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EPA JOURNAL

Making Economic and Environmental Sense

How Green Technology Works Better, Costs Less

EPA JOURNAL

A Magazine on National and Global Environmental Perspectives

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Front cover: Ozone bubbles upward in a drinking-water treatment process known as ozonation. Like many new environmental technologies, ozonation has raised both hopes and questions. It is a promising new process that may be more effective against microbial contamination than other processes commonly used to treat public water supplies–primarily chlorination. At this juncture, however, questions remain as to the comparative health risks of ozonation byproducts versus those of chlorination.
Robert Essel photo. The Stock Market. Copyrighted.

From the Editors

In keeping with the theme of this *EPA Journal,* an article in the *Wall Street Journal* of November 22 cited evidence that corporate investments in energy-saving technology can cause productivity to jump by as much as 16 percent. Reported gains in profits from boosted productivity actually exceeded money saved through energy conservation. Among the examples mentioned were Wal-Mart's store in Lawrence, Kansas, where departments with sky lights log higher per-square-foot sales than those without; a Boeing aircraft factory where energy-saving lights illuminated the inside of parts so that a worker could see what she previously worked on through touch; and a Reno, Nevada, post office where better lighting coincided with workers sorting more mail per hour with fewer errors.

The examples cited in the *Wall Street Journal* are noteworthy not only because they are green-technology success stories, but also because they highlight a few of the ways in which environmental and economic gains can be two sides of the same endeavor. In this country, there are numerous such success stories and successes in the making, including those profiled in this magazine. At the same time, to state a premise shared by our contributors, there is a clear need to promote further advancements in environmental technology. Simply put, we need more technologies that work better and cost less, technologies not only to clean up the environment but to prevent pollution from happening in the first place.

In this issue, we are fortunate to have an article by Vice President Al Gore introducing the role of environmental technologies in securing a sustainable future–a future in which a clean environment supports a high quality of life, and technological advancement means economic growth and better jobs for American workers. The theme section of the magazine concludes with an article by the distinguished economist John Kenneth Galbraith that explores an aspect of what he has called "the economic case for the environment." ❑

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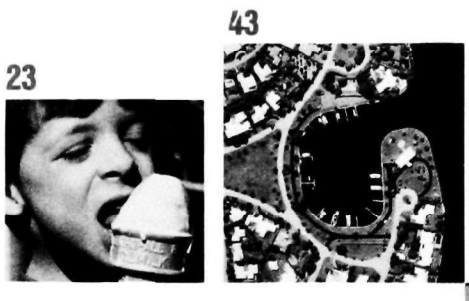


The U.S. Environmental Protection Agency is charged by Congress to protect the nation's land, air, and water systems. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions which lead to a compatible balance between human activities and the ability of natural systems to support and nurture life. *EPA Journal* is published by EPA. The Administrator of EPA has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Agency. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget. Views expressed by the authors do not necessarily reflect EPA policy. No permission needed to reproduce articles except those showing a specific copyright claim; no permission needed to reproduce photos credited to EPA. Contributions and inquiries are welcome and should be addressed to: **Editor, EPA Journal (1704), Waterside Mall, 401 M Street, SW, Washington, DC 20460.**

Reassessment Reaffirms Dioxin-Cancer Link

EPA has released a public review draft of its reassessment of the health effects of dioxin. The draft reaffirms a 1985 assessment in which the Agency concluded that dioxin is a proven animal carcinogen and a probable human carcinogen. The draft reassessment also incorporates evidence suggesting that at some dose, dioxin exposure can result in noncancer health effects in humans. These might include developmental and reproductive effects, immune suppression, and disruption of regulatory hormones. The reassessment is the most exhaustive scientific review of a single compound ever made by EPA and represents the cutting edge of environmental toxicology, but it is not yet complete. Once public comments have been taken on the draft, the Agency's Science Advisory Board will conduct a formal scientific peer review. The process should conclude in late 1995.

The Washington Post reported: "... The study .. said that most adverse [noncancer] effects from dioxin occur at a level 10 to 100 times that to which most Americans are exposed.... The controversy over dioxin dates to the Vietnam War, when returning troops complained of tumors resulting from dioxin-tainted Agent Orange, a herbicide sprayed on vegetation in Vietnam. Environmentalists also laid blame for a wide range of health and ecological woes on dioxin. When the EPA made the 1985 assessment that dioxin was a probable carcinogen in animals and humans, chemical industry executives and some scientists challenged the findings and asked that the EPA reexamine the potency of dioxin. In 1991, EPA researchers began to reassess.... The EPA's conclusions about the cancer-causing qualities of dioxin are based largely on recent scientific research into the molecular reactions provoked by the chemical compound when it enters animal cells.... The findings are also based on several new studies of human populations exposed to dioxin in which the rate of cancer among exposed individuals rose sharply. Anticipating the EPA's findings, parts of which were leaked last May, environmentalists have called for severe restrictions on ... dioxin. The environmental group Greenpeace has called on the Clinton administration to ban chlorine, for example, and in a Thursday news conference, Ellen Silbergeld, a dioxin specialist at the Environmental Defense Fund, suggested that the same kinds of controls be put on dioxin that are now placed on lead. But industry groups caution against overreaction...."

The Wall Street Journal said: "... Substantial 'data gaps,' important to understanding dioxin's effects, need to be filled in, the report says. For example, direct evidence is lacking to show that any cancer or noncancer effects–such as developmental and reproductive impacts, immune suppression and disruption of regulatory hormones–occur in humans at everyday exposure levels, the report says. But, the study concludes, it can be inferred that the average exposures are close to ones known to cause such effects in laboratory animals. It is likely that there are several unknown dioxin sources, the study said. The EPA will ask that industry, public interest groups, state and local governments, academia and hospitals examine their files to find any information on dioxin sources, as well as releases and levels of dioxin in air, water, soil, food, animal feed and human tissues. The agency said that in addition to general exposure, some individuals or groups may be exposed to dioxin-like compounds from 'special,' more intense sources such as occupational exposures, nursing mother's milk or fishing.... The agency plans by next February to propose strict air standards for reducing dioxin and other emissions from medical waste incinerators. The EPA also recently proposed emission standards for municipal waste incinerators, [and] stringent water effluent standards for pulp and paper mills and waste incinerators."

EPA Awarded $1.9 Million Grant for *AmeriCorps* Projects

Under President Clinton's National Service Program, EPA has received a $1.9 million award to conduct several *AmeriCorps* projects that will help address the environmental needs of disadvantaged communities in nine states, ranging from the Mexican border to Alaska. Specifically, the projects will:

- Help clean up polluted drinking-water wells at the U.S.-Mexico border.
- Help revitalize inner-city neighborhoods in Boston, Providence, Newark, San Francisco, Atlanta, and Washington State by working on radon and lead abatement and restoring urban streams and parks.
- Help Alaskan native villages with waste management and water quality.
- Reduce air pollution by helping public schools in Oregon to install energy-efficient lighting.
- Help clean up the Anacostia River in Washington, DC.

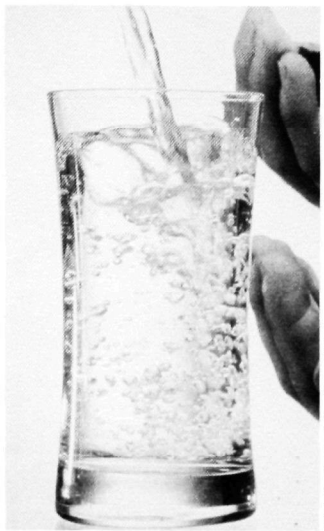
AmeriCorps is the centerpiece of the Corporation for National and Community Service, created by the 1993 National Community Service Trust Act. The program offers opportunities for Americans of all ages to perform community service and earn education awards and modest salaries in return for their efforts.

Tougher Rules Proposed for Drinking Water

Under new rules proposed by EPA, limits on the amount of disinfectant byproducts allowed in drinking water would be lowered and, at the same time, safeguards would be strengthened against disease-causing microorganisms such as *cryptosporidium*, the parasite behind Milwaukee's crisis last spring.

Chemicals used to disinfect drinking water, such as chlorine, form byproducts that can harm human health. For example, chronic exposure to excessive amounts of trihalomethanes, a class of byproducts, can cause cancer, liver and kidney damage, heart and neurological effects, and effects on fetuses. The proposed rule would lower the maximum contaminant level for total trihalomethanes from 100 micrograms per liter to 80. To make sure that in meeting these stricter standards water suppliers don't inadvertently increase the risk of contamination, the rule sets for the first time a limit on *cryptosporidium* and tightens existing limits on other microorganisms. The *cryptosporidium* limit would be met through enhanced water filtration.

The new limits on disinfection byproducts would initially apply to 13,000–out of 80,000–public water systems and would cost an estimated $1 billion annually. For most customers, the cost would be less than $2 a month; for a very few–one percent–it would be over $16 a month. The higher costs would occur in water systems serving fewer than 10,000 people. Precise cost estimates for the rule to strengthen safeguards against microorganisms are not available; however, it is expected that the national costs would be less than $500 million.



Malcolm Pirnie photo Copyrighted

Tougher rules for drinking water target disinfection byproducts and microorganisms.

Because of the technical complexity, the controversy over public health impacts, and the potential cost of controlling disinfection byproducts, EPA formed a team of state and local officials, water industry representatives, and representatives of consumer and environmental groups to develop a consensus on the rules. They are the first "negotiated regulations" to be proposed under the Safe Drinking Water Act. As part of the consensus, EPA and drinking-water suppliers are planning to fund a five-year, $50-million research program on disinfection byproducts and microorganisms.

Emissions Standards Proposed for Marine Engines

Working in cooperation with the marine industry, EPA has proposed the nation's first emissions standards for marine engines. The standards proposed would apply to all new outboard, inboard, sterndrive, and personal watercraft engines (such as Jet Skis and Wave Runners). Manufacturers would begin phasing in the new standards over a nine-year period, beginning with the 1998 model year. The technology developed will create a new generation of low-emission, high-performance engines. Older models would be unaffected by the new standards.

The 12 million marine engines now in the United States give off about 700,000 tons per year of hydrocarbon (HC) and nitrogen oxide (NOx) emissions; the new generation of marine engines is expected to reduce NOx emissions by 37 percent and HC emissions by more than 75 percent. HC and NOx emissions create ground-level ozone, which can irritate the respiratory tract, causing chest pain and lung inflammation. Ozone can also aggravate existing respiratory conditions such as asthma.

Of all "non-road" engines, only lawn and garden engines emit higher levels of HC, a 1991 EPA study found; only farm and construction equipment emit higher levels of NOx. New standards for lawn and garden engines were proposed in May. Standards for land-based, non-road diesel engines such as those in farm and construction equipment were finalized in June.

It is expected that the design changes necessary to reduce emissions will also improve performance and fuel economy, make starting easier and acceleration faster, and produce less noise, odor, and smoke.

Steve Delaney photo EPA

Proposed standards would for the first time reduce air pollution from boats.

Common Sense Initiative Begins With Six Industries

EPA's Common Sense Initiative, in which whole industry strategies will be developed to replace the current pollutant-by-pollutant approach to protecting the environment, will focus first on six of the largest: auto manufacturing, computers and electronics, iron and steel, metal finishing and plating, petroleum refining, and printing. According to the Department of Commerce, together these industries spent more than $8.2 billion in 1992 on compliance with environmental laws; their combined release of toxic pollutants came to 395 million pounds, 12.4 percent of all reported emissions nationally. In announcing the initiative, Administrator Carol Browner said: "The successes that are available if we continue down the path of traditional regulation are incremental at best. I don't think anyone in this country, whether environmental leader or corporate CEO, believes incremental steps will achieve the kind of future we all want."

Jim West photo. Copyrighted.

Drop forge operation at automobile factory. The* Common Sense Initiative *will look at whole industries.

The Washington Post commented: "... The 'Common Sense Initiative' attempts to achieve three goals. One is to eliminate the paradoxical problems that can occur when the agency focuses too narrowly on one pollutant. For example, when EPA rules led industries to install smokestack 'scrubbers' to reduce sulfur-dioxide emissions, air pollution was reduced–but the scrubber waste added to water contamination. Another is to stop the traditional practice of making environmental policy in response to emergencies such as the Love Canal incident. A third goal is to bring about a cease-fire in the increasingly acrimonious battles dividing environmentalists and industry by inviting specialists from these groups–along with other selected 'stakeholders' with expertise in a particular industry–to meet regularly with EPA specialists and hammer out their differences. . . . The plan's provisions, gradually introduced over the next couple of years, could eventually result in a thorough restructuring of the 24-year-old EPA, replacing the longstanding offices of air and water and other pollution areas with industry-oriented departments, Browner said. Environmentalists were divided over the plan. William K. Reilly, who had experimented with different ways to improve the agency's record as Browner's predecessor in the Bush administration, said it 'sounds like a good idea.' National Audubon Society spokesman Maureen Hinkle disagreed. 'Regulating pollutant by pollutant has not been the most efficient way, but it has produced some clear successes, like the banning of DDT,' she said. 'An industry-by-industry approach will probably not work any better, in part because of the vast range of companies within a particular industry. What do you do to bridge those gaps? . . .'"

The Chicago Sun Times commented: ". . . The administration said Wednesday that it is abandoning 25 years of one-size-fits-all pollution control in favor of environmental policies tailored to specific industries, beginning with such pollution giants as oil, automotive, steel and electronics. . . . Six industries, representing one-eighth of all toxic releases reported to EPA, 15 percent of the Gross Domestic Product and employing 4 million workers, were chosen as part of the EPA's pilot program. Most environmental groups and affected industries welcomed the new pollution-control approach as a departure from years of litigation and infighting on environmental issues. Joining the auto, oil, electronics and computer, and iron and steel industries in the pilot project are the metal plating and finishing industry and the printing industry. Browner said printing is of particular interest because most of the nation's 68,000 printers are small businesses employing 20 or fewer workers. . . . 'This will enable the agency to better promote prevention by tailoring policies to the peculiarities of different businesses,' said Kevin Mills, director of the Environmental Defense Fund's Pollution Prevention Alliance. Historically, each industry regulated by EPA faced multiple groups of regulators, each with a narrowly defined mission such as air emissions, water or solid waste. Under Browner's initiative, teams representing all areas of concern would be built around each participating industry. If all goes as planned, the inclusion of environmental groups and local interests should minimize suits and other snags that delay environmental cleanup. 'This is the kind of thing most of the states have been looking for,' said Langdon Marsh of New York's Department of Environmental Conservation. . . ."

Ongoing Enforcement

Pipeline to Pay $6.4 Million for PCB Violations in Nine States

Tennessee Gas Pipeline Company (TGPL) of Houston, Texas, and its parent company, Tenneco Inc., have agreed to pay $6.4 million to settle an administrative action alleging environmental release of polychlorinated biphenyls (PCBs) in Texas, Louisiana, Mississippi, Alabama, Tennessee, Kentucky, Ohio, Pennsylvania, and New York. TGPL used a PCB-based fluid to lubricate air compressor systems at 42 stations along its 16,000-mile pipeline. EPA's action alleges that, during maintenance operations at the stations, PCBs were routinely released to the environment in violation of regulations issued by the Agency under the Toxic Substances Control Act. PCBs are highly persistent, toxic compounds that accumulate in food chains as well as in the environment. In addition to paying the penalty, TGPL and its parent have agreed to clean up the contaminated compressor stations and to conduct contamination studies at various points along the pipeline. The cleanups will be conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund.

Ore-Ida Foods to Pay $1 Million for Polluting Snake River

After pleading guilty to five criminal violations of the Clean Water Act, Ore-Ida Foods Incorporated was fined $1 million and placed on three years' probation in U.S. District Court in Portland, Oregon. The violations included discharging potato and other vegetable wastes into the Snake River from the wastewater-treatment plant at Ore-Ida's facility in Ontario, Oregon, in violation of the company's permit issued under the National Pollutant Discharge Elimination System (NPDES). EPA's Criminal Investigation Division initiated the complaint after being tipped by an employee about data manipulation, illegal discharges, and tampering with monitoring devices at the treatment plant. Ore-Ida will pay $250,000 of the fine immediately; it has until the end of the probation period to pay the rest or spend it on wastewater-recycling equipment at the treatment plant. The company has already spent $12 million on upgrading the plant. Ore-Ida Foods is headquartered in Boise, Idaho; it is a wholly owned subsidiary of H.J. Heinz Corporation.

Applicator Convicted of Spraying Cereal Oats with Unapproved Pesticide

An Edina, Minnesota, businessman, Y. George Roggy, has been found guilty by a U.S. district court jury in St. Paul of knowingly spraying an unapproved pesticide on almost 19 million bushels of oats used by General Mills in the production of approximately 160 million boxes of cereal, including Cheerios and Lucky Charms. Roggy's company, Fumicon, had a contract to apply an approved pesticide, Reldan, to oats stored in General Mills elevators in Duluth. But evidence at the trial showed that for more than a year, Roggy substituted Dursban, a pesticide not approved for stored oats, because it was cheaper: He submitted invoices totalling $166,120 that falsely represented he had used Reldan, thereby saving $85,319. Roggy faces a maximum of five years in prison and/or a fine of $250,000 on each of 11 counts of mail fraud; up to three years in prison and/or a $250,000 fine on one count of adulterating foods; and 30 days in prison and/or a $5,000 fine on one count of misusing pesticides. Federal authorities said cereal made from the oats was not a health hazard.

Eastman Kodak Consents to Clean up Hazardous Waste

Under a consent order, Eastman Kodak Company has agreed to pay an $8 million penalty and spend millions more to upgrade, inspect, and repair the industrial infrastructure at its 104-year-old, Rochester, New York, facility, including an incinerator and an estimated 31 miles of industrial sewers. The company will implement a state-of-the-art tracking system for all of its industrial wastes and must undertake a number of environmental projects that will benefit the water quality of the Genessee River and the air quality in northwestern New York.

This is the first lawsuit attacking pollution from leaking sewers that EPA has brought under the Resource Conservation and Recovery Act. Eastman Kodak violated the act by failing to identify hazardous wastes and by allowing the unlawful disposal of various hazardous wastes through leaks in the facility's industrial sewer system.

Louisiana Firm Sued for Multiple Violations

The U.S. government has charged Borden Chemicals and Plastics Operating Limited Partnership and two related Borden entities in Geismar, Louisiana, with repeated violations of federal hazardous waste and clean air laws. The Geismar facility manufactures chemicals, including vinyl chloride, ammonia, and polyvinyl chloride (PVC), which are used in the production of plastic products.

Borden is charged with operating a hazardous waste incinerator and other hazardous waste units without permits at its Louisiana facility and violating state standards for air emissions. Borden is also charged with failing to notify authorities following a 1990-91 release of thousands of pounds of chemicals, including vinyl chloride and ammonia. In addition, the lawsuit claims that the firm illegally shipped more than 300,000 pounds of hazardous waste to a Thor Chemicals plant in South Africa.

In addition to fines for the illegal shipments, the civil action seeks to compel Borden to clean up contaminants at the Geismar site, including known carcinogens like vinyl chloride and probable carcinogens like ethylene dichloride. ❑

Environmental Technologies for a Sustainable Future

by Vice President Al Gore

Our environment and our economy are mutually dependent

EPA photo.

Vice President Al Gore, EPA Administrator Carol Browner, and Energy Star™ computers. EPA's Energy Star program, launched in 1993, is a public-private partnership to maximize energy savings at a profit.

From local crises of air and water pollution to global phenomena such as the destruction of the rainforests, global warming, and the diminished diversity of plant and animal species, our relationship with nature is undergoing profound change, and not for the better. A burgeoning worldwide population and our natural environment are on a collision course, with potentially catastrophic consequences. At the same time, the nation is passing through a time of tumultuous change and great economic uncertainty. Across the country, people are anxious about the future and their opportunity to achieve greater prosperity.

There are those who would prey upon this uncertainty and use it as an excuse to justify rolling back health and environmental protection. They say that we cannot have both a strong economy and a safe environment. They are wrong. In fact, our environment and our economy are mutually dependent; only with responsible environmental policies can we provide lasting economic opportunity. A clean environment means a higher quality of life, and technological advancement means economic growth and better jobs for American workers.

Today, we stand at a crossroads. The decisions we make now will determine whether we leave to future generations a healthy, livable world or an ever-escalating series of problems. To choose the first path, we must invest and develop sustainable technologies–those that increase economic growth *and* protect the environment.

Since taking office, President Clinton has made promoting environmental technologies a priority, launching interagency environmental technology initiatives, issuing executive orders to help spur the application of these technologies, and taking concrete steps to expand their export around the world. In addition, this past July, I released an Administration report outlining a broad, government-wide strategic framework for advancing environmental technologies. *Technology for a Sustainable Future* outlines a series of current Administration initiatives and sets forth strategic policy directions and potential next steps in this area. Throughout the process, we are consulting with members of Congress,

elected officials at the state and local levels, representatives from industry and non-governmental organizations, and interested citizens.

In our effort to design and implement a long-term environmental technology strategy, EPA plays a pivotal role in at least three ways: developing strong and sensible environmental policies, promoting investment and innovation in environmental technologies, and increasing the export of U.S. technologies.

Strong Environmental Policies

Each of us deserves to know that the water we drink, the air we breathe, and the food we eat are safe from harmful pollution. To that end, this Administration is pursuing environmental policies and building important partnerships to accomplish these goals. We are committed to "reinventing" environmental protection to ensure maximum protection of public health and the environment, while minimizing costs. This Administration is seeking new ways to prevent pollution before it happens and manage whole ecosystems, rather than small disparate pieces of natural habitat.

One example of this new approach is EPA's Common Sense Initiative, a program that fundamentally redesigns environmental policy to focus on environmental results rather than one-size-fits-all pollution-control approaches. The Common Sense Initiative is different because it does not seek to adopt environmental standards in a vacuum. Rather, EPA is involving from the very beginning the affected stakeholders–representatives of industry, labor, state governments, and the environmental community. Only by bringing people together from all sides of these issues can we identify common ground, bridge old differences, and find new solutions.

The Common Sense Initiative also replaces the pollutant-by-pollutant regulatory regime favored in earlier policies with an approach that looks at facilities and industries in a more holistic way. With the old approach, pollution was regulated piecemeal. Regulations affecting water were written in isolation of pollution guidelines for air and solid waste. Too often, this approach merely shuffled and shifted pollutants. With the new common sense approach, EPA will address the full range of environmental and health impacts of a given industry-steel or electronics for example–to get better results that cost less.

Innovation in Environmental Technologies

Another example of this Administration's commitment to a long-term environmental technology strategy is the Environmental Technology Initiative. Spearheaded by EPA, this program is designed to spur the development and marketing of innovative technologies throughout the economy. By encouraging businesses to produce and use pollution-prevention technologies, we can increase U.S. competitiveness and work to capture this fast-growing market.

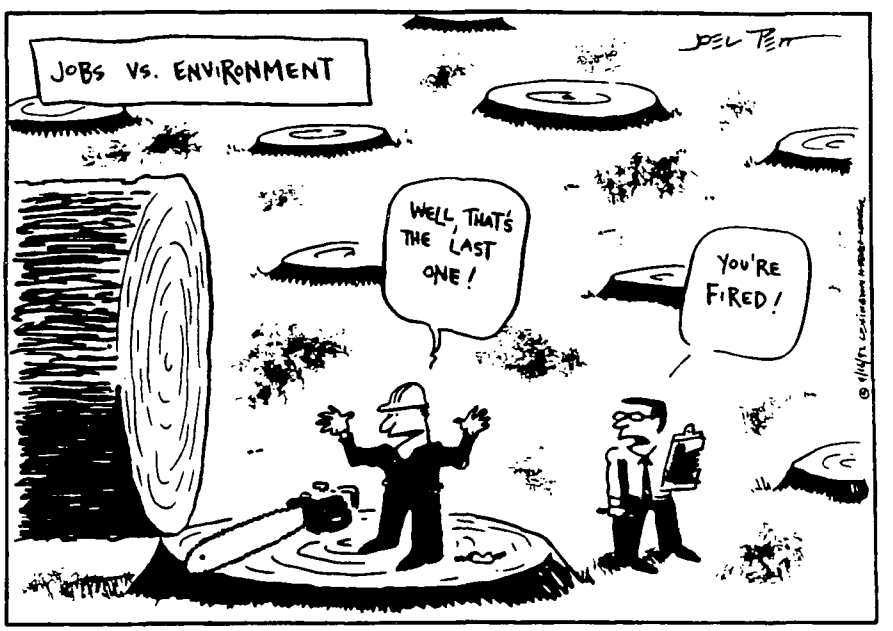
The Administration also is working toward a responsive and coordinated environmental technology research and development program. For example, EPA is developing a technology-verification program that will help to test and confirm the cost and environmental performance of new technologies. Armed with EPA-verified testing information, it will be easier for businesses to sell their new technologies and consumers to get information about innovative solutions to tough environmental problems.

