**WATER SCIENCE AND
TECHNOLOGY BOARD**

***Annual Report
1992-1993***

NATIONAL RESEARCH COUNCIL

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WATER SCIENCE AND TECHNOLOGY BOARD

Annual Report 1992-1993

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ABOUT THE WATER SCIENCE AND TECHNOLOGY BOARD

The Water Science and Technology Board is a unit of the National Research Council, which serves as an independent adviser to the federal government on scientific and technical questions of national importance. The National Research Council, jointly administered by the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, brings the resources of the entire scientific and technical community to bear on national problems through its volunteer advisory committees. The board's objective is to improve the scientific and technological basis for resolving important questions and issues associated with the efficient management and use of water resources.

MEMBERS

Daniel A. Okun, *Chair*, University of North Carolina, Chapel Hill, environmental engineering
A. Dan Tarlock, *Vice Chair*, Chicago-Kent College of Law, Illinois, natural resources law
J. Dan Allen, Chevron USA Inc., New Orleans, Louisiana, environmental science
Norman H. Brooks, California Institute of Technology, Pasadena, hydraulic engineering
(through June 1992)
Richard A. Conway, Union Carbide Corporation, South Charleston, West Virginia, chemical engineering (through June 1992)
Kenneth D. Frederick, Resources for the Future, Washington, D.C., economics
David L. Freyberg, Stanford University, Stanford, California, hydrology
Wilford R. Gardner, University of California, Berkeley, soil and agricultural sciences
Duane L. Georgeson, Metropolitan Water District of Southern California, Los Angeles, water supply engineering
Lynn R. Goldman, California Department of Health Services, Emeryville, public health and epidemiology
William L. Graf, Arizona State University, Tempe, geomorphology and hydrology
Thomas M. Hellman, Bristol-Myers Squibb Company, New York, environmental science
Robert J. Huggett, College of William and Mary, Gloucester Point, Virginia, environmental chemistry
Charles C. Johnson, consultant, Bethesda, Maryland, sanitary engineering
Judy L. Meyer, University of Georgia, Athens, aquatic ecology
Donald J. O'Connor, HydroQual Inc., Glen Rock, New Jersey, environmental engineering (through June 1992)
Stavros Papadopoulos, S.S. Papadopoulos & Associates Inc., Rockville, Maryland, hydrogeology
Kenneth W. Potter, University of Wisconsin, Madison, hydrologic engineering
Bruce E. Rittmann, Northwestern University, Evanston, Illinois, environmental engineering
Donald D. Runnells, University of Colorado, Boulder, hydrogeochemistry (through June 1992)
Philip C. Singer, University of North Carolina, Chapel Hill, environmental engineering
M. Gordon Wolman, Johns Hopkins University, Baltimore, Maryland, hydrology (through June 1992)
Joy B. Zedler, San Diego State University, California, aquatic biology

STAFF

Stephen D. Parker, Director	Jacqueline MacDonald, Staff Officer
Sarah Connick, Senior Staff Officer	Jeanne Aquilino, Administrative Associate
Sheila D. David, Senior Staff Officer	Anita A. Hall, Administrative Assistant
Chris Elfring, Senior Staff Officer	Patricia L. Cicero, Senior Project Assistant
Gary D. Krauss, Staff Officer	Gregory K. Nyce, Senior Project Assistant

MAILING ADDRESS

Water Science and Technology Board
National Research Council
2101 Constitution Avenue, N.W. (HA-462)
Washington, D.C. 20418

ELECTRONIC MAIL

BITNET: USERNAME@NAS
INTERNET: USERNAME@NAS.EDU

OFFICE LOCATION

2001 Wisconsin Avenue, N.W.
Milton Harris Building, Suite 462

PHONE AND FAX NUMBERS

(202) 334-3422 (office phone, commercial)
(202) 737-3422 (FTS, incoming)
(202) 334-1961 (fax)

MESSAGE FROM THE BOARD

Editor's note: Below, A. Dan Tarlock, vice chair of the Water Science and Technology Board (WSTB), speculates about the WSTB's future mission. Tarlock is a professor of law at Illinois Institute of Technology Chicago-Kent College of Law. He has authored many publications, including a casebook on water law, concerning water resource management, land use, and environmental law and policy. Mr. Tarlock is a long-time participant in WSTB activities. He chaired the board's study of western water management, currently serves on a committee that reviews environmental studies of the Glen Canyon Dam, and has been a board member since 1988.

Nineteen ninety-two was an especially significant year for the Water Science and Technology Board, as the board celebrated its tenth anniversary. The board marked its anniversary in November with a symposium, "Sustaining Our Water Resources," at which participants reflected on the evolution of water resources management in the past decade and the board's role in this evolution. At the symposium, I offered an assessment of the WSTB's future, based on both the common themes of the board's past major studies and my four-and-a-half years of service on the board. They reflect no official National Research Council or WSTB positions, but I am pleased to share my views of the future with those interested in the board's mission.

Sound water management, informed by both the physical and social sciences, is becoming a more and more important social objective as the list of competing water uses grows and the nation's commitment to improved water quality increases. The board has become a successful influence in ensuring rational water management because it has been active in setting its own agenda, has built on its past studies, and has integrated its studies into progressively larger and more comprehensive frameworks. It is impossible to predict the future water agenda with any assurance, but I think it is conservative to predict that for the foreseeable future the board will continue to render scientific advice to guide federal research programs and science policy in four areas:

A. Dan Tarlock, vice chair of the Water Science and Technology Board and professor of law at Illinois Institute of Technology Chicago-Kent College of Law.

1. *Allocation of water resources:* The competition for water resources is becoming more intense. Our traditional allocation strategies—which rely on dams and subsidies—are being rejected (with some exceptions) because they do not reflect the full range of relevant demands and social values. The board has explored and continues to explore the acute allocation problems in the West, but its work is national in scope, as its new investigations of issues such as urban water supply management and the reclamation and reuse of wastewater illustrate.

2. *Adaptive management and monitoring:* A continuing theme in the board's work is the difficulty of applying good science to the management of natural resources. Both institutional and disciplinary barriers impede the effective use of scientific information in solving a range of modern water problems, such as managing reservoirs and deciding what qualifies as a wetland. The need to make decisions in the face of scientific uncertainty is now a familiar management challenge. There is a need to ask why the uncertainty arises, to determine whether and how it can be mini-

mized, and to provide a range of appropriate responses to these problems.

3. *Ground water:* The board has developed considerable expertise and credibility with its studies on ground water hydrology and management, and this tradition will serve it well in the future as the use of this resource increases. The board's work on the technical aspects of ground water models, which can be used to aid in aquifer cleanups and to evaluate other management issues, is an example of the role that the board can play in applying science to solving a wide variety of regulation-driven problems.

4. *The application of U.S. experience to other countries:* The United States has experience, positive and negative, related to almost all water resources issues. We have much to learn from other countries, both developed and developing, but we also have a great deal of information and experience to share with the rest of world. Expanding the board's focus internationally will be an important future board mission.

The board already has been involved in several studies with international dimensions. It carried out a joint study with Canada, *The Great Lakes Water Quality Agreement: An Evolving Instrument for Ecosystem Management*; wrote a report, *Toward Sustainability: Soil and Water Research Priorities for Developing Countries*, on the integration of sustainable development concepts into U.S. support of soil and water research in developing countries; and, in 1991-1992, began a major study with the Mexican Academy of Sciences on managing the Mexico City aquifer. In 1992, board staff aided

Indonesia's academy of sciences in the design and organization of a major water resources study.

As environmental problems become a larger part of the United States' international affairs agenda, the board can play an important role in facilitating the international exchange of water resources management information. The board should be represented at major international meetings on issues related to water science and technology, such as drought management, global climate change, and irrigation; it should pursue joint studies with countries whose geography and resource allocation patterns and problems match those of the United States; and it should seek to integrate its efforts with major international agencies, such as the World Bank, that are working on urban water supply and sanitation problems and the development of sustainable irrigated agriculture. Wherever relevant, board studies should include a comparative context to alert scientists, managers, and scholars to the international dimensions of the issue.

Adaptation through new knowledge is the hallmark of successful resource management. The board's tradition of introspection and self-education has made it a respected and forceful objective voice in the water community. This tradition will serve the board well as it continues to grapple with the increasingly difficult problems of nurturing the relevant engineering, natural, and social sciences necessary for adaptive water management and the application of science to serve the public interest.

OVERVIEW

This report summarizes the activities of the Water Science and Technology Board during 1992-1993. The WSTB is intended to be a dynamic forum, a mechanism by which the broad community of water science, technology, and policy professionals can help assure high-quality national and international water programs. We welcome inquiries about our work.

Who We Are

The WSTB is a group of experts available to advise the government on water issues. We are a unit of the National Research Council (NRC), the operating element of the National Academy of Sciences (NAS), National Academy of Engineering (NAE), and Institute of Medicine (IOM). Together, these organizations comprise the most important independent scientific advisory bodies available to the federal government.

History

The National Academy of Sciences was chartered by Congress in 1863. It was initially composed of 50 of the nation's most eminent scientists. These scientists, in addition to being honored for their achievements, were available to advise the government on technical matters. The Academy's charter specified that the scientists would not be compensated for their labor, only for direct costs incurred in carrying out studies. Since its inception, the Academy's financial and organizational independence from the government have enabled it to provide scientific advice unbiased by political influences.

The onset of World War I increased the government's need for scientific advice. In 1916, the Academy created the National Research Council at President Woodrow Wilson's request to broaden the scientific expertise available to the government. Wilson envisioned an institutional mechanism through which large numbers of American scientists and engineers could provide impartial technical advice. Today, about 10,000 highly qualified scientists and engineers serve the nation each year without compensation by participating in National Research Council activities.

The National Academy of Engineering was created in 1964 to recognize the importance of engineering in technological advancement. The Institute of Medicine

The WSTB report Opportunities in the Hydrologic Sciences presents a blueprint for furthering the science of hydrology.

was created in 1970 to work on matters affecting the status of medicine and the adequacy of national health services. Today, the two academies and the institute serve as honorary societies, while the National Research Council carries out the work of advising the government.

As the National Research Council grew in response to the increasing need for unbiased scientific information, it was divided into commissions, which were further subdivided into boards, to guide studies in specific scientific disciplines. Reports issued by various units within the National Research Council cover a vast array of topics, from scientific conduct, to AIDS prevention, to new technologies.

The Water Science and Technology Board, created in 1982, oversees studies of water issues. Approximately 20 volunteers from universities, government, and industry serve as board members for three-year terms. Several hundred other volunteers serve on study committees, as report reviewers, and as government agency liaisons to the board.

