Classifying Drinking Water Contaminants for Regulatory Consideration

By Mark Gibson

The provision of safe drinking water has been an important factor in improving public health in U.S. communities since the turn of the 20th century. Despite advances in water treatment, source water protection efforts, and the presence of several layers of local, state, and federal regulatory protection, many sources of raw and finished public drinking water in the United States periodically contain chemical, microbiological, and other types of contaminants at detectable and sometimes harmful levels. Furthermore, the production and use of new chemicals that can reach water supplies and the discovery of emerging microbial pathogens that potentially can resist traditional water treatment practices and/or grow in distribution systems pose a regulatory dilemma: Where and how should the U.S. government focus its attention and limited resources to ensure safe drinking water supplies for the future?

To help address these difficult issues, one of the major requirements of the Safe Drinking Water Act (SDWA) Amendments of 1996 is that every five years the U.S. Environmental Protection Agency (EPA) publish a list of unregulated chemical and microbial contaminants and contaminant groups that are known or anticipated to occur in public water systems and may pose risks in drinking water. The first such list, called the Drinking Water Contaminant Candidate List (CCL), was published in March 1998 under pressing time constraints stipulated by the amended SDWA. The primary function of the CCL is to provide the basis for deciding whether to regulate new contaminants from the list every five years. However, it is also used to prioritize additional research and monitoring on these contaminants.

Previous Committee Work, and the New Charge

This is the third and final report of the Committee on Drinking Water Contaminants. The committee was formed in 1998 at the request of EPA's Office of Ground Water and Drinking Water to provide advice regarding the setting of priorities among drinking water contaminants in order to identify those contaminants that pose the greatest threats to public health. The committee was comprised of 14 experts in water treatment engineering, toxicology, public health, epidemiology, water and analytical chemistry, risk assessment, risk communication, public water system operations, and microbiology.

In its first report, *Setting Priorities for Drinking Water Contaminants*, the committee recommended a phased decision-making process, time line, and related criteria to assist EPA efforts to set priorities and decide which contaminants already on a CCL should be subjected to regulation development, increased monitoring, or additional health effects, treatment, and analytical methods research. That report also includes a review of several past approaches to setting priorities for drinking water contaminants and other environmental pollutants. The second report, entitled *Identifying Future Drinking Water Contaminants*, provided a conceptual two-step approach to the creation of future CCLs. It recommended that this process should be made more scientifically defensible and transparent, and its development should take place with increased opportunities for public input and comment.

For present study, EPA asked the committee to further develop this new conceptual approach to the generation of future CCLs. In addition, EPA asked the committee to explore the feasibility of developing and using mechanisms for identifying emerging microbial pathogens (using what the committee now terms virulence-factor activity relationships, or VFARs; discussed below) for research and regulatory activities—also as recommended in the second report.

A Two-step Process for Creating Future CCLs

Despite data and resource limitations, this report continues to recommend that EPA develop and use a two-step process for creating future CCLs (see Figure 1). In this process, a broadly defined universe of potential drinking water contaminants would first be identified, assessed, and culled to a preliminary CCL (PCCL) that is likely to be on the order of several thousands of substances and microorganisms, using

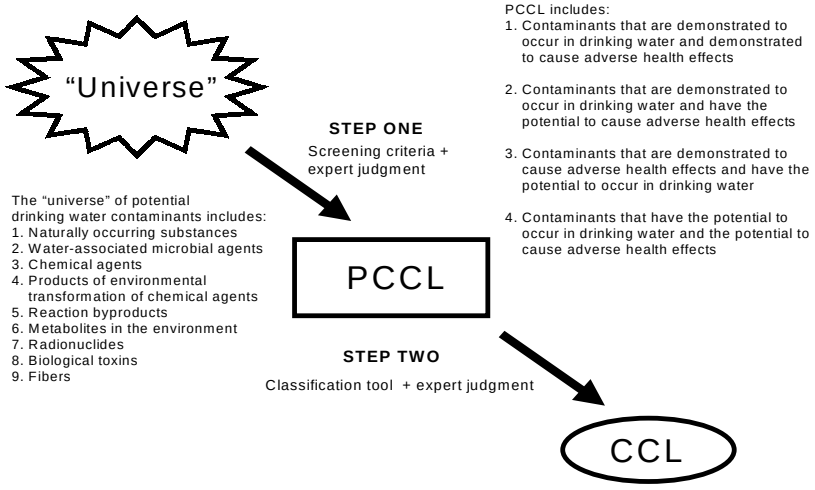

FIGURE 1 Recommended two-step process for developing future CCLs.

