "most likely" estimate of potential human risk?

What's the Problem?

The term "risk" implies uncertainty. While science has made and is making great strides in understanding the biological processes that induce cancer, we do not yet understand the mechanism or mechanisms of action. Each advance in science reduces the area of uncertainty but at the same time opens new areas for research.

How do we deal with the problems of uncertainty and how do we take advantage of scientific development?

The principal tools that EPA uses are guidelines for scientific assessment: for cancer risk, the *Guidelines for Carcinogenesis Risk Assessment*. The guidelines are a mixture of an expression of scientific objective, along with directions on methods to use to assess risk. The guidelines emphasize the importance of having a sound scientific appreciation of the true nature and magnitude of the risk. But to deal with uncertainty, the guidelines specify certain assumptions and procedures to be used in the analysis. As EPA recognizes, these are policy choices and they are sometimes called "default options." These default options are to be used in the assessment unless facts demonstrate otherwise. In practice, the default options are used in virtually all cases.

It has been said that the science is dynamic, but the default options are static. There is a tension between the default options and the use of new scientific developments.

Without being technical it helps to illustrate. For example, EPA uses a statistical procedure—known as a "model"—for estimating the impact at low doses of exposure to a substance. Normally, the doses at which an experimental animal is exposed is hundreds or even thousands of times higher than those which man commonly experiences. There is no scientific agreement on which extrapolation model is appropriate. Since alternative models use different mathematical formulae for the estimate, the choice can change the risk estimate by a factor up to 10,000,000.

The extrapolation model the guidelines select—the linearized multistage model—was chosen originally in 1980 and represented operational consensus at that time. However, the model uses only part of the data actually or potentially available: that part pertaining to tumors as a function of doses. The EPA Science Advisory Board has been recommending that EPA use the pharmacokinetic data, and EPA is exploring the use of an alternative model to take advantage of the newer data. Last summer, EPA presented to the EPA Science Advisory Board an analysis of methylene chloride that included estimates from a more advanced model incorporating pharmacokinetic data, along with the estimate from the standard model.

The choice of the data base to be used in estimating risk is also important because changes in the starting base can have a large impact on the size of the estimates. The default options also pick the data base to be used: the results of experiments using the most sensitive species. The increasing scientific understanding of the way animals and man handle and respond to a substance have revealed a class of cases where there is no doubt about the fact that the animal got tumors, but there is a question about the relevance to man. Unleaded gasoline is a good example. In that case, science has clarified the biological process by which male rats get kidney cancers, and, since the process is peculiar to male rats, that understanding has raised a serious question of the relevance to human risk. EPA is aware of the problem.

What About the Future?

The question is how best to balance the "inflexibility" of the default options with the objective of improving the scientific risk assessment by using the latest scientific understanding and data.

Risk managers both at EPA and in industry want a scientific evaluation of the hazard and the human exposure that is as accurate and complete as possible. Public perception of risk depends on confidence that the analysis has presented the most complete information science can provide.

Industry and government may not always be in step regarding how long we should cling to old concepts and when we ought to move to use new scientific developments in assessing risk. Happily, however, there is general agreement on the direction and the objective. And both industry and government agree that the objective should be educational, not manipulative. What is really being discussed between industry and government is the most effective implementation.

The bottom line is how we can improve scientific risk assessment so that we make best use of the rapid advances in science. When scientific advances are used in the assessment, research is stimulated. As we succeed in improving the risk assessment process, government, industry, and the public will benefit. □

(Barnard is counsel to Cleary, Gottlieb, Steen & Hamilton, practicing in the firm's Washington, D.C., office. He is also attorney for the American Industrial Health Council and represents a number of industrial companies.)

Environmental Journalism: Inflaming or Informing? A Forum

Some observers have accused the media of sensationalizing environmental stories. Others believe journalists are doing a good job of informing the public about environmental problems. Which point of view best conforms to reality? Are journalists whipping up needless hysteria with "Scare of the Week" coverage? Or are they accurately stating, perhaps even understating, the significance of environmental stories as they arise? EPA Journal asked three journalism professors and five environmental reporters to address this issue.

The pesticide EDB on the nightly news on national television before EPA acted to ban it. One of the major environmental stories in recent years, it was a drama which stretched over several months.

David B. Sachsman, *Chair, Department of Journalism and Mass Media, Rutgers University*

We collected the best environmental risk stories written in New Jersey in a year, and we analyzed them, using both content analysis and experts. We found that the articles were indeed more alarming than reassuring, and three of the four experts felt that the articles painted a more alarming picture of New Jersey's environmental issues than was justified by the reality. What this says to me, as a journalist and a journalism professor, is that scientists, government officials, and industry representatives do not truly understand the role of the press. It is, in fact, the business of the press to cover alarming news, and it is a natural failing of the press to ignore situations that are not alarming. So by definition, the press will always be more alarming on any issue than it will be reassuring.

