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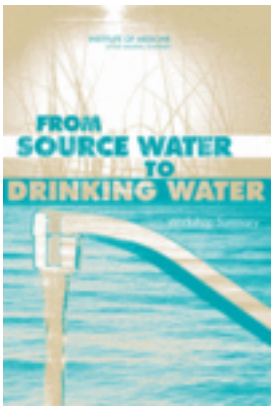

From Source Water to Drinking Water: Workshop Summary

Lawrence Reiter, Henry Falk, Charles Groat, and Christine M. Coussens, Editors, Roundtable on Environmental Health Sciences, Research, and Medicine

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Summary

The reliable provision of safe drinking water in the United States and other countries represents one of the outstanding public health accomplishments of the past century. This capability derived from major and mutually reinforcing efforts by researchers in public health, engineers, and governments at all levels—municipal, state, and federal—to put the necessary infrastructure in place, develop standards and regulations, and implement them effectively. As a result, the majority of people in the United States today enjoy an unprecedented level of protection and safety in the drinking water they consume. However, the system that was put in place for delivering safe and adequate supplies of drinking water has been in existence for more than 100 years. During the ensuing century, the United States has experienced a surge in population growth, which is projected to increase until 2050; a shift of population from densely populated urban areas to sparsely populated rural areas; and greater demands on water for multiple needs such as recreation, drinking water consumption, industrial use, and agricultural use. All of these needs have resulted in additional pressure on our waterways and will likely affect our ability to supply adequate water in the future, according to some workshop participants. This workshop, which was sponsored by the Institute of Medicine's Roundtable on Environmental Health Sciences, Research, and Medicine, provided an opportunity to look at the progress achieved since the passage of the Safe Drinking Water Act and the Clean Water Act. It looked at previous and future challenges that will continue in environmental health.

CURRENT STATUS OF SCIENCE AND POLICIES FOR ENSURING THE PROTECTION OF SOURCE AND DRINKING WATER

To answer the question of whether science and technology are adequately providing safe drinking water we should first understand the risks that drinking water may carry, noted Jeffrey Griffiths, Tufts University School of Medicine. Some of them are related to the population, which is not only growing in size but changing in its characteristics—particularly with respect to enhanced sensitivity to waterborne contaminants. Thus, at the same time that water must be reused—given the growing demand—there is additional pressure to ensure that the drinking water remain at levels of acceptable public health protection. Meanwhile, the changing activities and increasingly concentrated locations both of people and of industries result in significant levels of new emerging contaminants. These, together with agents already well established in the inventory, confront us with approximately three million potential chemical contaminants—that calls for paradigm shifts in the ways we think about these issues, suggested Griffiths.

There are many interfaces between the science and the policy of the Safe Drinking Water Act (SDWA), according to Frederick Pontius, president of Pontius Water Consultants, Inc. In fact, the policy and current provisions of the SDWA grew out of our prior failures and scientific advances. There are the legal mandates and requirements that control options, exposures, dose–response relationships, costs and benefits, laboratory methods, and agency processes. The SDWA is a mixture of different lines of reasoning, different facts, different assumptions, and different judgments made by people with different perspectives. Such decision making cannot be based on science alone and requires a blending of science and policy in order to achieve the necessary end points, noted Pontius. Scientists are struggling with data gaps across all aspects of regulation from how to select contaminants to the establishment of health goals. Further challenges for maintaining the use of the best science include filling data gaps and ensuring high-quality peer reviews so that future and revised drinking water regulations are based on the best available science.

ASSESSMENT AND MANAGEMENT PRACTICES: IMPACT ON HEALTH

Source water protection needs broad regional, state, and national attention to continue to ensure the availability of safe drinking water. But it also must be recognized that local planning and community involvement are the cornerstones for approaching source water protection in a holistic plan, according to Douglas "Dusty" Hall of Ohio's Miami Conservancy District. Many localities have developed comprehensive programs to balance the need for source water for public drinking and the use of rivers and aquifers for industrial purposes. While this has helped to ensure the availability of safe drinking water, many urban areas are experiencing population loss to rural townships, which do not have comprehensive planning and rely heavily on household sewage treatment systems, which have an estimated failure rate of 25 percent, and only a small fraction (8 percent) are subject to oversight in Ohio. Hall suggested that partnerships are needed to help stakeholders understand the health effects of increased population growth in areas with limited authority to implement comprehensive planning.

