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Tracing risk in the water we drink

EPA's contaminant limits affect utilities, environmental firms and itself

It is one of the most influential programs in the Environmental Protection Agency, providing a common tool for several divisions of the historically balkanized organization. It is one of the most pressing programs as well, involving questions of public exposure to an array of potentially hazardous chemicals. It is also one of the most difficult, pitting pervasive fear against scientific data that is permeated with uncertainty. And by all accounts, including EPA's, the agency has not done a very good job in carrying it out so far.

The risk management program mandated under the Safe Drinking Water Act requires EPA to do the near-impossible. First, it must decide how much is too much for dozens of health-affecting chemicals found in drinking-water supplies. Then it must make a separate decision on how much of each chemical can economically be removed from water using technology now available. The first decision relies on sketchy health research and nebulous issues of how much risk society is willing to tolerate. The second brings in equally nebulous questions of how much money society is willing to pay to eliminate various chemicals from its drinking water.

But no matter how cloudy the origins of the resulting numbers—called maximum contaminant levels, or MCLs—their effect will be profound. Every public water system in the country will soon have to begin extensive and costly monitoring of drinking-water quality and must install new treatment equipment under various deadlines if it finds that its water does not meet the MCLs. Water testing labs, environmental engineering firms, equipment suppliers and contractors that build water treatment plants are likely to see a steady increase in business over several years. Furthermore, the MCLs are likely to influence more than drinking water as EPA, states and the courts use them officially or unofficially as standards for the cleanup of hazardous-waste sites.

Congressional crackdown. Given the importance of the MCLs and the difficulty of deciding what they should be, it is no surprise that EPA has produced numbers for only 20-odd contaminants since the drinking water act passed in 1974. Congress is not satisfied. In preparing to reauthorize the act this year, the House mandated a set of firm deadlines under which EPA must regulate 83 hazardous chemicals singled out by the agency unless it can demonstrate a "rational basis" for not limiting a particular substance. The Senate declared flat out that EPA must set standards for all 83 substances.

"We're not sure what the 'rational basis' means," says one Senate aide. "We're very uncomfortable adopting that language." As of now, it is questionable whether "rational basis" will make it to the final bill, but the Senate's absolute approach is also unlikely. Although Congress is still working out those and other minor differences in the two bills, however, its mood is unmistakable.

"I think it's a foregone conclusion that there are going to be deadlines," says Arnold M. Kuzmack, acting deputy director of EPA's Office of Drinking Water. "We do agree that we should produce more standards. We prefer not to have big, visible deadlines that we might miss, but we're likely to produce more if we have them."

"They're way behind," says Velma M. Smith, director of the groundwater protection project at the Environmental Policy Institute, a Washington, D.C.-based advocacy group. "The

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general consensus is that they just haven't kept pace with the intent of the act, which was to address a broad array of toxics."

States left waiting. Not only environmentalists but state officials as well are impatient with the agency. "States are looking to the federal government to put their resources into those areas of research," says Alfred E. Murrey, chief of Idaho's water quality bureau. States generally don't have the technical or financial wherewithal to do the research necessary to set an MCL, says Murrey. Until the numbers are available, however, states can't judge the significance of contaminants found in groundwater. "States don't know what this means from an enforcement standpoint," Murrey complains.

Others, however, are not as enthusiastic about hurrying EPA along. "Congress . . . , as Congress is wont to do, overreacts and wants to put deadlines on setting the MCLs. They're into a technical area that few of them understand," says Kenneth J. Miller, a vice president of Denver engineering consultant CH2M Hill, Inc., and former president of the American Water Works Association.

Chicago environmental attorney Joseph V. Karaganis worries that EPA will rush to generate numbers that mean little but have a profound impact nevertheless. "We have seen EPA spend billions of dollars in public money implementing cures without accurately defining the disease," he says. "We shouldn't hesitate to protect the public health. On the other hand, we shouldn't raid the national treasury simply on the basis of unsubstantiated and undefined hazards."

EPA confident. Despite the misgivings of outsiders like Karaganis, EPA's Kuzmack believes the agency's work is now progressing well, that the numbers it produces will be credible and that the time constraints of Congress will not prove too confining. Under the Senate bill, EPA would have to meet deadlines at the one-year, two-year and three-year marks, promulgating MCLs for certain contaminants by each checkpoint. Under the House bill, the agency would have only one-year and three-year deadlines.