Studies

Studies undertaken by the WSTB can be initiated in either of two ways. Traditionally, and most commonly,

studies are undertaken at the request of a government agency seeking assistance. Alternatively, the WSTB may identify a topic of pressing concern and initiate a study. In either case, studies are designed according to criteria spelled out in the board's Terms of Reference (see page 30). The principal products of studies are written reports. These reports cover a wide range of water resources issues of current national concern. A few recent examples illustrate the WSTB's scope of work:

- *Managing Wastewater in Coastal Urban Areas*, to be published in 1993, identifies opportunities for improving coastal wastewater management through integrated coastal management.

- *Ground Water Vulnerability Assessment*, also to be published in 1993, evaluates methods for assessing the susceptibility of ground water to pollution.

- *Water Transfers in the West: Efficiency, Equity, and the Environment*, published in 1992, discusses water transfers as one way to improve management of increasingly scarce water supplies in the western United States.

- *Opportunities in the Hydrologic Sciences*, published in 1991, presents a blueprint for furthering the science of hydrology. Many of the report's recommendations, including establishment of a hydrologic sciences research grants program within the National Science Foundation and reorganization of water science programs in universities, were implemented in 1992.

Symposia and Lectures

In addition to conducting studies and producing reports, the WSTB hosts symposia for discussing current water issues. In 1992, the board held a symposium, "Sustaining Our Water Resources," to celebrate its tenth year. The board also hosts an annual lecture in honor of Dr. Abel Wolman, a pioneer in the water-supply and sanitation field. The 1992 Wolman lecturer, Dr. Jan van Schilfgaarde of the Agricultural Research Service, discussed the future of irrigated agriculture.

Meetings

The WSTB generally meets three times each year. At meetings, WSTB members monitor ongoing projects

and develop new initiatives. In addition to providing time for WSTB business, the meetings foster communication within the water resources community. Most agencies with water-related responsibilities have liaison representatives who regularly attend the meetings.

Staff

The WSTB is supported by a ten-member staff in Washington, D.C. Because the board's volunteer members are widely dispersed around the country, the staff is critical to completing board activities. The staff helps formulate study topics and select committee members, maintains contact with government agencies, performs research, organizes meetings, provides editorial guidance for reports, directs outside review of reports, and produces a quarterly newsletter.

Financial Support

In 1992, financial support for the WSTB's activities totalled about \$1.6 million. Support was provided by internal National Research Council and National Academy of Engineering funds and the following sponsors:

- **Federal government agencies:** the Bureau of Reclamation, the Department of Agriculture, the Department of the Army, the Department of Energy, the Department of the Interior, the Environmental Protection Agency, the Federal Emergency Management Agency, the National Science Foundation, and the U.S. Geological Survey.

- **State and municipal governments and water utilities:** the Association of Metropolitan Sewerage Agencies, the Central and West Basin Water Replenishment District, the City of San Diego, the East Bay Municipal Utility District, and the Orange County Water District.

- **Private foundations:** the Ford Foundation, the Freeman Fund, and the Tinker Foundation.

- **Corporations and associations:** the American Petroleum Institute, Chevron USA Inc., the Coalition on Superfund, and Mobil Oil Corporation.

- **Research institutes:** the Electric Power Research Institute, the Gas Research Institute, and the National Water Research Institute.

PROJECTS COMPLETED IN 1992-1993

In 1992, the Water Science and Technology Board and its committees completed 10 reports, including final reports on the results of long-term studies and interim reports from committees that provide continuing program advice to federal agencies. In addition, in 1992 the board hosted a lecture on the future of irrigated agriculture by world-renowned irrigation and drainage expert Dr. Jan van Schilfgaarde and a symposium, "Sustaining Our Water Resources." These projects are summarized below.

FINAL REPORTS

Managing Wastewater in Coastal Urban Areas

Close to one-half of all Americans live in coastal counties. The resulting flood of wastewater, stormwater, and pollutants discharged into coastal waters is a major concern. *Managing Wastewater in Coastal Urban Areas*, the result of a three-year study, offers an approach to integrated coastal management beginning with wastewater and stormwater control.

The report presents an overview of current management practices and problems. The core of the report is a detailed model for integrated coastal management, offering basic principles and methods, a direction for moving from general concerns to day-to-day activities, specific steps from goal setting through monitoring performance, and a base of scientific and technical information. Examples of areas where integrated coastal management concepts are beginning to be applied are described and include the Chesapeake and Santa Monica bays. The report also discusses potential barriers to integrated coastal management and how they may be overcome and suggests steps for introducing this concept into current programs and legislation.

Financial support for the study was provided by the Environmental Protection Agency, the National Science Foundation, the National Academy of Engineering, the City of San Diego, the National Oceanic and Atmospheric Administration, and the Boston Society of Civil Engineering Freeman Fund. The responsible staff officer was Sarah Connick. Members of the committee and its panels were:

Committee on Wastewater Management for Coastal Urban Areas

John J. Boland, *Chair*, Johns Hopkins University,
Baltimore, Maryland
Blake P. Anderson, County Sanitation Districts of
Orange County, Fountain Valley, California
Norman H. Brooks, California Institute of
Technology, Pasadena
William M. Eichbaum, World Wildlife Fund,
Washington, D.C.
Lynn R. Goldman, California Department of Health
Services, Emeryville
Donald R.F. Harleman, Massachusetts Institute of
Technology, Cambridge
Robert W. Howarth, Cornell University, Ithaca, New
York
Robert J. Huggett, Virginia Institute of Marine
Science, College of William and Mary, Gloucester
Point
Thomas M. Keinath, Clemson University, Clemson,
South Carolina
Alan J. Mearns, National Oceanic and Atmospheric
Administration, Seattle, Washington
Charles R. O'Melia, Johns Hopkins University,
Baltimore, Maryland
Larry A. Roesner, Camp Dresser & McKee Inc.,
Orlando, Florida
Joan B. Rose, University of South Florida, Tampa
Jerry R. Schubel, State University of New York, Stony
Brook
Richard A. Conway, *ex officio*, Union Carbide
Corporation, South Charleston, West Virginia

Panel on Health, Ecosystems, and Aesthetics

Lynn R. Goldman, *Chair*, California Department of
Health Services, Emeryville
William M. Eichbaum, World Wildlife Fund,
Washington, D.C.
Robert W. Howarth, Cornell University, Ithaca, New
York
Robert J. Huggett, Virginia Institute of Marine
Science, College of William and Mary, Gloucester
Point
Alan J. Mearns, National Oceanic and Atmospheric
Administration, Seattle, Washington
Joan B. Rose, University of South Florida, Tampa

Panel on Environmental Processes: Source, Fate, and Transport

Norman H. Brooks, *Chair*, California Institute of Technology, Pasadena
Wayne R. Geyer, Woods Hole Oceanographic Institution, Massachusetts
Robert J. Huggett, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point
George A. Jackson, Texas A&M University, College Station
Alan J. Mearns, National Oceanic and Atmospheric Administration, Seattle, Washington
Charles R. O'Melia, Johns Hopkins University, Baltimore, Maryland
Donald W. Pritchard, State University of New York, Stony Brook (retired) (*resigned September 1991*)
Jerry R. Schubel, State University of New York, Stony Brook

Panel on Source Control and Publicly Owned Treatment Works Technologies

Thomas M. Keinath, *Chair*, Clemson University, Clemson, South Carolina
Blake P. Anderson, County Sanitation Districts of Orange County, Fountain Valley, California
Takashi Asano, University of California, Davis
Glen T. Daigger, CH₂M Hill, Denver, Colorado
Donald R.F. Harleman, Massachusetts Institute of Technology, Cambridge
Billy H. Kornegay, Engineering-Science Inc., Fairfax, Virginia
James F. Kreissl, EPA Risk Reduction Engineering Laboratory, Cincinnati, Ohio
Joseph T. Ling, 3M (retired), St. Paul, Minnesota
P. Aarne Vesilind, Duke University, Durham, North Carolina

Panel on Sources

Larry A. Roesner, *Chair*, Camp Dresser & McKee Inc., Orlando, Florida
James P. Heaney, University of Colorado, Boulder
Vladimir Novotny, Marquette University, Milwaukee, Wisconsin
William C. Pisano, Havens and Emerson Inc., Boston, Massachusetts
Richard A. Conway, *ex officio*, Union Carbide Corporation, South Charleston, West Virginia

Panel on Policies, Institutions, and Economics

John J. Boland, *Chair*, Johns Hopkins University, Baltimore, Maryland
John M. DeGrove, Florida Atlantic University, Fort Lauderdale
William M. Eichbaum, World Wildlife Fund, Washington, D.C.
Katherine Fletcher, People for Puget Sound, Seattle, Washington

Ground Water Vulnerability Assessment: Predicting Relative Contamination Potential Under Conditions of Uncertainty

Contamination of ground water supplies is a serious environmental and public health concern. The costs of remediation are high, and monitoring programs, which are also costly, serve only to identify existing pollution, not to prevent it. Thus environmental managers have attempted to develop strategies to protect this vital resource.

One approach to protecting ground water resources is first to identify areas vulnerable to contamination and then to institute appropriate protective measures. *Ground Water Vulnerability Assessment: Predicting Relative Contamination Potential Under Conditions of Uncertainty* evaluates the scientific basis of existing and potential vulnerability assessment techniques and identifies opportunities for development of more reliable methods. It provides guidance on the application of regional-scale vulnerability assessments, the interpretation of assessment results, and the use of assessments in decision making.

Financial support for the study was from the Environmental Protection Agency, the U.S. Geological Survey, and the Department of Agriculture. The responsible staff officer was Sarah Connick. Committee members were:

Armando J. Carbonell, *Chair*, Cape Cod Commission, Barnstable, Massachusetts
Hugo F. Thomas, *Chair*, Connecticut Department of Environmental Protection, Hartford (*through March 1991*)
William M. Alley, U.S. Geological Survey, Reston, Virginia
Lawrence G. Batten, Environmental Systems Research Institute, Boulder, Colorado
Cheryl K. Contant, University of Iowa, Iowa City

Pamela G. Doctor, Battelle Pacific Northwest
Laboratory, Richland, Washington
Anthony S. Donigian, AQUA TERRA Consultants,
Mountain View, California
Robert H. Dowdy, U.S. Department of
Agriculture, Agricultural Research Service, St. Paul
Donald I. Siegel, Syracuse University, New York
P. Suresh C. Rao, University of Florida, Gainesville
Gale Teselle, U.S. Department of Agriculture, Soil
Conservation Service, Washington, D.C.
Roberto Teso, California Department of Food and
Agriculture, Riverside
Scott R. Yates, University of California, Riverside

Water Transfers in the West: Efficiency, Equity, and the Environment

Prolonged drought is a fact of life in the western United States. To meet the region's needs, water resource planners need to consider how to allocate water supplies more equitably and efficiently. The report *Water Transfers in the West: Efficiency, Equity, and the Environment* examines one often-discussed mechanism for responding to the region's changing water needs: water transfers. The report concludes that while voluntary water transfers should be encouraged as a flexible management option for dealing with changing water demands, rural communities, American Indians, and diverse groups of water "users," including the environment, deserve more careful consideration when water is transferred.