(The research to which Professor Sachsman is referring is contained in a book he co-authored with Dr. Peter Sandman and Dr. Michael Greenburg. The book, entitled Environmental Risk and the Press, *was published in October 1987 by Transaction Press in New Brunswick, NJ.)*

Robert E. Taylor, *Wall Street Journal*

The media both inform and inflame. The quality of environmental reporting on environmental and health risks is as varied as reporting on arms control or any other complex topic. Officials, companies, and environmentalists often make misleading statements. Many reporters oversimplify. My

Cleaning up a beach after the Santa Barbara oil spill in 1969. This widely reported incident contributed to the environmental awakening which was taking place in the U.S.

flesh still crawls when I hear the question repeated, "Just tell us if it's safe." The question should be, "How safe, or compared to what?" But the general quality of coverage is improving, and public attitudes are changing. The lack of response to the recent discovery of dioxin traces in paper may show the public can accept low risks. On the other hand, it may show people are just tired of hearing about the cancer "threat of the week."

Philip Shabecoff,

The New York Times

Coverage of environmental issues by the national media, particularly the national print media, has become increasingly sophisticated and knowledgeable over the past decade. I think we look hard at the science and economics of environmental policy issues in ways we did not when the issues first became important news. As a reporter, I only respond to what emerges from the Environmental Protection Agency and the other sources of news that I cover, and I try to reflect accurately what is communicated to me by the Agency. The other side of the coin is that policymakers and their spokesmen in this field have become increasingly sophisticated in communicating their message to the press.

Sharon M. Friedman,

Chair, Department of Journalism, Lehigh University

While environmental reporting is not generally inflaming the public, it is not informing them as well as it should be. Particularly on the local level, there is too much concentration on short-term news events, rather than on long-term, complex environmental issues. There is little follow-up of environmental concerns; reporters do not check back later to see if an environmental problem has been resolved. The media also do not offer enough explanation of environmental risk for readers. This is particularly true for environmental stories that involve radiation. Studies we have done on local radon reporting and national coverage of the Chernobyl accident both showed that many readers lacked enough information to evaluate risks for themselves. On the bright side, even with these two potentially fear-inducing subjects, most of the newspapers we studied did not try to scare readers unnecessarily or sensationalize their articles.

Robert Hager, *NBC-TV News Network*

By and large, the reporting of environmental issues is very responsible. It's not inflammatory and it performs a very valuable public service. It is a particular challenge for us in television reporting. Often, we have to squeeze the information into just a few minutes of air time, but I think we try very hard to get in the essentials in a balanced way.

I am thinking of some recent stories where things were presented very much in perspective. For example, there was the story about traces of dioxin in paper products: it was good, balanced reporting by all concerned. There was also the National Academy of Sciences report on pesticides in food: it was presented in a very thoughtful way that wasn't sensationalized. Both of these stories gave people information that they needed to know.

Ruckelshaus always criticized us on the reporting on the fungicide EDB and I think in retrospect he was partially right; maybe EPA was forced to make the decision in an atmosphere that was heated beyond what it needed to be. I think we learned some lessons from that.

The recent treaty in Montreal to protect the upper atmosphere layer of ozone from CFCs was a remarkable example of where the public has been educated to the point where diplomats and industry can get together on a problem perceived to be well out into the future; the public understands that problem because of the extensive reporting on it. The Hartz flea tick spray story recently is another example of responsible reporting: it got coverage, but it did not get an inordinate amount, nor did the story deserve a lot.

Rochelle Stanfield,

National Journal

I think the national media try very hard to be balanced and accurate and to put things in perspective. That's what we're paid for. Perhaps some local media will take something that's controversial on the local level and treat it with blacker headlines and more dramatic objectives. But I think, if anything, environmental issues are underreported rather than overreported. It is a situation where not enough information has gotten out to the public rather than too much information or too much incitement. I don't even see it as a very heavy news area; I see environmental reporters struggling to get ink. And I don't believe we are seeing "scare of the week" kind of coverage; the only ones talking about that are industries who are upset about reporting on areas affecting them that is actually pretty moderate.

Wide World Photos

Guy Darst, *Associated Press*

Environmental journalism is more and more effectively informing the public. As we as a society accumulate experience, we are better able to get a real handle on what's important for the public to know and what is simply flashy but not that important. I think this is true of all sorts of topics, not just the environment but also public health, individual health, foreign policy, etc. New concerns come up and when a whole new cluster of issues comes to public attention, this always stimulates a scramble by people in the press to bring the *new* to public attention. This process by which the press and other institutions—Congress, advocacy groups, corporations, universities—get a handle on what's important and what isn't important has been going on in the environmental area for several years and will continue to go on.