EPA already has had great success in promoting innovative environmental technologies. Working together with the electric utilities and environmental groups, EPA pooled $30 million in utility rebates and sponsored a contest to see which manufacturer could make the most energy-efficient refrigerator. The winning model, the "Golden Carrot" Super-Efficient Refrigerator, which has been installed at the White House, uses 50-percent less energy than most models and doesn't use CFCs–harmful chemicals that damage the ozone layer. It's now available on the market for about the same price as a less efficient model.

Promoting Exports

In addition to developing strong and sensible environmental policies and promoting investment and innovation in environmental technologies, EPA is working to increase U.S. exports. The world market for environmental technologies is nearly $300 billion today, and there are predictions that it could grow to nearly $600 billion by the year 2000. It's critical that U.S. businesses are prepared to compete in this global market. By creating more business for American products, we also create more jobs for American workers–high-wage, high-skill jobs that accompany the development of environmental technologies.

That is why, in his first environmental address, President Clinton directed his Administration to prepare a comprehensive strategy to take advantage of this economic opportunity by promoting environmental technology exports. EPA Administrator Carol Browner, Commerce Secretary Ron Brown, and Energy Secretary Hazel O'Leary are leading this effort. They are providing technical advice to environmental companies, expanding export financing for environmental projects and, in some cases, coupling export promotion with environmental technical assistance to emerging countries. The goal is to promote the use of environmentally safe technologies in



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developing nations and throughout the world.

The Goal of Sustainable Development

Attaining sustainable development is one of the greatest challenges facing our country and the global community–a challenge that can only be met by developing and deploying technologies that will protect the environment while sustaining economic growth. It starts with strong and sensible environmental policies and includes promoting investment and innovation in new technologies. Finally, there must be a continued commitment to encourage their application both here at home and throughout the world.

We can build a world transformed by human ingenuity and creativity, a world in which economic activity and the natural environment support and sustain one another. Economic growth *and* environmental protection. The choice is clear not just for this generation, but also for all those to come. And EPA is helping to get us there. ❑

What is Environmental Technology?

For many readers, the term *environmental technology* brings to mind the products and services offered by *environmental businesses*. There are now, for example, about 1,600 commercial laboratories in the United States that provide analytical environmental testing services for their clients. The global market for all environmental businesses put together, including the United States' domestic market, has been estimated at $300 billion annually, and going up.

Although common, this use of the term leaves out the vast majority of incremental changes made by manufacturers to minimize waste or reduce toxic releases. These pollution-prevention or avoidance technologies will play an important role in the next century.

In this issue of *EPA Journal,* environmental technologies, sometimes called "dark green" technologies (as distinguished from "light green" technologies, described below), include four kinds of activity:

- **Avoidance.** Usually substitutes products or redesigns processes to reduce waste or prevent the release of hazardous substances.
- **Control.** Renders hazardous substances harmless *before* they enter the environment.
- **Remediation.** Renders hazardous substances harmless *after* they enter the environment.
- **Monitoring/Assessment.** Establishes, monitors, and assesses the condition of the environment, including pollutant releases and exposure levels.

EPA's Technology Innovation Strategy also embraces "light green" technologies–those developed primarily for non-environmental reasons which have an unintended beneficial effect on environmental quality. For example, the design of a local computer network to enhance communication might also result in the use of less paper.

What is ETI?

In concept, the Environmental Technology Initiative (ETI) began with President Clinton's State of the Union Address of February 17, 1993. In that address, titled "Vision of Change for America," President Clinton described the plan as follows:

> *EPA/Environmental technologies.* . . . EPA currently allocates about $120 million annually to these activities. The focus of this initiative will be long-term research and pollution prevention by EPA, other federal agencies, and the private sector. The goal is to develop more advanced environmental systems and treatment techniques that can yield environmental benefits and increase exports of "green" technologies. This investment will aid in the transition away from a defense-oriented economy, by stimulating the increased use of private sector R&D resources for environmental quality-related purposes.

Work being done under ETI involves many federal agencies and is being coordinated through the White House Office of Science and Technology Policy. Federal agencies working with EPA on ETI projects include:

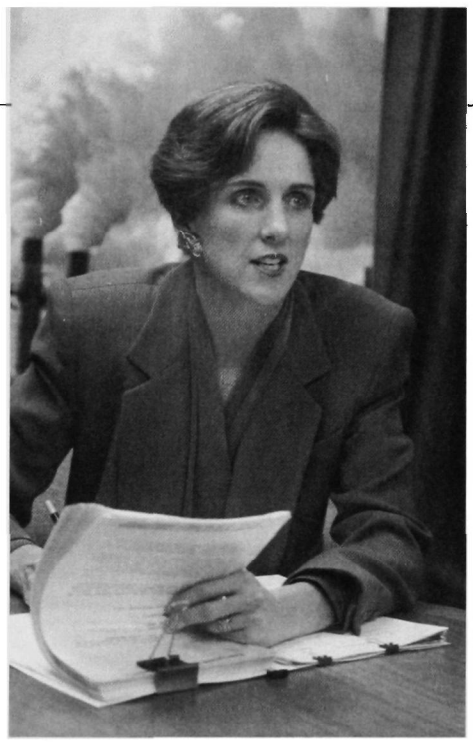
- Department of Commerce
- Department of Energy
- Department of Defense
- Export-Import Bank
- Overseas Private Investment Corporation
- Agency for International Development
- The Trade and Development Agency
- Small Business Administration
- U.S. Trade Representative
- Department of Labor.

–Eds.

EPA's Technology Innovation Strategy

We need technologies that work better and cost less

by Carol M. Browner



Steve Delaney photo, EPA

Twenty-five years ago, widespread U.S. public concern gave rise to the most advanced system of environmental regulation in the world, including the creation of EPA, state agencies, federal laws and regulations, and state laws and regulations.

In what is really a very short history, we have made tremendous progress. We have succeeded in solving the most obvious problems. We no longer have rivers catching on fire. Our skies are cleaner. Our surface waters are less contaminated by untreated sewage and industrial wastewater. At the same time, U.S. environmental expertise and technology have come into demand throughout the world.

But after 25 years we find ourselves with difficult problems–a complex and unwieldy system of laws and regulations, and increasing conflict and gridlock. It will take a new generation of environmental protection to meet the challenges of the next 25 years.

Perhaps nothing is more essential to achieving our nation's environmental goals than developing and deploying new technologies for environmental protection. The technologies we have today are not adequate to solve many of today's environmental problems, let alone the challenges that lie ahead. To protect public health and our environment both in the United States and abroad, we need new technologies that work better and cost less.

Because new technology is so important, EPA has embarked on an ambitious program to launch a new era of technological progress in environmental protection. This program is laid out in the Agency's draft Technology Innovation Strategy (TIS), which was circulated for public comment in January 1994. (The final strategy is scheduled for release this winter.) The draft outlines a broad range of EPA activities both to expand our environmental technology industry here at home and to increase our exports of environmental technology. It covers EPA's $100 million base program in environmental technology; the EPA-led Environmental Technology Initiative, which President Clinton announced in February 1993; and the interagency export strategy for environmental technologies, released in November 1993.

Global demand for environmental technologies is currently estimated at roughly $300 billion a year and projected to rise steeply over the coming decade. To help this country maintain a strong and competitive environmental industry, the Clinton Administration aims to nurture environmental innovation. Our principal trade competitors, Germany and Japan, have already positioned themselves to capture a leading share of the global market by supporting innovation in environmental technology. To avoid being left behind, I believe the United States must strengthen our own presence in the market in four ways.

(Browner is Administrator of EPA.)

Change EPA to Promote Innovation

The U.S. market for environmental goods and services is largely determined by our environmental laws and regulations. American businesses spend over $130 billion a year to comply with federal environmental mandates. Yet, our laws and regulations often end up hindering innovation by making it difficult for polluters to try out new techniques.

These barriers to innovation take many forms. For example, most environmental standards serve to "lock in" the use of existing technologies. Companies receive neither rewards for trying something new nor protection against failure. Even where companies are legally permitted to use alternative methods to meet a standard, they are usually unwilling to risk noncompliance by implementing a relatively unknown or unproven technology. Traditionally, enforcement personnel have been reluctant to grant exceptions for businesses that make bona fide attempts to comply using an innovative approach but need extra time or fall short of the

Global demand for environmental technologies is . . . projected to rise steeply over the coming decade.

regulatory mark. As a result, the same old technologies are used over and over, year after year, freezing out newer and more effective options.

Another problem is the unpredictable nature of the regulatory development process. Often, the promulgation of a new environmental standard takes many years. Only at the end of that long process do companies find out what will be required of them. At that point, they may be required to meet the new standards within a relatively short period of time. Yet the development cycle for new technologies can be 10 years or longer. Even when technology developers begin their efforts well before a new standard is promulgated, the lack of predictability in the rulemaking process makes it hard for them to obtain financing. They run the risk of producing an innovation that either over- or under-complies with the final requirement.

Many barriers that inhibit innovation are rooted in environmental laws. The Clinton Administration has proposed changes in several key laws that maintain a firm commitment to environmental goals while incorporating new opportunities for innovation. In addition, EPA is striving to make our regulatory programs more friendly towards innovative technologies. In so doing, we hope to lead other federal, state, and local agencies to reduce barriers to innovation.

Among the measures we are considering are these:

- Increasing the predictability of our regulatory process through negotiated rulemaking and other regulatory development processes that broaden the participation of affected parties
- Widening the range of technologies accepted for compliance
- Using economic incentives (including emissions trading and other market-based instruments) to reward businesses that use technology not just to meet the minimum standards but to exceed those standards (see box on marketing acid rain control)
- Streamlining our permit processes and our enforcement practices to promote innovative technologies.

EPA's new Common Sense Initiative, launched in July 1994, will help us carry out these objectives. The Common Sense Initiative is a fundamentally different system of environmental protection that replaces the pollutant-by-pollutant approach of the past with an industry-by-industry approach for the future.

Through the Initiative, we will analyze thoroughly the overall environmental impact of six pilot industries. For each industry, we will do a comprehensive analysis of the successes, the failures, the problems, the achievements, and the unintended consequences of environmental regulation.

The six pilot industries that will be the focus of the first phase of the Common Sense Initiative are the auto industry, the iron and steel industry, the electronics and computer industry, the metal plating and finishing industry, the printing industry, and the oil refining industry.

Auto manufacture is one of six pilot industries analyzed in the **Common Sense Initiative.**

Outfalls like this one are no longer so likely to degrade our rivers and streams, but new problems are more complex.

Documerica photo: National Archives

Help Developers and Users

Inventors of new environmental technologies often lack the information, skills, tools, and facilities required to move their technology from the garage to the global marketplace. At the same time, firms that could use these new technologies may not know enough to be able to evaluate them. Small businesses, in particular, are at a disadvantage on both counts. Nor are financial institutions, regulators, or the public consistently able to make informed decisions about innovative technologies.

EPA is well positioned to help address these problems. We can provide information, skills, tools, testing protocols, and facilities to make the environmental technology market function more smoothly and efficiently.

Fund Invention

EPA's unique vantage point allows us to identify emerging technologies which can fill a present or anticipated environmental need. In such cases, strategically targeted EPA funding for promising new technologies can boost the chances for success. (See box on co-funding ADVACATE.)

Help Distribution

By working to strengthen institutions that compile and disseminate information on innovative technologies, EPA can broaden the choices available to potential customers and help create a more informed domestic and international market in which American developers can sell their high-quality products.

EPA can work with public and private organizations to spread information on what companies need and what kinds of technologies are available, at what cost. EPA can catalyze demand by promoting federal purchases of innovative technologies. And we can provide technical assistance and training to strengthen environmental infrastructures abroad, thereby expanding the global demand for innovative environmental technologies. (See box on the U.S. Environmental Training Institute.)

In all that we do, we need to work with businesses, regulators, environmental groups, and the public–to ensure that our policies work for communities across this country.

We also need to be sure to promote technologies that *prevent* pollution. To date, most environmental technologies have been designed to control pollution once it has already occurred–i.e., at the "end of the pipe." Increasingly, the best environmental solutions are found to involve changes in the production process, feedstocks, and product design,

Marketing Acid Rain Control

The Clean Air Act of 1990 established a stringent market-based program to further reduce acid-rain-causing emissions of sulfur dioxide by 50 percent. Under this program, coal-fired powerplants can choose from a wide variety of control options in meeting their emission-reduction requirements, including demand-side management programs, switching to lower-sulfur fuel, buying emissions credits, and installing scrubbers. Although still in its infancy, the acid rain program, by rewarding superior performance with tradeable credits, has already led to a variety of innovations in pollution control, including major advancements in scrubber technology. For example, U.S. vendors are now guaranteeing retrofit scrubbers at 98-percent control efficiency, whereas the ability to achieve even 90-percent control at existing units was in doubt just a few years ago.

Co-funding ADVACATE

A major obstacle to achieving the Clean Air Act's goals has been the high costs to coal-fired electric utilities of scrubbing stack gases by the wet lime process. In the mid-1980s, EPA's Air and Energy Research Laboratory entered into a cooperative research partnership with the University of Texas to develop a more cost-effective method of cleaning flue gases. Out of this collaboration came a technique known as ADVACATE, which uses an advanced silicate that is more absorbent than lime. This process removes 90 to 95 percent of the sulfur dioxide and other acidic gases from stacks of any coal-fired boiler. The Electric Power Research Institute estimates the new process to cost $85 per kilowatt–versus $215 per kilowatt for conventional flue gas scrubbing. If the process proves as successful as projected, it could save billions of dollars in compliance costs for electric utilities and go a long way towards achieving the acid-rain-reduction goals of the Clean Air Act Amendments of 1990.

so as to eliminate pollution *before* it is generated. (See box on Design for the Environment.)

EPA is serious about fostering environmental innovation in every way possible. Over the next few years, we aim to improve the regulatory climate for technology innovation, increase the capacity of innovators to provide new and better environmental solutions, forge new partnerships between government and the private sector, and help new American technologies compete in markets throughout the world. ❑

Design for the Environment

Decisions made in design affect not only a product's cost but also the risks to human health and the environment that arise from its manufacture and use. EPA's Design for the Environment (DfE) program helps businesses incorporate pollution-prevention considerations in the design and redesign of products and services. The Agency lends its expertise through voluntary partnerships with industries, professional organizations, state and local governments, other federal agencies, and the public. Here is a sampling of current DfE projects:

Accounting and Capital Budgeting

EPA is working with the private sector to develop accounting tools that will incorporate environmental costs and benefits into managerial accounting and capital budgeting practices, thus allowing businesses to more fully understand their environmental costs.

Chemical Design

Many of the traditional ways of synthesizing new high-volume industrial chemicals use toxic feedstocks or catalysts, or they create hazardous byproducts. In cooperation with the National Science Foundation, EPA is encouraging university research into alternative methods for producing chemicals that minimize or eliminate hazardous substances. (See related article on page 22.)

Curriculum Development

EPA has established a National Pollution Prevention Center at the University of Michigan. The center is developing curricula in multiple disciplines (e.g., business, engineering, accounting, marketing) which incorporate principles of pollution prevention, lifecycle analysis, and Design for the Environment, rather than traditional end-of-pipe pollution-control techniques.

Risk Management/Insurance

EPA has entered into a cooperative effort with the American Institute of Chartered Property Casualty Underwriters, an independent, nonprofit organization offering educational programs and professional certification for the property and liability insurance industry. EPA is helping to incorporate pollution prevention into the curriculum for the institute's certification program for Associates in Risk Management.

Dry Cleaning Project

Through the DfE program, EPA is working in partnership with the dry cleaning industry and environmental organizations to reduce exposure to perchloroethylene ("perc"). Perc is a chemical solvent, used by most dry cleaners, that poses potential health and environmental concerns. EPA will examine alternative technologies, solvents, and control methods as part of a Cleaner Technology Substitutes Assessment. An important part of the project will be finding ways to provide small dry cleaners with both technical assistance and incentives to implement pollution-prevention measures.

Printing Project

The DfE Printing Project is a cooperative EPA-industry project aimed at developing pollution-prevention information specific to small and medium-sized printers. Six different methods of printing are in use today, and each employs a different set of chemical and technological alternatives. Industry representatives identified several priority environmental concerns for lithographic, screen printing, and flexographic printing methods.

Cleaning Products

EPA and the General Services Administration are collaborating on a long-term project to promote the use of environmentally preferred cleaning products in government-owned buildings. This effort will mean developing standards for cleaning products, performing integrated risk assessments, and evaluating product performance.

U.S. Environmental Training Institute

The U.S. Environmental Training Institute (USETI) is a public-private partnership launched by EPA and the U.S. business community in 1991 to build environmental institutions and in-country capacity in industrializing countries. USETI serves as a training forum to link U.S. businesses with foreign professionals in need of environmental solutions. By providing these professionals with comprehensive, short-term training courses, USETI seeks to forge long-term, productive relationships between the private sector, governments, international agencies, and nongovernmental organizations in the United States and industrializing countries.

Through human resource development and continuous opportunities for information and technology exchange, professionals can work together to generate positive global environmental change. USETI has scheduled over 25 courses in 1994, including nine overseas. Organized to meet the specific needs of participants, these courses range from a general overview of environmental risk management, pollution prevention, and other environmental management techniques to more specific courses on water-quality testing, bioremediation, and air- and water-pollution control techniques.

Environmental Business Segments

Pollution prevention will reshape the market

by Grant Ferrier

The U.S. environmental industry is a $134-billion business that employs more than one million individuals. Not bad for an industry that generated roughly $10 billion in revenues 25 years ago, when it consisted mostly of the public services of waste hauling, water delivery, and sewage treatment.

What is the industry today? Technology has always played a key role in integrating environmental solutions into industrial society. But the moniker "environmental technology industry" has never been appropriate for this commercial sector. *Environmental Business Journal* defines the industry not by *technology* but by *business* segments (see top bar graph), which integrate new technologies into engineered solutions to the vast array of environmental problems. Some of these segments are completely technology or equipment based, but the vast majority of their revenues are in services.

Analysis from our annual industry overview indicates that 74 percent of the revenues in the industry are from services. Revenues in instrument manufacturing, air-pollution-control equipment, water infrastructure, and waste-management equipment are almost completely equipment, but only a small portion of these can be characterized as "high technology." In fact, only 6 percent of revenues in the industry result from the sale of high-tech equipment; the remaining 20 percent are low-tech.

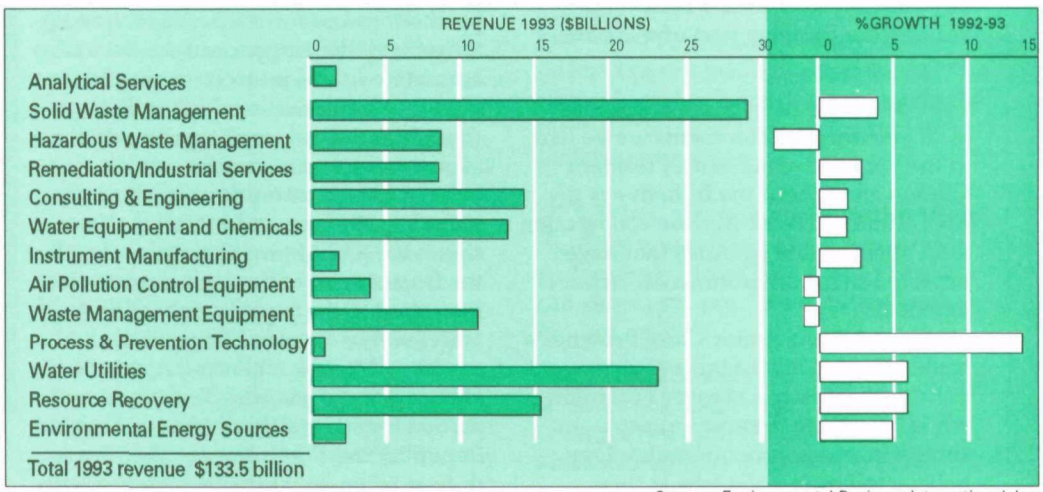
How is the industry doing? The recession sent chills through revenue growth and profitability in 1991 and 1992. In spite of the fact that growth was projected to be above that of the economy at large, trends indicated that the industry could not sustain itself in its nascent form. In other words, the vast majority of business was related to cleaning up "sins of the past" or controlling emissions from now outdated facilities, and each of these had a finite life span. The emerging "paradigm shift" in the pollution- and waste-generating community from pollution control and cleanup to pollution prevention and waste minimization mandated a similar shift in the environmental industry.

When 1993 brought a third consecutive year of stagnant growth, environmental companies wondered when their luck would turn. The worst should be over, however, and many factors now indicate positive trends for the industry. Firms will have to be more selective in their opportunities, more aggressive in pursuing them, more patient in anticipating results, more innovative in their technical applications, and, above all, more business-oriented when looking at customers' problems.

How is the industry developing around the world? With the passage of time, environmental problems have become increasingly international, as has the scope of environmental programs. Issues were once confined mostly to local concerns, such as solid waste and sewage treatment. Air quality and water supply soon emerged as state and regional issues, evolving eventually into national issues. The addition of hazardous materials laws further solidified the importance of national environmental policy. The effects of cross-border pollution brought environmental issues onto the international stage, and, finally, with the specter of ozone depletion and global warming, many environmental issues have become truly global. A more recent and even greater incentive for international environmental regulation and standards is the proliferation of trade agreements. International competitiveness in many industries will increasingly hinge on environmental and worker-safety issues. (See lower bar graph for growth of the industry internationally.) ❑

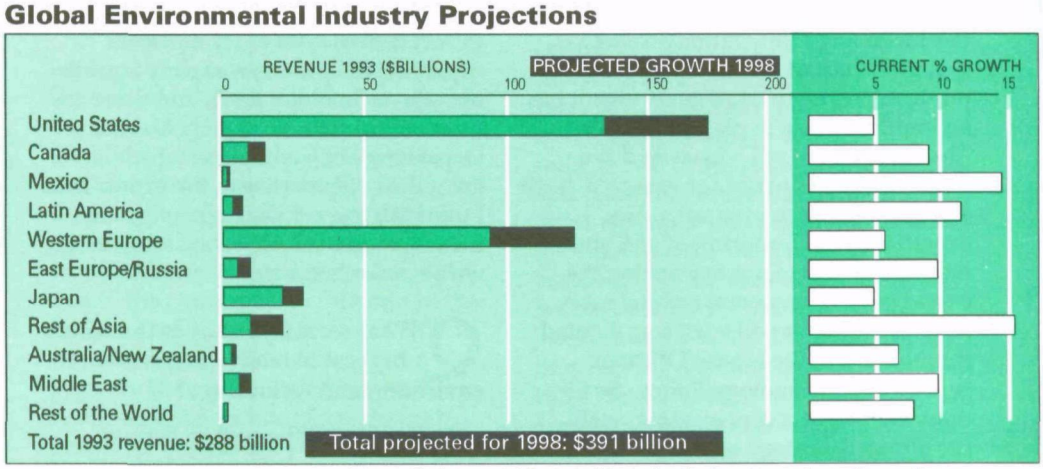
(Ferrier is President of Environmental Business International, Inc., and Editor-In-Chief of Environmental Business Journal.)