Current Environmental Protection Agency (EPA) estimates suggest that approximately one-third of all assessed rivers, streams, and lakes are impaired, primarily through nonpoint source pollution, noted Thomas Christensen of the U.S. Department of Agriculture's Natural Resources Conservation Service. Although these pollutants come from many sources, agricultural practices are a significant contributor, especially in the Mississippi River basin. Agricultural pollutants, such as sediment, nutrients, pesticides, and pathogens, contribute to the cost of providing safe drinking water.

Of the potential nutrients, nitrogen and phosphorus are two nutrients of concern because of their potential health linkages, noted Kenneth Reckhow of Duke University and the University of North Carolina. Although scientists have broad understanding of their sources, both natural and anthropogenic scientific information available in current models do not provide the necessary reliability for making water quality decisions. He suggested that scientists will have to employ adaptive management to improve their models by observing how the actual water body responds, and then use this information to augment the predictive power of the model system.

To begin to address the assessment, the Safe Drinking Water Act requires the states to identify areas that provide drinking water, delineate

their boundaries, register potential sources, assess their vulnerability to potential contamination, inform the public of the results, and implement a source water protection program, noted Greg Rogers of the Texas Commission on Environmental Quality. This can be a challenge for many states, including Texas, which has more than 6,000 separate water systems, approximately 20,000 public water supply wells, and 600 water intakes. By partnering with federal agencies, the commission was able to develop a database that can address water needs from the state level and aid in planning new water intakes and monitoring for contaminants through modeling and data collection.

EMERGING ISSUES IN PROVIDING SAFE DRINKING WATER

Chemical and biological pollutants, whether from natural or human sources, that are regulated under various state, national, and international programs represent but a small fraction of the universe of chemicals present in the environment. The majority of contaminants are not regulated; however, this does not imply that they do not pose risks, according to some participants. Some contaminants are now being recognized as emerging pollutants, but it is important to realize that the vast majority of recently identified potential pollutants were previously unrecognized and are of interest now as a result of advances in chemical analysis, noted Christian Daughton of the U.S. Environmental Protection Agency. Some of these chemicals are consumer goods and pharmaceutical agents that we have routinely neglected, ignored, or omitted. In addition, scientists are just beginning to evaluate what defines persistence because even chemicals that have short environmental half-lives can be persistent if they are continually reintroduced to water.

An emerging area for studying the source of contamination is the hydrologic cycle, which connects surface water, groundwater, and the atmosphere (atmospheric deposition), according to Mark Nilles of the U.S. Geological Survey. Whereas ammonia emissions are correlated with agricultural areas, nitrogen oxides are strongly associated with industrial activities. The highest concentration of nitrogen oxides is near areas of significant industrial activity and fossil fuel combustion. Mercury deposition, however, is more complex and not associated with agricultural or industrial practices; it is concentrated predominately in the Indiana-Minnesota-Wisconsin corridor and in the southeastern United States.

Science has not made as much progress in the past decade as needed to address emerging waterborne pathogens, noted Joan Rose of Michigan State University. Although industrialized countries have made significant progress in containing and eliminating outbreaks as a result of infectious agents, only 1 percent of the organisms associated with disease have been identified that might be found in wastewater. This has dire consequences because new pathogens are identified every year and researchers are learning of the role of infectious agents in chronic diseases such as ulcers and cancer.

GLOBAL WATER ISSUES: IMPLICATIONS AT THE WATER–HUMAN HEALTH INTERFACE

Central to the rising demand for water is the increase in population growth that is projected to continue until 2050 and beyond. The per capita availability of water across the planet is decreasing because the population is increasing, while the total amount of water is static. Approximately 1.1 billion people do not have access to clean drinking water and 2.4 billion do not have access to adequate sanitation services, noted Peter Gleick of the Pacific Institute for Studies in Development, Environment, and Security. These failures to meet basic human needs for water lead to millions of outbreaks each year of water-related disease such as cholera, dysentery, schistosomiasis, and guinea worm.

Just as governments have struggled to meet basic human needs for water, they have similarly struggled to meet environmental needs for water, noted Gleick. The twentieth century was a time in which water demand was met through increased water supply. Dams, aqueducts, reservoirs, and pipelines were constructed without an understanding of the ecological implications. The result has been ecosystem collapse and contamination because of modified river flows, fluctuating temperatures, decreased water quality, and dams that trap sediments needed to maintain river deltas. Thus, Gleick called for governments and organizations to adopt a new paradigm for managing water and policy. Governments have failed to realize that programs that work in the developed world may not be the best systems to address these basic needs in developing countries. There are many connections between water policy and human health, and they are complex. This requires that our approaches to addressing them also be complex—our systems have to be multiple and varied.