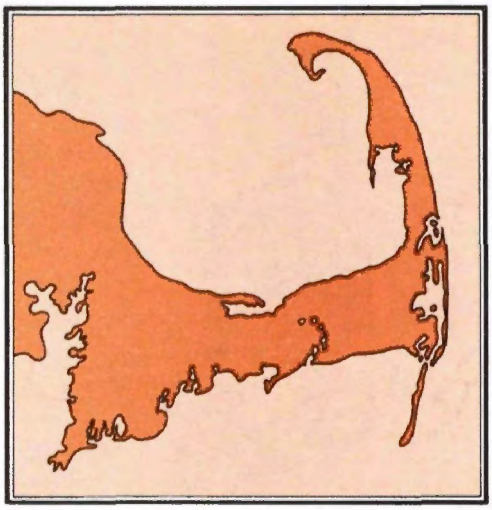
Robert Logan,
Director, Science Journalism Center, University of Missouri School of Journalism

Science and environmental coverage are more effective in larger metropolitan newspapers that have better trained reporters and more internal resources than small or medium-size newspapers. On television, coverage varies widely. The very nature of television, with its emphasis on visual impact, means that news reporting often appears to be unnecessarily inflammatory to many scientists. Television is sensational per se. I think that fact is often overlooked by television's critics.

Also, all journalists, no matter how skilled they are, have problems when there's a fast-breaking news story where the reporters have little experience with the events. When the story is new or unique and needs to be reported in several minutes, well-intentioned mistakes can be made by anybody. Many environmental stories have fit this category in the past decade. Some environmental stories happened quickly and needed to be reported immediately to calm public fears, and even well-trained reporters had little frame of reference regarding the particular chemical or other environmental issue they were reporting about. The real test of a good news organization is how well they follow up a story during the days after a major environmental event or crisis, when they have a little more time to piece the story together and the reporters develop some knowledge and expertise about the subject. □

Protecting Cape Cod's Ground Water

by Greg Supernovich



Cape Cod, Massachusetts

Tell someone your well water on Cape Cod is replenished by an underground river flowing from the mountains of New Hampshire, and your listener is apt to wonder if you've spent too much time in the sun. But such disbelief wasn't always the case. Many believed the underground river story even a decade ago. The fact that most Cape Codders now consider the story part of their folklore shows that new scientific research into ground water has dramatically changed their understanding of water supplies.

In retrospect, it seems illogical that many Cape Codders accepted the underground river story. Cape Cod is a relatively narrow sand and gravel peninsula in southern Massachusetts that curls like a flexed arm as it stretches more than 50 miles into the Atlantic Ocean. The New Hampshire mountains lie hundreds of miles to the north. Several major rivers and canals, not to mention the ocean, separate the Cape from the mountains. How could an underground river pass beneath these geographic features? Yet the story persisted.

Perhaps its origin can be traced to early native Americans who lived on the Cape after the sandy spit of land was formed by receding ice masses 12,000 years ago. Perhaps the story evolved because Cape Cod's drinking water—rain water that has filtered through natural layers of sand and gravel into underground reservoirs—tastes like cool, clear mountain water. Perhaps the legend survived because there weren't enough facts to prove otherwise.

Officials say that dispelling the underground river myth on Cape Cod and breaking down resistance to new ideas have probably been the most difficult tasks they have encountered during their fight to protect Cape Cod's billions of gallons of ground water.

"It comes down to this. If you were having a home built, you drilled a well in your front yard and dug a pit in the back and put in a septic tank. You'd be concerned. You'd want to believe in an underground river from Lake Winnepesaukee (in New Hampshire). People don't want to believe they are putting waste into their well, and yet that's the case," says Michael Frimpter, chief of the Massachusetts office of the U.S. Geological Survey.

One of the main problems, according to Frimpter, is that ground water is invisible. The challenge is to help people who draw their water from wells realize that they live on top of their aquifer—on top of their reservoir—and that whatever they discharge into the ground will likely find its way into their drinking water.

Cape Cod's aquifer is extremely fragile. Its porous sand and gravel subsurface not only allows rain water to easily recharge ground water, it also facilitates the passage of man-made pollutants into the aquifer. One toxic spill could contaminate the water of a hundred thousand people. And it would be exorbitantly expensive, if not impossible, to pipe in water from other parts of Massachusetts.

Despite this natural limitation, however, the Cape is one of the fastest growing counties in the United States. New condos, houses, and businesses are popping up everywhere. The Cape's winter population of 170,000 swells to a half-million in the summer as vacationers flock to the beaches, cottages, and resorts.

Yet, while the Cape is booming, the water supply remains constant. Cape Cod has only one principal source of water. EPA has designated it as a Sole Source Aquifer, a special federal status for aquifers that supply at least 50 percent of the drinking water for an area that has no reasonably available sources if those aquifers become contaminated.

The Cape's ground-water programs are among the most advanced in the nation. They have to be to protect the Sole Source Aquifer. Early studies of the Cape's ground water indicated that a single interconnected aquifer supplied all of Cape Cod's 15 towns.