U.S. Environmental Industry Segments



Source: Environmental Business International, Inc.

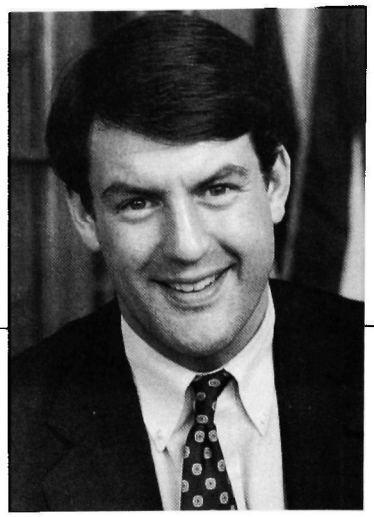
Global Environmental Industry Projections



Source: Environmental Business International; average annual growth over 5 years

Questions the Reader Might Ask

An Interview with David Gardiner



Steve Delaney photo EPA

EPA's Office of Policy, Planning, and Evaluation has a key role to play in the development and implementation of EPA's Technology Innovation Strategy--an external discussion draft of which was published last January. To get answers to questions readers might have about the proposed strategy and the real-world problems it is intended to address, EPA Journal *interviewed David Gardiner, the Agency's Assistant Administrator for Policy, Planning, and Evaluation. Gardiner is also EPA's National Program Manager for the Environmental Technology Initiative.*

Q EPA is one of several federal agencies involved in carrying out the President's Environmental Technology Initiative. Is EPA's Technology Innovation Strategy part of a master plan?

A Yes, it is. In fact, one of the most exciting developments we've had in the year and a half since President Clinton announced the Initiative is the opportunity to work in close cooperation with other federal agencies that have expertise in the environmental technology field.

Under Administrator Carol Browner's leadership, we have aggressively sought policies that foster a vigorous economy while benefiting the environment. A successful environmental technology policy can create good jobs in this country while simultaneously improving the environment at home and abroad. So the Technology Innovation Strategy is definitely part of a master plan, as you put it, and every part of government has an important role to play in that plan. The Department of Defense and the Department of Energy, for example, have extensive research programs. The expertise of the Department of Commerce is critical to our expanding the export of environmental technologies. And this work has all been coordinated through the White House Office of Science and Technology Policy. So I think we've got a very exciting, well-coordinated strategy across the government.

Q Can you give us an example of how you work together?

A Well, I think a very good example is the strategy we developed with the Department of Commerce, starting in 1993, to look at how we might expand exports of environmental technology. We were aware that, despite U.S. leadership in many areas of environmental technology, the myriad governmental programs available to help improve our world environment and domestic economy were not being coordinated. So we set out to create an export strategy. We wanted to bring together the resources of the federal government–in terms of expertise in environmental issues, capacity building, and export promotion–and form a partnership with technology developers and vendors who have state-of-the-art technologies but inadequate international sales. We thought we could work together to boost exports and American jobs, while helping foreign countries to reduce or prevent pollution, and I think we were right. We brought in other agencies, like the Department of Energy, which is also interested in the export market. We targeted five countries or regional markets: Mexico; Chile and Argentina; Hong Kong, China, and Taiwan as a market together; Poland and the Czech Republic; and South Korea. The idea is to coordinate government activities with activities in the private sector to expand U.S. opportunities in the marketplace. EPA contributes its environmental expertise, the private company contributes the technology itself, and these are matched up with an agency like the Department of Commerce, which has a great deal of expertise in the export field. I think it's a good marriage of government agencies which, to my knowledge, we've never had before.

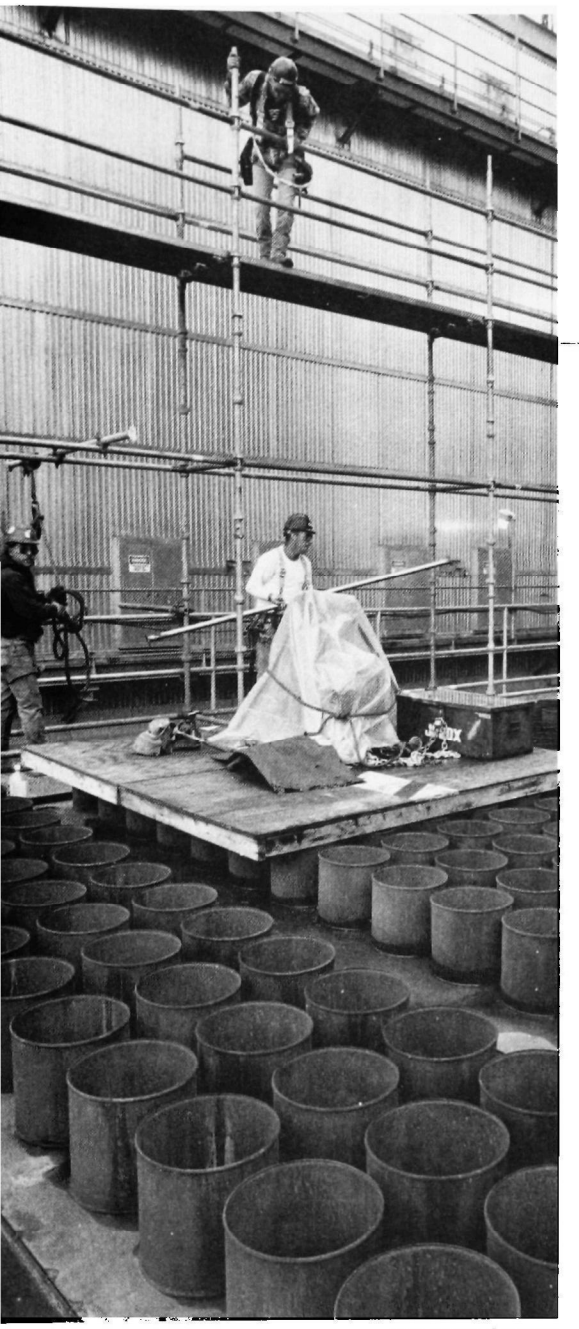
Q What would you say is the single biggest barrier to innovation in environmental technology?

A That's a hard question because each technology manufacturer may face a different kind of barrier. But the major problem a lot of developers face is that the environmental technology market is so conservative. Whether you're a permit writer asked to approve a new technology or a company that might buy one, you're basically risk-averse. You're not interested in taking risks because you might be slapped with a lawsuit or an enforcement action. So what we hear from technology manufacturers is that their most difficult challenge is to establish credibility for their technology in the marketplace. They are looking to EPA to establish that credibility for them, to say their technology meets EPA standards and will work.

Q Some industry people say that EPA's own institutional barriers discourage innovative technologies. What is being done on that front?

A We've heard from both users and developers that EPA's policies can inhibit the introduction of new and innovative technologies into the marketplace. For that reason, our fiscal 1995 ETI Solicitation Package put special emphasis on proposals addressing policy-framework and innovation-capacity issues. The policy-framework area addresses barriers to innovation erected by our own policies, practices, and institutional culture. The innovation-capacity area addresses ideas for facilitating EPA's verification of technologies and the barriers to innovation inherent in other, non-EPA activities, like building codes.

Under the Environmental Technology Initiative, we're looking at our fundamental statutes, at the rules we write, the permits we issue, even at our enforcement programs to find ways we can structure them that will work better for environmental technology. And I think we've already found some places in



Air-pollution controls being installed at Detroit trash-to-energy incinerator. Establishing credibility for a new technology is the biggest challenge.

Jim West photo. Copyrighted.

which we can make a difference. For example, under the legislative proposal the administration made on Superfund, the government would assume some of the risk for testing new technologies at Superfund sites. The administration's proposal on the Clean Water Act includes provisions to allow demonstrations of new and innovative technologies that go beyond the existing legislation. We're looking carefully at the National Pollutant Discharge Elimination System to see if it inhibits the introduction of innovative technology and, if so, what can be done to remove the obstacles. In the upcoming fiscal year, we expect our regional offices, in particular, to propose innovative efforts in the permitting and enforcement area on a case-by-case basis. These are the kinds of things that we think EPA can do to help structure policy in a way that encourages the introduction of innovative environmental technologies.

Q In the past, government regulations have been the major force driving the development of environmental technologies. These same regulations, however, can lock in existing technologies to inhibit innovation. Take us through a case in which the strategy will unlock the status quo, allowing innovation to take place.

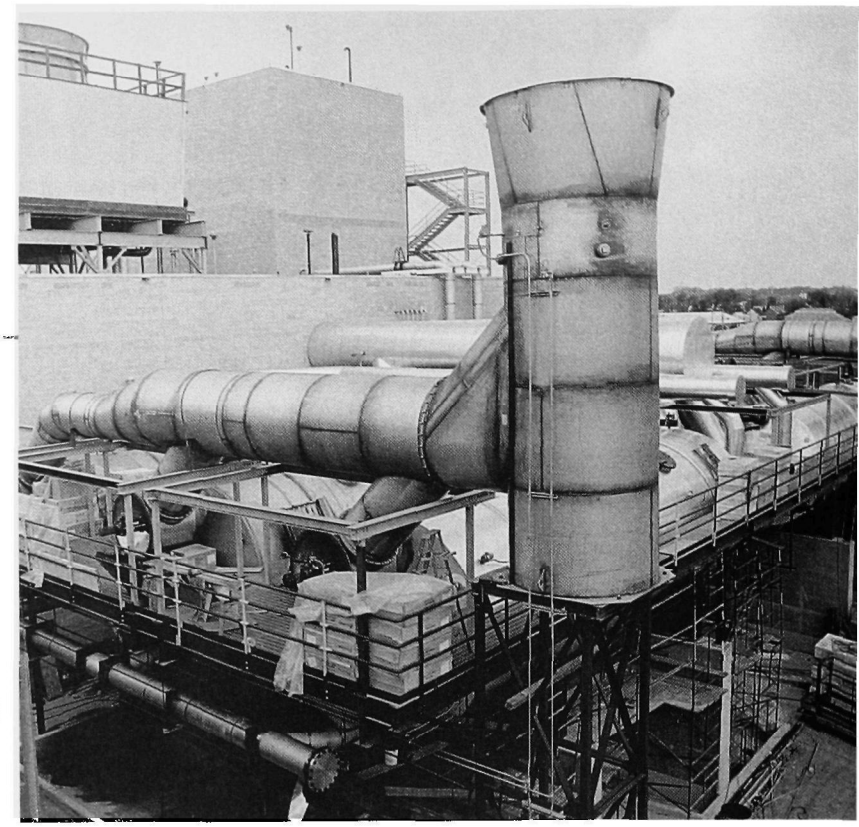
A Probably the most frequent criticism that we hear about EPA's policies is that they do tend to "lock in" particular technologies. I believe that the problem is more complex than the critics say it is; however, we do have to look at whether our policies–be they statutory, regulatory, or even permitting or enforcement policies–inhibit the introduction of innovative environmental technologies. It's also clear that even if EPA's policies encouraged innovation there are other factors that prevent people from introducing it. A good example, I think, is that many of the most innovative ideas that might be applied in a particular facility have to work their way through a permitting process. And many times the permit writers themselves, or indeed the people who might buy those technologies, aren't sure they work.

In the projects we fund in fiscal 1995, we hope to have several "Innovation Ombudsmen"-type functions created in the states and regions. An Ombudsman would be given responsibility, with commensurate resources, for shepherding through the permitting process innovative technologies that would otherwise be neglected, mainly due to the conservatism inherent in the process I spoke of earlier. In addition, we are thinking about how we can improve the credibility of innovative environmental technologies through programs that–as the terminology calls for–*verify* that they work. In some cases, I think EPA should actually certify technologies that are really good, so that we can overcome the conservative nature of the environmental technology marketplace.

EPA is already engaged in a number of activities aimed at improving the credibility of technologies. We have several situations in which we're working jointly with developers and users to demonstrate innovative technologies at facilities owned by the federal government. A good example is the collaborative work going on at McClellan Air Force Base. EPA's Region 9 has joined together with the California EPA and several Fortune 500 companies to test two innovative technologies at McClellan Air Force Base. The McClellan Partnership, as it is called, selected the technologies and the test methods and will jointly disseminate the results. Thus, the chances for success at each juncture are being maximized.

Q When you talk about certification, are you talking about a written endorsement from EPA that a company can show and say, "Here, EPA stands behind us"?

A That's one way in which EPA could play a role in this. There are others. For example, there are certain kinds of monitoring for which EPA actually pre-approves technologies for use in satisfying environmental regulations. In the RCRA program the developer must apply to EPA for approval of a monitoring technology, before industry can use it for certain specified applications. After extensive evaluation, EPA puts its seal of approval on the method and publishes it in a compendium. In other cases, EPA may evaluate technologies, not because our pre-approval is required and not necessarily to say that we are sure they will work, but just to verify that the technologies are capable of achieving a certain level of pollution reduction or environmental cleanup. Under the Superfund Innovative Technology Evaluation or SITE program, we've now tested a substantial number



Solvent recovery system at a 3M plant in Hutchinson, Minnesota. This technology helped 3M reduce air emissions at its U.S. and international plants by 70 percent from 1989 through 1993.

3M photo

of innovative technologies. This is a very helpful thing to developers: to have an opportunity to test their technology at a particular site or at a particular facility and show that it can actually work. A lot of what we're trying to do in this whole area of certification and verification is not necessarily to put an EPA stamp of approval on something, but rather to provide opportunities for developers to test their technologies. We then verify and share the results of the tests.

In the Superfund program, use of innovative technologies has more than doubled, thanks in part to our SITE program. (See article on page 24.) Savings at a sample of sites using innovative technologies averaged $21 million per site.

Q How do you respond to critics who claim that EPA's ETI program fences out America's premier innovators, the anonymous small entrepreneurs?

A We've heard from people in the private sector that our program is too focused on government agencies, and it is true that one of our top priorities is to construct partnerships with other agencies at the federal level as well as at the state, local, and tribal levels. But we have also set up a special program for fiscal year 1995 in which academic and other nonprofit institutions can compete, as well as a special program aimed at small businesses–the Small Business Innovative Research grants. And so a fairly substantial portion of our money in fiscal year 1995 will be aimed at nongovernmental institutions that have expertise in the environmental technology area, and we're hopeful of bringing them into the program. I should also say that a lot of the efforts we are currently funding involve partnerships with the private sector. We see this as critical, because the private sector is where the ideas for technology are coming from and where the customers are. Clearly, government plays a unique role because it drives the marketplace, but ultimately the private sector is going to spend more money and develop more environmental technology than government can ever hope to do.

We should also remember that inventors in their garages, and the entrepreneurs they team up with, will be the prime beneficiaries of our efforts to reduce barriers to innovation. In fact, I think that a good gauge of success for our environmental technology policy will be, when all is said and done, does the world really beat a path to your door if you invent a better environmental technology? That doesn't happen now, unfortunately, but I'm confident that we can make it happen.

Q EPA is a regulatory agency and traditionally has kept the industries it regulates at arm's length. Speaking of critics, how do you respond to those who claim that "a plan to directly and indirectly support private sector innovation" is bound to create conflicts of interest? Are safeguards built into the strategy?

A Well, it's a situation that has to be watched, but my impression is that it's also one that provides opportunities. Because it is a regulatory agency, EPA is in exactly the right place to be the focus for environmental technology activities. We're familiar with what the environmental problems are, and we can make educated predictions about what the next 10 or 20 years of environmental protection might bring. To understand the environmental technology marketplace, it is critical to understand the regulatory framework in which both the users and the developers of technology work and exist. Without EPA's expertise in environmental science and technology, and its experience with environmental rules and regulations, I think it would be extremely difficult to launch a major new initiative in the environmental technology marketplace. There will be opportunities to make mistakes; however, we've built safeguards into our program to avoid them. In proposing the Environmental Technology Initiative, the President recognized that EPA does not have all the answers. We have a lot of expertise, but so do other parts of the federal government, and so do people in the private sector. That's why the focus of the program is partnership: partnership with other agencies of the government at the federal, state, local, or tribal levels; and partnership with the private sector. I think that's a critical safeguard against people saying, "Yes, as a regulatory agency you are expert in understanding this particular kind of a problem, but from your perspective you may not see this other issue over here." And I think that is one kind of safeguard that we have.

Q In the *Federal Register* notice announcing EPA's Technology Innovation Strategy and Program Plan, you asked for comments on the strategy and indicated you would hold public hearings. What kind of reception did you receive?

A We had a fantastic response in our public meetings, with good turnout and lots of excellent ideas put on the table. As I indicated earlier, we heard two overwhelming messages in the public comments on the strategy, and we've heard them elsewhere as well. The first is that the most important thing EPA can address is structuring its policies to encourage the development and use of innovative environmental technologies. That includes the whole subject of how we verify or certify technologies to give them credibility in the marketplace. The second message which we heard loud and clear was the importance of the international marketplace and the need for not just EPA, but government in general, to assist technology developers in breaking into it. That's a difficult thing to do for many of them, because they are small businesses and they don't have experience working in the international marketplace. They need everything, from the basics about "how do I get started" to the kinds of contacts–in some cases, financing–that government agencies can be helpful with. So, those messages are giving us very strong indications about what we should focus on.

Q In EPA's strategy, much is made of finding partners, including private sector partners, that will contribute their expertise and resources to a project. Could you take us through the Dry Cleaning Project, in which EPA is working both with industry and with environmental organizations, to show us how that works?

A The focus of the project is to reduce the use of solvents in the dry-cleaning industry through pollution prevention. The idea is to work in partnership, not just with the industry itself, but with the environmental community and others to identify innovative technologies and find out whether they work. Ultimately, we would try to diffuse those technologies that do work throughout the dry-cleaning industry.

EPA has been working with a long list of partners, including the Fabric Care Institute, the Neighborhood Cleaners Association, Greenpeace, the Amalgamated Clothing and Textile Workers' Union, the Center for Neighborhood Technology, Dow Chemical Company, and the Toxics Use Reduction Institute.

Three separate demonstration projects are being set up. EPA is funding one in which technologies aimed at reducing the use of solvents are being used at an actual dry cleaning establishment in Chicago. Environmental organizations are monitoring the results. Our thought is that, if these technologies are supported by not only EPA, but also environmental and other nonprofit organizations, then they will be enhanced in the rest of the dry cleaning marketplace.

The other two demonstration projects are being funded by the dry cleaning industry itself; EPA is funding the staff to monitor and evaluate progress.

I think this project is a good example of the sort of partnership we hope to have, in which several different stakeholders seek opportunities for pollution-prevention technologies. At the table we have environmental and other nonprofit organizations, who not only help identify good technologies, but verify that they really work and, therefore, establish their credibility in the marketplace. Then, because we have the participation of the industry through its trade association and others, we can diffuse these technologies rapidly through the marketplace.

Q Will the President's Environmental Technology Initiative affect the national economy in a significant way, do you think?

A There's no doubt that it already does. There are more than a million people already employed in the business of environmental protection in this country, whether in technology or some other aspect. We anticipate that our own environmental technology market is going to grow, and we certainly see a growing market on a worldwide basis. It's currently estimated that the worldwide market is in the neighborhood of $300 billion dollars, and this market is projected to grow to $400 or even $600 billion by the end of the century. The major effort across the government has been in the export field so that we can capture a share of that very large and rapidly expanding global market. For each additional billion dollars we can generate in environmental technology exports, we think we can generate in the neighborhood of 17,000 additional jobs. So, it clearly does have benefits for the U.S. economy.

Q We understand that differing versions of a "green" technology bill have passed the Senate and the House in the last session of Congress. Would you comment on the bill? If the current proposals become law, what will this mean for ETI?

A Two pieces of legislation passed: the Senate bill, authored by Senator Baucus (see article on page 37) and other leaders of the Senate Environment Committee; and the House bill, authored by Congressman George Brown, Chairman of the Science and Technology Committee. Unfortunately, these two bills did not get out of conference before the end of the session. We expect similar legislation to move next session. Basically, the legislation authorizes the Environmental Technology Initiative. It calls for a government-wide strategy to be coordinated by the White House, and it gives EPA a prominent role in a program of verifying environmental technologies. Although there are details of the legislation that need to be worked out in conference, there has been a great deal of support for the Agency's environmental technology activities in Congress. ❑

Breakthrough in Plastics Recovery

VinylCycle® units are operating on three continents

by Brian Moore

Using technology to address environmental problems is the main direction of National Recovery Technologies, Inc. (NRT). The Nashville, Tennessee, company has developed equipment and integrated systems to process solid wastes, recover recyclables, and aid in reducing air pollution. NRT's most successful commercial application of technology has been its VinylCycle® machines, which automatically detect and separate whole PVC containers from PET and HDPE bottles.

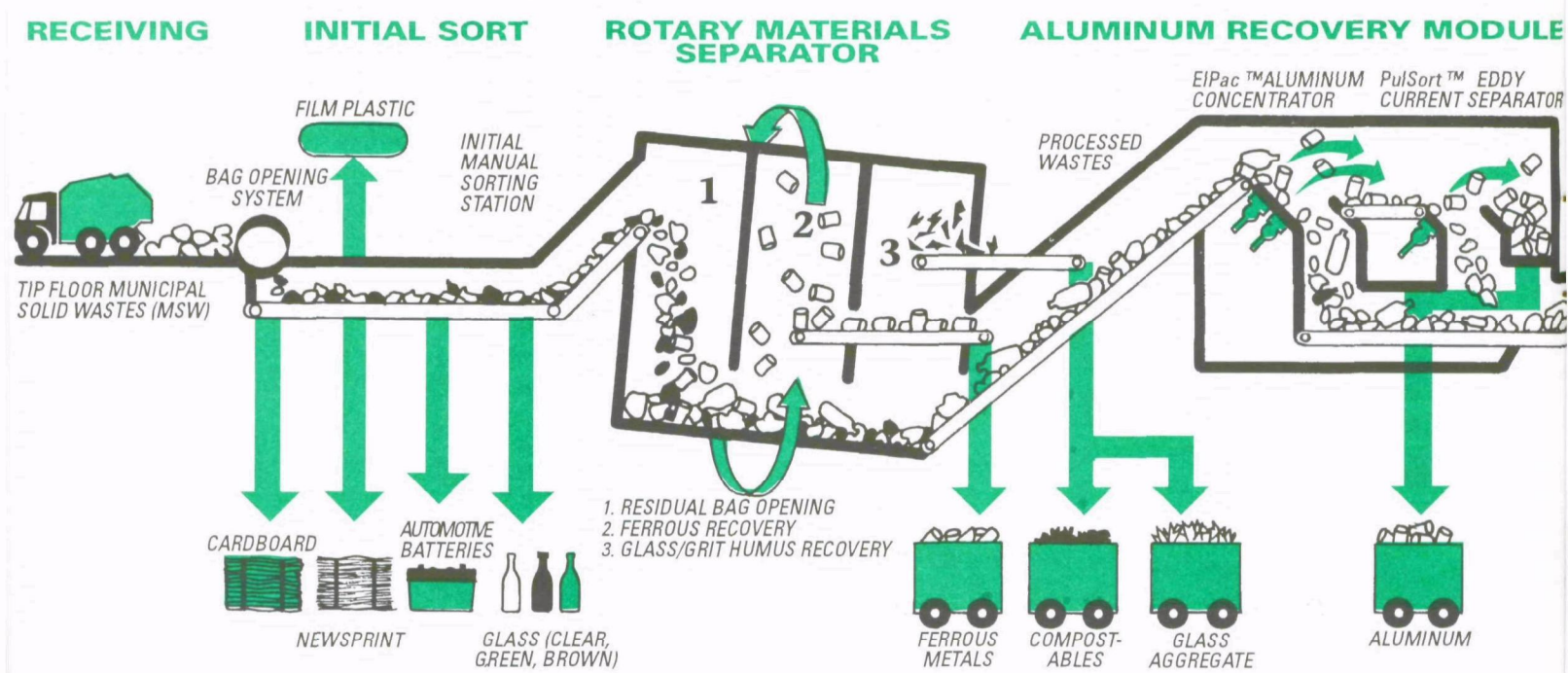
VinylCycle® technology originated in a project designed to address an air-pollution problem. NRT's founders had designed and were operating a prototype 150 ton-per-day automated recycling facility that processed mixed solid waste to produce fuel for a local energy recovery facility. The presence of PVC plastics in the waste stream created high chlorine emissions after incineration. To reduce the emissions, NRT proposed using x-rays to identify the PVC, then mechanically remove it from the waste stream prior to burning.

