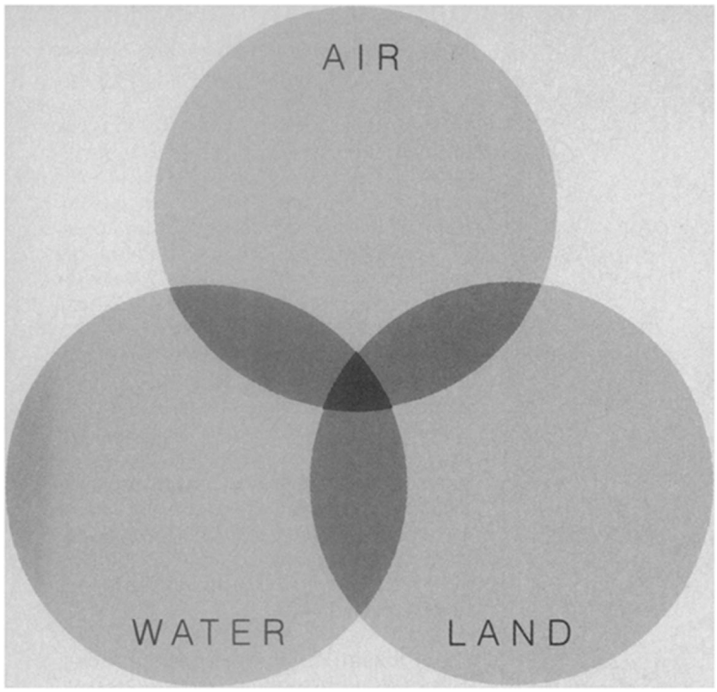

MULTIMEDIA MANEUVERS

Shifting tactics for controlling shifting pollutants

By CHRISTINE MLOT

In the District of Columbia telephone book, the Environmental Protection Agency (EPA) lists separate numbers for air, water and solid waste. The numbers correspond to offices and staffs that in turn oversee the agency's separate laws regulating the air, the waters and the land.

But pollutants don't correspond as neatly. They waft from the air onto soils, wash into streams and seep from landfills into groundwater supplies. And in each different medium they can change chemical character, reacting with water in one phase to become acidic or turning toxic through microbial degradation in the soil. Often, one regulatory office's cleanup becomes another's undetected problem.

Acid rain is the most mentioned cross-media pollution. Standards set by EPA's air office to control sulfur dioxide have led some coal-burning plants to send emissions up and away from the locale through tall smokestacks. But once delivered to the upper atmosphere, the gas can disperse, combine with water vapor and rain down as weak acid onto distant forests and lakes.

Sulfur dioxide is among a spate of such pollutants. The large category of synthetic organic chemicals may be the most arresting cross-media problem, given their toxicity and wide use. These compounds — chemical arrangements of carbon, hydrogen and most often chlorine — are manufactured in billions of pounds annually and constitute industrial solvents, pesticides, household cleaners and dry-cleaning fluids. The compounds themselves or caustic by-products of their manufacture eventually become the stuff of hazardous waste. Because they can easily evaporate as well as dissolve in liquids, they have entry to air, soil, water and organisms. In animals they affect heart, nerve, liver and kidney function; some cause cancer.

"These substances, including carbon tetrachloride, perchloroethylene, trichloroethylene, methylene chloride and methyl chloroform [trichloroethane], are ubiquitous in society and in the environment," says Alvin L. Alm, who, as deputy administrator of EPA, spoke to a pollution control conference in Washington, D.C., last fall. "We find them in landfills, in urban ambient air, in discharges to surface waters and now in some soils and aquifers. They move readily from land to water or from water to air, and persist in the environment long after their release." Alm has since left EPA to join Clean Sites, Inc., an Alexandria, Va.-based organization working on hazardous waste cleanup.

The conference, sponsored by the Washington, D.C.-based Conservation Foundation, was the first national meeting to focus on cross-media pollutants. One hundred environmentalists, industrialists, academics and EPA regulators discussed the problem of splintered environmental laws and whole-environment pollutants. An integrated approach should be the rule of pollution control, they agreed, but shortcomings in existing laws and in scientific understanding of how pollutants circulate suggest that a truly integrated environmental policy is not likely to be realized anytime soon. Still, uncontainable hazardous wastes are drawing more attention to cross-media problems and may prompt a change from the prevailing view of pollution as a single-medium, neatly boxed affair.