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simple screening criteria and expert judgment. To create the corresponding CCL, all PCCL contaminants would then be assessed individually using a "prototype" classification tool (neural network or similar methods) in conjunction with expert judgment to evaluate the likelihood that they could occur in drinking water at levels and frequencies that pose a public health risk. This two-step process would be repeated for each CCL development cycle to account for new information.

The report recommends a generally conservative approach to this process that errs on the side of public health protection. It also urges that the selection process place high priority on the protection of vulnerable subpopulations as intended by the SDWA Amendments of 1996.

Virulence-factor Activity Relationships (VFARs)

In this report, the committee also explored the feasibility of developing VFARs (virulence-factor activity relationships) as a tool to help identify emerging waterborne pathogens, and provided some initial guidance and recommendations on the necessary steps for their construction and use. A VFAR is defined as the known or presumed linkage between the biological characteristics of a microorganism and its real or potential ability to cause harm (pathogenicity). The term is rooted in a recognition of the utility of using (quantitative) structure-activity relationships (QSARs or SARs) to compare the structure of new chemicals to known chemicals to enable prediction of their toxicity. Research has increasingly shown certain common characteristics of virulent pathogens such as the production of specific toxins, specific surface proteins, and specific repair mechanisms that enhance their ability to infect and inflict damage in a host. Recently some of these "descriptors" have been tied to specific genes, and it has become evident that the same can be done for other descriptors as well. Identification of these descriptors, either directly or through analysis of genetic databases, could become a powerful tool for estimating the potential virulence of a microorganism. This is particularly true for two important aspects of virulence: potency and persistence in the environment. The report conceives of VFARs as being the relationship that ties specific descriptors to outcomes of concern as illustrated in Figure 2.

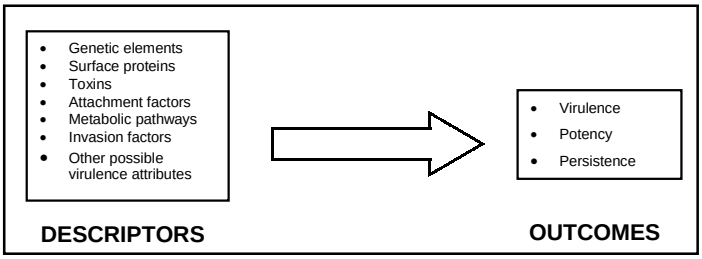

FIGURE 2 Schematic drawing of VFAR predicting outcomes of concern (virulence, potency, persistence) using the presence or quality of descriptor variables.

The report reviews several aspects of feasibility of the VFAR concept for adoption and use by the EPA. These include scientific validity and applicability; technological feasibility; application of these technologies to studying disease in humans (validation); the degree to which these methodologies are being universally adopted within the scientific community; and the need for their development and use to adhere to the principles of transparency, public participation, and other sociopolitical considerations. These elements either are present or can reasonably be expected to be available in the near future, so the report concludes that the use of VFARs is indeed feasible.

The committee chair was Deborah Swackhamer of the University of Minnesota, and the vice chair was R. Rhodes Trussell of Montgomery Watson, Inc. Funding was provided by EPA's Office of Ground Water and Drinking Water. To order the report, contact National Academy Press at (800) 624-6242, *http://www.nap.edu*.

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CURRENT PROJECTS

Restoration of the Greater Everglades

The committee on the Restoration of the Greater Everglades Ecosystem (CROGEE) is providing a scientific overview and technical assessment of the many complicated, interrelated activities that are occurring at the federal, state, local and non-governmental levels. In addition to strategic assessment and guidance, the committee provides more focused advice on technical topics of importance to restoration efforts. The committee met in February and in April to discuss performance measures for restoration. At the February meeting at Everglades National Park, efforts were focused on the Ridge-and-Slough and Mangrove Estuary systems. Also at this meeting, the NRC released a report on the proposed pilot projects to test the feasibility of large-scale Aquifer Storage and Recovery (ASR). In April, the committee met in Key Largo to discuss Florida Bay indicators. Plans are currently underway for a September workshop on the Monitoring and Assessment Plan designed by Everglades scientists. A major committee report is expected to be generated as a result of the workshop.

Jim Davidson of the University of Florida, former committee chair, resigned for health reasons. Jean Bahr, an existing member of the committee, was appointed the new chair. Scott Nixon will continue as vice-chair and Henry Vaux was appointed to the committee. For more information, contact William Logan at 202-334-3422 or *wlogan@nas.edu*.

Bioavailability of Contaminants in Soils and Sediments

The committee on bioavailability of contaminants in soils and sediments will

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