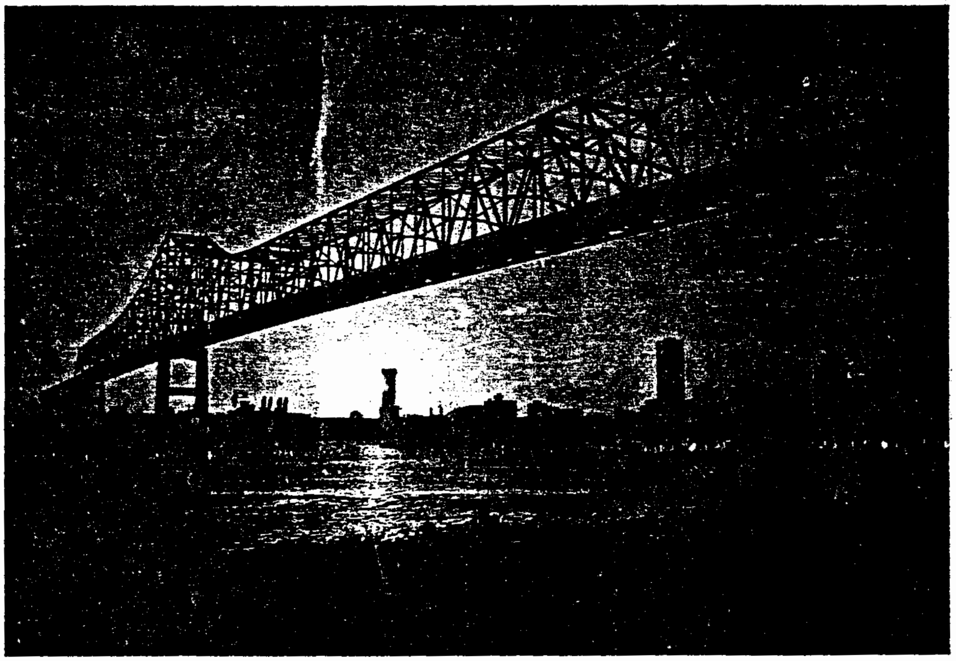
EPA plans to have a proposal for dealing with the first-year deadline within the next few weeks, Kuzmack says. The contaminants included under that first list will be several of the critical group known collectively as volatile organic compounds (VOCs), low-molecular-weight organic solvents that have been found in increasing quantities in groundwater. Among the VOCs listed are trichloroethylene, tetrachloroethylene, benzene and a number of related compounds.

A list of proposed MCLs should appear in the *Federal Register* soon, and a rule is likely within the one-year limit, says Kuzmack. "I would not bet the mortgage that we won't miss it by a day, but as congressional deadlines go [it's] pretty reasonable," he says.

As with all of the contaminant limits EPA sets, the numbers for VOCs will come in two parts. Under the Safe Drinking Water Act, EPA is directed first to use the best scientific data available to determine the concentration below which there is no observable health danger. This is called the recommended maximum contaminant level (RMCL) or, under the new drinking water act revisions, the "MCL goal." It is a non-enforceable limit that Congress intended as a target only. The MCL goal shows what the MCL would be in an ideal case where a water utility had unlimited money and technical capability to remove contaminants from drinking water.

No tolerance for cancer. For carcinogens, the MCL goal is generally considered to be zero. The assumption is that any amount of a proven carcinogen present in water results in an increased risk of cancer to some degree, and that there is no such thing as a safe level of the contaminant. For non-carcinogens, a threshold level is established experimentally, often using data from animal tests (see box p. 46).

EPA considers the action of each contaminant working by itself, ignoring any intensifying effect that two or more contaminants might have when acting together. Although one chemical might increase or cancel out the health danger of another, little is known about these synergistic effects. "In the absence of any information we just don't deal with it," says Kuzmack.



New Orleans inspired Safe Drinking Water Act when river water contaminants were tied to cancer.

Once the MCL goal is decided on, EPA considers the available water treatment technology to determine to what degree drinking water can be decontaminated economically. This level of purity is the MCL, the maximum concentration of a contaminant that will be permitted in drinking water provided to consumers by public water systems.