A first step in controlling pollutants on a cross-media basis is knowing where a volume of chemical goes after it's created. Mass balance studies chart a pollutant's path by comparing the amount of the chemical in the air, water and soil with how much has been released.

New Jersey has one of the few organized programs compiling information on production and emissions to track specific chemicals. State regulators survey some 45,000 industrial sites, quantifying the chemicals that go into a product and amounts that are discharged into air or water, or trundled off as solid waste. The valuable chemical bookkeeping has pinpointed, for example, which generators are responsible for making toluene the most prevalent toxic substance in the New Jersey air — the kind of information policymakers need but rarely get.

Mass balance studies can be done on any environmental scale, and EPA is tracking the paths of chlorinated organic solvents nationwide as a model for cross-media control. According to Alm, "The work [EPA is] doing on chlorinated solvents grapples with the issue that lies at the heart of the cross-media problem: Where do we really want the stuff to end up?"

The air may be the sink for many toxic compounds. Most air today holds a mix of about 100 organics and other toxic chemicals that may or may not be harmful at their parts-per-billion and parts-per-

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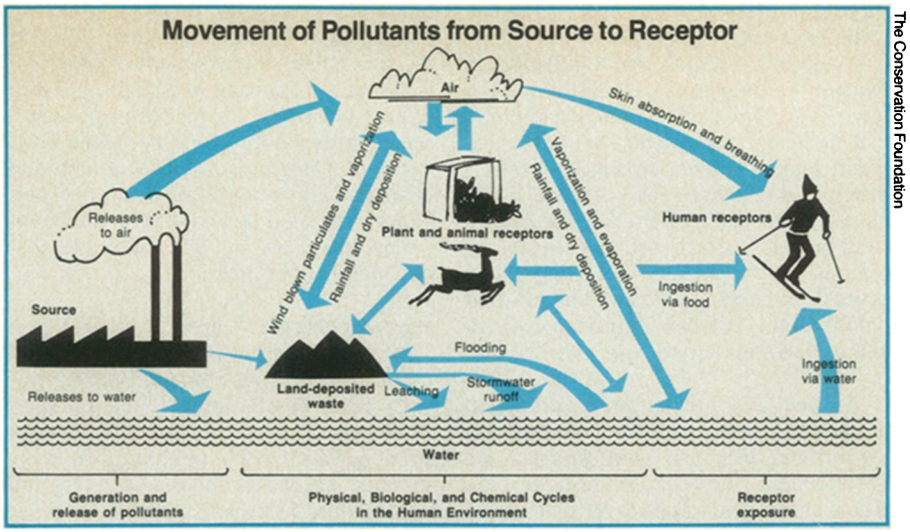
trillion levels. The spotty data on their health effects, as opposed to the better-known hazards of conventional air pollutants such as lead, leave them in regulatory limbo.

The first EPA study on the extent of airborne toxic chemicals may prod some action when official review of the report is completed. Currently only two toxic organic compounds — vinyl chloride and benzene — fall under enforceable EPA standards, along with six other toxic air pollutants. An additional 25 hazardous compounds, including some organics, are under study for possible regulation.

Direct release from stacks and tailpipes is not the only way toxic pollutants from other media get shunted to the air. Contaminated groundwater is commonly cleaned up by pumping the water to the surface and allowing the undestroyed organics to volatilize into the air. In other cases, the pumped water is run through charcoal granules that sponge out the chemicals. Though spent carbon can be recycled — an extra cost-incurring step — it can also be dumped into landfills from which the volatile compounds can enter the air.



The Conservation Foundation

Hazardous pollutants can sidle into the air from other unsuspected places. An EPA study in Philadelphia found that sewage plants, in treating municipal waste and an increasing amount of commercial waste, are releasing as much of that city's toxic air pollutants as the more obvious chemical factories.

If the air is becoming the sink for volatile and toxic pollutants, they can still drain out. A report to be published in ENVIRONMENTAL SCIENCE & TECHNOLOGY describes a model for one known carcinogenic organic, trichloroethylene (TCE), that shows how TCE in the air — where about 60 percent of all manufac-

Silicon Valley: A case study in cross-media management

California's Silicon Valley may be a model of both the way cross-media problems develop and a means for managing them.