"The people on the Cape drink from the same cup. If anyone is allowed to contaminate that cup, the contamination will remain for generations. Hence, it's in everyone's interest to keep that cup as clean as possible," says Michael Deland, EPA's regional administrator in Region 1. And even though more recent geological surveys have revealed not one, but six aquifers on the peninsula, Deland still finds the cup analogy useful. It teaches people that water issues cross town lines just as aquifers cross town borders.

EPA officials say they are beginning to see improvements in ground-water protection on the Cape, but they warn that much more needs to be done. Armando Carbonell, the executive director of the Cape Cod Planning and Economic Development Commission, says he has seen attitudes about water supply on the Cape change rapidly in recent years. "Every Cape Cod Chamber of Commerce puts ground-water protection at the top of its list," he says. "The business community recognizes its survival is dependent on the protection of its resource."

New ground-water programs have spurred the changes: Officials have spent millions of dollars studying the location and flow of the Cape's ground water. Several Cape towns have each bought hundreds of acres of land around their wells to keep the land undeveloped in order to protect the quality of the water passing through the wells' "zone of contribution." Some towns have tightened up zoning laws to prevent dense residential development or industrial growth in well-field areas. Some towns have begun to regulate and monitor underground tanks and landfills and are using less salt on their roads to melt snow. Their police and fire departments have learned to absorb spills from car accidents instead of washing the contaminants into a ditch. A few businesses have learned to store hazardous waste properly. And nearly

Teamwork

Local, state, and federal agencies may have excellent programs and regulations to protect ground water, but contaminants frequently pollute the drinking water anyway because the agencies don't coordinate their efforts.

To keep this from happening on Cape Cod, government officials are building "institutional teamwork" into the two-year Cape Cod Aquifer Management Project (CCAMP) in Massachusetts. The 35 people working on the project represent six branches of government, including EPA's Region 1 Office (Boston), the Massachusetts Department of Environmental Quality Engineering (DEQE), the Cape Cod Planning and Economic Development Commission, the U.S. Geological Survey, and the towns of Barnstable and Eastham. Their goal is to better understand how to manage ground-water protection at all levels of government through an intensive study of land-use activities around water supply wells.

Barnstable and Eastham were chosen to participate in CCAMP because together they span Cape Cod's ground-water problems. Barnstable, a town of seven villages, has a major business and population center, a wastewater treatment facility, and extensive public water-supply systems. Eastham is a rural community with only private wells, no full-time public health officer, and a primarily seasonal economy.

Some say that the CCAMP project is a national prototype. "We want to have an all-out attack. We don't want to just see landfills or underground tanks as a threat, but to ask, 'What is in that area and what will the problems be?'" says David Fierra, of EPA's Region 1.

Tara Gallagher, CCAMP project coordinator at DEQE, said that some effects of the program might be to prevent problems such as a proposal by a public works department to build a solid waste transfer station near a well, or a plan by a town to locate an industrial park near another town's well.

Robert Mendoza, director of EPA's office of ground-water protection in Region 1, said that CCAMP's wellhead protection project will probably lead to a redefinition of the "zone of contribution," which is the land area around a well through which rainwater passes into a well's aquifer. Traditionally, a 400-foot radius has been accepted as the zone of protection around public wells in Massachusetts. However, Mendoza says that DEQE is finding that this protection area in some cases needs to be a thousand feet or greater.

In addition, CCAMP's staff is expected to produce water-table maps and land-use maps, recommend where to situate facilities such as landfills and sewage treatment plants, inventory underground storage tanks, and suggest protections for private wells. The staff will also design a computer system that will display potential ground-water threats in such a way that decision-makers will be better able to see the consequences of their decisions.

CCAMP is cost-efficient. Very little money is being spent on the project. Only one new person (the coordinator) was hired. All the other CCAMP staff had already been working on related issues at their agencies. At EPA, a hydrologist, an environmental protection specialist, a computer specialist, and a manager are spending part of their work-time on the project.

every town now has a water-quality advisory committee to plan ground-water management programs.

"We still have near disasters. That's scary. What it suggests is: as smart as we've become, we have to become smarter," Carbonell says.

Thomas Mullen, the former water superintendent for 15 years at one of the four water districts in the town of Barnstable on Cape Cod, was one of the first local officials to sound the alarm about ground water. Initially, he says, he met widespread opposition; people didn't want "outside" consultants telling them how to manage their water supply. Yet the town was headed on a collision course. Its water supply and land use were in conflict with each other. Although the Cape's county government began to get actively involved in ground-water programs about 10 years ago, Mullen says that many of Barnstable's branches of town government only started their water protection efforts three years ago.

According to Mullen, one of the recent ground-water battles in Barnstable centered on Cape Cod Potato Chips, a business located 1,000 feet from one of the town's wells. The company wanted to discharge daily into the ground a large amount of treated wastewater from its potato-peeling operation. However, the ground was part of the area that contributed water to the town's well, and local officials feared that the discharge would add excess nitrates and salt to the well. As a result, they spent $5.5 million to buy and protect 65 acres of open land around the well, while also convincing Cape Cod Potato Chips to truck its waste to the town's sewage treatment plant.