Water transfers are a long-standing tradition in the West, and interest in them is increasing as competition for water increases. The most common type of transfer occurs when a farmer sells water rights to a nearby city, but in recent years transfers have been designed to accomplish other goals, such as to restore fisheries and wetlands. To help readers better understand the characteristics of water transfers, the report includes case studies focused on seven areas: the Carson-Truckee basin, Nevada; the Arkansas River and Front Range area, Colorado; northern New Mexico; the Yakima River basin, Washington; central Arizona; the Central Valley, California; and the Imperial Valley, California. Although each case is unique, all faced common issues relating to area-of-origin concerns, instream uses, and transaction costs. The report presents 11 recommendations designed to help federal, state, and tribal officials make improvements in the water transfer process.

Water Transfers in the West addresses how the western United States can meet its escalating water needs in an environmentally responsible manner.

Sponsors for this study were the Ford Foundation, the Bureau of Reclamation, the Environmental Protection Agency, the Metropolitan Water District of Southern California, and the East Bay Municipal Utility District of California. The responsible staff officer was Chris Elfring. Committee members were:

A. Dan Tarlock, *Chair*, Chicago-Kent College of Law, Illinois
D. Craig Bell, Western States Water Council, Midvale, Utah
Bonnie Colby, University of Arizona, Tucson
Leo M. Eisel, Wright Water Engineers, Denver, Colorado
David H. Getches, University of Colorado School of Law, Boulder
Thomas Graff, Environmental Defense Fund, Oakland, California
Frank Gregg, University of Arizona, Tucson
R. Keith Higginson, Idaho Department of Water Resources, Boise
Marvin E. Jensen, Colorado State University, Ft. Collins

Restoration of Aquatic Ecosystems outlines a national program to restore the nation's degraded wetlands, rivers, streams, and lakes.

Duncan T. Patten, Arizona State University, Tempe
 Clair B. Stalnaker, U.S. Fish and Wildlife Service, Ft. Collins, Colorado
 Luis S. Torres, Northern New Mexico Water Project, Espanola
 Richard Trudell, American Indian Lawyer Training Program, Oakland, California
 Henry J. Vaux, Jr., University of California, Riverside
 Susan Williams, Gover, Stetson, Williams & West, Albuquerque, New Mexico
 Jan van Schilfgaarde, *Board on Agriculture liaison*, U.S. Department of Agriculture, Agricultural Research Service, Beltsville, Maryland

Restoration of Aquatic Ecosystems: Science, Technology, and Public Policy

This report outlines a national strategy for restoring the nation's damaged wetlands, rivers, streams, and lakes. To prevent permanent ecological damage, the report urges the federal government to institute a long-term strategy for restoring aquatic ecosystems, which are essential for controlling floods, filtering pollution

from runoff, and providing wildlife habitat and recreational opportunities.

The study was funded by Living Lakes Inc., Chevron USA Inc., the Soil Conservation Service, the Environmental Protection Agency, the Bureau of Reclamation, and the National Research Council. The responsible staff officer was Sheila David. John J. Berger served as a consultant. Committee members were:

John Cairns, Jr., *Chair*, Virginia Polytechnic Institute and State University, Blacksburg
 G. Ronnie Best, University of Florida, Gainesville
 Patrick L. Brezonik, University of Minnesota Water Resources Research Center, St. Paul
 Stephen R. Carpenter, University of Wisconsin, Madison
 G. Dennis Cooke, Kent State University, Kent, Ohio
 Donald L. Hey, Wetlands Research Inc., Chicago, Illinois
 Jon A. Kusler, Association of State Wetland Managers, Berne, New York
 Claire L. Schelske, University of Florida, Gainesville
 Leonard Shabman, Virginia Polytechnic Institute and State University, Blacksburg
 Rebecca R. Sharitz, Savannah River Ecology Laboratory, Aiken, South Carolina
 Soroosh Sorooshian, University of Arizona, Tucson
 Richard E. Sparks, Illinois Natural History Survey, Havana
 James Tripp, Environmental Defense Fund, New York
 Daniel E. Willard, Indiana University, Bloomington
 Joy B. Zedler, San Diego State University, San Diego, California

Regional Hydrology and the USGS Stream Gaging Network

This report lays out concepts that the U.S. Geological Survey (USGS) could use to improve its stream gaging network. It discusses the validity of the assumption that the streamflow patterns are stationary over specific time intervals, the role of modeling in stream gage network design, monitoring of small river basins, and enhancements to increase the network's effectiveness. The report was authored by the Committee on USGS Water Resources Research, established in 1985 to provide ongoing advice to the USGS on complex or evolving

scientific questions in water resources. (See the membership list on p. 19.)

A Review of Ground Water Modeling Needs for the U.S. Army

The U.S. Department of Defense (DOD) is mounting a \$20 billion effort to clean up contaminated ground water at hundreds of the nation's Army installations. The report *A Review of Ground Water Modeling Needs for the U.S. Army* reviews the types of models available for helping the Army track the fate of ground water contaminants and plan the cleanup effort. The report assesses the state of knowledge of ground water modeling, updating the WSTB's comprehensive 1990 report *Ground Water Models: Scientific and Regulatory Applications*. It recommends that the Army develop in-house expertise in ground water modeling by establishing a ground water modeling support center at the Army Corps of Engineers Waterways Experiment Station. It also recommends that the Army conduct field research to test models and expand partnership programs with academic researchers.

The report was prepared by a special study group of WSTB members and members of the committee that authored *Ground Water Models*, with funding from the Army Corps of Engineers. The responsible staff officer was Gary Krauss. Study group members were:

David L. Freyberg, *Chair*, Stanford University, Palo Alto, California

Mary P. Anderson, University of Wisconsin, Madison
James W. Mercer, GeoTrans Inc., Sterling, Virginia
Stavros Papadopoulos, S.S. Papadopoulos & Associates Inc., Bethesda, Maryland

Bruce E. Rittmann, Northwestern University, Evanston, Illinois

Donald D. Runnells, University of Colorado, Boulder
Frank W. Schwartz, Ohio State University, Columbus

The Global Climate Change Research Program: A Midcourse Evaluation

This report was prepared by the Committee on Climate Change and Water Resources Management as part of its two-year review of the Bureau of Reclamation's Global Climate Change Response Program (GCCRP). This research program was designed to help the bureau understand how climate change might affect its water management mission in the western United States. The

A REVIEW OF GROUND WATER MODELING NEEDS FOR THE U.S. ARMY

A Review of Ground Water Modeling Needs for the U.S. Army reviews the models available for planning cleanup of contaminated ground water at Army installations.

report evaluates the scope of the program, the nature of the research projects underway, and the program's future, given expected budget cuts.

The report concludes that the bureau made good progress within a short time frame in developing projects that address climate change and water management. It highlights the need for the bureau to develop a sound research program and also to consider the wider issues of population changes, increased water demands, and institutional responsibilities along with possible climate change scenarios.

The committee sponsor was the Bureau of Reclamation. The responsible staff officers were Chris Elfring and Gary Krauss. Committee members were:

Stephen J. Burges, *Chair*, University of Washington, Seattle

John J. Cassidy, Bechtel Corporation Inc., San Francisco, California

Robert E. Dickinson, University of Arizona, Tucson

Kenneth D. Frederick, Resources for the Future, Washington, D.C.

At the WSTB's tenth anniversary symposium, board volunteers presented papers related to the evolution of water resources management.

Roger E. Kasperson, Clark University, Worcester, Massachusetts
 Bruce A. Kimball, U.S. Water Conservation Laboratory, Phoenix, Arizona
 Diane M. McKnight, U.S. Geological Survey, Arvada, Colorado
 David A. Woolhiser, U.S. Department of Agriculture-Agricultural Research Service, Tucson, Arizona

INTERIM REPORTS

Glen Canyon Environmental Studies Reports

In 1992, the Committee to Review the Glen Canyon Environmental Studies (GCES) issued two reports as part of its continuing role to advise the Bureau of Reclamation on its studies of how the Glen Canyon Dam affects the Colorado River (see the description of the committee's work and the membership list on

p. 19). Both reports, issued as letters to the Bureau of Reclamation, review the bureau's studies of how changes in dam operation would affect the dam's hydropower production. The reports provide a range of suggestions for improving the bureau's economic analyses of alternative dam operations.

Review of EPA's Environmental Monitoring and Assessment Program

The Committee to Review the Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP) issued an interim report as part of its review of EMAP, a program designed to assess the distribution and condition of the nation's ecological resources (see the description of the committee's task and the membership list on p. 17). The report endorses the effort to monitor the nation's natural resources and concludes that EMAP's probability-based sampling system is appropriate for surveying resource distribution. However, it questions the ability of the current EMAP design to achieve EMAP's other major goals, which include detection of changes in resource condition over time and the establishment of associations between ecological condition and human-induced stresses. In addition, the report questions the adequacy of EMAP's financial and human resources and suggests greater involvement of the broader scientific community in all aspects of EMAP.

Review of the National Irrigation Water Quality Program—Part II

This interim report, prepared by the Committee on Planning and Remediation for Irrigation-Induced Water Quality Problems, is the committee's second midcourse evaluation of the Department of the Interior's National Irrigation Water Quality Program (NIWQP). The report is part of the committee's ongoing oversight of the NIWQP and its efforts to plan mitigation activities for sites in the western United States that show irrigation-related trace element contamination (see the description of the committee and its work on p. 18). The report contains guidance to the NIWQP about its planning strategies, systems analysis, and development of remediation options. It also reviews cost considerations, public involvement, and the types of special expertise needed for a sound planning activity.