In 1988, EPA awarded NRT a Small Business Innovative Research (SBIR) grant to develop the technology. Additional funding was contributed by the Vinyl Institute and European Vinyls Corporation. The resulting technology was the VinylCycle® line of plastics separators, for which NRT received EPA's 1991 "Outstanding Small Business Enterprise Award."

The patented NRT VinylCycle® system accepts whole or crushed plastic bottles as they are fed by a vibrating conveyor. Once inside the machine, the bottles pass over a detector array that can sense the presence of the chlorine atoms in PVC bottles. Air jets are triggered to separate and kick the PVC bottles away from the remaining PET and HDPE containers. As many as 10 bottles per second can be processed.

While developing the VinylCycle® technology was an admirable accomplishment, adapting the process to commercial applications was the ultimate goal. The plastics recycling industry was an ideal candidate because the VinylCycle®'s automated technology reduces manpower needs and boosts product purity. Purity is critical to users of recycled PET plastics because PVC and PET plastics have incompatible chemistries, and it takes only one PVC bottle among 20,000 PET bottles to contaminate an entire batch.

Public announcement of the VinylCycle® line by NRT in 1991 was soon followed by numerous orders for the equipment from recycled plastic processors. To meet their differing requirements, NRT developed three machines with varying capacities. Over 30 VinylCycle®



units have been sold and are now working in the United States, Europe, Australia, and Japan.

The success of the NRT vinyl separation technology has fostered the development of a color/polymer sorter for plastics. Separate funding from an EPA SBIR grant has resulted in successful development and placement of five AutoSort® machines. Two are co-located with three VinylCycle® units at the Replastic demonstration facility outside Milan, Italy. Three AutoSort® machines and a VinylCycle® unit are operational in the Sunnyvale, California, "SMaRT Station," a mixed solid waste processing center.

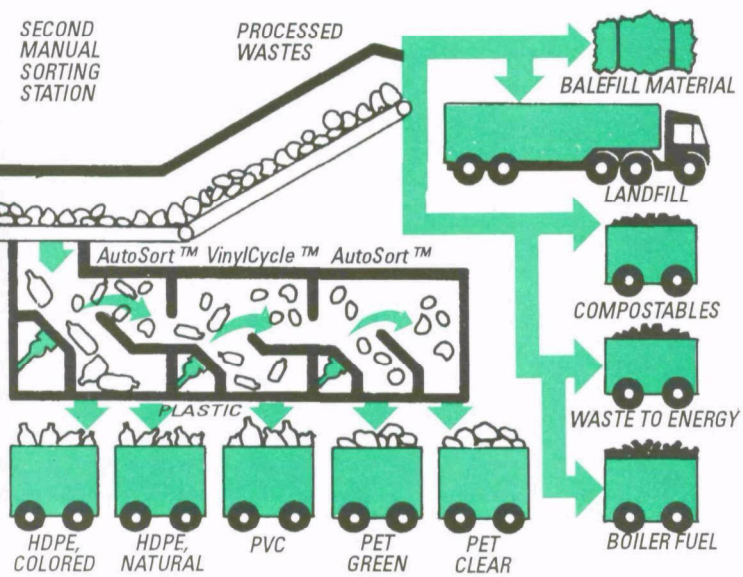
Recycled PET that has been processed by NRT VinylCycle® units can now be found in everything from carpets to clothing. Besides being ecologically correct, it has become quite fashionable for clothing to be manufactured from recycled PET containers. The clothing company Patagonia was the first to use Fortrel Eco-Spun fibers, and the company has now been joined by Wickers and Eastern Mountain Sports in the "clothing from bottles" initiative. Even more products are expected from the likes of Nike, Reebok International, Jansport, Timberland Company, and even L. L. Bean. ❑

(Moore is marketing coordinator at National Recovery Technologies, Inc., in Nashville, Tennessee.)

New products can be made from recycled plastic containers. These jackets were made from recycled soda bottles.

Wellman, Inc., photos. Copyrighted.

PLASTICS RECOVERY



Plastic Primer

PVC	polyvinyl chloride	cooking oil and mineral water bottles
PET	polyethylene terephthalate	soda bottles
HDPE	high density polyethylene	milk jugs

Analytical Technology to Go

Environmental testing goes into the field

by Sandra Wester

American industry spends more than $1.5 billion a year analyzing soil and water samples to comply with EPA wastewater-discharge and soil-cleanup requirements. This represents more than 10 million samples per year.

Analytical testing must be performed during every phase of hazardous-waste site cleanup. During the site assessment phase, a small number of samples are collected and analyzed to identify hazardous compounds. Sites characterized as hazardous ultimately require mapping, remediation, and ongoing closure monitoring.

Customarily, this analytical testing is performed in the laboratory. Highly sophisticated instruments are required because the contaminants can be hazardous at very low concentrations. The primary instruments used for detection are laboratory-based gas chromatography, gas chromatography/mass spectrometry, and high performance liquid chromatography. Because of the complexity and sequential nature of laboratory testing, test results often take weeks to obtain and cost hundreds of dollars per sample.

In 1991, North Carolina-based EnSys Environmental Products, Inc., introduced immunoassay-based analytical test systems as an alternative to traditional laboratory testing. The decision came after EnSys had conducted extensive research with EPA, environmental engineers, and focus groups and found that the environmental testing market was in desperate need of a rapid, accurate, and cost-effective method of detecting hazardous contaminants.

Immunoassay technology, which has long been approved by the Food and Drug Administration as a standard method for disease detection and drug monitoring, dramatically reduces the time and cost of site assessment and remediation. The technique relies on a molecule–referred to as an antibody–that is developed to have a high degree of affinity for the target analyte. In this case, the target is a contaminant. The high specificity and high affinity of the antibody is coupled with a sensitive colorimetric reaction that illustrates the result. The same features that motivated widespread adoption of immunoassay technology by the medical community apply to the environmental arena. For instance, immunoassay-based tests are extremely specific; the tests are accurate, precise, and easy to use; the immunoassay reaction is rapid, less than 30 minutes; the immunoassay reaction is not significantly affected by the composition of the sample, soil, or water.

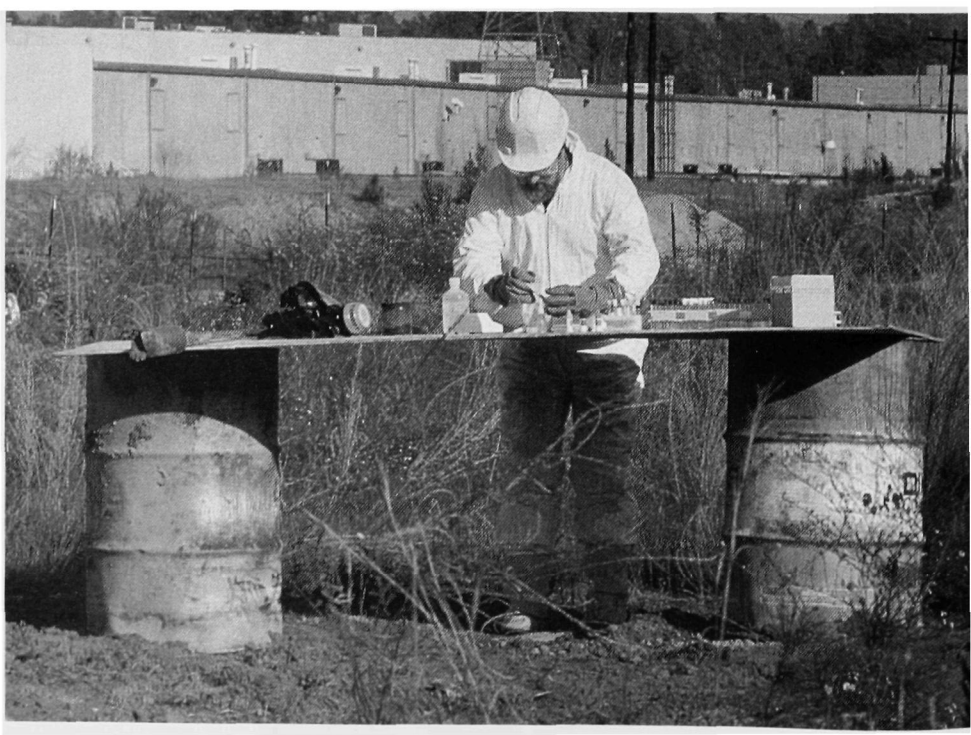
EnSys, however, had to overcome several obstacles before opening its doors to the environmental testing market:

- *The immunoassay-based technology worked for the home pregnancy test, but would it perform on soil, sludge, and water?*

Because immunoassay had never been used to detect analytes in soil and water, EnSys had very little background information from the literature to develop its test systems. Most EPA methods were extracted with organic solvents, which were not compatible with antibodies. In addition, soil samples varied greatly in their composition, and there was no way of knowing what interferences would be present.

- *Sample processing had to be quick and easy.*

Existing laboratory methods used high temperatures and long extraction times to get efficient recoveries of analytes from the matrix. In the EnSys system, samples are tested in tubes coated with antibodies; the result is a color change that is proportional to the concentration



EnSys Environmental Products photo Copyrighted

The great advantage of immunoassay testing is that it can be performed in the field.

(Wester is Public Relations Manager at EnSys, Inc.)

Technician collects soil samples for immunoassay testing.

of the compound in the sample. EnSys decided to keep its entire sample-processing procedure under five minutes.

- *Even though immunoassay technology had been used in the medical industry for over three decades, it had low acceptance in the environmental testing market.*

EnSys overcame this obstacle by extensive training of its users. EnSys' technical expertise allowed the company to educate the public and demonstrate first hand the cost and time savings associated with the new technology.

- *EnSys systems also had to gain regulatory acceptance.*

If a project is under legal and regulatory scrutiny, as almost all remediation work is, testing must be done by a method acceptable to state and federal authorities. In most cases, these authorities refer to methods approved by EPA under the Resource Conservation and Recovery Act. Prior to being approved, a new method must go through extensive validation, including field trials. EnSys currently has eight tests with draft EPA approval. Its pentachlorophenol test received final approval in early 1994. Because the reagents used are proprietary to EnSys, and it was the first to seek EPA approval of the technology, EPA draft approvals specify that tests under the generic methods must be EnSys tests or their equivalents. ❑

Immunoassay in Action

Three U.S. government-owned facilities in a remote part of Alaska, under investigation since 1989, were suspected to be contaminated with metals, chlorinated solvents, and polychlorinated biphenyls (PCBs) from electrical equipment and spills. Screening results from initial borings measured PCBs at an alarming level of 70,000 parts per million. Due to adverse Alaskan weather and declining crew morale, the consulting company called in by the government to study remedial alternatives wanted to complete the project quickly.

The company had two choices for testing the samples, the laboratory or an immunoassay-based test system. The usual laboratory-based gas chromatography method for PCB soil analysis required a two- to four-week turnaround or more, because it was necessary to send samples out of state for analysis. The company chose the immunoassay-based EnSys system.

The project took only 40 days, cutting 50 days off the estimated schedule. At a cost of $6,044 per day for field equipment and labor, expediting the project saved the government $302,200. Sending samples to the lab instead of using the EnSys test would have cost an additional $150,000. One hundred and twenty-six samples were randomly selected and confirmed in the laboratory at a cost of $20,160. Additional disposal costs totalling $69,000 were incurred.

The project director for the company commented: "My goal was to get the job done quickly and accurately. Saving the government money was bonus. The material on-site was immediately hazardous and needed to be isolated without delay. Also, the conditions were affecting the crew's morale. Without the EnSys test kits, people would have been sitting on their hands waiting for lab results while equipment lay idle. I had a 50-day head start on the next phase of the project."

Green Chemistry at Work

Products can be made from glucose instead of benzene

by John Frost

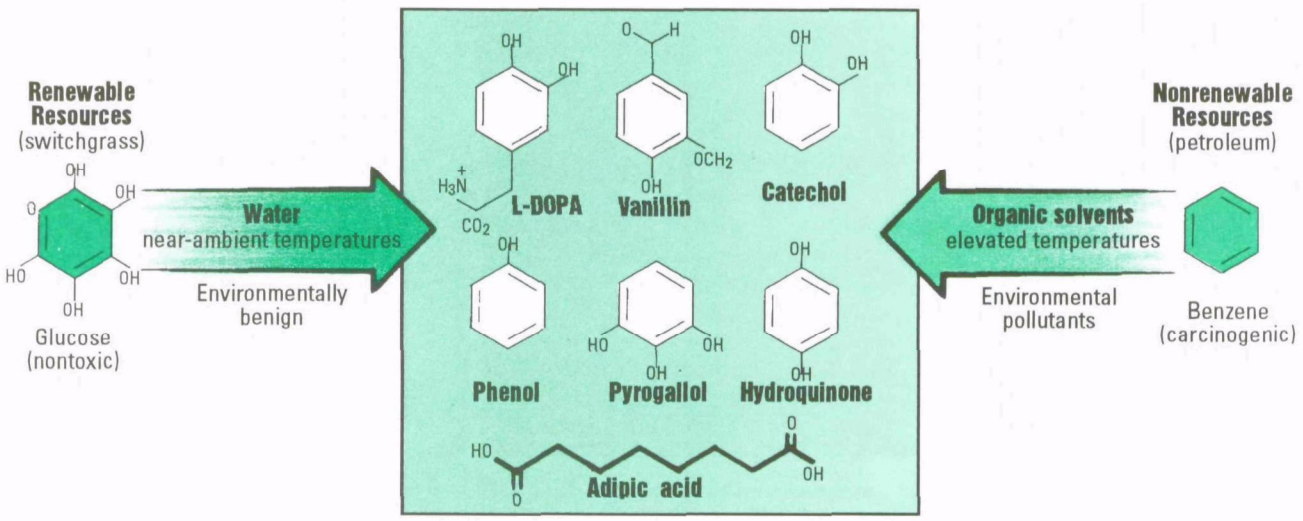
Although many people may never have heard of benzene, everyone has come in contact with the materials, flavors, or medicinal agents that come from manufacturing processes using benzene as a starting material. Vanillin, a dominant flavor component of vanilla ice cream, is derived from benzene, as is hydroquinone, a chemical essential to image formation in photography. Nylon 66, a synthetic fiber widely used in fabrics, is made from benzene. Benzene is the starting material for synthesis of drugs such as L-DOPA, used to treat Parkinson's disease. Phenol, catechol, and pyrogallol are examples of "building block" molecules derived from benzene that are employed in chemical manufacture.

The 1.7 billion pounds of benzene produced each year in the United States provide one measure of its utility. At the same time, there are a number of environmental reasons for avoiding the use of benzene in chemical manufacture. Perhaps most compelling: Benzene is a potent carcinogen.

Scrutiny of many of the aforementioned chemicals derived from benzene reveals that each molecule contains at least one oxygen atom while benzene completely lacks oxygen atoms. Introduction of oxygen to make up for this lack can require processes that are environmentally problematic. One of the steps used to introduce oxygen atoms during manufacture of adipic acid, a component of Nylon 66, is responsible for 10 percent of the annual global increase in atmospheric nitrous oxide. This byproduct is a causative agent of atmospheric ozone depletion and has been implicated in global warming. Conversion of benzene into catechol, a chemical essential to vanillin manufacture, requires use of concentrated hydrogen peroxide. This oxidant is a highly energetic, corrosive material requiring special care during handling and storage.

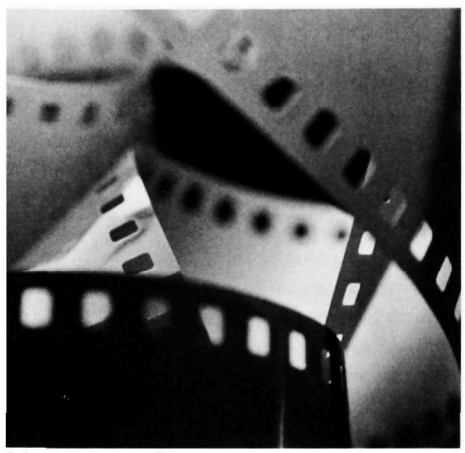
Also, benzene is primarily obtained from petroleum. All of the environmental costs, such as from oil spills, associated with use of this nonrenewable resource must be factored into the true environmental cost of using benzene as a starting material. With support from EPA and the National Science Foundation, alternative manufacturing processes are being explored. By these new methods, chemicals usually created from benzene are made instead from nontoxic glucose, a component of table sugar.

Nontoxic glucose has six oxygen atoms attached to six carbon atoms. Use of this highly oxygenated starting material eliminates the step during manufacture of adipic acid that generates nitrous oxide. The route developed for conversion of glucose into catechol eliminates use of corrosive hydrogen peroxide. Processes using glucose as the starting material typically employ water and temperatures no higher than body temperature. This procedure contrasts with the elevated temperatures and organic solvents often used in chemical manufacture where benzene is the starting material. Waste streams for use of glucose as starting material are typically no different than what is normally handled by municipal sewage treatment facilities. This is not necessarily the case with traditional chemical manufacture. Unlike benzene, glucose is obtained from such renewable resources as plant starch and cellulose.



Steve Delaney photo EPA

In "green" manufacturing, nontoxic glucose substitutes for benzene in making substances like vanillin flavoring and photographic film.



Catharina Japikse photo EPA

The key to employing glucose in chemical manufacture is the use of biocatalysis. Enzymes found in laundry detergents are one type of biocatalyst; the intact microbes used to make beer represent another. The processes developed to convert glucose into chemicals such as adipic acid, catechol, and hydroquinone employ intact microbes. Normally, glucose is consumed by microbes and then "burned," producing carbon dioxide and providing the energy needed for growth and reproduction. This process is very similar to the production of energy (i.e., heat) when wood is burned.

By altering a microbe's metabolism, glucose that would normally be burned can instead be channeled into biosynthetic pathways used by the microbe to make chemicals. A biosynthetic pathway consists of a series of enzymes that are located inside the microbe. By isolating DNA fragments from one type of microbe and then introducing these DNA fragments into another microbe, biosynthetic pathways can be created that do not normally exist in nature. This is the process used to create the microbial biocatalysts that can convert a solution of sugar (glucose) water into a solution of adipic acid, catechol, or hydroquinone.

"Green" manufacturing routes ideally should lead to chemicals that are economically competitive with chemicals produced by traditional methods. For two chemicals of roughly comparable cost, the consumer or producer can then be realistically expected to choose in favor of the chemical produced by a "green" process. Projections indicate that catechol and hydroquinone can be biocatalytically produced from glucose at a cost competitive with current market prices. Although the estimated manufacturing cost for adipic acid exceeds the market price, the costs of eliminating emissions of benzene and nitrous oxide will put upward pressure on the cost of current manufactures of adipic acid from benzene.

Deriving chemicals from glucose presents numerous scale-up and processing problems. The best crops for manufacture of chemicals may not be those that currently dominate American agriculture–such as corn. More appealing are plants like switchgrass, that can be harvested multiple times during a growing season and that require minimal fertilizing and pesticide inputs. Additional challenges confront the grain processing companies that control the renewable resources and glucose supply. These commercial entities typically have little experience in traditional chemical markets. At the same time, chemical companies lack a significant presence in renewable resources and typically lack experience in biocatalysis.

These barriers to change in the manufacture of chemicals are imposing, although powerful incentives for surmounting such barriers are generated by the need for compliance with increasingly strict governmental regulations and the need to fulfill public environmental expectations. Synthesis of chemicals from glucose using biocatalysis offers the promise of achieving fundamental environmental improvement while increasing the demand for agricultural products. In the final analysis, what is good for the environment can also be good for American agriculture. ❑

(Frost is Professor of Chemistry at Michigan State University.)

EPA's SITE Program: Sharing Innovation Risks with Industry

Some program graduates are now considered conventional

by Alfred Lindsey and Meg Kelly

In 1980, when the Superfund program began, the technologies available to clean up hazardous waste sites involved either reburial or containment of the waste on-site or shipment of the waste off-site to an incinerator or landfill. The authors of the original Superfund law must have believed these technologies were adequate to do the job because they rejected proposals to include research and development provisions in the legislation. Consequently, there was little attempt to develop better solutions.

This was very shortsighted, as early experience showed. For the first six years, the Superfund program struggled to apply limited and often inadequate technologies to some very complex and difficult clean-up problems. The early Superfund experience with technology applications is briefly summarized below.

A Wicked Brew of Chemical Soup

Superfund sites contain complex chemical mixtures of hazardous substances in many different physical forms. Such wastes include, for example, lagoons or ponds filled with sludge and oils, large areas of soil that have been contaminated with heavy metals and solvents, contaminated ground water where wastes have leaked below the water table, and assorted debris such as old barrels and tanks that contain remnants of hazardous substances. The physical and chemical properties of these wastes vary considerably. Some bind tightly to soil particles. Others dissolve in ground water. Some volatilize into the air. Others sink to the bottom of underground aquifers.

(Lindsey is Director of the Office of Environmental Engineering and Technology Demonstration at EPA. Kelly is Deputy Director of the Technology Innovation Office, also at EPA.)

Wastes at Superfund sites include both organic and inorganic toxic contaminants. Organic substances are carbon-based molecules, often in combination with hydrogen, oxygen, and chlorine linked together in long chains or ring structures. The resulting chemicals have intimidating names such as polychlorinated biphenyls (PCBs) and tetrachlorinated dibenzo dioxin (or more simply, dioxin). Inorganic substances include toxic heavy metals such as lead, mercury, and cadmium.

The Early Years: "Hold 'em or Run 'em"

In the early 1980s, a widely used clean-up method involved trying to hold hazardous wastes on site through the use of various containment devices. Slit trenches were dug around the contaminated areas and filled with cement-like material to form slurry walls or grout curtains to block contaminant spread. Ground water was redirected by installing wells which would be pumped to affect the flow direction. Wastes were excavated and reburied on liners composed of compacted soil or plastic membranes. Caps or covers were placed over wastes to prevent rainwater infiltration.

These containment devices were often very difficult to install properly in the field. They were hard to control, and they sometimes impeded contaminant flow only temporarily. Over time they could break down, or the contaminants could simply find an alternate route around or under them. While some of these devices are still in use today, they require long-term monitoring and maintenance to ensure proper operation.

A second site clean-up method used in the early years involved shipping hazardous wastes off-site to other facilities. However, these facilities were sometimes poorly located, designed, and operated. This practice of running wastes off-site was labeled the "toxic shell game" by the press and often met hostile opposition from citizens in the receiving communities.

Enter SARA and SITE

By the mid 1980s, it became clear that innovative technologies for cleaning up Superfund sites were not coming forth. This was puzzling, given the potential market size and fanfare surrounding Superfund. It was also troubling because the established technologies either did not inspire confidence as permanent solutions or cost too much. Discussions with vendors, many of which were small businesses, indicated a lack of credibility. EPA, state, and private Superfund clean-up decision makers were unwilling to select untried technologies for cleanups under their jurisdiction.