In the common terminology used in controlling risk, the setting of the MCL goal is a "risk assessment" operation, and setting the MCL corresponds to "risk management"—deciding how best to reduce the risk once it is identified.

The MCLs will generally appear in order of health priority, starting with the VOC levels to be proposed soon, says Kuzmack. VOCs are the contaminants found most often at hazardous-waste sites and are considered a threat. The VOC levels will be followed by MCLs for pesticides, other contaminants found commonly in groundwater.

Water supply checkup. In addition to the 83 contaminants that will receive MCLs, EPA will establish a list of about 40 additional chemicals for which utilities must test their water periodically. The results of the monitoring will tell EPA the extent of different types of contamination in water supplies across the U.S., giving the agency information on which to base future MCLs.

To date, drinking water has been monitored only sporadically. "We've never had every water supply looked at to see what's there," says Jacqueline M. Warren, a senior staff attorney with the Natural Resources Defense Council, a New York City-based environmental group. At present, the only contaminants for which a water system must monitor are those few for which MCLs have already been set. Consequently, water utilities can easily boast that their drinking water meets all EPA standards. "That and a token will get you on the New York subway," says Warren.

The monitoring of water supplies will not come cheap. According to Leo C. Fung, chief chemist with the Hackensack Water Co., an investor-owned utility based in Harrington Park, N.J., a test for VOCs can run $60 to $80 per sample. The same costs are typical in testing for trihalomethanes—carcinogens commonly formed from the chlorine used in disinfection. For a gas chromatograph-mass spectrometer test the price to water utilities can run anywhere from $500 to $1,000, Fung says.

The Hackensack Water Co. has increased its laboratory staff from four technicians and two chemists to five technicians and four chemists because of the Safe Drinking Water Act and a similar New Jersey law for which the monitoring requirements are already in effect.

Hard on the little guy. For a large system with its own testing lab like the 800,000-consumer Hackensack network, the costs of increased monitoring can be absorbed without a rate increase, Fung says. Because two-thirds of the water-supply systems in the U.S. serve fewer than 500 people, however, the testing and treatment required by the Safe Drinking Water Act will be a burden.

The federal government plans to subsidize the costs of monitoring for the smallest water systems. In treating water that does not meet the MCL limits, however, they are on their own.

Some people favor a federal subsidy program for drinking water testing and treatment similar to the construction grants program for sewage treatment plants. "I think it's crazy to spend millions for sewage treatment and provide it for every city in the country, whether they need it or not, [on the basis] of whether they can afford it, and then have nothing for drinking water," says the Natural Resources Defense Council's Warren.

EPA's Kuzmack disagrees. A sewage plant's benefits are felt by people downstream, he points out. Without federal intervention, the people whose sewage

The standards so far

Contaminant	ppm (or as shown)
inorganic chemicals	0.05
arsenic	0.05
barium	1
cadmium	0.010
chromium	0.05
lead	0.05
mercury	0.002
nitrate (as N)	10
selenium	0.01
silver	0.05
fluoride	1.4-2.4
organic chemicals turbidity	1-5 turbidity units
coliform bacteria	1/100 ml (mean)
endrin	0.0002
lindane	0.004
methoxychlor	0.1
toxaphene	0.005
2,4-D	0.1
2,4,5-TP (Silvex)	0.01
radionuclides	
radium 226 + 228 (combined)	5 picocuries/l
gross alpha particle activity	15 picocuries/l
gross beta particle activity	4 millirem/year
total trihalomethanes	0.1