CHARTING A COURSE FOR THE FUTURE

There has been much progress since the passage of the Safe Drinking Water Act and the Clean Water Act. Regulations adopted under these regulations served as a means of enacting many beneficial measures; however the issues facing society today are more complex, often having societal and personal implications, and are not fixed by quick regulatory decision. Workshop participants discussed whether the approaches that government has traditionally used are feasible as the United States faces a growing population and increased consumption per capita. Further, any new paradigm will not be the sole regulatory domain of one agency, but will rather rely on smaller shifts and increased coordination among multiple agencies at the federal, state, and local levels.

The participants noted that water has to be valued as a commodity and that wastewater treatment is costly, especially with regard to reclaiming water for beneficial purposes. In most states, the entire burden of water quality is placed on the drinking water system, and its customers to pay for what happens upstream. Planned potable reuse also affects private wells as people move from urban to suburban areas. A small, but malfunctioning septic tank system can have the same microbiological loading in certain locations as a large metropolitan area wastewater treatment plant.

Participants suggested that government has to achieve water capture at the community and watershed levels for purposes such as recharging groundwater. This could work in concert with land-use planning and monitoring, because the ability to understand the effects of point and nonpoint source pollution has to be addressed on a local level.

FROM SOURCE WATER TO DRINKING WATER

Workshop Summary

Lawrence Reiter, Henry Falk, Charles Groat,
and Christine M. Coussens, *Editors*

Roundtable on Environmental Health Sciences, Research,
and Medicine

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The serpent has been a symbol of long life, healing, and knowledge among almost all cultures and religions since the beginning of recorded history. The serpent adopted as a logotype by the Institute of Medicine is a relief carving from ancient Greece, now held by the Staatliche Museen in Berlin.

"Knowing is not enough; we must apply.
Willing is not enough; we must do."
—Goethe

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This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

Ronald Linsky, Executive Director, National Water Research Institute, Fountain Valley, CA
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Arthur Rogers, President, Environmental Sciences, Inc., Springfield, VA
Jane L. Valentine, University of California, School of Public Health, Los Angeles, CA

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the final draft of the report before its release. The review of this report was overseen by **Melvin Worth**, Scholar-in-Residence, Institute of Medicine, who was responsible for making certain that an independent examination

of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

Preface

The Institute of Medicine's Roundtable on Environmental Health Sciences, Research, and Medicine was established in 1988 as a mechanism for bringing the various stakeholders together to discuss environmental health issues in a neutral setting. The members of the Roundtable on Environmental Health Sciences, Research, and Medicine come from academia, industry, and government. Their perspectives range widely and represent the diverse viewpoints of researchers, federal officials, and consumers. They meet, discuss environmental health issues that are of mutual interest (though sometimes very sensitive), and bring others together to discuss these issues as well. For example, they regularly convene workshops to help facilitate discussion of a particular topic. The Roundtable's fifth national workshop entitled *From Source Water to Drinking Water: Ongoing and Emerging Challenges for Public Health* continued the theme established by previous Roundtable workshops, looking at rebuilding the unity of health and the environment. This workshop summary captures the discussions and presentations by the speakers and participants, who identified the areas in which additional research was needed, the processes by which changes could occur, and the gaps in our knowledge. The views expressed here do not necessarily reflect the views of the Institute of Medicine, the Roundtable, or its sponsors.

This workshop brings back many memories of the early 1970s, which was a critical time for environmental issues. It was when people from all walks of life began to acknowledge the strong linkage between the environment and health. Bipartisan support resulted in significant actions on Capitol Hill with the passage of the Clean Air Act, the Safe Drinking Water Act (SDWA), and the Clean Water Act (CWA)—bills that laid the foundation for protecting health from environmental threats.

Even though they have since been modified a little, the basic tenets of these acts still prevail and are helping us even today to try to keep our air and waters clean and to make our drinking water safe.

This workshop provided an opportunity to look at the progress since the Safe Drinking Water Act and the Clean Water Act. It looked at previous and future challenges that will continue for those of us in environmental health. Many people realize that providing ample and safe drinking water is growing in complexity as policy makers are under pressure to balance the needs of numerous stakeholders. There is pressure on this basic resource because of industrial growth as well as agricultural, housing, and recreational needs. Rather then seeing an easement of water needs, the pressures will continue for the foreseeable future.