With new authority granted by the Superfund Amendments and Reauthorization Act (SARA) of 1986, EPA established the Superfund Innovative Technology Evaluation (SITE) program to accelerate the development, demonstration, and use of new treatment technologies. Under SITE, innovative technologies are demonstrated and evaluated at full scale at actual Superfund sites. Credible cost and performance information is developed.

SITE is a public-private partnership where the costs and monetary risks are shared by EPA and the technology developer. The developer pays for the design and construction of the technology and must bring it to the Superfund site, install it, and operate it during the demonstration period. EPA pays for the evaluation of the technology, including the collection and analysis of chemical samples. EPA also prepares the final evaluation report, which describes how well the technology worked and presents all of the data collected. This informa-

Superfund sites contain mixtures of hazardous wastes in many different forms. Here a team collects samples.

Michael G. Stoner photo, EPA Region 10

tion is sent to EPA regional staff and many others, who use it when selecting technologies at other sites. The SITE program also supports the evaluation of emerging technologies that are not yet ready for full-scale demonstration by supporting tests at the bench-scale and pilot-plant level. Innovative methods for monitoring and taking measurements at Superfund sites are also evaluated. The program includes extensive technology-transfer activities to disseminate cost and performance information to environmental managers in governmental agencies, the engineering community, industry, and the public.

Technology with an Impact

The results have been gratifying. Innovative treatment technologies have become increasingly accepted since the advent of the SITE program. During the early 1980s, innovative treatment technologies were rarely used. Between 1986 and 1987, they comprised approximately one-quarter of the total number of technologies selected for Superfund projects. In the period from 1987 to 1991, this figure rose dramatically. While SITE was only one contributing factor in increasing innovative technology selection, the program played a significant role. The number continued to rise in 1992, indicating increased credibility for a variety of innovative treatment technologies.

A wide range of technologies demonstrated under SITE are now being selected as Superfund remedies. Often it is necessary to use these technologies in combination with each other in what are called "treatment trains" to deal with the mixtures of chemical substances present. For example, a waste mixture containing heavy metals and organic materials might be treated by first removing, concentrating, and recovering the metals and then degrading or destroying the organic matter. Sometimes the waste components need to be separated from each other before they can be properly treated. Therefore, it is very important to develop a full set of technologies and put together marriages that will deal with the different possibilities.

Many of these innovative technologies provide a significant cost saving over standard treatments. In a four-region sample of 17 Superfund sites, the use of technologies tested under the SITE program saved $21 million per site, or 62 percent.

The program also provides a real advantage to technology vendors in that many of the barriers associated with commercialization of innovative treatment technologies are removed through participation. SITE vendors who have completed demonstrations report 533 contract awards comprised of 395 non-Superfund and 138 Superfund jobs. (See figure on page 26.)

Achievements

As of June 30, 1994, the SITE program had 102 participants and 64 completed projects. An additional six are ongoing in the field. One-fifth of the completed SITE demonstrations have been conducted at federal facilities and additional projects at federal sites are planned.

The SITE program has been instrumental in enhancing the arsenal of available technologies for Superfund cleanups. Some SITE graduates have become so widely used that they are no longer considered innovative–they've graduated to conventional status. Chief among these are SVE (soil vapor extraction), which removes volatile compounds from soils *in situ*, and the various forms of thermal desorption, used to destroy or remove toxic organic compounds in wastes. Bioremediation, a very promising technology originally developed under a Cooperative Research and Development Agreement, has also progressed rapidly. Additional work is necessary, however, to achieve off-the-shelf status, particularly for on-site applications. (See box on page 26.)

What's Next

The SITE program encourages commercialization of new environmental technologies by working cooperatively with private companies, universities, nonprofit organizations, and other federal agencies to provide reliable cost

and performance data. SITE is one model for verification programs called for in the proposed National Environmental Technology Act. (See article on page 37.)

The environmental community continues to search for technologies that perform faster, safer, and more effectively than those typically used. For example, one of the critical needs in remediation technology is a method to accelerate the cleanup of aquifers. Finding and removing or remediating DNAPLs (Dense Non-Aqueous Phase Liquids) is a particular ground-water problem. Quicker screening methods are badly needed for characterizing contamination at sites. And any effective technology that doesn't require excavating soil or pumping ground water is likely to receive a ready reception. These are just a few of the technology needs for which the SITE program hopes to spur innovative solutions. ❑

Bioremediation

Waste-degrading microbes or microorganisms exist virtually everywhere in the natural environment. In fact, microorganisms are Mother Nature's own clean-up crew. When living beings such as trees, plants, or people die, naturally occurring microorganisms degrade the organic matter into carbon dioxide and water. If it were not for microorganisms, the world would be cluttered with organic matter from the past. Bioremediation attempts to harness the waste-degrading capability of microorganisms and use it to destroy toxic organic substances found in hazardous waste.

Often, waste-degrading microorganisms exist right at a Superfund site. Their natural capabilities can be enhanced by adding oxygen, nutrients such as nitrogen or phosphorous, or other microorganisms cultured in a laboratory. If the waste is first excavated, it may be biodegraded in a reactor vessel. Alternatively, bioremediation may take place *in situ* to biodegrade contaminated soils and ground water in place. *In situ* bioremediation is often used in conjunction with a ground-water pumping and reinjection system to circulate nutrients and oxygen through a contaminated aquifer and associated soils.

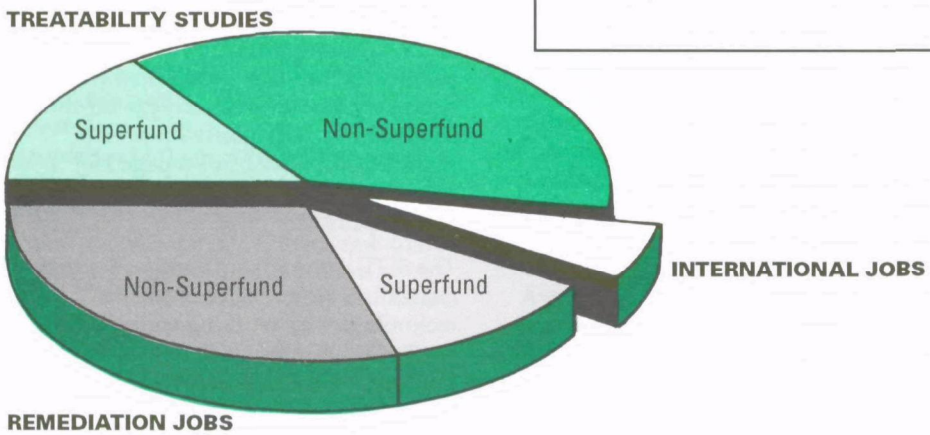
In 1989, bioremediation was used successfully in Prince William Sound, Alaska, to clean up over 100 miles of shoreline contaminated by the Exxon Valdez oil spill. To determine whether it would work on sandy beaches–the Alaska beaches were covered with stoneslast summer EPA scientists applied 540 gallons of light crude oil to 15 specially prepared plots at Fowlers Beach, Delaware. These included plots to which nutrients (fertilizers) had been added to stimulate the activity of indigenous microorganisms, plots to which additional native microorganisms were applied as well as nutrients, plots to which only oil was added, and an unchanged plot to be used as a control. Initial results are expected in the fall of 1994, and a final report is scheduled to be issued in early 1995.

From the study, the scientists hope to compute the rate of bioremediation and to establish engineering guidelines for using the technique. EPA conducted the research in cooperation with the states of Delaware and Texas, other federal agencies, Sun Oil Company, the Marine Spills Response Corporation, Environment Canada, and several universities.

Market Activities Reported by SITE Vendors

Based on 1994 vendor survey

Total number of jobs (contract awards) = 533



Lasagna in the Making

–Catharina Japikse

In January 1994, EPA signed an agreement with three private companies–Monsanto, DuPont, and General Electric (GE)–to develop a new remediation technology. Dubbed the "lasagna" process because of its layers, this technology cleans up liquid-borne organic and inorganic contaminants in dense, clay-like soils. Initial work is focused on removing chlorinated solvents.

Because clay is not very permeable, it holds ground water and other liquids well. Traditional remediation for this type of site requires that the liquid in the soil (usually ground water) be pumped out. The water brings many of the contaminants with it, then is chemically treated and replaced–a time-consuming and expensive solution.

The lasagna process, on the other hand, allows the soil to be remediated *in situ* by using low-voltage electric current to move contaminated ground water through treatment zones in the soil. Depending on the characteristics of the individual site, the process can be done in either a horizontal or vertical configuration. (See figure below.)

The first step in the lasagna process is to "fracture" the soil, creating a series of zones. In a horizontal configuration, a vertical borehole is drilled and a nozzle inserted; a highly pressurized mixture of water and sand (or another water/solid mix) is injected into the ground at various depths. The result: a stack of pancake-shaped, permeable zones in the denser, contaminated soil. The top and bottom zones are filled with carbon or graphite so they can conduct electricity. The zones between them are filled with treatment chemicals or microorganisms that will remediate the contaminants.

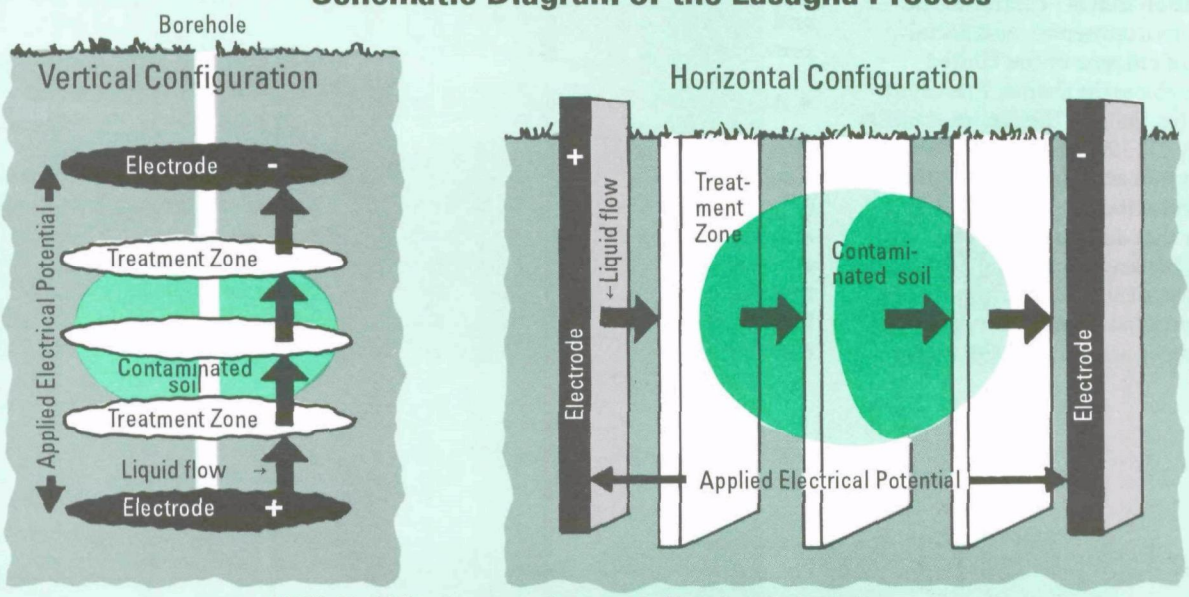
When electricity is applied to the carbon and graphite zones, they act as electrodes, creating an electric field. Within the field, the materials in the soil migrate toward either the positive or negative electrode. Along with the migrating materials, pollutants are carried into the treatment zones, where they are neutralized or destroyed.

The vertical configuration works in much the same way, differing only in installation. Because the electrodes and treatment zones extend down from the surface, this configuration does not require the sophisticated hydraulic fracturing techniques that are used in the horizontal configuration.

Lasagna partnership members are pursuing a range of options for developing the process for commercial use. Monsanto conducts research on the use of electric currents to move contaminants through soil. DuPont contributes expertise on the installation of vertical treatment zones and electrodes. GE performs computer-driven modeling of how contaminants move through soil. GE, DuPont, and EPA jointly pursue bioremediation techniques for use in treatment zones. Monsanto and GE cooperate on basic research into metal-catalyzed dechlorination. EPA investigates and develops the hydraulic fracturing techniques that could be used to install the process in the horizontal configuration. The Department of Energy (DOE) also lends its support; DOE brings its knowledge of electrokinetics and bioremediation to the partnership and provides analytical and field support work. EPA and the nonprofit group Clean Sites provide facilitation services. Clean Sites also manages the private partners' project funds.

In order to get the process out of the laboratory and closer to the marketplace, DOE awarded Monsanto, on behalf of the partners, a contract to demonstrate that contaminants can be moved in the field using the vertical configuration. A series of field tests began in the spring of 1994 at and around DOE's Paducah Gaseous Diffusion Plant in Kentucky. The tests are expected to continue through 1996.

Schematic Diagram of the Lasagna Process



NOTE: Liquid flow is reversed upon switching electrical polarity.

EPA's CRADA Agreements: Sharing Expertise with Industry

Government and industry collaborate to commercialize technologies

by Peter W. Preuss

In the past, legal and institutional barriers have hindered goverment/industry partnerships from developing and marketing technologies for preventing, controlling, or cleaning up pollution. Many companies, struggling to translate their ideas into innovative technologies, have been held back by lack of access to scientific experts in a particular field or to highly specialized equipment. In 1986, Congress passed the Federal Technology Transfer Act (FTTA), which removed many of the barriers to the public-private partnerships needed to develop and commercialize innovative environmental technologies.

The Act makes possible Cooperative Research and Development Agreements (CRADAs) between federal laboratories, industry, and academic institutions. CRADAs set forth the terms of government-industry collaboration and allow the free flow of ideas, expertise, and material essential to the development of commercially competitive technologies. These agreements will, according to the Act, foster the technological and industrial innovation that is "central to the economic, environmental, and social well-being of citizens of the United States." On the same theme, President Clinton, in his State of the Union address on February 17, 1993, advanced the proposition that economic development and environmental protection go hand in hand. In that address, the President announced his Environmental Technology Initiative, designed to promote the development of innovative environmental technologies and to help the United States compete in the global market place. (See box on page 8.)

Since 1989, EPA has entered into 59 CRADAs and has negotiated 13 patent licensing agreements with the private sector to work together to commercialize environmental technologies. Recent CRADAs have harnessed the expertise of industry and EPA to address several leading environmental issues.

- **"Lasagna" Anyone?**

One of our most creative CRADAs helps to illustrate how the Act can yield important benefits to both industry and the environment. Three leading U.S. technology companies recently signed the "Lasagna" CRADA which will develop and field-test a new technology to treat dense (clay-like) contaminated soil. This will eliminate the need for the slow, expensive "pump and treat" method, in which contaminated liquids in the soil are pumped out, treated, and replaced. The CRADA uses the technical expertise and environmental research capabilities of EPA, Monsanto, DuPont, and General Electric. (See box on previous page.)

- **Air Pollution Control:**

EPA signed a CRADA with the U.S. Coalition for Automotive Research (Chrysler, Ford, and General Motors) and the State of California to develop and commercialize new technologies to measure evaporative emissions and hard-to-detect exhaust emissions from cars and trucks. The goal is to help industry and government agencies properly test vehicles in accordance with the Clean Air Act Amendments of 1990 and recent California standards.

- **Pesticide Exposure:**

EPA teamed up with the U.S. Department of Agriculture and an industry consortium of 32 agricultural pesticide manufacturers called the "Spray Drift Task Force" to develop a validated model to evaluate the potential risk to human health and the effects on crops, livestock, and other agricultural resources. This CRADA was signed at the 1994 National Agriculture Day ceremonies.

- **Pollution Prevention:**

Our CRADA with the optical industry (the makers of eyeglasses) and the U.S. Navy will help to eliminate lead and other hazardous materials from the optical manufacturing process. This partnership provides an excellent opportunity to help the industry develop environmentally acceptable products.

Many of EPA's CRADAs are with small and mid-sized companies. Since the time of Eli Whitney, small entrepreneurs have revolutionized U.S. business, but it is increasingly costly for such businesses to transfer their technologies into the marketplace. For Southern Bio Products, Inc., a relatively new company, the CRADA provided a way to develop a product quickly. Under the agreement, the company and EPA investigated the use of microorganisms to metabolize or

degrade polycyclic aromatic hydrocarbons. Some of these hydrocarbons are carcinogens and thus represent a risk to human health and the environment. Under this CRADA, EPA submitted three patents for this new technology, field-tested it, and granted a license to Southern Bio to commercialize the patented technology. The company is currently marketing this technology in the United States and Europe.

The Federal Technology and Transfer Act program will continue to provide EPA with an effective means to work in partnership with industry and academia. We at EPA are eager to discuss possibilities for collaboration with any potential partner. Interested parties may get more information by calling the program coordinator, Mr. Larry Fradkin, at 513 569-7960. ❑

(Dr. Preuss is Director of the Office of Science, Planning, and Regulatory Evaluation at EPA.)

CRADAs enable industry and government to work together. The "Spray Drift Task Force" teamed EPA, USDA, and pesticide manufacturers.

Colorado's Pollution-Prevention Partnership

Public and private organizations work together to cut use of toxic chemicals

by Paul Ferraro

The Colorado Pollution Prevention Partnership is a nonprofit, voluntary alliance of government, business, and public interest groups organized in 1990 to develop and promote pollution prevention and waste minimization in Colorado industries. The partnership started with discussions between two individuals concerning a difficulty in a public-private working relationship. The discussions soon expanded to several individuals meeting on a regular basis, then to informal breakfast meetings with representatives from industry, EPA, and the Colorado Department of Health (CDH). Eventually, organizations representing the public interest joined the discussions. The partnership now includes senior management representatives from EPA and CDH; industry representatives from Martin Marietta, Coors, Hewlett Packard, Public Service Company of Colorado (PSCO), AT&T, and Kodak; public interest representation from the Colorado League of Women Voters and Colorado Public Interest Research Group; and Geraghty & Miller, environmental consultants.

The goals of the partnership are clear:

- Strengthen the working relationship between the private and public sectors.
- Improve capabilities for anticipating and avoiding environmental problems.
- Pool resources and focus attention on the mutual goal of pollution prevention.
- Exchange information and expertise, and help transfer these to medium and small companies and the general public.

(Ferraro is Secretary of the Colorado Pollution Prevention Partnership and Vice President of Geraghty & Miller, Inc., Environmental Services in Denver, Colorado.)

Partnership activities are funded through corporate donations. Member companies agree to commit to the goals of the partnership, to maintain accountability in reaching those goals, and to share expenses in an equitable manner. Currently, the partnership has a budget of approximately $65,000 of in-kind donations from member companies and approximately $30,000 in actual expenditures. Companies typically donate $3,000 to $5,000 annually to pay for project costs.

Under SolvNet I, the first major project initiated by the partnership, member companies committed to significantly reducing use of 1,1,1-trichloroethane (TCA). TCA is widely used in industry as a solvent to clean products and metal surfaces before further processing. It is also a major ozone-depleting chemical. Companies in the SolvNet I group wanted to cut their combined TCA use 70 percent by December 1991. They used 1988 as their base year. The pollution-prevention measures used were: process modification–eliminating the need for TCA; chemical substitution–finding safe alternatives; and revised operating practices–reducing use at the source through education and management practices.

Colorado Public Interest Research Group (CoPIRG) analyzed TCA use and emissions for the base year, 1988, and for 1991. The partnership companies provided data from Toxic Release Inventory (TRI) reports. As part of their responsibilities to the partnership, CoPIRG provided SolvNet results during the fall of 1992. The four companies reduced annual use of TCA by a combined total of 1,128,100 pounds, representing a 90-percent reduction from 1988.

Building on the successes of SolvNet I, the partnership planned additional reductions of hazardous waste through voluntary prevention in SolvNet II. Since each member company uses different hazardous materials, reduction goals needed to be customized. In SolvNet II, each company made its own choice as to the chemicals to be reduced over the next three to five years. They have submitted reduction plans to the partnership advisory committee and have begun implementing their plans. They will reduce emissions or use by one-quarter to two-thirds through pollution-prevention measures.

Business helping business is a very effective way to facilitate technology transfer of pollution prevention strategies. SolvNet II companies would like to "mentor" smaller companies with processes similar to theirs through short, process-specific discussion meetings. The project included a study of smaller companies to gather information concerning their pollution-prevention needs and resources.

The study was conducted by the Center for Research on Writing and Communication Technology at Colorado State University. It consisted of a random phone survey of 300 small and medium-sized businesses across Colorado. Small and medium-sized businesses were defined as those having fewer than 500 employees.

The sample consisted of businesses from 14 industries:

Furniture manufacturing
Printing and publishing
Rubber and plastic manufacturing
Fabricated metal manufacturing
Electrical machinery manufacturing
Instrument manufacturing
Dry cleaning
Pulp and paper manufacturing
Chemical manufacturing
Primary metal manufacturing
Machinery manufacturing
Transportation equipment manufacturing
Photo finishing
Auto maintenance and repair.

Steve Delaney photo EPA

Industries made up of small to medium-sized businesses, like dry cleaners, were surveyed for their pollution-prevention needs.

The results of the study provided some interesting answers to the partnership's research questions.

• *How well do Colorado's small and medium-sized businesses understand pollution prevention?*

Businesses generally comprehend what pollution prevention means. Most of the respondents knew the term and could choose a definition that fit well with the EPA definition. Further, many respondents provided detailed and accurate definitions of pollution prevention. However, it should be noted that a substantial minority of businesses were confused about pollution prevention.

• *What pollution-reducing behaviors are Colorado's businesses currently practicing?*

It is clear that the businesses surveyed have actively implemented pollution-reducing practices in the past year. They have engaged in a number of activities, ranging from chemical substitutions to construction of new production facilities. The most common action appears to be the use of alternative solvents.

• *Where do Colorado's small and medium-sized businesses go for the information they need?*

Suppliers, other businesses, and printed materials are the most frequent sources of information. When respondents were asked to compare workshops, newsletters, magazines, and site visits, they rated them all as being equally useful. They did not like information clearinghouses.

• *What barriers prevent smaller businesses from engaging in pollution prevention?*

First was the perceived cost of pollution prevention. Although most of the businesses sampled felt that prevention was cheaper than waste storage or treatment, many noted that prevention would only save them in the long term. A second and more serious barrier was the antagonistic relationship that the companies perceived to exist between small business and the government. Survey takers noted very strong, negative attitudes toward the government in response to this survey question.

• *What incentives would motivate smaller businesses to increase their pollution-prevention efforts?*

The most frequently mentioned pollution-prevention incentives were "intrinsic motivations." Essentially, these are motivations that have nothing to do with tangible rewards or outcomes. They are largely moral or ethical motives. The second most frequently mentioned incentive was government support. Respondents were very interested in having the government subsidize their prevention efforts. Business contacts mentioned grants, loans, and tax credits as ways the government could help reduce the cost burden. The third most frequently mentioned incentive was maintaining profitability. The responding businesses indicated a desire for the government to help them bear the costs of initiating prevention measures. Surveyed businesses also wanted to be sure that pollution prevention would pay for itself, have a demonstrable effect on the environment, or improve employee health. ❑

U.S. TIES: Diffusing Technologies Abroad

EPA puts overseas problems together with U.S. vendors

by Jamison Koehler and Stephen Lingle

Technology transfer programs in the United States have traditionally concentrated on the supply side of the market for environmental technologies. Using a procedure often referred to as "technology push," these programs first identify a promising technology, then attempt to place it with a user who needs it. Conversely, U.S. development assistance programs abroad have tended to focus on the user's environmental problems and the consequent demand for environmental technologies and expertise–in other words, "market pull." They have not, as a matter of course, tried to match an identified environmental problem overseas with the vendor of a technology or service in the United States.

Designed to enlist the private sector on behalf of the global environment, U.S. Technology for International Environmental Solutions (U.S. TIES) brings together the supply and demand sides of environmental technology in a way EPA has never done before. Launched in 1994, with funding of more than $11 million in its first year, this EPA-led technology diffusion program serves as the primary international component of the President's Environmental Technology Initiative.