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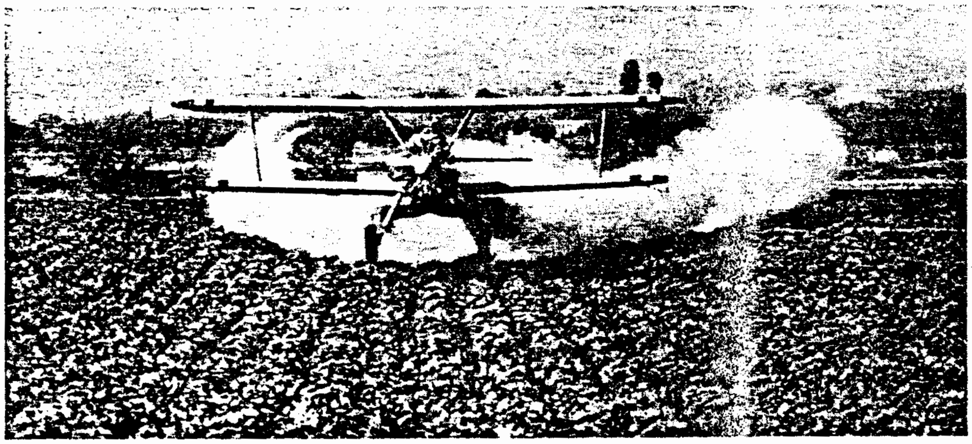
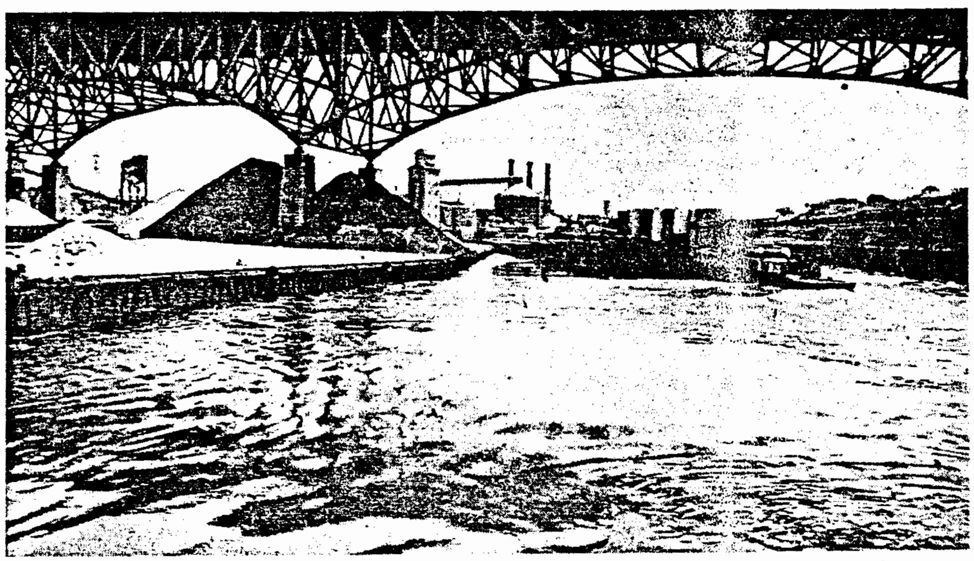


Pesticides frequently leach into groundwater and are considered a high priority under EPA program.



River discharges by industry are down since Clean Water Act, making groundwater key MCL target.

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The science and the guesswork of MCLs

The setting of maximum contaminant levels, or MCLs, for contaminants in drinking water is a complex process requiring careful scientific and political judgement. In total, more than 100 contaminants will be considered, and under the requirements of the Safe Drinking Water Act two separate limits must be assigned to each one. To make matters more complicated, Congress is now in the process of rewriting the procedures by which the standards must be set.

The starting point is the recommended maximum contaminant level (RMCL), an ideal number that Congress, in its current reworking of the drinking water act, has redubbed the "MCL goal" to make its purpose clearer. According to the Environmental Protection Agency, MCL goals are "non-enforceable health goals which are to be set at levels which would result in no known or anticipated adverse health effects with an adequate margin of safety."

Once the agency has considered available health data and has established an MCL goal for a contaminant, it sets the MCL itself, the limit that public water systems across the country will have to abide by. "MCLs are enforceable standards and are to be set as close to the RMCLs as is feasible and are based upon health, treatment technologies, cost and other factors," EPA said in a set of proposed rules last year.

For proven carcinogens, MCL goals have generally been set at zero. Science has not been able to establish threshold exposures below which no carcinogenic health effects occur, the logic goes, so even a single molecule of a cancer-causing substance theoretically creates some finite risk. The ideal limit to which water system operators should aspire is zero for carcinogens, EPA has said.