The once-agricultural Santa Clara County, now better known for the semiconductor silicon, is shedding the clean image long associated with its microelectronics industry, as workplace and environmental health risks surface. The reputation grew out of the seemingly sterile conditions for manufacturing integrated circuit chips, the base of the valley's $19 billion industry. Chipmakers in "clean rooms" wear white suits and masks to keep dust off the silicon chip surfaces; the factories themselves are low, smokestackless buildings. But the surrounding landscaped lawns cover underground tanks storing toxic organic solvents used in cleaning the chips as the circuitry is developed on them. And since 1981 a series of tank and pipe leaks contaminating groundwater and soil have been discovered.

One of the first and largest detected leaks, from the Fairchild Camera and Instrument Corp. in San Jose, Calif., contaminated a public drinking well with 1,700 to 8,800 parts per billion of the solvent trichloroethane (TCA). (The state standard for TCA is 200 parts per billion.) Last month the California Department of Health Services released a report of pregnancy outcomes around the time of the leak. The neighborhood serviced by the well experienced three times as many birth defects and twice as many miscarriages as a control neighborhood with uncontaminated water. But the report concluded that without details about specific exposures to the contaminated water, the leak cannot be definitely blamed as the cause, nor can it be ruled out.

To date, about 100 other chemical leaks in the valley have sunk into upper groundwater supplies, closing 38 private and four public wells.

When EPA proposed its 1984 update of new "Superfund" sites needing cleanup, 19 Silicon Valley firms were included because of their common groundwater contamination problem. Most of these firms ranked in the lower half of the 244 new sites, well below the most hazardous smelters and chemical dumps, but any Superfund ranking designates a site "that appears to present a significant risk to public health or the environment," according to an EPA notice. The sites are to be finally approved by summer 1985 for eventual Superfund cleanup.

Two Santa Clara County firms, IBM and Fairchild, have been pumping 16 million gallons per day of chlorinated solvent-contaminated groundwater, according to an EPA report, and channeling the water to San Francisco Bay after carbon treatment or aeration. The practice has local regulatory approval, but others consider such groundwater aeration to be an example of cross-media transfer of pollutants.

"You're taking the problem from the water and putting it in the air," says Yoram Cohen, a chemical engineering professor at UCLA's National Center for Intermedia Transport Research. And though chlorinated solvents will eventually break down in sunlight, "the chlorine remains to react and form other chlorinated compounds. I don't think it's a solution," he says.

A new way to manage cross-media pollutants, including the diaphanous problem of hazardous organics in the air, is under trial in Silicon Valley. A special $1 million EPA program, the Integrated Environmental Management Project, is designed to take a ringmaster approach to consider contamination problems in all environmental phases at once. The project has chosen 54 toxic chemicals circulating in the valley and is comparing their health risks in all phases.

Ted Smith, head of the Silicon Valley Toxics Coalition, a community watchdog group in San Jose, Calif., calls the project a "nice idea" but questions what its numerical analysis will actually accomplish.

The project's goal is to determine where a contaminant will do the least harm, and then manage it accordingly. Toxic substances demand such a cross-media analysis, says program manager David Morell, because they can't be made to vanish but have to be tackled somewhere.

Similar studies are ongoing in Baltimore and Philadelphia, but so far integrated environmental management is an EPA experiment, not the norm. —*C. Mlot*

tured TCE is lost — disperses to soil and water over time.

Coauthors Yoram Cohen and Patrick A. Ryan of the University of California at Los Angeles (UCLA) constructed a mathematical model to represent air, soil, water, sediment and fish, then looked at how TCE distributes itself into each of these. If TCE stayed in the air, it would degrade in sunlight as all chlorinated organic compounds do (though some take longer than others). But the UCLA model shows that before all the TCE can be broken down, it settles into soils and sediments, where it is more stable.

The final TCE concentrations predicted by the model reasonably correspond, say the authors, to actual levels found in the environment. And because the model considers shifting pollutants over time, it can be used to point out to policymakers which chemicals pose the most threat and where.

"This is a tool for determining pollutant pathways and where the environmental hot spots are," says Cohen. A toxic chemical may not be an air problem if it breaks down quickly, but it can become a serious land problem if it accumulates in the agricultural topsoil. Cohen expects multimedia modeling to be useful in screening new chemicals as well as existing ones. Manufacturers develop more than 1,000 new chemicals each year.