TENTH ANNIVERSARY SYMPOSIUM: SUSTAINING OUR WATER RESOURCES

The WSTB celebrated its tenth year of providing advice to the government by holding a symposium, "Sustaining Our Water Resources," for past and present sponsors, committee and board members, and the public. Seven past and present board and committee members presented papers related to the evolution of water resources management. The papers and speakers were "Intergenerational Equity," by Edith Brown Weiss; "The Relationship between Policy and Science for American Rivers," by William Graf; "The Changing Knowledge Base: Keeping Pace with Changing Values and Perceptions," by George Hornberger; "Changing Patterns of Water Resources Decision-Making," by Walter Lynn; "Changing Water Resources Institutions," by Kenneth Fredrick; "Changing Concepts of System Management," by Judy Meyer; and "Looking Back and Ahead: The WSTB's Future Agenda," by A. Dan Tarlock (the symposium chair). The symposium coordinators were Sheila David and Jeanne Aquilino. A symposium proceedings will be published in 1993.

WOLMAN LECTURE

Irrigation: A Blessing or a Curse?
At the WSTB's third annual lecture in honor of Dr. Abel Wolman, pioneer in the water-supply and sanitation field, Dr. Jan van Schilfegaarde discussed the future of irrigated agriculture worldwide. Dr. van Schilfegaarde, associate deputy administrator of the U.S. Department of Agriculture Agricultural Research Service, outlined the impacts of irrigation. He described the negative environmental effects caused by irrigation and explained how, economically, some irrigation development can be challenged as unproductive. Yet, he emphasized that in appropriate circumstances irrigation is vital to the production of adequate food for the world's growing population. As problems of past practices are identified and resolved, and as new development is planned, it is crucial to consider both the important benefits and the inevitable negative consequences of irrigation. Only then can proper decisions be implemented, van Schilfegaarde said. (See p. 28 for information on ordering a lecture transcript.)

Dr. Abel Wolman, one of the century's leading figures in improving water-supply and sanitation technologies. The WSTB holds an annual lecture in honor of the late Dr. Wolman.

ONGOING STUDIES

The Water Science and Technology Board's most important asset in carrying out studies is its access to the nation's leading experts in water science, engineering, and policy. The board's network provides the capability to bring to bear on critical water resources problems the most advanced scientific knowledge available.

Board studies are initiated when the federal government requests advice or when the board identifies a problem requiring critical analysis. Studies are carried out by committees of experts appointed to work under the board's supervision. When a study begins, the board surveys the scientific community for committee member nominations. The board may gather 100 or more names, from which it selects the best-qualified experts. Committee size ranges from fewer than 10 to 20 or more members, depending on the complexity of the study.

Study committees generally meet several times each year to exchange ideas, discuss the problem they are investigating, and gather information from those knowledgeable about the subject, including representatives of federal, state, and local agencies, private corporations, and public interest groups. At the end of the study, the committee publishes a report. Periodically throughout the study, the committee may also issue brief interim reports on particular elements of the problem. Current WSTB studies cover three broad categories:

- *Natural systems cleanup and protection studies* analyze issues related to the wise stewardship of freshwater resources.
- *Water management and infrastructure studies* deal with questions related to the management of water-supply and sanitation services.
- *Federal program advisory studies* provide continuing advice for federal agency programs.

NATURAL SYSTEMS CLEANUP AND PROTECTION

Ground Water Cleanup Alternatives

Recent studies have shown that attempts to restore contaminated ground water to a condition safe for drinking have been largely unsuccessful. The inability

of existing ground water remediation systems to meet cleanup goals is cause for serious concern because it raises the possibility that contaminated sites may never be fully restored and because the nation has invested hundreds of millions of dollars in these systems.

The Committee on Ground Water Cleanup Alternatives is evaluating the capabilities of ground water cleanup technologies, with a special focus on "pump-and-treat" systems, the most commonly used decontamination method at Superfund sites. The committee's final report is scheduled for release in December 1993.

The study is a joint effort between the WSTB and the Board on Radioactive Waste Management (BRWM). Financial support is from the Environmental Protection Agency, the Department of Energy, the Coalition on Superfund, and Chevron USA Inc. The responsible staff officer is Jacqueline MacDonald. Committee members are:

- Michael C. Kavanaugh, *Chair*, Montgomery-Watson Inc., Walnut Creek, California
James W. Mercer, *Vice Chair*, GeoTrans Inc., Sterling, Virginia
Linda M. Abriola, University of Michigan, Ann Arbor
Charles B. Andrews, S.S. Papadopoulos and Associates, Rockville, Maryland
Mary Jo Baedecker, U.S. Geological Survey, Reston, Virginia
Edward J. Bouwer, Johns Hopkins University, Baltimore, Maryland
Patricia A. Buffler, University of California, Berkeley
Robert E. Connick, University of California, Berkeley
Richard A. Conway, Union Carbide Corporation, South Charleston, West Virginia
Ralph d'Arge, University of Wyoming, Laramie
Linda E. Greer, Natural Resources Defense Council, Washington, D.C.
Joseph H. Highland, ENVIRON Corporation, Princeton, New Jersey
Douglas M. Mackay, University of Waterloo, Canada
Lynne Preslo, ICF Kaiser Engineers, Rancho Cordova, California
Paul V. Roberts, Stanford University, California
William J. Walsh, Pepper, Hamilton, and Scheetz, Washington, D.C.
C. Herb Ward, Rice University, Houston, Texas

Marcia E. Williams, Williams and Vanino Inc., Los Angeles, California

Glenn Paulson, *BRWM liaison*, Illinois Institute of Technology, Chicago

***In Situ* Bioremediation: How Do We Know When It Works?**

In situ bioremediation—the use of microbes to degrade contaminants in place—is increasingly advertised as a more cost-effective ground water and soil cleanup method than conventional technologies. Nevertheless, the effectiveness of bioremediation remains a hotly debated issue. Evaluating whether bioremediation works for ground water and soil cleanup presents a scientific challenge because there is no agreed-upon method for establishing whether decreasing contaminant concentrations are due to biodegradation or some abiotic process, such as sorption to aquifer solids, transport away from the original contamination site, or chemical reactions.

The Committee on *In Situ* Bioremediation is preparing a report with guidelines for determining the effectiveness of bioremediation for ground water and soil cleanup. The committee's report will be based upon the findings developed at a one-week workshop held in October 1992. The report is scheduled for release in June 1993.

Financial support for the committee's work is from the American Petroleum Institute, Chevron USA Inc., the Electric Power Research Institute, the Environmental Protection Agency, the Gas Research Institute, Mobil Oil Corporation, and the National Science Foundation. The responsible staff officer is Jacqueline MacDonald. Committee members are:

Bruce E. Rittmann, *Chair*, Northwestern University, Evanston, Illinois

Lisa Alvarez-Cohen, University of California, Berkeley

Philip B. Bedient, Rice University, Houston, Texas

Richard Brown, Groundwater Technology Inc., Trenton, New Jersey

Francis H. Chapelle, U.S. Geological Survey, Columbia, South Carolina

Peter Kitanidis, Stanford University, California

Eugene L. Madsen, Cornell University, Ithaca, New York

William R. Mahaffey, Waste-Tech Services Inc., Golden, Colorado

Robert D. Norris, Eckenfelder Inc., Nashville, Tennessee

Joseph P. Salanitro, Shell Development Company, Houston, Texas

John M. Shauver, Michigan Department of Natural Resources, Lansing

Jim Tiedje, Michigan State University, East Lansing

John T. Wilson, Robert S. Kerr Environmental

Research Laboratory, Ada, Oklahoma

Ralph W. Wolfe, University of Illinois, Urbana

WATER MANAGEMENT AND INFRASTRUCTURE

Ground Water Recharge

The reuse and recycling of wastewater for both potable and nonpotable purposes is increasingly being employed as a means to augment water supplies, especially but not exclusively in arid regions. Supplementing the natural recharge of ground water with reclaimed municipal wastewater, stormwater, irrigation return flows, and other water of impaired quality offers considerable potential for enhancing regional water-supply systems. However, many unresolved questions must be answered to pursue such approaches effectively.

The Committee on Ground Water Recharge Using Reclaimed Wastewater, Stormwater, and Irrigation Return Flows is evaluating questions associated with the augmentation of natural recharge of ground water using waters of impaired quality. Issues the committee is addressing deal with source-water quality characteristics, pretreatment and recharge technologies, transformations during transport, environmental impacts, economic feasibility, and public health implications.

Support for the project is from the Environmental Protection Agency, the Bureau of Reclamation, the Orange County Water District, the West Basin Water Management District, and the Water Replenishment District of Southern California. The responsible staff officer is Chris Elfring. Committee members are:

Julian Andelman, *Chair*, University of Pittsburgh, Pennsylvania

Herman Bouwer, U.S. Department of Agriculture,

Water Conservation Laboratory, Phoenix, Arizona

Randy Charbeneau, University of Texas, Austin

Russell Christman, University of North Carolina, Chapel Hill

This 1990 report provides advice on using ground water models in the regulatory process. Several ongoing studies continue the WSTB's tradition of reviewing ground water problems.

James Crook, Camp Dresser & McKee Inc., Clearwater, Florida

Anna Fan, California Department of Health Services, Berkeley

Denise Fort, University of New Mexico, Albuquerque

Wilford Gardner, University of California, Berkeley

William Jury, University of California, Riverside

David Miller, Geraghty & Miller, Plainview, New York

Robert Pitt, University of Alabama, Birmingham

Gordon Robeck, consultant, Laguna Hills, California

Henry Vaux Jr., University of California, Berkeley

John Vecchioli, U.S. Geological Survey, Water

Resources Division, Tallahassee, Florida

Marylynn Yates, University of California, Riverside

Philip Singer, WSTB liaison, University of North Carolina, Chapel Hill

Mexico City Aquifer Management

The problem of a reliable, safe drinking water supply is one of the most important issues currently facing Mexico City. Residents depend on the aquifer underlying the city for 80 percent of their water needs. Over the past 100 years, overpumping of the aquifer has

caused more than 5 meters of land subsidence. In addition, unregulated land disposal of wastes may have caused ground water contamination.

As part of the National Research Council's program of collaboration with the Mexican Academia de la Investigación Científica (AIC) and the Mexican Academia de la Ingeniería (ANIAC), the WSTB, AIC, and ANIAC initiated a study on the limitations of the Mexico City aquifer as a water-supply resource. The study is being carried out by the Committee on Use of the Mexico City Aquifer as a Water-Supply Resource. The committee is addressing not only issues concerning the quantity and quality of aquifer water, but also the socioeconomic, public policy, and institutional issues affecting Mexico City's water resources. The committee's work will culminate in a report, in both English and Spanish, scheduled for release in mid-1994.