Moving target. Critics have called this an unattainable, moving target. Measurement equipment cannot measure zero contamination, and as the bottom limit of what developing technology can detect gets smaller and smaller, the level to which water technicians are aiming changes constantly as well. The zero concentration is not intended to be an enforceable limit, however.

For non-carcinogens, EPA states, "It is assumed that an organism can tolerate and detoxify some amount of a toxic agent without ill effect up to a certain dose or threshold. As the threshold is exceeded, the extent of the response will be a function of the dose applied and the length of time exposed."

Using data from experiments on humans or animals, researchers can establish a graph of dose vs. response for a particular contaminant (see facing page). Using the level of "no observed adverse effect" (point A) they establish an acceptable daily intake (B) by dividing the dose of point A by an uncertainty factor. That factor is 10 if there have been studies on humans, 100 if there have been long-term studies on animals only, and 1,000 if the animal studies have been inadequate. Depending on how the dose-response curve is extrapolated backward to the point of zero response (various dotted lines), the acceptable daily intake may actually be greater than this zero level, an uncertainty inevitable with incomplete data.

Deciding on what is and is not an acceptable health risk frequently requires some interpreting and some political decision-making. For example, an excessive amount of fluoride, a naturally occurring mineral that plagues water supplies in some parts of the country, mottles the teeth without endangering health in more serious ways. At one point, EPA thought about classifying this as a "cosmetic" rather than a "health" effect, and therefore something not covered under the Safe Drinking Water Act.

Cost considerations. Different philosophically from MCL goals, MCLs are more pragmatic numbers for which cost-effectiveness must be considered. In this process, EPA considers the capital cost of applying new technology, the operating and maintenance cost and the feasibility of financing new treatment systems. The financing feasibility is estimated using a financial model of the water-supply industry developed by EPA.

The agency also considers financial impacts on the consumer compared with what the costs of water have been historically. The cost vs. benefit of decontaminating water to meet the MCLs also is considered for the nation as a whole.

Because EPA must base its analyses on estimates, it then performs another analysis to measure the sensitivity of its results to changes in various assumptions.

Although health considerations were earlier part of the setting of MCLs, as they are for MCL goals, Congress is leaning now toward a process that only considers the level of cleanup possible with "best available technology." Staff members in both the House and Senate feel that the health rather than technology emphasis in the past is the main reason EPA has been so slow in setting standards.

"There is no clear technology required in current law," says a member of the staff of Sen. David F. Durenberger (R-Minn.), the key Senate member of the conference committee now fine-tuning the drinking water act reauthorization. "By going to a technology-based standard, we hope to cut through all that," the staffer says.

Animal tests are main source of health data.

is being treated would have no incentive to build the plant because they would not enjoy any of those benefits. In drinking-water treatment, however, the same people paying for the treatment plant are the ones consuming the water. Those consumers should pay water rates that cover the costs of adequate treatment without expecting help from the U.S. Treasury, he says.

Water too cheap? There is nearly unanimous agreement, except perhaps among consumers, that water rates in the U.S. are generally far too low. "A lot of these systems are underfunded," says Larry J. Silverman, executive director of the American Clean Water Association, a Washington, D.C.-based industry group. "Also, they're starting to get a little bit old. But nobody's really bitten the bullet on rates yet. The water industry is proud of saying that they're self-sufficient . . . , they're funded by their rates. But I think a lot of them are funded by deferred maintenance. The day of reckoning is coming."

Warren notes that Americans already spend significant sums of money for home water filters and bottled water of dubious purity out of concern with what's coming out of the tap. She thinks that once the monitoring results start coming in and people realize for the first time what contaminants they are routinely exposed to, they will be glad to pay higher rates to remove those contaminants. "I don't think most people want to be drinking pesticides in their water," says Warren. "Once they know they're in there and that they're poison they'll be asking how much it will cost to get them out."