Greg Supernovich

A deputy chief in one of the fire departments in Barnstable is responsible for making sure that underground storage tanks are safe and do not pose a threat to a fragile aquifer.

Many in the village of Barnstable do business differently now that there is a new awareness about ground water. The owner of a small auto tuneup station should no longer carelessly store waste oil and waste antifreeze. To prevent

Greg Supernovich

At the docks on Cape Cod. While recreation has boomed on the Cape, ground-water supplies remain the same.

spills or leaks, the wastes should be poured into drums that are placed inside other plastic drums and then strapped to a wall.

Lester Mason, a deputy fire chief who heads an underground tank program at one of the fire departments in Barnstable, also handles his job differently than he did several years ago. He is now responsible for hundreds of underground tanks holding petroleum products or chemicals, all of which must be registered, tested, and replaced when necessary. Mason is fully aware of the danger that leaking underground tanks pose to ground water. A vacant lot is no longer just an empty lot to him. It may contain buried, corroding tanks full of oil or sludge that could leak and pollute the water supply.

Ground-water vigilance on Cape Cod did not begin easily. It took several crises before people understood its importance. In 1977, 3,000 gallons of gasoline from a leaking underground tank at a gas station in Truro knocked out one of the main wells for Provincetown. Cleanup of the well so far has cost approximately $3 million. In recent years, Falmouth and Mashpee have also lost wells due to contamination from a sewage treatment plant at the Massachusetts Military Reservation.

Meanwhile, the Center for Health Promotion and Environmental Disease Prevention of the Massachusetts Department of Public Health is trying to determine the cause of elevated levels of leukemia and lung cancer in Falmouth, Mashpee, and three other Upper Cape towns. Massachusetts public health spokesman John Stobierski says that if the center finds clusters of people with cancer, ground-water contamination or air pollution may be the cause.

Other efforts are also underway. The U.S. Geological Survey is studying how bacteria and dissolved contaminants move and disperse in ground water, using ground-penetrating radar to map the elevation of the water table. And the Cape's county health department is purchasing an automated gas chromatograph to test water supplies for volatile organic compounds.

The new knowledge about aquifers on Cape Cod clearly indicates that ground water nationwide is endangered not only by steel mills or chemical plants, but by sources perceived as less threatening, such as gasoline stations, homes, the town landfill, or the local laundromat. "The prevention of ground-water contamination is a much more intelligent approach than cleanup. Cleanup is expensive," explains David Fierra, director of the water division in EPA's Region 1. "Prevention is largely a land use activity. It involves a conflict of economic development and environmental conservation. But without potable water, economic development is not possible, and people will learn that sooner or later."

Region 1 Administrator Michael Deland adds that aquifer studies on Cape Cod will prove invaluable to many other parts of New England, where 90 percent of the rural population is solely dependent on ground water for drinking water, and 77 percent of the municipal water systems are dependent on ground water. "We need to zealously guard ground water not only for ourselves," he says, "but for our children and those to come." □

(Supernovich is a writer/editor in the Office of Public Affairs in EPA's Region 1.)

The Lower Hudson: Environmental Resource in Megacity

by Tom O'Keeffe

Around the base of an ancient island-mountain created over 400 million years ago, a wide natural harbor forms where the fresh waters of the Hudson blend with the cold salt of the Atlantic. Many species of birds and fish still come to New York harbor to feed and spawn, and on the bottom of New York harbor lie remnants of oyster beds once counted among the richest in the world.

Centuries ago, Dutch sailors who dropped anchor at the mouth of the river the Indians called Muhheakunnuk reveled in a land whose woods and marshes teemed with mountain lions, bears, beaver, elk, swans, and geese. In spring, Manhattan Island was cut in half by flooding streams that flowed where traffic-choked Canal Street today forms a barrier between Little Italy and Chinatown.

There was a time when New York City's 578 miles of waterfront were the focal point of the region's economy and culture. Pier after pier of sloops, clippers, steamboats, and fishing vessels lined the harbor, alive with sailors and merchants and news of commerce from around the world. And there was talk of the day's fishing. Then, as now, the fish outnumbered the people. Besides the legendary striped bass that migrate between fresh and salt water, the waters were plentiful with white perch, shad, sea sturgeon, bluefish, tomcod, killifish, eels, menhaden, alewife, winter flounder, herring, clams, mussels, and blueshell crabs. Just out to sea, there were whales.

Much has changed since then, but despite more than two centuries of industrial pollution, overfishing, dredging, mining of the river bottom, toxic contamination, daily pumping of raw sewage, thermal pollution from power plants, and systematic destruction of marshland and river habitat, these species still inhabit harbor waters, some in surprising numbers. And, according to EPA and U.S. Fish and Wildlife Service experts, anti-pollution efforts over the last 15 years have resulted in dramatic improvements in water quality, with markedly positive effects on marine life. Continuing projects promise to restore much of what years of neglect took away.