The project is sponsored by the Ford Foundation, the Tinker Foundation, the Environmental Protection Agency, the Mexican National Science Foundation, and the National Research Council. Gary Krauss is the responsible NRC staff officer, and Alejandro Lozano is the project coordinator for the ANIAC. Committee members are:

Charles T. DuMars, *Co-chair*, University of New Mexico, Albuquerque

Ismael Herrera Revilla, *Co-chair*, National University of Mexico, Mexico City

Irena Cech, University of Texas, Houston

Randall Crane, University of California, Irvine

Cristina Cortinas DeNava, National University of Mexico, Mexico City

Richard Engelbrecht, University of Illinois, Urbana

Robert N. Farvolden, National Ground Water Association, Dublin, Ohio

Helen Ingram, Udall Center for Studies in Public Policy, University of Arizona, Tucson

Lucrecia Lozano Garcia, National University of Mexico, Mexico City

Ruben Martinez Guerra, Mexican Institute of Water Technology, Mexico City

Juan Manuel Martinez, Hydraulic Construction Operations, Mexico City

Carlos Velez Ocon, National Institute of Nuclear Research, Col. Lomas de Barrilaco, Mexico

The Use of Treated Municipal Wastewater Effluents and Sludge in the Production of Crops for Human Consumption

The application of treated municipal wastewater and sludge to agricultural lands for irrigation and fertilization is a prime example of an opportunity for resource conservation. Wastewater reuse frees higher-quality water for purposes other than irrigation, and fertilization with sewage sludge recycles valuable organic matter and nutrients while improving soil and agricultural productivity.

A new study, *The Use of Treated Municipal Wastewater Effluents and Sludge in the Production of Crops for Human Consumption*, will focus on several issues associated with the use of treated effluents and sludges in the production of food crops. The study committee, which will begin its work in early 1993, will evaluate technologies for treating wastewater and sludge prior to reuse, assess the risks associated with applying wastes on food crops, review relevant regulations, and identify potential barriers to reuse and ways to overcome them. The committee's work will result in a report to be published in early 1995.

Sponsors are the Environmental Protection Agency, the Bureau of Reclamation, the Department of Agriculture, the National Water Research Institute, the Association of Metropolitan Sewerage Agencies, the Water Environment Research Foundation, the National Food Processors Association, the Eastern Municipal Water District of Southern California, and BioGro Technologies Inc. The responsible staff officer is Gary Krauss. Committee members are:

Albert L. Page, *Chair*, University of California, Riverside
Abateni Ayanaba, Del Monte Corporation, Walnut Creek, California
Michael S. Baram, Boston University Law School, Boston, Massachusetts
Gary W. Barrett, Miami University, Oxford, Ohio
Sarah L. Clark, Environmental Defense Fund, New York
Robert C. Cooper, University of California, Berkeley
Richard I. Dick, Cornell University, Ithaca, New York
Stephen P. Graef, Western Carolina Regional Sewer Authority, Greenville, South Carolina

Carol S. Kramer, U.S. Department of Agriculture, Washington, D.C.

Thomas E. Long, Washington State Department of Health, Olympia

Gerald T. Orlob, University of California, Davis
JoAnn Silverstein, University of Colorado, Boulder
Catherine St. Hilaire, Hershey Foods, Hershey, Pennsylvania

Paul E. Waggoner, Connecticut Agricultural Experimental Station, New Haven

FEDERAL PROGRAM ADVICE

Environmental Monitoring and Assessment Program
The Committee to Review the Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP) was appointed in 1990 jointly by the WSTB and the Board on Environmental Studies and Toxicology (BEST) to review a new Environmental Protection Agency initiative known as EMAP. The goal of EMAP is to monitor the nation's ecological status and identify emerging environmental problems before they reach crisis proportions.

The committee is considering ways to increase EMAP's effectiveness in monitoring seven representative types of ecosystems: near-coastal waters, arid lands, inland surface waters, wetlands, agroecosystems, forests, and the Great Lakes. The committee is also reviewing EMAP's overall design, data collection and analysis methods, and indicators used to monitor ecosystem conditions.

In June 1992, the committee released an interim report (see p. 12) raising substantive questions about EMAP's design and implementation. A second report that will review EMAP's near-coastal and forest-health monitoring components will be issued in mid-1993. The committee's final, comprehensive review will be issued by December 1994.

Financial support is from the Environmental Protection Agency. The responsible staff officers are Sheila David (WSTB) and David Policansky (BEST). Committee members are:

Richard Fisher, *Chair* (as of April 1, 1993), Texas A&M University, College Station

James R. Gosz, *Chair* (from 1990 to March 31, 1993), National Science Foundation, Washington, D.C.

This 1989 report by the Committee on Irrigation-Induced Water Quality Problems provides guidance on preventing future problems like the selenium contamination at Kesterson National Wildlife Refuge.

Patrick L. Brezonik, University of Minnesota, St. Paul
Ingrid C. Burke, Colorado State University, Ft. Collins
Edwin H. Clark II, Delaware Department of Natural Resources, Dover

Loveday L. Conquest, University of Washington, Seattle
Arthur W. Cooper, North Carolina State University, Raleigh

Shirley Dreiss, University of California, Santa Cruz
Thurman L. Grove, North Carolina State University, Raleigh

John E. Hobbie, Marine Biological Laboratory, Woods Hole, Massachusetts

Charles C. Johnson, Jr., consultant, Bethesda, Maryland
Tim K. Kratz, University of Wisconsin Trout Lake Station, Boulder Junction

Anne E. McElroy, State University of New York, Stony Brook

John Pastor, University of Minnesota, Duluth
James N. Pitts, consultant, San Clemente, California
Raymond A. Price, Queen's University, Ontario, Canada
Terence R. Smith, University of California, Santa Barbara

Susan Stafford, Oregon State University, Corvallis
Donald R. Strong, University of California, Bodega Bay
Michael J. Wiley, University of Michigan, Ann Arbor

Planning and Remediation for Irrigation-Induced Water Quality Problems

Since 1985, the WSTB has supported a committee studying irrigation-induced water quality problems. The original committee, which existed from 1985 to 1990, provided oversight specifically to the San Joaquin Valley Drainage Program in response to selenium contamination at Kesterson National Wildlife Refuge. The current committee provides oversight to the Department of the Interior's National Irrigation Water Quality Program (NIWQP), a research and planning program designed to identify and plan remediation for trace-element contamination at sites on national wildlife refuges and similar habitats associated with federal irrigation projects around the West.

To date, some 600 sites have been evaluated for trace-element contamination, with more than 22 sites in 13 states showing high potential for problems and at least 4 sites showing problems severe enough to warrant mitigation. The committee is particularly concerned with these 4 problem sites (in Stillwater, Nevada; Salton Sea, California; Kendrick, Wyoming; and the Middle Green River, Utah) and with the design of the planning and remediation process. The committee has issued two interim reports evaluating the program (see p. 12) and plans to host a conference of NIWQP researchers and managers in April 1993.

The committee sponsor is the Department of the Interior. The responsible staff officer is Chris Elfring. Committee members are:

Rolf Hartung, *Chair*, University of Michigan, Ann Arbor
Charles D.D. Howard, Charles Howard and Associates, Victoria, Canada

John A. Kadlec, Utah State University, Logan
Lawrence W. Libby, University of Florida, Gainesville
Rosemary O'Leary, Syracuse University, New York
Albert L. Page, University of California, Riverside
Ernest T. Smerdon, University of Arizona, Tucson
Kenneth Tanji, University of California, Davis
Milton W. Weller, Texas A&M University, College Station

Robert Young, Colorado State University, Ft. Collins

This report of a colloquium held by the Committee to Review the Glen Canyon Environmental Studies assesses how the Glen Canyon Dam has affected Colorado River ecology.

Glen Canyon Environmental Studies

Formed in 1986, the Committee to Review the Glen Canyon Environmental Studies (GCES) provides ongoing advice to the Bureau of Reclamation on the bureau's environmental studies of the lower Colorado River, below Glen Canyon Dam. The committee meets as needed to provide advice and conveys recommendations to the bureau through interim reports, colloquium reports, and formal bound reports reviewing GCES research.

In 1992, the committee transmitted two short reports related to the economics of hydropower production and alternative dam operating procedures (see p. 12). In October 1992, the committee held a workshop to help the GCES team develop a long-term monitoring plan for the Colorado River. The committee plans to review the draft environmental impact statement that is being prepared to determine the environmental effects of dam operations. The committee will issue a comprehensive report on the Glen Canyon studies by September 1994.

The committee's work is supported by the Bureau of Reclamation. The responsible staff officer is Sheila David. Committee members are:

William M. Lewis, Jr., *Chair*, University of Colorado, Boulder

Gail Bingham, World Wildlife Fund, Washington, D.C.
Bonnie Colby, University of Arizona, Tucson
David Dawdy, consultant, San Francisco, California
Ian Goodman, The Goodman Group, Boston, Massachusetts

William Graf, Arizona State University, Tempe
Clark Hubbs, University of Texas, Austin
Trevor C. Hughes, Utah State University, Logan
Roderick Nash, University of California, Santa Cruz
A. Dan Tarlock, Chicago-Kent College of Law, Illinois

U.S. Geological Survey Water Resources Research
Formed in 1985, the Committee on U.S. Geological Survey (USGS) Water Resources Research advises the USGS on research issues and matters involving difficult or evolving scientific questions. The committee meets three times each year, rotates one-third of its membership annually, and periodically issues reports transmitting its advice. Topics on which the committee has provided advice include the agency's water quality data and stream gaging networks, National Research Program, institutes and grants programs, and National Water Quality Assessment Program (NAWQA). Currently, the committee is assessing the national synthesis aspects of NAWQA, including the use of models and biological tools. A report is in preparation and should be published in late 1993.

Financial support for the committee's work is from the USGS. The responsible staff officer is Stephen Parker. Committee members are:

George M. Hornberger, *Chair*, University of Virginia, Charlottesville

James W. Biggar, University of California, Davis
Wilfried H. Brutsaert, Cornell University, Ithaca, New York

Lenore S. Clesceri, Rensselaer Polytechnic Institute, Troy, New York

Robert K. Davis, University of Colorado, Boulder
Steven J. Eisenreich, University of Minnesota, Navarre
Dawn S. Kaback, Westinghouse, Aiken, South Carolina
Eugene M. Rasmuson, University of Maryland, College Park

Frank W. Schwartz, Ohio State University, Columbus
James A. Smith, Princeton University, Princeton, New Jersey

Kenneth N. Weaver, Maryland Geological Survey, Baltimore

FUTURE PLANS

Since its beginning in 1982, the Water Science and Technology Board has become increasingly recognized as a credible source of advice on difficult water resources problems. The number of studies underway at the board has grown annually in response to an increasing number of requests from federal agencies and Congress and greater awareness of the need to safeguard the nation's water resources. Future board studies will continue to break new ground in subjects related to water science, technology, and management. The following brief reviews describe the projects the board is considering for 1993 and beyond.