Until now, utilities have been dodging the rate issue by claiming that U.S. water is generally safe and that the extra

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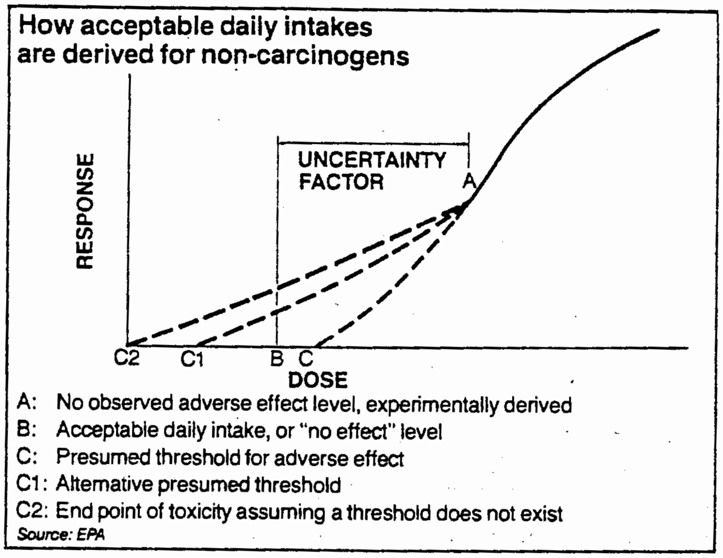
ment required by the program is a waste of ey, Warren says. In-l, she says, they should been convincing their omers to pay adequate for a better-quality, saf-product. "They haven't using the tried-and-methods of selling that country is known so well ' she says.

onsolidation. With or out rate increases, the a costs of supplying wa-may prove too much for thousands of small water ems across the country. ere are economies of e in water treatment, and pensive treatment tech-ues for small water sup-systems are scarce. The ılt could be the death of ne small systems. "If this is taken seriously, I think 'll see a reorganization of water industry toward ater consolidation," says erman.

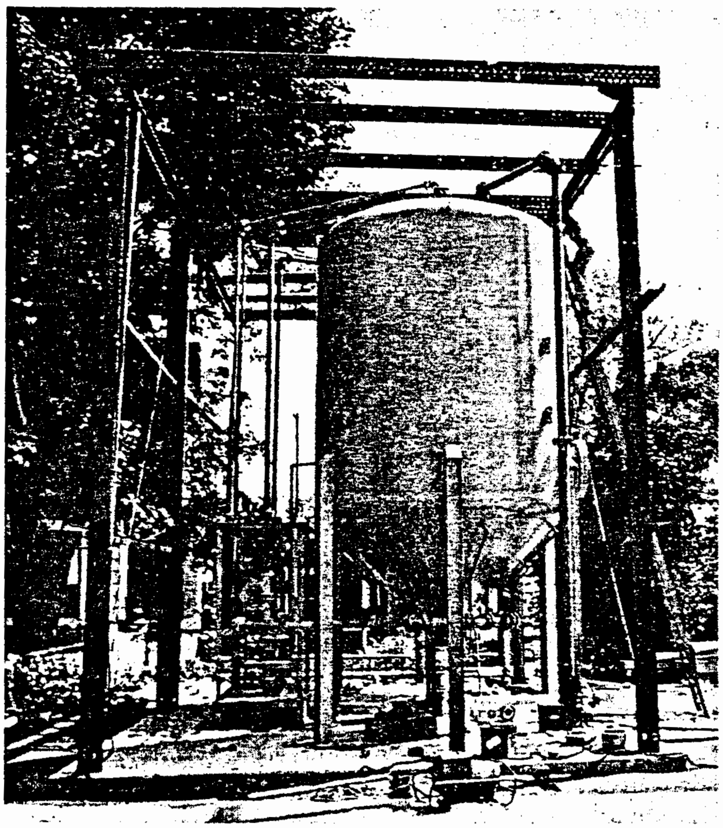
Another possibility, some , is that there will be an reased national effort to serve the quality of water ırces so that water doesn't uire expensive treatment fore it can be used. "May-what is going to happen-. with these requirements ing put into the law is that e utilities will become ore aggressive participants pollution-prevention pro-ams," says the Environ-ental Policy Institute's nith. "When you have a nall system serving 30 peo-e in a trailer park, you n't afford to put in an ex-ensive treatment system."

Opportunity. One clear re-lt of the law is a coming onanza for water testing boratories, engineering nsulting firms, manufac-rers of treatment equip-ent and other companies that have services to sell to the ırveyors of drinking water. EPA is confident that the free arket will respond to the demand for new equipment or ıtire water treatment plants. For laboratory services, how-er, there may not be enough capacity to handle all of the quired tests for several years. Many of the tests are sophisti-ted, requiring a great deal of expertise and costly equip-ent. "It takes a certain minimum amount of time to produce PhD in chemistry," notes EPA's Kuzmack. "Over the longer rm [the need for competent laboratories] will take care of elf, but in the meantime we may have some problems."