Marshlands and Manhattan: the natural environment in the big city.

The wildlife that has survived has been able to adapt to human progress. As the wetlands they depended on for nutrients and spawning grounds were filled in, fish came to rely instead on the areas in and around the piers, where pilings slowed the water and fish could rest, spawn, and feed. This made the "interpier" area between and around docks excellent grounds for waterfowl and the migratory birds for whom the Hudson River valley is a major flyway in the spring and fall.

The shipping industry that helped crown New York "the Empire State" did not adapt as well to its changing environment. Most of it has left Manhattan for New Jersey and Brooklyn because of competing forms of transportation, growth of other seaports along the East Coast, and new technologies. Now most of the Hudson's wharves stand empty and rotting, and half-sunken ships and barges, some dating back to the 1850s, lie along the shore. Riverfront property remains vacant or the home of salvage yards, car lots, and oil drums. New Yorkers do not come here much anymore, but they would like to. Interest in redeveloping waterfront areas on the East River and the Manhattan and New Jersey sides of the Hudson River has exploded in recent years. Developers and

communities are scrambling to create a riverfront renaissance of spectacular commercial and residential properties, of fishports, marinas, and recreational areas. For New Yorkers, a condominium with a waterfront view means city lights, harbor lights, moonlight, and candlelight. A one-bedroom condominium with a fireplace, a balcony, just ten minutes from work, a marina...such places are selling instantly at regal prices.

In the planning stages or under construction are some 59 major projects on the East and Hudson rivers. In Manhattan, one success story is the South Street Seaport, whose shops, markets, and visiting sailing ships recall the romance of New York's maritime tradition, bring in tidy income for its merchants and the city's coffers, and entertain millions who visit each year.

All this development has sparked debate over the competing uses of the Hudson. The issues at stake are economic, environmental, and aesthetic, and involve the interests of industry, sportsmen, ecologists, developers, community leaders, planning officials, and fishermen.

Planners say the current development is haphazard. Because the harbor is shared by New York City and eight municipalities on the New Jersey side and comes under the jurisdiction of numerous regional, state, and federal agencies, decisions about how the region should develop are being made on an isolated, case-by-case basis with little attention being given to their cumulative effects. The result may be a patchwork of unorchestrated commercial and residential projects that place unplanned-for strains on regional transportation, utilities, public amenities, and services.

Environmentalists fear that the proposed projects could destroy fragile habitat that supports fish and birds. Key to many plans is the construction of high-rise buildings on platforms over the river on reinforced piers in an attempt to comply with the environmental restrictions on the use of fill. While developers argue that the platforms will not damage the interpier habitat, the possibilities, yet unstudied, disturb many.

Platforms, they suggest, would block light needed for photosynthesis, and water slowing down among the pillars may deposit silt that would build up and create a landfill over time. Some fear that multi-million dollar platforms that begin to fail are likely to be reinforced not with new piling but with landfill. Proposed marinas may threaten wildlife with added petrochemical pollution and turbulence.

At the root of these concerns is a lack of knowledge about how much and what kind of habitat exists in the area, and how much is needed to sustain wildlife. Knowing which areas are most important should be the first step to sound planning for development, but these critical environmental questions have so far gone unanswered. This lack of knowledge notwithstanding, waterfront land-use choices are being made, one by one, that will have a profound and permanent effect on the quality of life for New Yorkers now and in the future.

Out on the docks, there is the wail of gulls and the smell of money.

These choices are being made in a tangle of overlapping local, state, regional, and federal jurisdictions whose decisions often seem to check and countercheck each other. Most Clean Water Act Section 404 permit decisions, for example, require developers to deal with as many as 12 agencies and government bodies, each with its own concerns about what costs and benefits the project will bring. Federal agencies involved may include EPA, the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the Federal Highway Administration, and the Coast Guard.

Yet despite the number of regulatory agencies and involvement from communities, the progress of development projects through the regulatory process is often complicated by failure to analyze environmental impacts early on. The ensuing regulatory battles work to the disadvantage of both the developments being proposed and the environment itself.

One memorable example of the paralysis of decision-making that may result is the 14-year-long battle over the West Side Development Project, known as Westway, whose proposed highway and landfilling threatened to destroy valuable interpier habitat used by the striped bass. The project pitted planning officials and developers against the environmentalists and the fishing industry. After years of exhaustive debate and expensive lawsuits, the project was scrapped.

This policy paralysis, a syndrome EPA's Region 2 Administrator, Christopher Daggett, calls "environmental gridlock," often results in decisions made through indecision or unsatisfactory compromise. Until those who hold an interest in the New York waterfront join together to face tough questions head-on, Daggett believes, critical environmental issues will go unresolved.