STUDIES SOON TO BEGIN

Flood Control Alternatives in the American River Basin
At the request of the Army Corps of Engineers, the WSTB is planning a study to reevaluate a Corps of Engineers investigation of flood control alternatives and recreation in California's American River Basin. The study, to begin in mid-1993, will examine the hydrologic and engineering methods used in the Corps' planning and environmental impact study of this river basin. The reevaluation will address the reliability, costs, environmental impacts, and benefits of seven alternative long-term approaches to flood control in the basin, with emphasis on the alternative that the Corps has tentatively identified as the best option. The study will not endorse a particular alternative, but it will evaluate the scientific and engineering knowledge base upon which the selection of a final strategy will ultimately be based. This study was mandated by Congress.

The Future of Irrigated Agriculture in the Face of Competing Demands and Water Quality Constraints
Agricultural irrigation is being transformed by changing supply-and-demand conditions, growing concerns about the environmental impacts of irrigation, and national and international economic forces. The WSTB plans to begin a study of the future of irrigation early in 1993. The study will identify pressures acting to change the availability of water for irrigation; explore the impacts of changing supply-and-demand conditions on the cost of water for irrigation; assess current and potential

future technologies that might help water users adapt to changing conditions; and identify policies that might facilitate the transition to a world of increasing water scarcity.

The Future Value of Ground Water

How do you determine the future value of a natural resource to ensure that it is adequately managed and protected for future generations? Current analytical techniques have been criticized for failing to estimate adequately either the full benefits of the subsurface or the full costs of activities that degrade it. Critics claim that analytical shortcomings may have provided justification for long-term overdevelopment and pollution of ground water for the sake of present gain.

In response to a request from the Environmental Protection Agency (EPA) and with support from EPA and the National Water Research Institute, the WSTB is planning to undertake a study of approaches to assessing the long-term economic value of ground water and other subsurface environmental resources and the economic impact of contaminating or depleting these resources. The study is likely to begin in late 1993.

Wetlands Characterization

In the past few decades, the benefits of the hydrologic and biological functions of wetlands have become increasingly understood and appreciated. Recently, proposed changes in the way wetlands are defined have heightened the focus of attention on scientific and economic factors associated with wetlands management. This heightened focus has made clear the need to understand the spatial patterns of wetland structure and function and the need to apply such understanding in delineating wetlands.

In September 1992, Congress mandated that the Environmental Protection Agency contract with the National Academy of Sciences to prepare a scientific analysis of wetlands delineation. In response, the WSTB, along with the Board on Environmental Studies and Toxicology, prepared a study plan. The study, expected to be under way in the spring of 1993, will evaluate the diverse hydrological, ecological, social, and other functions of wetlands, with a special focus on irregularly flooded sites. It will result in a report providing a scientific basis for rational technical and regulatory approaches to wetlands determination and management.

The planned study "Managing Landscapes to Protect Water Resources" follows on previous studies, such as this 1990 report, of how human activities on land affect water resources.

STUDIES IN THE PLANNING STAGES

Assessing the Science of Inland Aquatic Ecosystems
The United States may be entering an era of reorganization for environmental sciences that could redefine opportunities in many disciplines, including limnology and other water sciences. This reorganization is needed to bring together scientists with backgrounds in the wide range of disciplines—from water chemistry to aquatic ecology—required to understand ecosystems as a whole, rather than studying ecosystem components individually.

The WSTB is planning a study to assess the science of inland aquatic ecosystems, focusing on ways to encourage interdisciplinary education and research. The study would examine the current status of and need for interdisciplinary education in water science; provide guidance for the development of future education and research programs in interdisciplinary water science; and consider how the ecosystem perspective can be better applied in inland aquatic ecosystem management.

Contaminated Sediment Processes and Their Impact on Water Quality

A wide variety of toxic substances—from trace elements to pesticides—accumulate in the sediments of rivers, streams, and impoundments. Data from the Environmental Protection Agency indicate that hundreds of locations across the country harbor contaminated sediments and that there are many potential point and nonpoint sources of such contamination. A better understanding of the chemical, physical, and biological processes related to contaminant accumulation in sediments is needed to implement effective sediment control and management strategies.

The WSTB is planning a study to assess the state of knowledge related to sediment transport processes and the impact of contaminated sediment on water quality. The study would include policy recommendations and a review of research needs.

Managing Landscapes to Protect Water Resources

The WSTB is developing a study that would investigate the relationships between activities on land and their impacts on water resources. The study would describe landscape-level functions and principles pertinent to water resources management and identify landscape components that are important to sustaining the hydrologic system. It would assess the utility of using a landscape- or watershed-level perspective to guide management of different landscape types, reviewing examples of both successes and failures associated with using a landscape-level approach. The study would evaluate existing landscape management technology and techniques, both scientific and institutional, and it would recommend strategies for managing landscapes to sustain and enhance water resources.

Urban Water Management Options

Urban water conservation, wastewater reclamation, agricultural water transfers, and desalting of brackish and ocean water are examples of water management options being pursued by an increasing number of urban water utilities. Since broad implementation of these new programs has just begun, their reliability and cost-effectiveness are as yet unknown. However, because of problems with constructing new reservoirs and surface-water diversions, many urban agencies are committed to pursuing these programs despite the uncertainties.

The WSTB plans to undertake an investigation, beginning with a colloquium in mid-1993, of new urban water management programs. Important facets of such a project might include evaluation of current water use trends, quantification of individual conservation programs, evaluation of the potential for use of reclaimed wastewater, and evaluation of the impact of stringent drinking water standards on the availability of ground water to meet urban demand.

POSSIBLE FUTURE STUDIES

Alternative Paradigms for Superfund

The nation's Superfund program for cleaning up hazardous waste sites is increasingly being criticized for having accomplished little to reduce the overall risk these sites pose, despite a \$7.5 billion investment. Critics contend that Superfund cleanup technologies are inefficient and that the program's methods for assessing risks and ranking sites for cleanup are flawed.

In 1992, the WSTB, in conjunction with the Board on Environmental Studies and Toxicology, began planning a broad assessment of scientific and technological opportunities for improving Superfund's performance and cost effectiveness. The study would build on current and past National Research Council studies of risk assessment, alternative cleanup management strategies, and cleanup technologies. It would assess aspects of a

fundamentally different national approach to cleaning up hazardous waste sites. Study elements would include risk assessment methods, site classification procedures, remediation priorities, cleanup technologies, site monitoring plans, and research.

Water Resources Along the U.S./Mexico Border: Science and Policy Questions for the North American Free Trade Agreement

Competition for transboundary water resources is increasingly a point of contention on the U.S.-Mexico border. The border rivers, the Colorado and the Rio Grande, are neither plentiful nor clean sources of water, and ground water supplies are limited. The U.S.-Mexico Industrialization Initiative, launched in 1965 to stimulate the economy of the border states, has attracted a high population to the region. The proliferation of industrial plants and the resulting unplanned growth have caused deterioration of scarce water supplies by sewage, industrial effluent, and agricultural and mining wastewater. As a result, incidences of water-borne diseases such as cholera are increasing.

In anticipation of the North American Free Trade Agreement, which could lead to further growth and water quality degradation, there is interest in examining what role the U.S. and Mexican academies of science could play in solving the water resources problems along the border. The WSTB is in the preliminary stages of developing a workshop to identify critical border issues, possibly to be followed by a colloquium or focused study.

PUBLISHED REPORTS

The Water Science and Technology Board produces reports covering a wide range of water science, technology, and policy matters. This section provides information about reports dating back to 1982, the year the board was formed. These reports come in three general formats:

- **Committee reports** are the products of intensive deliberations about critical topics by a committee of experts in the field. These are published in book format.
- **Colloquium proceedings** contain papers presented at colloquia and an overview prepared by an expert committee. These are also published in book format.
- **Wolman lectures** are transcripts from the Water Science and Technology Board's annual lecture in honor of Dr. Abel Wolman. Both written transcripts and videotapes of the lectures are available:

Reports are available from one of the following three sources:

National Academy Press
2101 Constitution Avenue, N.W.
P.O. Box 285
Washington, D.C. 20055
(800) 624-6242
(202) 334-3313 in the Washington metropolitan area
Fax (202) 334-2451

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4650

Water Science and Technology Board
2101 Constitution Avenue, N.W.
Room HA 462
Washington, D.C. 20418
(202) 334-3422
Fax (202) 334-1961

To order the reports described in the following list, contact the source indicated. Note that information about interim reports—brief reports conveying the short-term assessments of committees involved in long-term projects—is not included here.

FINAL COMMITTEE REPORTS

Managing Wastewater in Coastal Urban Areas
Close to one-half of all Americans live in coastal counties. The resulting flood of wastewater, stormwater, and pollutants discharged into coastal waters is a major concern. This report, the result of a three-year study, offers an approach to integrated coastal management beginning with wastewater and stormwater control. *Committee chair:* John J. Boland, Johns Hopkins University.

1993
6x9, approximately 370 pages
Order from: National Academy Press
Approximate cost \$34.95

Ground Water Vulnerability Assessment: Predicting Relative Contamination Potential Under Conditions of Uncertainty
This report evaluates the scientific basis of techniques for ground water vulnerability assessment and identifies opportunities for development of more reliable methods. It provides guidance on the application of regional-scale vulnerability assessments, the interpretation of assessment results, and the use of assessments in decision making. *Committee chair:* Armando J. Carbonell, Cape Cod Commission.

1993
6x9, approximately 150 pages
Order from National Academy Press
Approximate cost \$24.95

Regional Hydrology and the USGS Stream Gaging Network
This report discusses concepts for improving the U.S. Geological Survey's stream gaging network. *Committee chair:* George M. Hornberger, University of Virginia, Charlottesville.

1992
6x9, 24 pages, paperbound
Order from: National Technical Information Service

A Review of Ground Water Modeling Needs for the U.S. Army

This review assesses the types of models available for helping the Army track the fate of ground water contaminants and plan the cleanup effort at Army facilities. It updates the comprehensive 1990 report *Ground Water Models: Scientific and Regulatory Applications*. *Committee chair*: David L. Freyberg, Stanford University.