U.S. TIES projects help strengthen environmental legislation and institutions worldwide. By focusing on the development of environmental assessment, monitoring, and human-resource capabilities, the programs help countries to deal with their environmental problems while creating the demand for U.S. environmental technologies and expertise.

U.S. TIES projects assist developing countries in identifying and mitigating specific environmental problems, with a particular emphasis on the assessment of various technology, supplier, and financing options. Funding in 1994 includes a grant to the U.S. Environmental Training Institute (see box on page 12) for training private and public sector officials in developing countries concerning U.S. environmental technologies and management techniques. Another project will develop environmental reference materials for U.S. commercial personnel in the field.

U.S. suppliers need information on international environmental markets, regulations, and needs. Foreign officials can benefit from credible information on the performance and cost of U.S. technologies to meet these needs. The 1994 program plan includes projects in both areas. One project, for example, will combine international workshops with the publication of technology monographs and handbooks to highlight U.S. technologies and services worldwide.

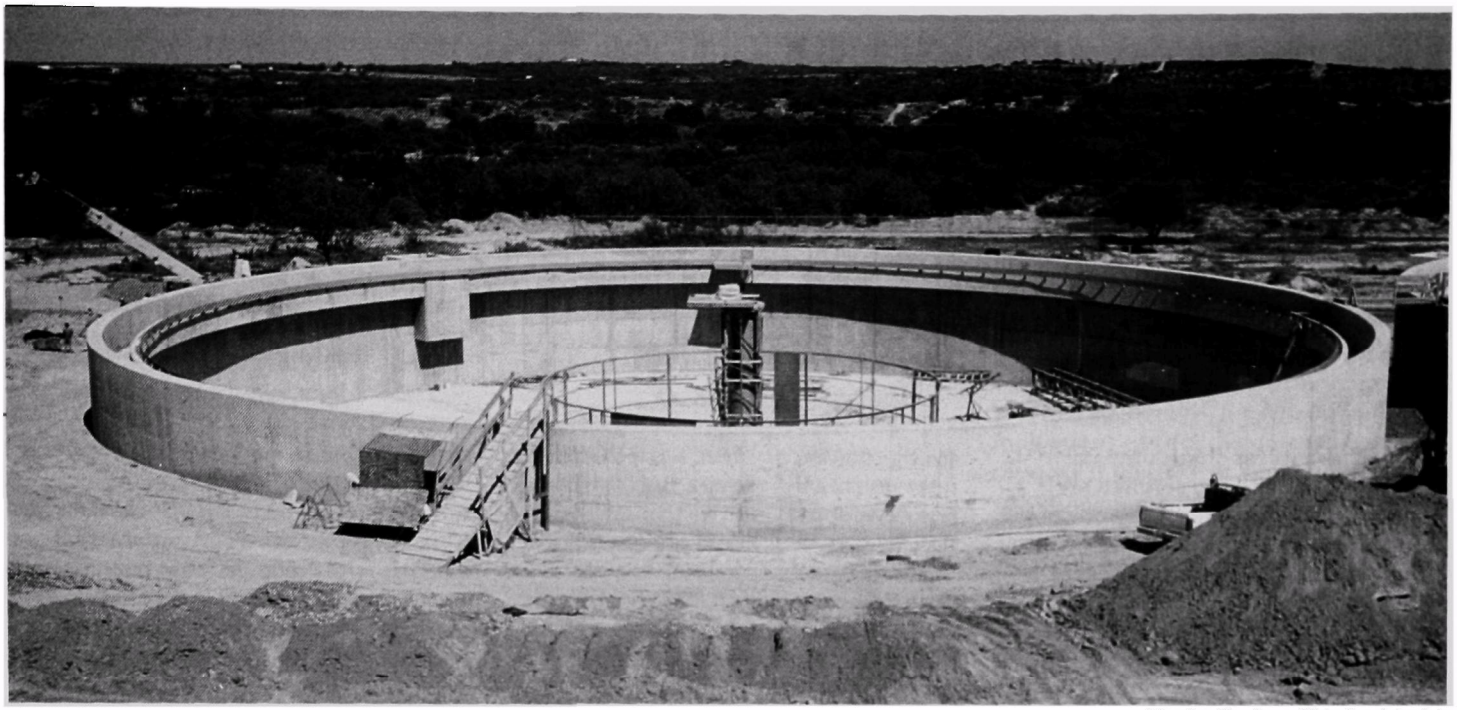
U.S. TIES demonstrates the specific performance capabilities of selected U.S. technologies under real-time, country-specific settings. Coupled with technical assistance, training, and other U.S. TIES programs, these demonstrations encourage the acceptance and use of U.S. technologies on a broader basis. Fiscal year 1994 projects include the demonstration of drinking water technologies in Mexico (see box) and Nepal, wastewater collection and treatment systems in the Middle East, and air-pollution control technologies in Russia and the Ukraine. EPA will work with other countries and with nonprofit groups in identifying opportunities for demonstration and with other agencies, such as the Agency for International Development and the U.S. Trade and Development Agency, in conducting the demonstrations.

Consistent with the Administrator's desire to redefine EPA's relationship with the business community, U.S. TIES is studying the feasibility of an environmental technology cooperation center to facilitate the interaction between government and the private sector. EPA clearly recognizes the important role the U.S. private sector can play in solving environmental problems overseas. U.S. business and industry possess unequalled environmental resources and expertise, and many of the technologies most relevant to the needs of developing countries can only be obtained through commercial channels. Environmental protection can benefit from business-to-business cooperation and the efficient functioning of international markets for environmental technologies and expertise.

At the same time, EPA's ability to fulfill its mission requires the Agency to preserve its credibility and reputation for objectivity. The delegation of broad powers to EPA is predicated on Congressional and public trust in EPA's integrity and its ability to make honest, credible, and independent technical judgements. This objectivity and independence of judgement imply certain boundaries on EPA's working relationships with the private sector.

A primary purpose of an environmental technology cooperation center would be to serve as an intermediary between EPA and the private sector in conducting technical assistance, technology demonstrations, and other U.S. TIES activities.

(Koehler is Acting Director of the International Issues Division of EPA's Office of International Activities. Lingle is Deputy Director of the Office of Environmental Engineering and Technology, which is part of the Agency's Office of Research and Development.)



International Boundary and Water Commission photo

Mexico's Nuevo Laredo Wastewater Treatment Plant under construction. The plant is located across the Rio Grande River from Laredo, Texas.

Based in the United States and tying into the existing network of domestic and international programs, the center would act as EPA's partner in mobilizing private sector expertise and resources on behalf of the global environment in a manner consistent with EPA's environmental mission.

The center would, for example, serve as an impartial third party in selecting private-sector participants for a particular project. Depending on the results of the feasibility study, the center could also serve as a resource for technology developers and entrepreneurs; as a point of contact for international users and businesses; as a financial broker or advisor; and as team-builder of private sector firms, trade associations, universities, and other governmental and nongovernmental groups.

Scheduled for completion in April 1995, the feasibility study will include a comprehensive needs assessment, a set of strategic options, and, based on the option eventually chosen by EPA, an implementation plan for piloting the center in 1995. ❑

U.S. TIES in Action:

Solving Drinking Water Problems in Mexico

The World Health Organization estimates that more than 35 percent of all deaths in developing countries are directly related to contaminated drinking water. The opportunities for U.S. technology vendors in providing solutions to drinking-water problems are enormous.

The passage of NAFTA has stimulated interest in demonstrating environmental technologies in Mexico. Of special interest is the control of diarrhea, cholera, typhoid, and other microorganism-related diseases caused by contaminated drinking water.

U.S. vendors of package plants for testing drinking water have records of success with proven technologies that can be applied in Mexico. With three U.S. TIES demonstration sites proposed, the intent is to use a mix of proven and advanced treatment technologies. The knowledge gained from these demonstrations will provide a competitive advantage for the U.S. environmental industry.

Emphasis will be on low-cost, reliable, and low-maintenance package plants manufactured by U.S. companies. The U.S. companies will team with host-country companies to install, operate, and maintain the treatment systems.

Potential technologies to be evaluated in Mexico include:

- A mixed oxidant for disinfection to control microorganisms.
- Advanced oxidation process to control organic contaminants such as trichloroethylene and also to provide some disinfection of microorganisms. An example of an advanced oxidation process is the use of ozone/ultraviolet light whereby the ultraviolet light will initiate ozone decomposition and accelerate the oxidation of refractory organics.
- Reverse osmosis to control inorganic compounds, bacteria, viruses, and to some degree organic compounds. Contaminant removal in a reverse osmosis process is obtained by passing contaminated water through a semi-permeable membrane; this membrane allows the passage of water molecules while blocking most dissolved and suspended molecules.
- Conventional treatment for control of turbidity and microorganisms. The process begins with the addition of a coagulant, and includes flocculation, sedimentation, clarification, and disinfection.

The International Market for Environmental Goods and Services

The United States, Germany, and Japan export the most

by Wendell Fletcher and Rodney Sobin

Markets for environmental products and services are growing in most regions of the world. Some believe this growth will present major new opportunities for exports and export-related job growth, while also improving the environment. Others fear that commercial objectives will overshadow environmental goals; the danger is that inappropriate technologies will be transferred, especially to developing countries with limited experience in environmental management. These tensions are apparent as the United States, Germany, Japan, and other industrialized countries shape policies for development assistance and export promotion. The challenge will be to assure that the commercial aspects of these policies contribute to development that is environmentally sound.

Environmental Market Characteristics

Dollar estimates vary concerning global demand for pollution control, waste disposal, and remedial clean-up goods and services, ranging from $200 billion to $300 billion; some projections indicate the market may reach over $400 billion by the year 2000. Market projections would be much larger if production technologies and green products that prevent pollution and waste rather than treat them after the fact were included; however, there are no good estimates of the size of this market. (See sidebar on page 36.)

Government regulations have been the most important contributor to environmental market growth. However, other factors should not be overlooked. A healthy economy is needed. Consumers and investors, including public and multilateral institutions, increasingly consider environmental criteria in making decisions; this can influence producers even in countries without strong standards. Then, some multinational companies require their facilities in less developed countries to meet the standards of their home country.

The advanced industrial economies–United States, Canada, Western Europe, Japan, Australia, and New Zealand–make up 80 percent or more of global demand and will account for most of the market for the next 10 to 15 years. These countries require technologies and services ranging from basic trash collection to state-of-the-art sensors and controls.

Several newly industrialized countries, some developing countries, and parts of the former Eastern Bloc, however, are beginning to make substantial environmental investments and may become the fastest growing environmental markets, albeit starting from a low base. Much of the emphasis in these countries is on basic environmental infrastructure–water and sewer service, solid-waste disposal, and some air-pollution controls. The demand is mostly for established technologies, although there is room for new technologies that offer cost advantages. Stopping additional environmental damage tends to have priority over cleaning up old contaminated sites.

The East Asian area, already a significant market for some environmental technologies, could emerge as a major new market for a full range of technologies. China, South Korea, Taiwan, and Thailand are among the rapidly expanding Asian economies that plan major environmental investments. Singapore already meets stringent standards and seeks to be a regional environmental technology center.

Environmental spending is expanding rapidly in Latin America. Mexico and Brazil, the largest regional markets, plan multibillion dollar water-quality projects and hope to tackle other urban and industrial environmental problems. Argentina and other countries also plan major environmental investments.

The nations of Central and Eastern Europe and the former Soviet Union are trying to repair severe environmental damage while redeveloping their economies. These huge potential markets are likely to be constrained by the rate at which they can successfully move to a market basis.

Bilateral and multilateral aid comprises a significant source of environmental investment in some areas. The poorest nations, many located in Africa, have major environmental problems but few resources with which to respond. They compete for aid with the better-off countries.

Environmental Trade and Competitiveness

The size of the world market should not be confused with the potential for international trade. Although many environmental projects are managed by international engineering and construction firms and involve some equipment trade, most environmental spending is for facilities construction and day-to-day operations that use local labor. Lower-value materials, like cement and sheet metal, often are produced locally. Also, environmental firms are springing up in many developing countries to compete for local and regional business (although the emergence of local environmental expertise may create demand for more sophisticated imported technologies). In some cases, local content regulations and tariffs limit imports. While the data are poor, it would be surprising if international trade filled more than 15 percent of global demand.

Even so, sizeable environmental trade does occur. Germany, the United States, and Japan are the largest exporters of environmental technologies and services with, according to one estimate, $11 billion, $7 billion, and $5 billion, respec-

tively, of environmental product exports in 1992. (The estimate did not encompass imports or services.) Britain, France, the Netherlands, and Sweden may also be net exporters. Firms from other industrial and newly industrialized countries have significant international presence. International trade, technology licensing, joint ventures, and acquisitions are increasing, and competition is growing.

Some U.S. environmental firms are established international players and appear well-positioned to profit from growing international markets. Yet most focus only on the United States, which is, by far, the world's largest market. Indeed, the U.S. market is a magnet for foreign environmental exports and investment. Licensing of foreign technologies–for example, air-quality and incineration technologies–has increased in recent years, as has foreign direct investment, including acquisitions of various water and air-pollution-control companies. Many American firms are small or medium-sized, have modest resources, and lack the wherewithal or interest to explore export markets.

Successful exporting often requires significant investment of time and resources to cultivate contacts, understand foreign markets and business practices, and learn the nuances of international transactions. Furthermore, a commitment to exporting may require adaptation of technology to local circumstances and attention to service, training, and supply of spare parts–areas in which some U.S. firms have fallen short.

There are no reliable estimates of U.S. jobs attributable to environmental exports. An export-led jobs bonanza is unlikely, however, because most environmental spending is for locally provided goods and services. Export-related jobs that do come about are likely to be professional engineering and management positions in the service sector or relatively high-paying manufacturing jobs.

Beyond the market for end-of-pipe environmental controls and cleanup lies an even greater export potential in the fast-growing global demand for facilities to produce electric power, fuels, chemicals, foods, paper, vehicles, electronics, and myriad other goods. The increased production has the potential to be environmentally troublesome, but recycling and cleaner production, including improved energy efficiency, offer hope of ameliorating conflicts between environment and development. They are often more efficient than older production approaches and less costly than conventional pollution control and waste treatment.

A gradual shift toward cleaner production is likely as manufacturers build new facilities and upgrade existing plants over the next 25 or 30 years. Countries with firms competitive in supplying cleaner, more efficient equipment and related engineering and management services will benefit from jobs and export income. Moreover, domestic industries that adopt cleaner production may benefit from efficiency gains and cost savings relative to conventional approaches.

A key question is the extent to which cleaner technologies will play a role in the economic strategies of developing countries. Such technologies could be important tools for promoting environmentally sustainable development. Up-front costs and insufficient technical know-how may discourage their use, although some pollution-prevention options are relatively inexpensive and simple.

Policy Issues

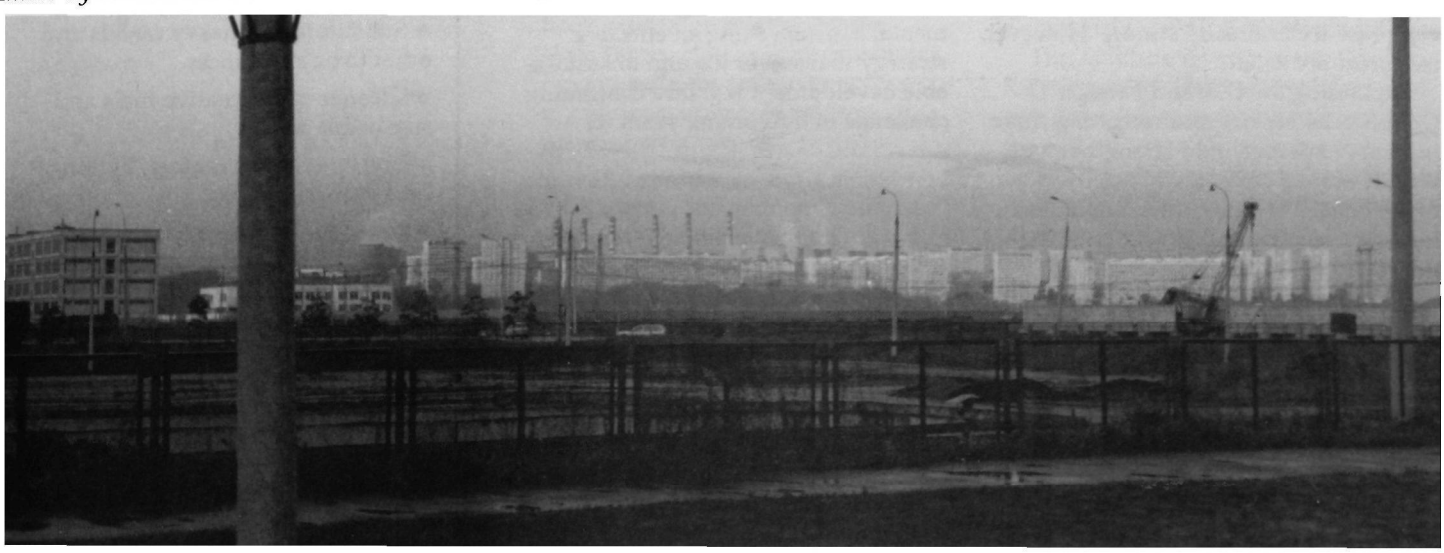
Developing and newly industrialized countries, as well as the former centrally planned economies, need to build their indigenous environmental management capacity if they are to progress toward environmentally sound development. These countries' ability to assess their environmental conditions, to create environmental policies and institutions, and to enforce regulations is prerequisite to growing environmental markets which could lead to business for U.S. and other environmental exporters.

Bilateral and multilateral aid to help these countries' capacity building could be mutually beneficial. Expansion of the capability of the United Nations Environment Program or other international agencies to provide objective information and technical advice on cleaner production and environmental technology is one promising avenue.

Some steps taken primarily for domestic purposes might both enhance U.S. exports and foster other countries' environmental progress. For example, as proposed in environmental technology research and development legislation, the U.S. government could support independent evaluations and performance verifications of U.S. environmen-

Industry encroaches on a residential Moscow neighborhood.

Carolyn Nunley photo Inform Copyrighted



tal technologies. Information could be made available globally to potential customers. Current U.S.-supported evaluations have focused on remediation approaches, not the prevention, control, and recycling technologies of greater interest to most manufacturers, utilities, and municipalities.

Compared to Japan and several European countries, the U.S. government provides relatively little export support, except for agricultural products. Recent congressional actions authorize a stronger federal role. Both the Bush and Clinton Administrations initiated policies to promote exports with environmental technologies as an area of emphasis. Many policy options for improving the American environment industry's performance in the global market are being considered and, in some cases, implemented.

Accessibility to the export bureaucracy has been a problem. Establishment of the Department of Commerce's Trade Information Center and 1-800-USA-TRADE telephone link during the last administration was a step forward. The Clinton Administration is using environmental exports as a case for demonstrating "one-stop shopping" to make federal programs more user friendly. Congress is considering a more far-reaching approach that would create a network of environmental business centers in the United States and abroad.

An environmental export initiative for Latin America is under consideration. A precedent for a regional focus is the public/private U.S.-Asia Environmental Partnership created during the last administration to give U.S. firms a more visible role in the fast-growing Asia-Pacific region, where Japanese commercial presence is already strong. However, resources are small.

Expanding the U.S. and Foreign Commercial Service and recruiting more industry experts would strengthen our weakly staffed commercial posts abroad to the benefit of American companies seeking trade leads, contacts, and market information.

Government funding for project-feasibility studies in developing countries–many are for environmental infrastructure or projects with environmental components–can help U.S. companies win contracts. The Trade and Development Agency, which funds such studies, estimates 25-to-1 returns on taxpayer expenditures. U.S. funding for such studies–about $40 million–is much less than the $200 million by Japan.

Lack of trained operators and maintenance personnel in developing countries sometimes wastes environmental investments and can be an obstacle to purchase of relatively sophisticated U.S. technologies. Although training is primarily an issue between vendor and purchaser, government could help identify training resources and, on occasion, support training.

Technologies can also be demonstrated abroad for their suitability and adapted to meet the financial and technical limitations of developing countries. Japan's adaptation of flue-gas desulfurization for Chinese power plants is an example of this approach. There is an especially critical need to expand pollution-prevention and cleaner-technology demonstrations–either through bilateral or multilateral efforts.

Favorable financing, rather than technical specifications, often makes or breaks deals. Small firms often are unable to export without loans or other temporary financing to cover expenses during the sometimes protracted period between shipment and payment. Compared to rivals in some other countries, U.S. firms seem to have more difficulty in obtaining export financing from private or public sources. Also, some U.S. firms contend that they are often at a disadvantage in competing for large development projects, many of which have an environmental component, because their rivals get more benefit from subsidies offered by their governments.

While more attention is now being focused on these and other issues, meshing export promotion and environmental assistance into an effective strategy that serves the aim of sustainable development will be a continuing challenge in the coming years. ❑

(Fletcher is a Senior Associate and Sobin is an Analyst at the Congressional Office of Technology Assessment. This paper is based largely on the OTA report entitled Industry, Technology, and the Environment: Competitive Challenges and Business Opportunities *(January 1994). The views expressed here are those of the authors and not necessarily those of OTA.)*

Control and Prevention Technologies–Some Examples

Control/Treatment/Disposal

- Sewage treatment
- Industrial wastewater treatment
- Refuse collection
- Incineration
- Off-site recovery and recycling of wastes
- Landfilling
- Catalytic conversion and oxidation
- Particulate controls
- Flue-gas desulfurization
- Nitrogen oxides control technology
- Volatile organic compound control and destruction
- Contaminated site remediation

Prevention

- Improved process control to use energy and materials more efficiently
- Improved catalysis or reactor design to reduce byproducts, increase yield, and save energy in chemical processes
- Alternative processes (e.g., low or no chlorine pulping)
- In-process material recovery (e.g., vapor recovery, water reuse, and heavy metals recovery)
- Alternatives to chlorofluorocarbons and other organic solvents
- High-efficiency paint and coating application
- Substitutes for heavy metals and other toxic substances
- Cleaner or alternative fuels and renewable energy
- Energy-efficient motors, lighting, heat exchangers, etc.
- Water conservation
- Improved "housekeeping" and maintenance in industry

The Case for an Environmental Technology Act

We can't have economic growth without environmental progress

by Senator Max Baucus

The National Environmental Technology Act, which came close to enactment during the last session of Congress, is designed to protect the environment and create jobs. It does not favor the environment at the expense of the economy, or vice versa. Instead, the bill embodies the concept that environmental progress and economic progress will be mutually reinforcing goals.

We haven't always thought this way. I've heard more than my share of complaints that protecting the environment destroys jobs and inhibits economic growth. This does not have to be the case. It doesn't have to be a zero-sum game. Economic progress and environmental progress don't have to be at odds. In fact, we can't have one without the other.

The National Commission on the Environment, chaired by Russell Train, put it this way:

> Economic and environmental well-being are mutually reinforcing goals that must be pursued simultaneously if either is to be achieved. Economic growth cannot be sustained if it continues to undermine the healthy functioning of the Earth's natural systems or to exhaust natural resources. By the same token, only healthy economies can generate the resources necessary for investments in environmental protection.

A recent study examining states' environmental and economic progress found that "the states that do the most to protect their natural resources also wind up with the strongest economies and best jobs for their citizens," according to Bob Hall of the nonprofit Institute for Southern Studies, which made the study. A long-term strategy of sustainable development doesn't mean living in tents in the forest. It means pursuing economic progress in a way that protects the environment. It means broadly improving the overall prospects of future generations.

The linchpin is technology. By the year 2050, both population and per-capita output are expected to more than double. As a result, the level of worldwide economic activity will be five times greater than it is today. That level is sustainable only if we make major improvements in the way that we produce goods and services, however.