With New Jersey's monitoring law already in force, water stems in that state often wait a month or a month and a half r test results because there aren't enough approved labs,



Dose-response curves are extrapolated to set limits (see box facing page).



GAC filters, efficient removers of carcinogens, almost became mandatory.

says Donald L. Hoven, president of Laboratory Resources, Inc., a small Westwood, N.J., testing company. Like Kuzmack, he expects the market to take some time to respond to the newfound demand.

As for the engineering and construction market, an increase in business is likely but an abrupt glut is not, says CH2M Hill's Miller. Many utility managers have already anticipated the coming of the MCLs and have begun planning to adopt the best available treatment technologies on their own. In addition, the technology is generally expensive and it cannot be implemented overnight. "It's going to take a while to gear up to do the design and construction of this type of thing, doing the pilot plant testing . . . to show that it's cost-effective," Miller says. "I don't see a great surge immediately when the Safe Drinking Water Act is [reauthorized]."

The requirements of the drinking water act could cost U.S. utilities billions of dollars for extra testing and treatment. Few people will guess at the exact size of the market, however, because of the unknowns that remain. With so few MCLs set so far, it is not clear how strict EPA's numbers are likely to be, for example. In addition, the quality of drinking water in the U.S. has been monitored so haphazardly in the past that little is known about what contaminants are there. Treatment needs vary with the contaminants that must be eliminated.

Broad influence. The MCLs will influence other environmental programs nationwide as the numbers are inevitably used to determine which aquifers need decontamination, which waste dumps are endangering groundwater supplies, which Superfund toxic dump sites have been cleaned up adequately and other issues involving the safety of water sources. Idaho's Murrey, for example, is eager to use the MCLs in regulating the cleanup of toxic spills, for which no other target numbers are available.

The numbers will be useful in other areas besides drinking water, at least informally, agrees EPA's Kuzmack. Because the Clean Water Act has been largely successful, he says, most surface water in the U.S. would already fall below the contamination limits specified in the MCLs. Groundwater is another matter, however. Specifically, under the Resource Conservation and Recovery Act (RCRA) the owners of hazard-

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Drinking water act: child of technology

Unlike the Clean Water Act, inspired by concern about visible pollution in lakes and streams, the Safe Drinking Water Act is purely a product of technology. It arose not because people were becoming visibly ill from their drinking water but because advances in measurement techniques allowed scientists to measure contamination in the parts-per-billion range or less for the first time. Once an increase in cancer risk was traced to some of that contamination—organic chemicals in the New Orleans water system—the Safe Drinking Water Act was created to bring public water supplies under federal regulation for the first time.

Eleven years later, the act still retains its strong dependence on technological advances. The maximum contaminant levels (MCLs) specified by the Environmental Protection Agency for a wide array of chemicals will all take into account what currently available technology can economically remove from drinking water. As the MCLs are revised in the future, EPA will reevaluate them in light of the technology available at the time.

In its current drive to establish MCLs expeditiously after years of slow motion, EPA has turned to outside help. Engineering consultant Malcolm Pirnie, Inc., White Plains, N.Y., is now working as an EPA subcontractor to evaluate various treatment technologies, judging their ability to reduce or eliminate contaminants, their efficiency and their cost.

Until recently, Congress was considering requiring that water supply systems across the U.S. not only limit the contaminants in their water to the MCL levels but install equipment using prescribed technology as well. The technology was granular activated carbon (GAC), an expensive but effective means of removing a range of organic contaminants.

Performance standard. Under protests from the water supply industry, Congress backed down. In the Safe Drinking Water Act reauthorization bill that will come up for the vote of the full Congress within the next few weeks, the GAC requirement will not appear. Instead, Congress has instituted a performance standard under which water systems can use alternative water treatment technology as long as it reduces the hazardous contaminants in their water at least as well as GAC would.