1992

8½x11, 39 pages, paperbound

Order from: Water Science and Technology Board

No charge—limited quantities

The Global Climate Change Research Program: A Midcourse Evaluation

This report evaluates the Bureau of Reclamation's Global Climate Change Response Program. *Committee chair*: Stephen J. Burges, University of Washington.

1992

8½x11, 24 pages, paperbound

Order from: Water Science and Technology Board

No charge—limited quantities

Restoration of Aquatic Ecosystems: Science, Technology, and Public Policy

This study outlines a national strategy for restoring the nation's degraded rivers, streams, wetlands, and lakes. It features case studies of aquatic restoration activities around the nation and offers practical recommendations for implementing a long-term, comprehensive strategy for restoring the nation's aquatic ecosystems. *Committee chair*: John Cairns Jr., Virginia Polytechnic Institute.

1992

6x9, 485 pages, hardbound

Order from: National Academy Press

\$39.95

Water Transfers in the West: Efficiency, Equity, and the Environment

As prolonged drought continues to grip the arid West, water resource planners face increasing competition for water. This report examines one response to these pressures on water supplies: water transfers. It evaluates the impacts on the environment, rural communities,

and other "third parties" that result when water is transferred from agricultural to other uses. *Committee chair*: A. Dan Tarlock, Chicago-Kent College of Law.

1992

6x9, 359 pages, hardbound

Order from: National Academy Press

\$39.95

Opportunities in the Hydrologic Sciences

This work presents a comprehensive assessment of scientific hydrology. The report covers research frontiers, data needs, education in the hydrologic sciences, and resources for future work in this field. *Committee chair*: Peter S. Eagleson, Massachusetts Institute of Technology.

1991

6x9, 348 pages, hardbound

Order from: National Academy Press

\$29.95

Preparing for the Twenty-First Century: A Report to the USGS Water Resources Division

This report outlines a plan for improved management of the U.S. Geological Survey's Water Resources Division. It covers the agency's organization, research priorities, data collection systems, and external outreach. *Committee chair*: Walter Lynn, Cornell University.

1991

6x9, 40 pages, paperbound

Order from: National Academy Press

\$10

Toward Sustainability: Soil and Water Research Priorities for Developing Countries

This report highlights soil and water research critical to fostering sustainable agricultural practices for developing countries. *Committee chair*: Leonard Berry, Florida Atlantic University.

1991

6x9, 65 pages, paperbound

Order from: National Academy Press

\$9.95

Ground Water Models: Scientific and Regulatory Applications

This work provides advice on the use of ground water flow and contaminant transport models in the regulatory process. *Committee chair:* Frank W. Schwartz, Ohio State University.

1990

6x9, 302 pages, hardbound

Order from: National Academy Press

\$29.95

Managing Coastal Erosion

This report discusses natural coastal erosion processes and how they are affected by human activity. It advises the Federal Emergency Management Agency on erosion management strategies and how to administer them through the National Flood Insurance program. *Committee chair:* William L. Wood, Purdue University.

1990

6x9, 182 pages, hardbound

Order from: National Academy Press

\$24.50

A Review of the USGS National Water Quality Assessment Pilot Program

This report reviews the U.S. Geological Survey's program to evaluate surface and ground water quality, the National Water Quality Assessment Program. *Committee chair:* Richard S. Engelbrecht, University of Illinois.

1990

6x9, 153 pages, paperbound

Order from: National Academy Press

\$15

Surface Coal Mining Effects on Ground Water Recharge

This volume assesses techniques for quantifying ground water recharge in surface-mined areas. *Committee chair:* Herman Bouwer, Water Conservation Laboratory, U.S. Department of Agriculture.

1990

6x9, 159 pages, paperbound

Order from: National Academy Press

\$17

Irrigation-Induced Water Quality Problems

This report addresses how irrigation can impair water quality. It advises how to mitigate existing irrigation-induced water quality problems and prevent future problems. *Committee chair:* Jan van Schilfgaarde, U.S. Department of Agriculture, Agricultural Research Service.

1989

6x9, 157 pages, hardbound

Order from: National Academy Press

\$24.95

Estimating Probabilities of Extreme Floods: Methods and Recommended Research

This report evaluates techniques for characterizing rare floods. It includes a general overview and detailed analyses of statistical and runoff modeling approaches. *Committee chair:* Jared L. Cohon, Johns Hopkins University.

1988

6x9, 141 pages, paperbound

Order from: National Technical Information Service

River and Dam Management: A Review of the Bureau of Reclamation's Glen Canyon Environmental Studies

This report provides recommendations to the Bureau of Reclamation about the Glen Canyon Environmental Studies (GCES). It reviews the bureau's planning and management of this project; the integration of the GCES results into a decision-making report; and the utility of the GCES results for management of the Glen Canyon Dam. *Committee chair:* G. Richard Marzolf, U.S. Geological Survey, Boulder, Colorado.

1988

6x9, 203 pages, hardbound

Order from: Water Science and Technology Board

No charge—limited quantities

Ground Water Quality Protection: State and Local Strategies

This report reviews ground water protection strategies in ten states and three local areas of the United States. The report provides a model for those looking to establish or improve ground water quality protection programs. *Committee chair:* Jerome B. Gilbert, East Bay Municipal Utility District, Oakland, California.

1986
8½x11, 296 pages, paperbound
Order from: National Academy Press
\$29.95

A Review of the U.S. Army Construction Engineering Research Laboratory Program for Recycling and Reuse of Laundry and Shower Wastewater
This study evaluates the U.S. Army's Construction Engineering Research Laboratory program for reusing field laundry and shower wastewater. *Committee chair:* Richard S. Engelbrecht, University of Illinois.

1986
6x9, 104 pages, paperbound
Order from: National Technical Information Service
Accession number: PB 87-157467
\$18.95

The Great Lakes Water Quality Agreement: An Evolving Instrument for Ecosystem Management
This report reviews the 1978 Great Lakes Water Quality Agreement between the United States and Canada. The report covers nutrient enrichment, toxic contamination, and institutional arrangements and sustainable development for preserving water quality. *Committee chairs:* Orie Loucks, Holcomb Research Institute, and Henry Regier, University of Toronto.

1985
6x9, 224 pages, paperbound
Order from: National Technical Information Service
Accession number: PB 87-186292
\$24.95

Safety of Dams: Flood and Earthquake Criteria
This volume assesses design levels for withstanding extreme floods and earthquakes at new and existing dams. The report includes a thorough inventory of safety criteria for dams in use in the United States and internationally. *Committee chair:* George W. Housner, California Institute of Technology.

1985
6x9, 224 pages, paperbound
Order from: National Academy Press
\$24.95

The Lake Erie-Niagara River Ice Boom: Operations and Impacts

This report responds to a request from the International Joint Commission of the United States and Canada to help resolve issues associated with the ice boom at the entrance to the Niagara River. *Committee chair:* Harry L. Hamilton Jr., State University of New York, Albany.

1984
8½x11, 74 pages, paperbound
Order from: National Technical Information Service
Accession number: PB 84-129709
\$11.50

The Potomac Estuary Experimental Water Treatment Plant

This report is the culmination of an eight-year review of the U.S. Army Corps of Engineers study to determine the feasibility of using Potomac estuary waters as a water-supply source for metropolitan Washington, D.C. *Committee chair:* Perry L. McCarty, Stanford University.

1984
6x9, 135 pages, paperbound
Order from: National Technical Information Service
Accession number: PB 84-195643
\$16

Water for the Future of the Nation's Capital Area
This report reviews the Army Corps of Engineers' determination of future water resources needs for metropolitan Washington, D.C. *Committee chairs:* Daniel A. Okun, University of North Carolina, and Walter R. Lynn, Cornell University.

1984
6x9, 78 pages, paperbound
Order from: National Technical Information Service
Accession number: PB 84-195585
\$11.50

Safety of Existing Dams: Evaluation and Improvement
This report addresses dam safety issues and provides guidance for achieving improvements in the safety of existing dams. *Committee chair:* Robert B. Jansen, consulting engineer, Bellingham, Washington.

1983
6x9, 384 pages, paperbound
Order from: National Academy Press
\$19.95

A Levee Policy for the National Flood Insurance Program

This report provides recommendations for integrating structural and nonstructural flood mitigation in the National Flood Insurance Program. *Committee chair:* L. Douglas James, Utah State University.

1982
8½x11, 187 pages, paperbound
Order from: National Technical Information Service
Accession number: PB 83-217992
\$17.50

Safety of Nonfederal Dams: A Review of the Federal Role

This report evaluates state and federal roles in enhancing dam safety programs. *Committee chair:* Robert B. Jansen, consulting engineer, Bellingham, Washington.

1982
6x9, 53 pages, paperbound
Order from: National Technical Information Service
Accession number: PB 82-188855
\$9

COLLOQUIUM PROCEEDINGS

Colorado River Ecology and Dam Management

For more than 30 years, critics have raised questions about how the Glen Canyon Dam on the Colorado River affects the river's ecology, especially along the portion flowing through the Grand Canyon National Park. The proceedings from this colloquium review existing information about the Colorado River ecosystem and how the dam has affected it. *Steering committee chair:* G. Richard Marzolf, U.S. Geological Survey, Boulder, Colorado.

1991
6x9, 276 pages, paperbound

Order from: Water Science and Technology Board
No charge—limited quantities

Managing Water Resources in the West Under Conditions of Climate Uncertainty

Western water managers are beginning to consider whether and how climate change may affect the region's already over-stressed water supplies. The papers in these proceedings examine the scientific basis for and the management options available for responding to climate change. *Steering committee chair:* Stephen J. Burges, University of Washington.

1991
6x9, 344 pages, paperbound
Order from: Water Science and Technology Board
No charge—limited quantities

Ground Water and Soil Contamination Remediation: Toward Compatible Science, Policy, and Public Perception

These proceedings focus on how science influences policy and public perceptions related to cleanup of ground water and soil contamination. The report describes the scientific constraints that should influence soil and ground water cleanup policy. *Steering committee chair:* Richard A. Conway, Union Carbide Corporation.

1990
6x9, 261 pages, paperbound
Order from: National Academy Press
\$19.00

Great Lakes Water Levels: Shoreline Dilemmas

These proceedings address hydrometeorological, engineering, land-management, and policy issues related to fluctuations in Great Lakes water levels. *Steering committee chair:* John J. Boland, Johns Hopkins University.

1989
6x9, 167 pages, paperbound
Order from: National Technical Information Service

Hazardous Waste Site Management: Water Quality Issues

This collection of papers covers ground and surface water cleanup levels at hazardous waste sites. *Steering*

committee chair: Michael Kavanaugh, James M. Montgomery Consulting Engineers.