Predicting that other projects may face the same fate as Westway, Daggett has proposed the formation of a multi-agency task force that would identify critical habitat in advance of development proposals. The group, to be comprised of representatives of community groups and developers as well as officials from local, state, and federal agencies, could come to agreement ahead of time as to which areas along the Hudson, East River, and the Harbor front should be targeted for development and which preserved as valuable habitat for wildlife.

Such joint undertakings have already shown promise elsewhere in the region; Daggett has suggested that a major cooperative initiative now underway to protect New Jersey's Hackensack Meadowlands serve as a model for the Hudson and East Rivers. The Hackensack initiative calls for a comprehensive evaluation of the area's numerous wetland tracts and interagency and public review of the findings. The result, it is hoped, will be a system identifying those tracts that are of critical environmental importance and those that may be safely developed.

Daggett hopes that the task force initiative will prompt local officials to begin viewing their development activities in a more regional perspective. With positive response so far from public officials and a quiet wait-and-see attitude among developers, he hopes that the gridlock can be tamed.

But out on the docks, there is the wail of gulls and the smell of money. There the future is developing brick by brick. And so far, no one can tell what it will look like when it arrives. □

(O'Keeffe is a public affairs specialist with EPA's Office of External Programs in the Region 2 Office.)

Update A review of recent EPA activities.

AGENCYWIDE

Environmental Youth Awards

In a ceremony held at EPA headquarters on November 16, EPA Administrator Lee M. Thomas and Nancy J. Risque, Assistant to President Reagan and Cabinet Secretary, presented the President's 1987 Environmental Youth Awards to ten winners: the Fourth Grade Class at Woodland Elementary School in Woodland, ME; the Environmental Studies Laboratory at John D. Wells Junior High School Number 50 in Brooklyn, NY; David Andrew Shemenski, a student at Linsly High School in Wheeling, WV; Amy Bustle, a student at Lexington High School in Lexington, SC; the Aquatic Biology Class at East High School's Summer Session in Madison, WI; the Leona River Ecology Project at Uvalde Middle School in Uvalde, TX; the Outdoor Classroom at Guthrie Center Elementary School in Guthrie Center, IA; the Eighth Grade Class at McGinnis Middle School in Buena Vista, CO; Bill Buck, a student at Righetti High School in Santa Maria, CA; and the Salmon Project at Phantom Lake Elementary School in Bellevue, WA.

AIR

Vehicle Tampering Survey

EPA issued results of its 1986 Motor Vehicle Tampering Survey. The survey concludes that one out of every five passenger cars or light-duty trucks shows evidence of tampering with at least one component of the emission-control system. EPA categorized 54 percent of the surveyed vehicles as "okay" in 1986, as opposed to 52 percent in 1985.

Auto Recall

EPA recalled 125,600 Chrysler, Dodge, and Plymouth passenger cars to correct an excessive hydrocarbon and nitrogen oxides emission problem. The affected models were certain 1982 Chrysler LeBarons and Town and Country Wagons; Dodge 400s, Aries, Omnis, Aries Wagons and 024s; and Plymouth Horizons, Reliants, TC3s, and Reliant Wagons. All are equipped with 2.2-liter, four-cylinder engines.

HAZARDOUS WASTE

Love Canal Decision

EPA announced its final decision for the Superfund cleanup of Love Canal creeks and sewers in Niagara Falls, NY. The selected remedy will use on-site thermal destruction to clean up the dioxin-contaminated creek and sewer sediments. The residuals from thermal treatment will be disposed of on site. The estimated cost of the entire remedy is between $26 and $31 million.

SITE Program Selections

EPA selected 10 developers to demonstrate technologies under the Superfund Innovative Technology Evaluation (SITE) program. The SITE program helps EPA to demonstrate, evaluate, and promote the use of new technologies that significantly decrease the toxicity, mobility, or volume of Superfund hazardous substances. The selected developer pays for the demonstration while EPA finances the evaluation.

Selected this year were: for solidification/stabilization processes: Solidtech, Inc., of Houston, TX; Chemfix Technologies, Inc., of Metrairie, LA; Waste Chem Corp. of Paramus, NJ; and Battelle Pacific Northwest Laboratory of Richland, WA; for biological technologies: Air Products and Chemicals, Inc., of Allentown, PA; Zimpro Environmental Control Systems of Rothschild, WI; and MoTec, Inc., of Mt. Juliet, TN; for a thermal technology, Retech, Inc., of Ukiah, CA; for an extraction process, C.F. Systems Corp. of Cambridge, MA; and for an ion-exchange technology, Sanitech, Inc., of Twinsburgh, OH.

PESTICIDES

Tributyltin Restrictions

EPA is proposing restricted use of antifoulant paint products containing Tributyltin (TBT) pesticides after determining that these products may present unreasonable risks to non-target aquatic organisms such as mussels, clams, oysters, and fish. The proposed EPA actions on TBT antifouling paints include prohibiting the use of TBT antifouling paint on non-aluminum-hulled vessels less than 65 feet long; classifying these products for restricted use and limiting sales to certified commercial applicators; and new use instructions for TBT labels.