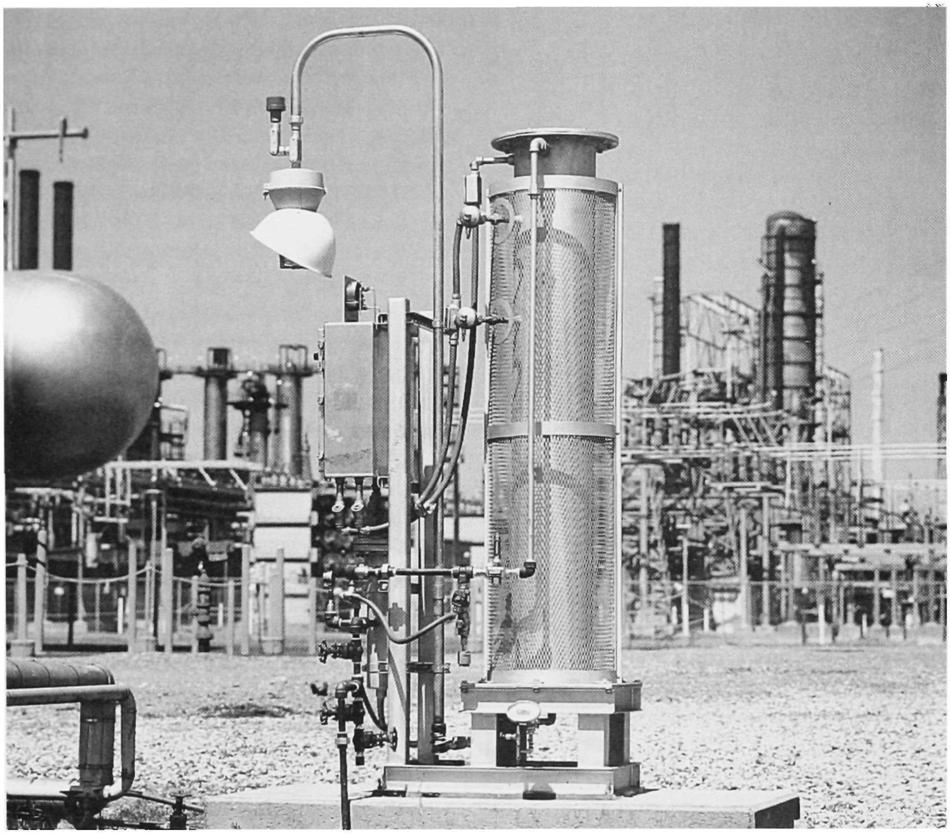
In his book *Preparing for the 21st Century,* Professor Paul Kennedy compares our situation today to that of 18th century Europe. Malthus had predicted that escalating population growth would lead to perpetual famine. The prediction was wrong, Kennedy writes, because it did not account for "humankind's capacity to develop new resources through technology." Similarly, our own ability to avoid an environmental catastrophe will be largely determined by our ability to develop environmental technology, according to Kennedy.

Bruce Smart, a senior Commerce Department official in the Reagan Administration, takes this idea one step further. He estimates that we eventually must reduce the environmental impact of each unit of industrial production by more than 80 percent if we are to achieve a sustainable level of development.

This is where environmental technology comes in. Environmental technology doesn't just mean a new black box at the end of a pipe. Environmental technology means the broad application of science to the entire production process. It means new ways to make products that waste less, new products that run cleaner. It means pollution prevention. It means life-cycle planning. It means, in short, a new way of thinking

Environmental technology makes good economic sense. After all, pollution is waste, and evidence is mounting that "thinking green" helps to keep a company in the black. There is another dimension to it, an international dimen-

(Senator Baucus (D-Montana) is chairman of the Committee on Environment and Public Works.)



Capital Environmental photo. Copyright.

The Thermatrix system, which destroys hazardous air pollutants, was developed by the Department of Energy and commercialized by a private U.S. firm.

sion. The global trend toward stricter environmental protection promises that companies that develop environmental technologies will have an edge. A market that already approximates $300 billion, and is growing by 10 percent a year, is a strong incentive for companies to get ahead of the curve.

At the 1992 Earth Summit, alongside the meetings of ministers and heads of state, there was an environmental technology exposition. It filled a huge arena with displays of pollution-control and monitoring equipment from around the world. I looked for the American companies and was disappointed to find only about 20. Japanese and German companies were everywhere, but Americans were almost invisible.

This doesn't make any sense. America's market is the world's largest. We produce and use more environmental technology than any other country. We cannot afford to give away another important manufacturing sector. We must develop policies that help American companies become the unchallenged leaders in environmental technology.

The National Environmental Technology Act is designed to take a major step in this direction. The bill, which I introduced with Senators Lieberman, Mikulski, and others, has five key elements:

- First, the bill requires the federal government to get its own act together. The federal government spends about $4 billion a year for research and development on environmental technology, but there is no coherent strategy for spending the money. Nobody looks at the big picture. Nobody considers whether we are investing the money wisely and in a coordinated way that will pay real dividends to our environment and our economy. Before we consider spending more on environmental technology, we need to make sure that we are getting the most for our money.

The National Environmental Technology Act requires the federal government to do that–by developing a coordinated strategy for environmental technology research and development, and by reviewing agencies' budgets in light of the strategy to avoid unnecessary duplication and to maximize our resources.

- Second, the bill stimulates research and development. Little of the billions spent cleaning up contaminated federal facilities is invested in developing new clean-up technologies. The bill changes that. A small portion of the money the government now spends on Superfund cleanups will be earmarked for innovative new technologies that have the potential to make clean-up efforts faster and cheaper.

- Third, the bill establishes an office at the EPA to help develop cutting-edge technology that otherwise may not get off the ground. This office will work with other technology programs in the Defense, Energy, and Commerce Departments to form partnerships with private companies developing the most promising innovations in environmental technologies.

- Fourth, the bill reduces market barriers. As it now stands, small companies that develop innovative environmental technologies may have a hard time penetrating the market. The environmental managers of large companies tend to be conservative. They are often reluctant to try a new technology that may not meet the applicable environmental standards. So they stick with the same old black box.

To address this problem, the bill sets up a voluntary verification program. A company that develops an innovative new technology can ask EPA to verify its cost and performance characteristics. This will give environmental managers more confidence in innovative technologies and help small companies break into new markets.

- Fifth, the bill establishes a new outreach program to help small businesses find environmental technology that suits their needs.

Although similar bills passed in both houses of Congress, no environmental technology bill was enacted into law this year. However, a strong majority supports the goals of the National Environmental Technology Act, and EPA is developing a similar program.

Our environment and our economy are inseparable, and this will increasingly guide EPA's work as it begins its third decade of environmental protection. A push by EPA to bring the environmental technology initiative online quickly, and prompt action by Congress to endorse this effort, will improve our environment, help make our businesses more competitive, and brighten our future. ❑

The Economy, the Environment, and Public Opinion

Most Americans feel we can have both jobs and the environment

by David B. Rockland and Gwyn L. Fletcher

"You don't have to sacrifice environmental protection to get economic growth. The choice between jobs and environment is a false one: We can have both." So wrote President Clinton in an environmental voters' guide to the 1992 elections carried in all the Times Mirror magazines and newspapers. It turns out that his words were right in keeping with how most Americans view the environment/economy relationship.

For the past three years, Times Mirror Magazines, Inc., America's leading publisher of outdoor, leisure-oriented magazines, has conducted its National Environmental Forum Survey with Roper Starch Worldwide. The survey gauges America's opinions on natural resource issues and on those solutions to environmental problems that have the greatest public support.

For three years running, the survey has found that most Americans (66 percent in 1994) believe that environmental protection and economic development go hand in hand. Almost every American (89 percent in 1994) feels that we can find a balance that allows us to enjoy economic progress while making sure our rivers, lakes, mountains, and wildlife are protected.

One reason for the public's positive outlook on the environment/economy interplay is a growing environmental industry. The worldwide market for environmental goods and services is currently estimated at about $300 billion. This market is expected to reach $400 billion or more by the year 2000, making it one of the world's fastest growing industries.

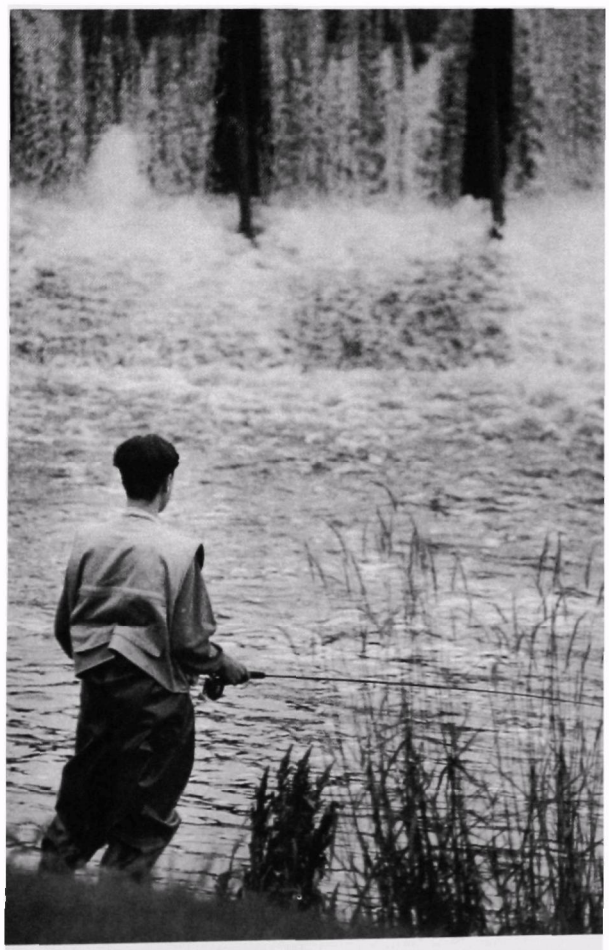
Also, outdoor recreation, in which most Americans participate, is a good example of the healthy environment/healthy economy relationship. Each year more than 100 million Americans enjoy pastimes like hunting, fishing, skiing, golfing, and boating. These recreationists spend more than $300 billion annually on their outdoor diversions. For those who enjoy the outdoors as well as those who profit from it, the link between a healthy environment and economic growth is undisputable.

Americans believe that the environment and the economy go hand in hand, but what happens when they're faced with a choice between these two goals? The environment wins, hands down: Six out of 10 Americans say that environmental protection is more important than economic development. Only 22 percent feel the economy is more important. This preference for environmental protection has been a consistent finding in each of the past three years.

However, just because environmental protection is viewed as a preferential societal goal does not mean that Americans are not sensitive to the costs of protection. In fact, the American people are not idealogues, but instead seek pragmatic solutions to vexing environmental problems. For example, when asked whether the cost of protection should be considered when deciding whether to save an endangered species, 63 percent of the Americans surveyed said yes. This is an eight-point increase over 1993 and a 13-percent change over 1992.

Lock it Up? No Way

Stereotypical thinking says if you're an environmentalist, you favor putting natural resources off limits. This is usually not true. While the 1994 survey finds 79 percent of Americans care about protecting the environment, the poll also reveals that Americans are interested in enjoying their environment. American attitudes about how the environment should be used fall mainly in two categories: *Conservationists* believe that through sound management, we can both protect and enjoy the use of natural resources; *preservationists* believe that the only way to protect the environment is to put it off limits to the public. Our poll



Mike Bryson photo Copyrighted

Three out of four Americans say water pollution is the greatest problem facing the environment.

results show 72 percent of respondents taking a conservationist stance; only about one in five Americans (20 percent) agrees with the preservationist position.

The conservationist approach is evident in the way Americans view outdoor recreation and its effects on the environment. More than eight in 10 feel that the use of land and water for hiking (88 percent), downhill skiing (81 percent), and fishing (80 percent) poses no harm to the environment. Slightly fewer (75 percent) feel this way about camping and golf; 68 percent believe hunting poses no harm to the environment.

Water is the Top Concern

There is a single aspect of the environment upon which our entire economic system and life as we know it is based–water. Everything and everyone is dependent upon clean, ample water. When asked what the greatest problem facing the environment is, three out of four Americans say, "water pollution." Water pollution and water conservation are by far the most important issues to the American public. Of those surveyed, almost nine in 10 people who said they would be likely to contribute to environmental groups pick pollution of lakes, rivers, streams, and coastal waters as well as shortages of safe drinking water (both 88 percent) as top priorities.

Opening Up the Wallet

Americans are ready to open up their wallets for the environment. More than 100 million individuals (42 percent) say they have contributed to environmental organizations, and 54 percent say they are likely to do so. A plurality (48 percent) say they are willing to pay an extra 25 cents a gallon for gasoline if the money is used to help the environment.

According to the survey, Americans believe that the federal government should be putting more money toward environmental programs. Despite the economic uncertainty of recent years, Americans support stricter environmental regulations and an increase in federal funding of environmental efforts. They do not believe that environmental protection is an optional indulgence that can be cut back with the rise and fall of economic cycles.

Americans also want to see more money spent on maintaining this country's public lands. Each and every American is part owner of more than 700 million acres in national parks, forests, and wildlife refuges, as well as Bureau of Land Management holdings. Congress has shown a propensity for buying new properties rather than spending money to care for existing public lands. The public says it would like to see $3.00 spent on maintaining public lands for every $2.00 spent on buying new lands. In addition, 86 percent say money generated from entrance fees on public lands facilities should remain with local parks and public lands rather than being turned over to the general coffers of the government, as is currently the case.

Satisfaction with Clinton

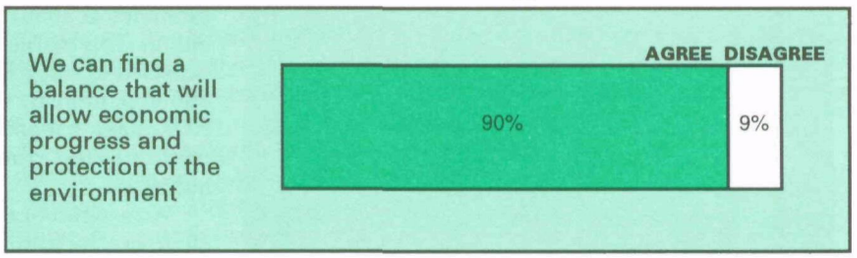
One in five Americans vote the environment when they go to the polls–enough to carry most elections. Hence, an administration's environmental record can be key to its re-election. Satisfaction with the Clinton administration's "positions and policies with respect to the environment" is up seven points from 1993 to 55 percent in 1994. Those dissatisfied constitute 32 percent of the public. Of the majority who view the administration favorably, 7 percent are very satisfied and 48 percent are somewhat satisfied.

This satisfaction may explain a decreasing public anxiety about the environment. At the end of the 1980s, about one-quarter of Americans identified the environment as one of their top two or three personal concerns. Concern today has settled to about one-sixth of the public. This change reflects a shift in focus to other issues–crime, health care, etc.–but it also suggests that this previous anxiety has been reduced somewhat by actions the public perceives to be currently underway.

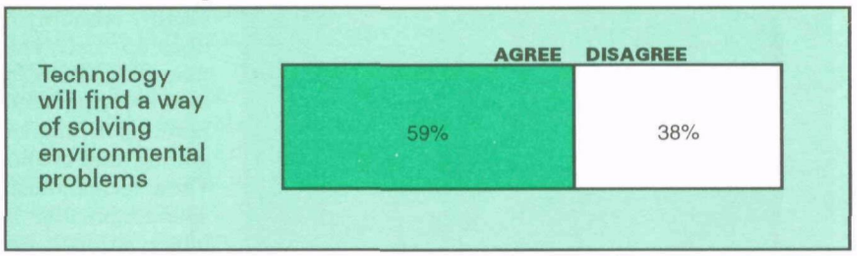
Conclusion

Statistics can be mind-numbing. What the National Environmental Forum Survey has found each year is that Americans are seeking sound, pragmatic solutions to environmental problems that balance environmental and economic concerns. In this new, positive way of living, environmental protection is no longer seen as a hindrance to economic development but rather as a forerunner of the next industrial revolution. ❑

The Environment and the Economy, Hand in Hand



A Sense of Optimism



(David Rockland and Gwyn Fletcher are the Executive Director and Government Relations Specialist of the Times Mirror Magazines Conservation Council. The Council is part of Times Mirror Magazines, publishers of Field & Stream, Golf Magazine, Home Mechanix, Ski Magazine, Popular Science, The Sporting News, Outdoor Life, Salt Water Sportsman, Skiing Magazine, Skiing Trade News, Yachting, *and* Sporting Goods Dealer.)

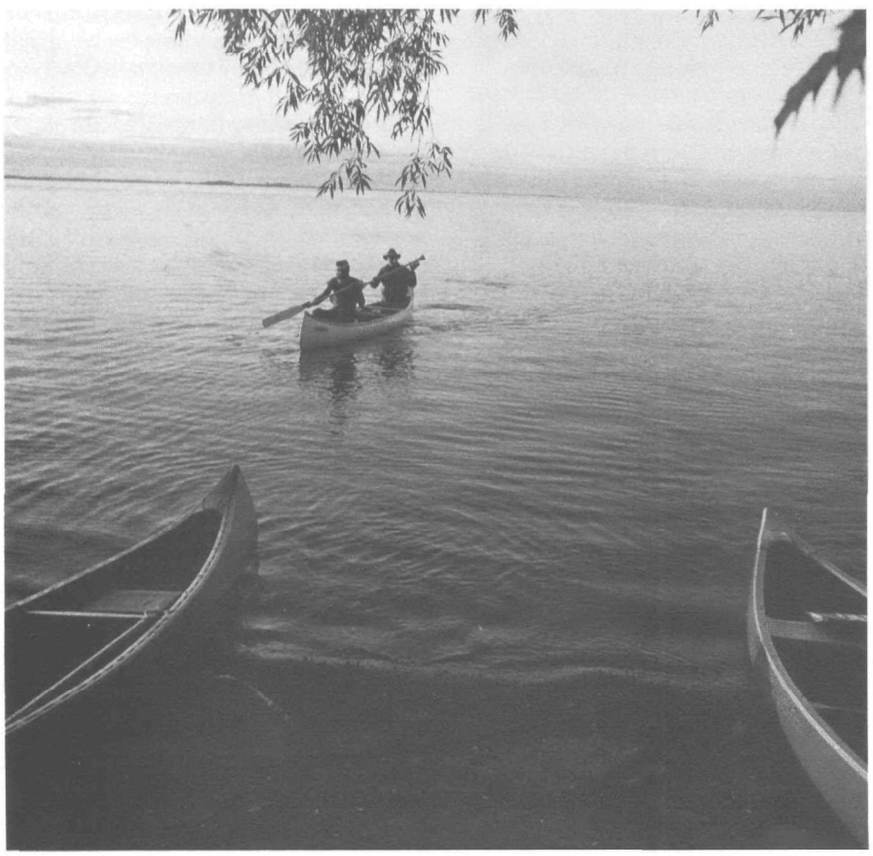
The "Living Industry" and the Environment

There is an extraordinary capacity for self destruction

by John Kenneth Galbraith

In November 1987, John Kenneth Galbraith gave a lecture at EPA headquarters in which he discussed the increasingly functional importance of the environment to the later stages of economic development. EPA Journal *finds his observations continue to be relevant and has excerpted the following remarks from a recorded transcript of Professor Galbraith's lecture.*

The benefits of a well-protected environment are worthy in themselves, something worth having quite apart from any functional justification. They have their own enjoyments, including that of good health. But I'm also going to argue that there are concerns having to do with countryside and urban life that are also increasingly functional. We inevitably find ourselves defending environmental concerns more and more for their positive, affirmative support to economic life in the later stages of economic development.



Mike Brisson photo. Copyrighted.

As our tangible needs are met, we move to enjoyments associated with our surroundings.

Let me say a word first about what I mean by economic development. This is of the utmost importance. We must always think of economic life as a process–a continuing, ongoing process of change. There has always been, and is now, a view of economics that seeks to find its ultimate, enduring, stable, unchanging truths. This search for enduring principles is an empty, invalid effort, one to which I take stringent exception.

There is no great mystery to the central feature of economic development. It is a process that moves economic life from producing things that are concrete to producing the less tangible objects of public consumption. In the elementary society (such as that in the United States until relatively recent times), the economic requirements of the standard of living were hard artifacts of one sort or another. These artifacts, these objects, were food, clothing, shelter, furniture, accoutrements, the components of the household establishment, and the means for travel and transportation.

Overwhelmingly, these constituted what we call the standard of living. And, indeed, they are central to the standard of living in poorer countries to this day. But with economic change, with the movement that is intrinsic in economic life, the importance of artifacts–the hard objects of production–gives way increasingly to the importance of less tangible things. In the simplest terms, we move to intangible enjoyments–from food, clothing, shelter, and travel equipment to education, television programs, the arts, music, libraries, and other public services. We also move to the enjoyments associated with the surroundings in which we live.

This is the process, and I emphasize it because it runs counter to the very deep commitment we all have to hard consumer goods. It perhaps seems unnatural that we move to the less tangible

In this stage of development we also see the rise of an industry devoted to the needs of living . . . .

forms of production and away from what have been regarded since ancient times as the very substance of economic life.

But this change is related to another one–one that is extraordinarily important today. That is the differential capacity in the provision of these two broad categories of economic products between the older countries and the newer. With economic development there is a tendency for the production of hard goods to move to the newer countries–not everything, but a great range of things such as textiles, clothing, chemicals, steel, machinery, and the like. Production of all these moves away from the advanced, developed countries to countries newer on the economic scene.

This comes about partly because of lower wage costs–wage costs that cover a lower standard of living–but also partly because of the particular qualities possessed by people who are new to industrial life, new to a life away from the more strenuous toil on the farm. They are, on the whole, more effective producers. Industrial life, we must always remind ourselves, is a wonderful thing for people who are just escaping the self-exploitation of peasant agriculture.

And there is another change of which we should be aware, a tendency in the older industries to become sclerotic. There is a certain hardening of the arteries among them that further accentuates the movement of the production of the goods they produce to their newer competitors.

The movement of the modern economy to the less tangible production that now characterizes the older countries strongly invites, in turn, a general invasion of the countryside because the latter offers particular advantages to the next stage of development. There is need for recreation–for skiing, hunting, biking, hiking–all activities for which the countryside is important and necessary. In this stage of development, there is also the obvious rise of travel, of the tourist industry–people who simply go to enjoy rural surroundings, to see the mountains, to rejoice in scenery that is not available in Manhattan.

And in this stage of development we also see the rise of an industry devoted to the needs of living, what we may perhaps call the "living" industry. It is one that is very important for all modern environmental concerns. Given this stage of development and the associated changes in consumption, a very large part of the population can now live away from a fixed place of work: people who live on social security or other pension entitlements, people who have accumulated savings or enough wealth to exempt them from a daily job. And there are also an incredibly large number of modern occupations, especially in the arts, where one can live and work with no fixed identification with a workplace. The living industry is now particularly important in some parts of the United States: in New England, New York, and on the Eastern Shore of Maryland. It is not uniformly distributed over the country, but it has become significant in large parts of it.

This living industry is associated also with other things, such as a second residence and the desire of people at a certain level of affluence to have a seasonal escape from neighbors or the tedium of local obligations, from all the things that encourage one to say, "Well, I'm off to Maine for the weekend."

However, this new industry also creates problems that we must address in the days to come; that we must, indeed, begin addressing now. These are the problems that come from tourism and recreation, from part-time residence, from the activities that are not a fixed part of work.

What encourages and supports the industries arising from the intangibles of life? What makes the living industries–the recreation industry, the tourist industry, and the like–important? And what do these portend for the countryside? What do they involve for its environmental protection?

There are many things that are important for the living industries. One is good government services. Many of the amenities of life in the countryside are associated with the services of government; accordingly, the latter must be easily and amply available.