1988

6x9, 212 pages, paperbound

Order from: National Academy Press

\$24.50

National Water Quality Monitoring and Assessment

These proceedings discuss the need for a national water quality monitoring and assessment program. *Steering committee chair:* Richard S. Engelbrecht, University of Illinois.

1987

6x9, 108 pages, paperbound

Order from: National Technical Information Service

Accession number: PB 87-157467

\$18.95

Drought Management and Its Impact on Public Water Systems

The papers in these proceedings address drought management and its impact on public water systems. *Steering committee chair:* Robert L. Smith, University of Kansas.

1986

6x9, 127 pages, paperbound

Order from: National Academy Press

\$22

Review of the Great Lakes Water Quality Agreement: Working Papers and Discussion

This report conveys the results of a conference to evaluate the Great Lakes Water Quality Agreement. *Steering committee chair:* Orie Loucks, Holcomb Research Institute.

1984

8½x11, 174 pages, paperbound

Order from: National Technical Information Service

Accession number: PB 85-110807

\$17.50

Cooperation in Urban Water Management: Conference Proceedings

These proceedings assess the barriers to efficient management of urban water supplies. *Conference chair:* David H. Marks, Massachusetts Institute of Technology.

1983

8½x11, 187 pages, paperbound

Order from: National Technical Information Service

Accession number: PB 83-217992

\$17.50

WOLMAN LECTURES

Irrigation: A Blessing or a Curse?

In this 1992 lecture transcript, Dr. Jan van Schilfgaarde, associate deputy administrator of the U.S. Department of Agriculture Agricultural Research Service, outlines the consequences of irrigation, from its critical role in food supply to its potential negative environmental impacts.

1992

8½x11, 18 pages, photocopied

Order from: Water Science and Technology Board

No charge—limited quantities

Meeting the Need for Water and Sanitation for Urban Populations

In most cities in Africa, Latin America, and Asia, water is undrinkable and sanitation services are inadequate or nonexistent. In this 1991 lecture transcript, Dr. Daniel A. Okun, Kenan Professor of Environmental Engineering, Emeritus, at the University of North Carolina, Chapel Hill, outlines a plan for expanding the water-supply and sanitation capacity in cities in the developing world.

1991

8½x11, 14 pages, photocopied

Order from: Water Science and Technology Board

No charge—limited quantities

Videotapes available on loan

Ethos, Equity, and the Water Resource

Fragmentation among U.S. water management institutions may be exacerbating the continued deterioration of the nation's water resources, contends Dr. Luna Leopold, Professor of Geology, Emeritus, at the University of California, Berkeley, in this 1990 lecture transcript. Water-supply engineers and public agencies focus on technology, overlooking the importance of

the hydrologic cycle, and water users focus on their individual needs, not on downstream impacts, Leopold says. The transcript discusses the need for an ethos—guiding beliefs—and equity—consideration of all the competing interests—in water resources management.

1990

8½x11, 21 pages, photocopied

Order from: Water Science and Technology Board

No charge—limited quantities

Videotapes available on loan

TERMS OF REFERENCE

The Water Science and Technology Board's terms of reference establish the board's operating policies: how study topics are selected, how committee members are nominated, and how board studies are managed. The terms of reference were adopted on November 29, 1982, and modified on December 13, 1990.

Introduction and Purposes

The Water Science and Technology Board was established in the National Research Council to provide a focal point for studies related to water resources accomplished under the aegis of the National Academy of Sciences and the National Academy of Engineering. The board's objective is to improve the scientific and technological basis for resolving important questions and issues associated with the efficient management and use of water resources.

In carrying out its responsibilities and to serve the national interest, the board responds to requests for evaluations and advice concerning specific and generic issues in water resources, influences action by initiating studies of issues that merit consideration by public agencies and others, identifies issues and topics of research related to water resources, and cooperates with other units of the National Research Council and groups with mutual interests outside the National Research Council.

The board's scope covers all aspects of water resources, including science, engineering, economics, institutions, relevant laws, educational issues, and social aspects.

Areas of Interest

To pursue its objectives, the board is concerned with:

- basic hydrologic and related sciences and their applications in water resource systems, including analyses of the hydrologic cycle, measurement of water quantity and quality, data analysis, and forecasting;
- planning, analysis, and operation of water systems, including resource management, water quality and quantity for all uses, public health and environmental protection, aquifer and watershed protection and management, economic analysis, design standards, modeling methods, risk assessment, system analysis techniques, and management systems;
- nonstructural water resources issues, such as

floodplain management, supply-demand relationships, water reallocation and reuse, effects of human activities on water resources, legal-institutional issues, ecosystem effects, and cultural and aesthetic values;

- structural and traditional engineering aspects of water projects, such as dams and other water control structures, renovation-retrofit technologies, and treatment processes; and
- the health and vitality of the nation's water-related science and engineering establishment, including its educational aspects.

General Activities

The board strives to accomplish its purposes through the following means:

- responding to specific requests for advice from government agencies and others;
- initiating investigations of issues considered to be appropriate by the board, its parent commissions, and the Governing Board of the National Research Council;
- reviewing research and the state-of-the-art in science, technology, and social sciences related to the development and management of water and related resources, especially in relation to national objectives and priorities;
- projecting future needs for and capabilities of multidisciplinary research and education in the water sciences, and technologies;
- disseminating the results of its studies, serving as a repository of scientific and engineering knowledge, and providing a forum for the exchange of information on water science and technology;
- fostering communication among members of the professional community in the United States on national and international water resources issues; and
- evaluating and articulating relevant educational issues, including undergraduate, postgraduate, continuing education, and public-education programs and the related needs for equipment and facilities.

Criteria for Activities

Proposed projects or other activities are individually evaluated by the board according to the following criteria (though there may be cases where for good reason not all of the criteria are met):

- generic applicability of the issues to the nation relative to its water needs and quality;
- important scientific and/or technological questions to be addressed;
- involvement of significant institutional and public policy issues, such as resource allocation, risk management, conflicting regulations, and inter-media tradeoffs;
- relevance of the work to the board's areas of interest and competence and its long-range objectives;
- availability of expert volunteers from relevant disciplines who can ensure that the board's contribution will be appropriate, effective, and timely;
- involvement of key policymakers and other interested parties to ensure that the board's response will have a significant audience; and
- uniqueness of the WSTB to conduct the study because of its breadth and independence as a National Research Council board.

Governance and Relationship with Parent Bodies

The board, although responsible for its own immediate governance, is accountable to and supported by two commissions of the National Research Council: the Commission on Engineering and Technical Systems (CETS) and the Commission on Geosciences, Environment, and Resources (CGER). CETS is primarily concerned with the development and application of engineering disciplines to technological systems and their relationship to societal problems, while CGER is primarily concerned with the sciences and policies relevant to resource identification and development and environmental management. For each of its specific technical, project, or administrative activities, the board or its study groups will be responsible to and supported by either CETS or CGER.

The board may undertake activities related to its mission, such as colloquia and seminars. It may collaborate with professional associations and other groups as may be necessary to fulfill its goals.

The board may recommend to the chair of the National Research Council and to the commissions such changes in the purposes, responsibilities, size, and functions of the board as it believes desirable.

Board Membership

To meet its broad needs, the board consists of about 15 to 18 members. Members are chosen for their

expertise and experience as well as for their familiarity with appropriate scientific, technological, and policy issues. While serving on the board, each member, insofar as possible, participates in at least one study conducted under the auspices of the board. Additionally, members normally participate in a variety of project development and oversight efforts.

Terms of appointment are normally for three years. Members are not eligible for more than two consecutive three-year terms. The board chair and a vice chair are appointed by the chair of the National Research Council for a period not to exceed three years. The board nominates individuals for its own continuing membership.

When appropriate, the board may invite federal agencies and organizations to nominate individuals to serve as nonvoting liaison representatives to the board and any of its work groups.

Study Group Activities

The principal operating units of the board are its separately appointed and individually mandated study groups. The board, assisted by its staff, manages the activities of these units. The scope of the board's activities will vary commensurate with the topic and need. Types of activities range from lectures, seminars, workshops, and colloquia to extended multiyear, carefully deliberated studies. In some cases, study groups will interact very closely with those receiving advice; in other cases, a more independent approach will be more effective.

The board exercises its oversight responsibility for ongoing studies by receiving reports from the chairpersons or staff and meeting with them as it deems appropriate.

The board originates or reviews and approves nominations for membership on the study group committees and transmits its recommendations to the appropriate commission.

The board chair, with the approval of the chair of the appropriate commission and the chair of the National Research Council, appoints members of committees of the board.

In recommending nominations for committees, the board seeks advice from within and outside the National Research Council. Normally, members of committees or panels serve for the duration of a given study.

Reports

The board's principal products are its reports. These range from "letter" reports, generally focused on particular agency programs and read by a limited, but important, audience of government managers, to major reference-type publications distributed by the thousands by the National Academy Press that address more general areas of water science, technology, and policy.

The board reviews all reports that develop from its program in accordance with procedures and requirements established by the appropriate commission and by the Report Review Committee of the National Research Council. All members of the board are routinely invited to participate in report reviews.

Additionally, the board's staff produces an annual report and quarterly newsletter, both of which communicate information about the board's interests, plans, accomplishments, and other activities relevant to the program.

Board Meetings

The board normally meets three times each year. Additional meetings are held as the board deems necessary to carry out its responsibilities for planning, oversight, and review including, but not limited to, review and assessment of current activities; consideration and approval of new projects, proposals, and proposed memberships; technical and programmatic briefings; and discussions with government decision-making and policy personnel.

Program Planning

Periodically, the board develops and reviews a strategic program plan, indicating general objectives and desired study initiatives for the subsequent three- to five-year period. The board then formulates programs and requests funds in support of undertakings deemed to be logical, appropriate extensions of its program plan, subject to appropriate approvals by National Research Council commissions and the Governing Board.

The board reviews all proposals for new activities that require the use of outside funds. Proposals must be approved by the board before a request for authorization to receive funds is submitted to the appropriate commission and the Governing Board.

Staff

The board director is responsible to the chair for the general management of the board's program and to the executive directors of CETS and CGER. The director has the authority to hire additional staff members and consultants necessary to assist in overall management of the board's program, subject to National Research Council administrative policies and financial constraints.

Expenses

Expenses of the board (core support) and its study groups (project funding), including support of its staff and meetings, are ordinarily financed by contracts, grants, or cooperative agreements from federal or state agencies, private foundations, or industries.