ODM Review

EPA has begun a special review of pesticide products containing oxydemeton-methyl (ODM) and restricted their use to certified applicators. The Agency has concluded that exposure to this chemical may result in adverse reproductive effects to persons mixing, loading, and applying it, and to field workers who may enter treated fields.

WATER

New Disinfection and Filtration Requirements

Under the authority of the Safe Drinking Water Act, EPA proposed new standards directing local water-supply operators to filter their water under certain conditions and to disinfect it to protect against *Giardia*, coliform bacteria, viruses, heterotrophic bacteria, turbidity, and *Legionella*.

These new standards consist of two separate proposals that expand the microbiological controls EPA has placed on coliform bacteria and turbidity since 1977: disinfection and (in some cases) filtration requirements, which apply only to public water systems that draw water from surface-water sources, and proposed coliform-bacteria standards that apply to all public water systems, regardless of whether they draw water from surface or ground-water sources.

New Water Pollution Standards

EPA issued a comprehensive regulation to control water pollution from the organic chemical, plastic, and synthetic fiber industries. These standards, called effluent limitation guidelines, require these industries to use the best practicable control technology for some types of pollution and best available control technology economically achievable for other types. The rules also include special standards for new sources and "pretreatment" standards for existing and new sources that discharge into publicly owned sewage-treatment systems rather than directly into rivers, streams, and other waterways. □

Appointments


Steve Delaney

Linda J. Fisher has been nominated by President Reagan to be EPA Assistant Administrator for the Office of Policy, Planning and Evaluation (OPPE). In that position, she will oversee the Agency's development of policy and manage its regulatory process. Fisher, who is Executive Assistant to EPA Administrator Lee M. Thomas, served as the Agency's chief expert on the reauthorization of Superfund in 1986. She also has served on the staff of the House Appropriations Committee and as a legislative assistant to two congressmen.

A native of Columbus, OH, Fisher is a graduate of the Ohio State University College of Law and Miami University in Oxford, OH. When confirmed by the Senate, she will succeed Milton Russell, who resigned in March, as Assistant Administrator for OPPE.


Steve Delaney

Charles L. Grizzle has been nominated by President Reagan to be EPA's Assistant Administrator for Administration and Resources Management. He will be responsible for providing executive support for Agency programs and the management of financial and budget policy and operations; Senior Executive Service and executive staff and the EPA Institute; Agency-wide ADP processing and procurement, data management, and computer network design; and personnel, grants and contracts, facilities management, and management and organization. Grizzle served as Deputy Assistant Secretary for Administration at the Agriculture Department since 1983, and was an assistant to the Secretary and staff assistant to the Director of the Office of Operations and Finance after he joined USDA in 1982. Before coming to Washington, he served as Executive Director of the Republican Party of Kentucky and was a banking officer in Lousiville.

Grizzle was born in Agrillite (Greenup County), Kentucky, and earned his bachelor's degree from the University of Kentucky in Lexington. After Senate confirmation, he will succeed Howard Messner, who resigned in May.


Steve Delaney

Henry B. Frazier, III, has joined EPA as an Administrative Law Judge. Prior to his appointment at EPA, Judge Frazier served as a member of the Federal Labor Relations Authority for eight years, including a period as its Acting Chairman from 1984 to 1985. Before joining the Federal Labor Relations Authority, Frazier was with the Federal Labor Relations Council for nine years. During the last six of those nine years, he was the Council's Executive Director. Prior to joining the Council, Frazier—an Air Force veteran—held several civilian positions in the Department of the Army, including Chief of Civilian Personnel Policy and Civil Rights in the Office of the Assistant Secretary for Manpower.

A member of the Virginia and District of Columbia Bars, Judge Frazier holds a J.D. with honors from George Washington University Law School, and an LL.M. in Labor Law and a Master of Laws in Taxation from Georgetown University Graduate Law Center. He also holds a B.A. with Honors in Political Science from the University of Virginia, whose alumni association he headed in 1985-6. He is a member of Phi Beta Kappa, the Order of the Coif, Omicron Delta Kappa, the Raven Society, and Phi Eta Sigma. □

Further Readings on Risk

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EPA documents are available at the EPA Library.

Steve Delaney

An EPA press conference. The Agency is involved in some of the most hotly-debated issues of the day.

Back Cover: A dusting of snow on Union Carbide's chemical works in Institute, W.Va. The chemical industry boomed with America after World War II, producing a flood of new, widely used products. More sophisticated science has revealed that many chemicals have potentially serious health effects, such as cancer. Industry, the government, environmental groups, the media, and the public are focusing now on how the risks from these chemicals can be assessed and dealt with while preserving the benefits and the economic viability of the society. Union Carbide in West Virginia recently held an open house attracting more than 12,000 visitors. Photo by Drew Harmon, Folio, Inc.