It is important also that full attention be paid to the range of cultural amenities that support and give depth to the interest of life. I have in mind schools, colleges, libraries, museums, and other sources of educational and cultural activities.

The next thing that is important in this stage of development, and to which I come at last, is the assurance of environmental protection or, more precisely, of environmental wisdom.

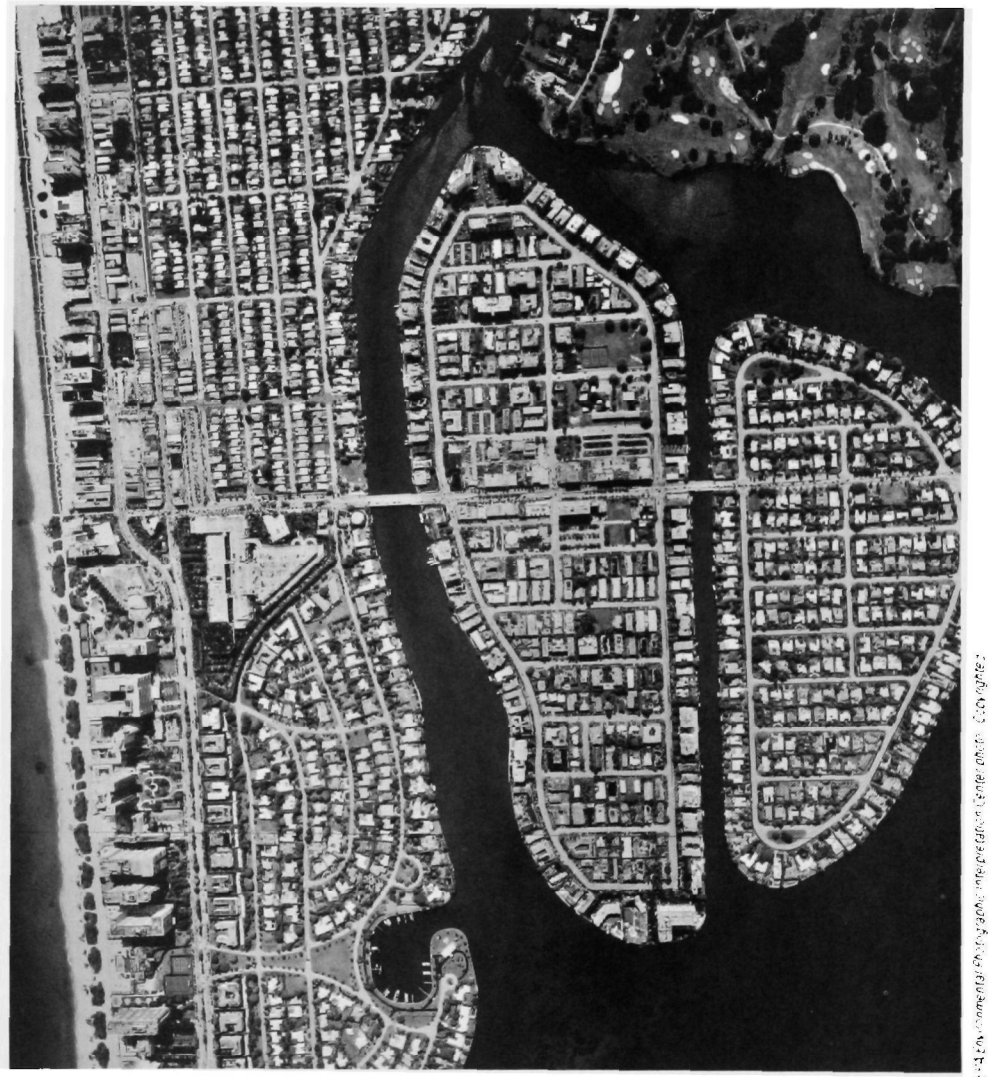
We are dealing here with industries and with a style of life that have, among

other things, a self-destructive capacity. One obvious example of this is tourism. The tourist industry, as it reaches out for customers, as it advertises, as it litters the roadsides, has an extraordinary capacity for destroying the very attractions that created the industry in the first place. What is advantageous for the individual enterprise in seeking a share of the business culminates in disaster for all enterprises.

Here, and in the companion problem area of designing and controlling the real estate development that serves the living industry, there is an extraordinary tension. The unspoiled landscape, the unspoiled environment, initially sustains and encourages the development. But that development, particularly if it is unwise, then repels the people who were initially attracted.

One of our greatest problems lies in this field of economic design. We want the living industry, and we want it to satisfy and serve us. But we need to realize that this industry, by its very development, must have a design and be controlled to avoid its own self-destructive character.

In consequence, we must accept that there will be tension, and that the tension will be between what is good, appealing, and profitable in the present and what is functionally necessary in the future. We must not have opposing groups, one side against the other. We must be wise enough to see that there is a common, long-run advantage in good developmental design: in zoning, building restrictions, architectural control, and other key matters. ❑



Land development in Florida. The "living" industry must be controlled to avoid its self-destructive character.

(Galbraith is Paul M. Warburg Professor Emeritus at Harvard University and the author of numerous books, including The Affluent Society, The New Industrial State, Economics in Perspective, *and* A Journey through Economic Time.)

The Irish Potato Famine

by Catharina Japikse

More than a million Irish people–about one of every nine–died in the Great Potato Famine of the 1840s. To the Irish, famine of this magnitude was unprecedented and unimaginable. Today, it may seem less surprising, though no less tragic, as television delivers up images of starvation more vivid and more frequent than ever before.

Besides the horror, what unites the famines today with one over a century ago are the reasons behind them. Ireland's famine and those of the 20th century have similar, complex causes: economic and political factors, environmental conditions, and questionable agricultural practices.

When the famine hit in 1845, the Irish had grown potatoes for over 200 years–since the South American plant had first arrived in Ireland. During this time, the lower classes had become increasingly dependent on them. Potatoes provided good nutrition, so diseases like scurvy and pellagra were uncommon. They were easy to grow, requiring a minimum of labor, training, and technology–a spade was the only tool needed. Storage was simple; the tubers were kept in pits in the ground and dug up as needed. Also, potatoes produce more calories per acre than any other crop that would grow in northern Europe. This was important to the Irish poor, who owned little, if any, of their own land. Often, a whole family could live for a year on just one acre's worth.

To increase their harvest, farmers came to rely heavily on one variety, the lumper. While the lumper was among the worst-tasting types, it was remarkably fertile, with a higher per-acre yield than other varieties. Economist Cormac Ó Gráda estimates that on the eve of the famine, the lumper and one other variety, the cup, accounted for most of the potato crop. For about 3 million people, potatoes were the only significant source of food, rarely supplemented by anything else.

It was this reliance on one crop–and especially one variety of one crop–that made the Irish vulnerable to famine. As we now know, genetic variation helps protect against the decimation of an entire crop by pests, disease, or climate conditions. Nothing shows this more poignantly than Ireland's agricultural history.

At the beginning of the 19th century, a Dublin Society survey recorded at least a dozen varieties of potato cultivated in the county of Kilkenny alone. Then, adults could still remember when most of the poor raised oats, barley, or rye, along with beans and other green vegetables. But according to Ó Gráda, this diversity had largely disappeared by the 1840s. He notes that while some people warned that Ireland's reliance on potatoes might prove disastrous, no one likely conceived of a famine as complete as what occurred. The poor certainly could not; it is doubtful they could have avoided it anyway, given the social and political conditions of their lives.

In 1845, the fungus *Phytophthora infestans* arrived accidentally from North America. A slight climate variation brought the warm, wet weather in which the blight thrived. Much of the potato crop rotted in the fields. Because potatoes could not be stored longer than 12 months, there was no surplus to fall back on. All those who relied on potatoes had to find something else to eat.

The blight did not destroy all of the crop; one way or another, most people made it through winter. The next spring, farmers planted those tubers that remained. The potatoes seemed sound, but some harbored dormant strains of the fungus. When it rained, the blight began again. Within weeks the entire crop failed.

Although the potatoes were ruined completely, plenty of food grew in Ireland that year. Most of it, however, was intended for export to England. There, it would be sold–at a price higher than most impoverished Irish could pay.

In fact, the Irish starved not for lack of food, but for lack of food they could afford. To buy food, many sold or pawned everything they owned. Often, this included the tools by which they made their living. Other people ate the food intended for rent, and the landlords quickly evicted them. By the next planting season, many farmers had no land to plant on, nor tools to plant with. Those who did often had nothing to plant. There were few potatoes, and no money with which to buy seed.

The Irish planted over two million acres of potatoes in 1845, according to Ó Gráda, but by 1847 potatoes accounted for only 300,000 acres. Many farmers who could turned to other crops. The potato slowly recovered, but the Irish, wary of dependence on one plant, never again planted it as heavily. The Irish had learned a hard lesson–one worth remembering. ❑

Famine victims, an 1847 engraving.
Illustrated London News. *Reproduced from the collections of the Library of Congress.*

(Japikse is *Assistant Editor of* EPA Journal.)

THE PLAGUE

by Wolfgang Luckmann

The cries from the farm workers
scatter from point to point
and break
against the inhuman choir of wings
that strums the blackening blue
that breaks the white light
that beats in creeping flight
across an open landscape

There
they have started their fires
while others wait with skin bags and cooking pots
to wade into the struggling crawling mass
of bloated insects
whose skeletal song
lifts every face towards
a darkening sun

Everywhere
apart and yet together
the locusts disperse
as boundaries merge
in the wake of leafless, lifeless space

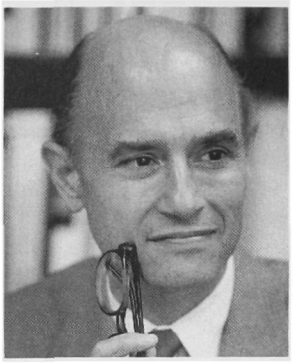
The sun no longer shines
on a hemmed-in line of humanity
clinging to a wall of fire
a body
strung in a crescent
despairing of rest and respite
heavy arms tending the fire
and scooping the creatures from the sky
to replace the corn lost
to survive the coming winter
if they live that long

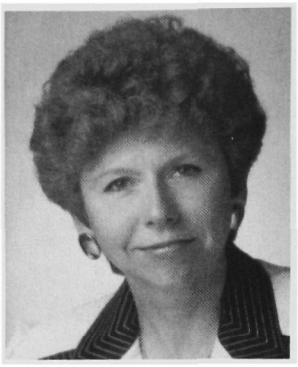
And still the locusts come
an intelligent malignity
scurrying and leaping
like clouds of sparks
A constant crackle
of mandibles and wings
eroding the land into obscurity

W. Luckmann, a Namibian poet and teacher, is an occasional contributor to EPA Journal. *His poem "Children yearn for rain" appeared in the April-June 1993 issue. Of "The Plague" he writes, "recently there has been an outbreak of locust plagues in the north of my country which has caused concern in the capital. As such plagues are only too familiar in the rest of Africa, I thought it might be a topic that would interest readers."*


HANSEN


HUGGETT


NITZE


WAYLAND

Fred Hansen has been confirmed as EPA's new Deputy Administrator.

Mr. Hansen comes to the Agency after serving 10 years as director of Oregon's Department of Environmental Quality, where he was an influential leader. As noted in a White House press release, during his tenure Oregon was continuously ranked in the top five most environmentally progressive states.

From 1970 to 1978, Hansen worked in Washington, DC, on Capitol Hill and in the Executive Branch. His positions included Executive Assistant to the Director in the Peace Corps and Deputy Director for President Carter's special project on federal cash management.

While directing Oregon's Department of Environmental Quality, he administered the state's environmental protection laws and filled many special assignments, serving on the EPA Science Advisory Board's Relative Risk Reduction Committee and Futures Committee, the Keystone National Superfund Commission, the Urban Institutes' Ground-Water Advisory Committee, the EPA/National Governors' Association Air Implementation Task Force, and many others.

He graduated Phi Beta Kappa from the University of Oregon in 1968 and received his master's degree in 1969 from McMaster University in Ontario. He completed a year of doctoral work at The Johns Hopkins University.

Hansen replaces Robert Sussman, who will pursue other opportunities in the administration.

Robert J. Huggett is the new Assistant Administrator of the Office of Research and Development.

An authority on environmental chemistry and marine science, he comes to EPA from the College of William and Mary. There, as a professor of marine science, he chaired the college's Department of Environmental Sciences of the Virginia Institute of Marine Science, School of Marine Science. Other positions he held at William and Mary include Director of the Division of Chemistry and Toxicology (1986-1991), Chairman of the Department of Chemical Oceanography (1982-1986), and Chairman of the Department of Ecology and Pollution (1972-1982).

His research interests have centered on the fates and effects of toxic chemicals in aqueous systems. He has published extensively in his field since 1968 and lectured to, and been consulted by, numerous organizations, including the U.S. Congress. He received the Izaak Walton League and DuPont Company's Chesapeake Bay Conservation Award for Fisheries and Wildlife in 1989 and the Shelton G. Horsley Award for Meritorious Fundamental Research from the Virginia Academy of Sciences in 1980.

He followed his undergraduate work at William and Mary with a master's degree in marine chemistry from the Scripps Institution of Oceanography in 1968 and a doctorate degree in marine science from William and Mary in 1977.

Before assuming this position, Huggett was a member of EPA's Science Advisory Board's Environmental Processes and Effects Committee and Executive Committee. He was also a member of the National Research Council's Water Science and Technology Board.

William Albert Nitze, an internationally renowned expert on environmental issues, is EPA's Assistant Administrator for International Activities. He has held key positions in government, nongovernmental organizations, and the private sector in the United States and abroad.

From September 1990 until his appointment at EPA, Nitze was President of the Alliance to Save Energy in Washington, DC, a nonprofit coalition of environmental, government, industry, and consumer leaders dedicated to promoting investment in energy efficiency. Prior to joining the alliance, he spent seven months as Visiting Scholar at the Environmental Law Institute, also in Washington, where he was at the forefront in developing international policy on climate change and other environmental issues.

As Deputy Assistant Secretary of State for Environment, Health, and Natural Resources from 1987 to 1990, Nitze played a lead role in international negotiations on global issues such as climate change, ozone layer protection, transboundary shipments of hazardous substances, biotechnology, and conservation of tropical forests. Nitze received the Superior Honor Award of the Department of State in 1988.

He is an alumnus of Harvard College (1964), Wadham College, Oxford (1966), and Harvard Law School (1969). He is a member of the State of New York and U.S. Supreme Court Bars.

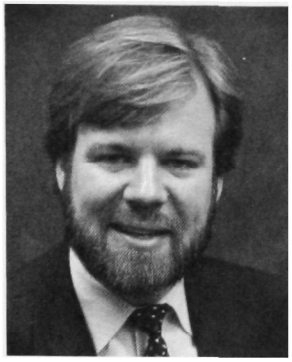
Susan H. Wayland brings over 20 years' experience in environmental regulation to her new post as Deputy Assistant Administrator for EPA's Office of Prevention, Pesticides, and Toxic Substances (OPPTS). The office is responsible for regulating pesticides and other chemicals used in U.S. commerce; it also establishes pollution-prevention strategies as a forefront defense against environmental problems.

From 1985 to 1994, Wayland served as Deputy Director of the Office of Pesticide Programs (OPP) within OPPTS. There she advised on amendments to the Federal Insecticide, Fungicide, and Rodenticide Act. She was also a principal architect in designing implementation plans to reregister all pesticides used in the United States and to dispose of millions of pounds of banned pesticides. She guided development and implemention of national strategies to protect ground water and endangered species from pesticides.

Wayland became Acting Deputy Assistant Administrator of OPPTS in 1993 and was Chief of Policy in OPP for four years. Before joining EPA, she served in the U.S. Department of Agriculture's Food and Nutrition Service (1968-1971).

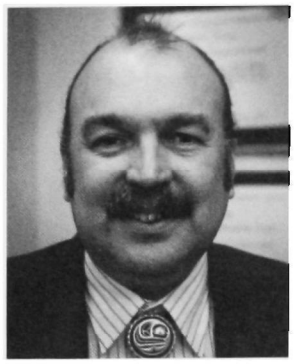
Wayland holds a bachelor's degree in liberal arts from the College of William and Mary (1968). She was awarded EPA's Gold Medal for Exceptional Service in 1978 and a Presidential Rank Award as a Meritorious Executive in 1989.

GUZY



ROBERTSON

McPOLAND



WILLIAMS

Gary S. Guzy is EPA's new Deputy General Counsel. Since January, he has supervised EPA's litigation and legal policy issues in legislative reauthorizations, and served as the Office of General Counsel's liaison to the Department of Justice (DOJ).

Guzy came to EPA from DOJ, where he served as Senior Attorney in the Environment and Natural Resources Division since 1987. There he represented the federal government in environmental litigation in federal district and appellate courts. On behalf of DOJ, he handled a number of significant environmental and natural resource cases, including the Arkansas v. Oklahoma water-quality standards dispute and defense of EPA's veto of the Two Forks Dam. He also served on the Everglades litigation team.

As an associate at the law firm of Kaye, Scholer, Fierman, Hayes and Handler (1983 to 1987), he represented clients in civil litigation over major environmental issues, Congressional policy, and constitutional and libel law. As a judicial clerk (1982 to 1983) to the honorable Elbert P. Tuttle of the U.S. Court of Appeals, Eleventh Circuit, he worked on a variety of civil and criminal matters. He also has provided pro bono representation to death row inmates.

Guzy received his bachelor's degree (1979) and law degree (1982) from Cornell University.

Peter D. Robertson has been named Deputy Assistant Administrator of the Office of Solid Waste and Emergency Response.

Before coming to EPA, he specialized in environmental and legislative law for seven years as an associate attorney at the law firm of Patton, Boggs, and Blow. His responsibilities in the environmental area included litigation, administrative law, and client counseling. Previously, he served a year as a law clerk at the firm of Paul, Weiss, Rifkind, Wharton, and Garrison, where he performed legal research. He also monitored major trade legislation in Congress. As a staff member for the Committee on the Budget at the U.S. House of Representatives (1981 to 1986), Robertson reviewed and analyzed the President's budget, briefed committee members and others on budget matters, and developed supporting documentation for the committee's recommended budget to the House of Representatives. He covered national security matters as well as transportation, administration of justice, and general government issues for the committee.

Robertson received a bachelor's degree in English from University of Oklahoma (1978) and a law degree from Georgetown University Law Center (1987).

The White House has named **Fran McPoland** as the Federal Environmental Executive, a newly created position at EPA. She will oversee implementation of President Clinton's October 1993 executive order, requiring the purchase and use of recycled and environmentally preferable products in all federal procurements.

In this post, she will coordinate federal agencies' waste-reduction and internal recycling programs, generate an annual report to the Office of Management and Budget, and consult with the director of the White House Office on Environmental Policy. Environmental executives appointed from each of the 22 federal agencies will assist her.

Since 1988, McPoland was Senior Legislative Assistant to Rep. Esteban E. Torres (D-California). Her responsibilities included policy development and drafting legislation for the House Appropriations Committee for the Environment, Energy, and Natural Resources. She also developed four comprehensive market-incentive recycling bills for inclusion in the reauthorization of the Resource Conservation and Recovery Act and a major Superfund policy initiative for local ground-water pollution. In addition, she organized subcommittee hearings on ground-water problems in California, pollution prevention and waste minimization, and scrap-tire utilization.

McPoland holds an associate's degree in horticulture from Diablo Valley College (1977), a bachelor's degree in conservation of natural resources from the University of California (1979), and a master's degree in public policy from George Washington University (1987).

Terry Williams, a member of EPA's Tribal Operations Committee, has been named director of the Agency's new American Indian Environmental Office, which was established in October. He is at EPA on an Intergovernmental Personnel Act assignment from the Tulalip Tribes Fisheries and Natural Resources Department near Marysville, Washington. The new office is located within EPA's Office of Water, which has worked on American Indian affairs in the past.

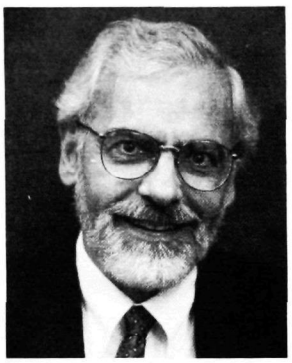
In the new post, Williams will work closely with the Administrator and the heads of all EPA program and regional offices. He will evaluate program activities in all media to assure strong EPA tribal operations and progress across the board.

From 1985 to 1994, Williams served on the Northwest Indian Fisheries Commission; since 1990, he also chaired the Commission's Environmental Policy Committee. He has represented Native American tribes on the Pacific Salmon Commission and worked on implementation of the President's Forest Plan.

His experience on the boards of many environmental and research organizations includes the Center for Streamside Studies and Adopt-a-Stream Foundation. He was Director of Fisheries for the Tulalip Tribes from 1982 to 1993. In 1993 he became Executive Director of Fisheries and Natural Resources, which includes fisheries, forestry, and environmental departments.

Two governors of Washington State have appointed Williams to the Board of the Puget Sound Water Quality Authority since 1985.

Williams received a bachelor's degree in law and justice in 1979 from Central Washington University.



BAROLO

Daniel M. Barolo is the new Director of the Office of Pesticide Programs within the Office of Prevention, Pesticides, and Toxic Substances. Prior to this promotion, he served, since 1991, as Director of the Special Review and Reregistration Division in the Office of Pesticide Programs.

Previously, from 1981 to 1991, he was Director of the Division of Water at the New York State Department of Environmental Conservation. Other positions he held in the department include Associate Director of the Air Pollution Control Program, Division of Air Resources (1977 to 1981); Regional Director of Environmental Quality Engineering, Syracuse Office (1973 to 1977); and Assistant Sanitary Engineer and Chief, Program Review and Grants Section (1967 to 1973).

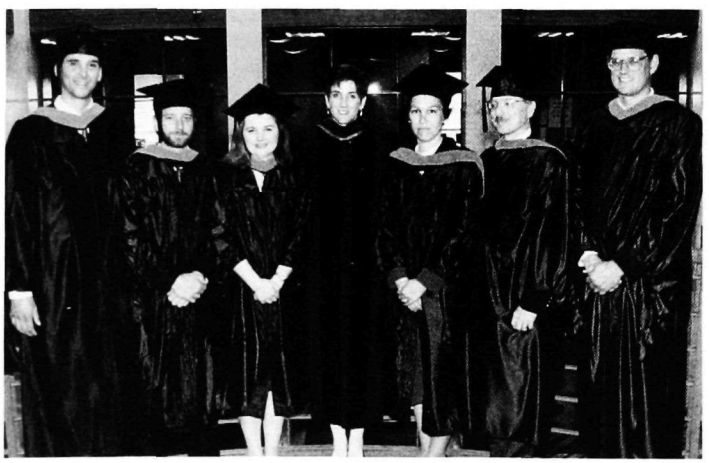
Barolo received a bachelor's degree in civil engineering in 1966 and a master's degree in sanitary engineering in 1967 from Vanderbilt University.

Career Enhancement Program

Under a program that began in fall 1989, the University of Maryland, George Washington University, and Johns Hopkins University teach graduate courses at EPA Headquarters in Waterside Mall. The courses, taught during work hours, may be taken for credit and can lead to a degree in Public Policy (U. of Md.) or Public Administration (GWU). The students work full time while attending one or two classes a week.

The first graduates received masters' degrees last year. This year six EPA employees who recently completed the master's program in Environmental Public Policy from the University of Maryland had the distinction of having Administrator Browner give their commencement speech. ❑

Administrator Browner (center) with the new graduates: (from left to right) Daniel Gogal (OARM), Christopher Dege (OSWER), Ann McDonough (OSWER), Denise Wright (OSWER), Thomas Miller (ORD), and Fielding Lamason (OAR).



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Innovative "constructed wetlands" provide homes with secondary treatment of wastewater in areas where poor soils preclude use of conventional drain fields.
Tennessee Valley Authority photo.