Too often, we rely on historical precedent for providing basic services to our population, this includes providing safe drinking water. Since the late 1800s, we in the United States have believed that all we had to do was locate our cities next to a large river from which we could bring in clean drinking water at one end and dispose of wastes at the other. Alternatively, we have relied on groundwater as a water source and continued to dispose our wastes in rivers, lakes, and streams. Throughout the workshop, we heard from many participants that these no longer are viable solutions since we are already tapping into every major water aquifer in the United States. Clearly this reinforces the adage that your waste water is someone else's drinking water.

The problems in ensuring safe water go hand in hand with urbanizing. In the United States, at the beginning of the last century, systems for providing safe drinking water began to be overtaxed, and we increasingly were required to treat the water that comes in (through chlorination, filtration, etc.) and to treat the wastewater (via the public owned treatment works [POTWs] primary, secondary, and now tertiary treatment required in many communities). Despite all these efforts, we still have problems such as the following:

- Treatment leaves chemical residues in our drinking water.
- Our infrastructure for the treatment and delivery of drinking water does not always work to keep drinking water safe, and we have outbreaks of drinking water–borne disease. This is further problematic for the vulnerable populations (infants; the elderly; the immunosuppressed via congenital immunodeficiency, transplants, HIV, and/or cancer therapy) who may be susceptible to lower levels of pathogens; drinking water from the tap must be safe for everyone.

- We have polluted some of our source waters by allowing polluting activities in sensitive groundwater areas and tolerating contamination of surface water, via wastes from combined sewer overflows, POTWs, and agricultural runoff ("nonpoint sources").

This does not imply that our drinking water is unsafe, but that priorities need to be established to determine which chemicals or pathogens should be regulated. Workshop participants noted that not everything that can be monitored should be monitored and that science needs to continue to underlie the regulatory decisions. The contaminants selected for regulation should be based on the results of scientific research performed and supported by research at the Environmental Protection Agency, National Institute of Environmental Health Sciences, National Center for Environmental Health, and many academic institutions. The regulations of the contaminants would be based on their actual human health implications and ramification and on the best practices of the scientific research and discovery.

At the same time, it is clear that not all of the goals of the SDWA and CWA have been fulfilled. We need to stick to the original vision of safe drinking water for all Americans and elimination of polluting discharges to water. It is ironic that permits under the National Pollutant Discharge Elimination System allow potential low levels of polluting discharges rather than eliminating them. We need to rethink our strategy both for provision of safe drinking water and for disposal of human waste materials. Some strategies were suggested at the workshop:

- Reuse is a reality. Everyone living downstream is using water that has previously been used many times. If we can provide safe drinking water via reuse in a spaceship we can do this for cities too. We must do so with strict standards with respect to pathogens and chemical residues.
- Much of our municipal water is used for irrigation, not drinking. We treat all water as if it will be used for consumption by humans, which may not be cost-effective. Communities have begun to experiment with the feasibility of alternative systems for delivering drinking water versus irrigation water. Such innovative approaches need to be researched but they need careful evaluation.
- The state and federal governments must continue to collaborate on assessing drinking water quality and source contamination on a regional basis.

- Source protection for groundwater is a priority and local communities should continue to be empowered on a regional basis with tools for assessment as well as for management (offer across multiple political jurisdictions).

Clearly, source protection for surface water urgently needs broad regional, state, and national attention. The assessment function (above) is critical but it is also critical to develop tools and incentives for management on a broad scale. Ultimately, it is time for Congress to consider the best way to bring the goals of the CWA and the SDWA together in order to ensure protection of the public's health and to keep pace with the true water demand for people, while protecting the environment. The next reauthorization of the SDWA should be coordinated with the reauthorization of the CWA while meeting the needs of the natural environment, industry, and farmers to ensure that communities have the tools that they need to continue to provide safe drinking water. Such a reauthorization process should establish formal mechanisms for involvement of the CDC/ATSDR to bring the best public health science. The NAS could play a role via committee that could review the science underlying these acts and advise Congress on the research, the information tools, the management tools, and the engineering alternatives that need to be pursued to provide safe drinking water to people in the future.

Paul G. Rogers, Chair
Lynn Goldman, Vice-Chair

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