Cohen conducts his research at the National Center for Intermedia Transport Research, an EPA-funded center at UCLA. In the young field of cross-media research, it is the only organized academic research group that studies the mechanisms of pollutant transport through the whole environment. The group of eight scientists and engineers is concentrating on organic pollutants and their behavior at media boundaries, as well as their flow and accumulation in the environment.

Tracking and transport studies look at pollutants once they are released into the environment. But the ultimate cross-media control, according to many speakers at the Washington conference, is to catch pollutants at their sources. Source reduction is going on, says Richard E. Heckert of E. I. du Pont de Nemours & Co. in Wilmington, Del. Industries are practicing "preventive environmental medicine," he says, by designing manufacturing processes to avoid or reduce waste, by recycling some wastes as fuel and by considering potential environmental impacts before building new plants.

Still, four-fifths of the 118 million metric tons (dry weight) of sludge generated annually in the United States comes from industries. Their wastes, along with the remains of sewage and water treatments, make up a morass of organic and inorganic chemicals, heavy metals, viruses and bacteria. Land receives the bulk of this waste, which is intended to be securely contained. But its more toxic and persistent ingredients often make their way into soils and groundwater as well as into the air.

Conference speakers pointed out the need for an umbrella policy to deal with the seemingly disparate problems of hazardous sludge, contaminated groundwater and acid rain, all of which affect mixed media. The basic ideas of integrated environmental control are not new — the EPA itself was formed in the ecology-minded mood of the late 1960s. But medium-specific laws, bureaucratic divisions, strict scientific specialties and even environmental groups that lobby separately for clean air, clean water and clean land have hampered the development of an integrated policy. "The lack of data hamstrings us all," says Glenn Paulson of the National Audubon Society in New York, but "we lack conceptual, intellectual tools, too" for an integrated control.

Resurgent interest in the cross-media problem may provide a few more tools that work within the existing framework. There is enough "wiggle room" in current laws to allow cross-media considerations at least at the state or local level, according to Ernest Abbott of EPA's policy office. But in the long run, says J. Clarence Davies of the Conservation Foundation, the media-oriented laws will at least have to be modified for an integrated approach. □

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from the Asilomar meeting slowed the initial stages of gene-splicing research, outlawing certain experiments and making others difficult or too expensive. In addition, hours and hours of scientists' time were spent drafting guidelines, applying for permission to perform experiments and appearing before legislative committees. Some scientists, such as Szybalski, refrained from doing any recombinant DNA experiments because they so strongly objected to being regulated.

Over the years the NIH guidelines have been repeatedly revised, easing the safety restrictions on gene-splicing research. "Much blood, sweat and tears went into changing the regulations," Szybalski says. "The people who undid all that damage should get a monument."

Berg, too, was dismayed at how much energy and time was consumed by the public debate in the years following the Asilomar conference. However, he believes that the overall effect was positive: "Now, 10 years later, no one could convince me that [guidelines arising from the Asilomar conference] impeded research. It only stopped things that we couldn't yet do anyway."

Has there been any ill effect on health or on the environment? Most scientists are convinced there has not been the slightest harmful outcome in the decade of widespread gene-splicing research. But King says he is disappointed that there is no program to monitor possible problems. "If no one is collecting data, we can make no statement," he says.

Paul Berg

Berg's greatest disappointment is that the experience gained in dealing with the recombinant DNA issue has not established any clear precedent for handling other potentially controversial new technologies. "In a sense, we went through the whole exercise...but left no process in place. If new concerns arise, it would be the same thing all over again — a process as primitive and as inefficient as before."

Today recombinant DNA controversies are still in the news. For instance, guidelines for the first research into clinical uses of gene splicing were recently recommended (SN: 2/2/85, p. 71). Harold Varmus of the University of California at San Francisco, who helped draft them, says, "The lesson of Asilomar should be transmitted to the gene-therapy people. That lesson is: Don't get bogged down in too many regulations."

Yet the absence of laws regarding recombinant DNA research has not granted gene splicers immunity from legal problems. Court decisions now block the first experiments involving deliberate release of genetically engineered microorganisms into the environment (SN: 12/22&29/84, p. 397). But even the biologists who are frankly upset by this obstruction of recombinant DNA research do not propose a return to Asilomar as a way of solving the problems they now face.

"The Asilomar conference was really a child of the '60s and early '70s, an innocent time for everybody," says Janet Hopson, who covered the meeting for SCIENCE NEWS. "Things will never be like that again." □