GAC is a technology much in vogue at the moment. It is used by about 50 drinking water systems nationwide, primarily for the reduction of taste and odor problems. It is found even more commonly in the food and beverage industry, where manufacturers use GAC filters to eliminate taste differences in the water that goes into soups and sodas at their far-flung plants.

The use of GAC as an eliminator of carcinogens is more recent. The City of Cincinnati now has one of the most ambitious plans to use the technology, envisioning the world's largest GAC treatment system to remove synthetic organic contaminants from its drinking water, which comes from the Ohio River. The plan has been held up by a lawsuit over water rates, reports Cincinnati Water Works Director Richard Miller, who also is the current president of the American Water Works Association (AWWA).

Another technology valuable in eliminating drinking water hazards is ozone disinfection, used in place of chlorine. Chlorine combines with other chemicals in drinking water to form trihalomethanes, carcinogens limited under the Safe Drinking Water Act.

Trihalomethanes are currently the most persistent problem in the Hackensack Water Co.'s system in New Jersey, says the utility's chief chemist, Leo C. Fung. The company plans to incorporate ozone equipment into a planned filtration plant expansion, however, and the trihalomethane level will be cut by about two-thirds, Fung says.

Research support. The water industry, through the Denver-based AWWA, has set up a foundation that is promoting the development of new technology with grants funded by industry subscription fees. According to John B. Mannion, deputy executive director of the foundation, the research is usually done by teams consisting of a university, a consulting firm and one or more utilities. Current projects involve GAC, alternative disinfection methods, microbiological contamination and other subjects. The foundation recently published a two-volume manual on the use of GAC.

One major problem in cleaning up drinking water inexpensively is not creating the technology but getting the regulatory authorities to approve it, says Craig C. Gaetani, director of marketing for Krofta Waters, Inc., Lenox, Mass. Krofta has developed a 1.25-mgd clarifier for the City of Lenox that measures only 22 ft in diameter and 4½ ft high. In that small space the system combines flocculation, dissolved-air flotation and sand filtration processes. After reluctant state officials would not put a penny toward funding the system, Krofta ended up building it at its own expense to show what it could do.

"It's very difficult to get a new idea accepted," says Larry J. Silverman, executive director of the American Clean Water Association, an industry group that promotes innovative technology and financing. "It's much easier to sell contaminated water than it is to market a new product for removing the contamination."

ous-waste disposal sites must monitor groundwater quality for various indicator contaminants and the MCLs would provide a useful yardstick with which to judge water quality, he says.

There is now some disagreement within EPA, however, about whether the MCLs should be officially incorporated into hazardous waste regulations. While the numbers would logically tie together the various EPA programs dealing with water quality, they would also raise some philosophical conflicts, says Kuzmack. The MCLs are set using information about the ability of available technology to remove various contaminants from water economically at a drinking-water treatment plant. The technology available for decontaminating an in-place aquifer could be a wholly different matter. Also, while cost considerations are a part of choosing treatment technology under the Safe Drinking Water Act, RCRA specifically excludes cost as a factor in judging which disposal sites are unsafe.

Margin for error. Another problem, says environmentalist Smith, is that by using the same numbers to judge groundwater contamination and drinking-water treatment, regulators would be allowing water sources to be polluted to the exact point to which water utilities would have to clean them up. That would leave no margin of error to allow for the normal degradation of water quality over time or the variations in water quality throughout an aquifer. Regulators should aim to keep the levels of groundwater contamination lower than the MCLs required for drinking water supplied to consumers, she argues.

Some states, Wisconsin for example, already specify such a double-tier system for water quality. Like anything underground, groundwater supplies will always be poorly understood, points out Snorre O. Gronbeck, an environmental engineer with the Wisconsin Department of Natural Resources. To ignore that lack of knowledge by neglecting to add a safety margin to environmental enforcement is "absurd," he says.

Many such questions remain about how broadly the MCLs should be used, what they will cost drinking-water consumers and how much business they will provide to companies in environmental fields. What is known is that after 11 years of meager progress EPA is finally ready to start generating these numbers and that their effect will be major.

"My experience with the agency is that the legislation hits them, then they wander around for a while trying to figure out what to do with it," says attorney Karaganis. EPA has figured out what to do with the Safe Drinking Water Act, has stopped wandering around and is finally ready to get down to business. ■

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