In This Issue

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Safety of Our Nation's Water

By Richard G. Luthy

Water is essential to life and it is obvious that an adequate supply of clean potable water is essential not only for personal health but also for maintaining our nation's economic wellbeing. One of our greatest engineering accomplishments of the twentieth century was the development of our nation's water systems. These water systems comprise a number of integrated components: 1) the water supply system, including dams, reservoirs, rivers, and aquifer systems and water wells that are the source of our water, and the associated conveyance devices for delivering water where it is needed for domestic, commercial, and agricultural uses; 2) the water treatment system, including water treatment plants that remove impurities and harmful agents and which makes water suitable for domestic consumption and other uses; and 3) the water distribution system, comprising networks of pipes, pumps, and storage tanks that deliver clean water on demand to homes, commercial establishments, and industries.

Beginning about 100 years ago and continuing throughout the twentieth century, cities and states and the federal government made enormous investments in water systems to provide adequate supplies of water for use in the home, industry, and agriculture. Enormous gains in public health were realized by protecting our source waters and installing water treatment plants to provide chemically and microbiologically safe water. These successes are evident by the virtual elimination of the most deadly water-borne diseases including typhoid and cholera. Today, because of our water supply, treatment, and distribution systems, we enjoy the best drinking water quality of anywhere in the world. This was achieved by unparalleled accomplishments in integrating and developing the components of the nation's water systems.

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Interview with Rita Colwell, 2002 Abel Wolman Lecturer

Photo courtesy of www.nsf.gov

Rita Colwell is Director of the National Science Foundation, and will give the next Abel Wolman Lecture on January 24, 2002 at the NAS building in Washington, DC. The topic will be *A Global Thirst for Safe Water: The Case of Cholera*. We asked her about her long-term research interest in this topic.

Dr. Colwell, you have spent over three decades studying cholera. How did you first get interested in this water-borne disease?

I became interested as a result of my doctoral thesis work at the University of Washington. As a graduate student, I studied the microorganisms readily cultured from seawater and those associated with marine animals, particularly invertebrates. My studies showed that *Vibrio* species were dominant in the marine environment. Subsequently, I was asked by a colleague to have a look at *Vibrio cholerae*, since I had done extensive work on *Vibrio parahaemolyticus*.

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Since the sad events of September 11, we now question the vulnerability of our water systems to deliberate attack or sabotage. Although recognized in the past, the vulnerability of our water systems to deliberate acts has not received sufficient attention. The reasons include the fact that simply developing and maintaining our existing water systems received primary attention. Aside from concerns about the vulnerability of our water systems to intentional acts, another reality is that many components of our water systems are aging and need repairs, replacements, or upgrades. This state of affairs is not new. We have heard repeated concerns about our aging infrastructure. But now in the context of September 11 we are looking at the infrastructure of our water systems in a new light and thinking about things that must be done to protect our water systems from intentional acts. While driven by a sense of urgency because of recent events, we should not act precipitously. We need to consider carefully what is possible and what can be done with new approaches that ensure both the security of our water systems while at the same time using such investments to enhance the reliability and capability of such systems. After all, the fundamental mission of such water systems is to protect human health and insure economic wellbeing, and we should be asking ourselves whether there are better ways to do that.

Some issues that need to be better understood to protect our water supply systems from intentional acts include the following. The answers to these questions require engineering analysis and problem solving, scientific advances, and evaluation of institutional arrangements and water policies.

What elements of the water system are most vulnerable to physical damage? How do concerns for physical damage vary depending on the source of water? How can we protect water systems from physical damage? Dams and aqueducts and pumping stations that capture and convey water over long distances are especially vulnerable to physical damage. But even water supplies taken from rivers or lakes may suffer if intakes are damaged. Similarly, groundwater withdrawn from wells relies on pumps and infrastructure delivery. The control of human access to critical water supply system components is an important issue and responses are likely to be much different for water supply systems located in parks and public places versus remote areas. While steps have been taken in the last twenty years, like fencing and covering reservoirs, more is needed to prevent intentional acts. Some aqueducts are hundreds of miles long; protecting these systems is especially challenging. Water supply systems are designed to withstand natural disasters. In-place systems for natural disaster monitoring and response could serve as platforms to incorporate intrusion sensors and quick response to intentional damage. The distribution system is more difficult to secure; though potentially affecting a smaller population, mass exposure is not needed if the goal is fear and anxiety.

What chemical or biological agents may do the most harm to human health and disrupt the beneficial uses of water? What points in the water supply, water treatment, and water distribution system are most vulnerable to release of such agents? What amount of such agents would harm humans or disrupt service? It is believed for many toxic chemicals that truck-load quantities are needed to cause harm to the water supply system because of the very large volumes of water being handled. But this matter needs thoughtful analysis. Small quantities of toxic chemicals, even if not directly harmful, may cause panic and great economic disruption. Who would want to consume water with intentional addition of low levels of lead or cyanide? Biological agents may be harmful at very low levels. Levels of concern for certain spores or protozoan oocysts may be fewer than ten, and thus small volumes of these agents in concentrated form may contaminate very large volumes of unfiltered water. These issues are relevant to both surface water systems and those relying on groundwater as their source, especially those using water from carbonate or other aquifers in which the water residence times are relatively short. Elevated portions of distribution systems are a concern, being more vulnerable to entry of chemical or biological agent than pressurized conduits. Something added to water does not have to toxic; merely introducing taste or odor would be very disruptive if the goal is fear and anxiety.

How can we achieve early detection of chemical or biological agents in the water supply system in time to take corrective action before water gets to a water treatment plant or into the distribution system? We need better monitoring for early warning of the intentional addition of chemical or biological agent to the water supply. Water supplies are monitored routinely for a small number of contaminants and much less frequently for a large number of contaminants. Conventional laboratory methods are time consuming and require skilled analysts. Together, this means that problems arising from intentional acts may not be detected until chemical or biological agents are at the treatment plant, or worse, in the distribution system (many large U.S. systems, notably those of San Francisco and New York City have no treatment, other than disinfection). However, much can be done to improve this situation. Most analytical equip-

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ment is highly automated and could very likely be made more autonomous with new technologies. The chemical industry and some of our national laboratories are developing 'chemical analysis on a chip' for hand-held, portable, chemical analysis systems, and 'canary on a chip' for detection of hazardous compounds in the work place. With modification, such systems may be useful in routine monitoring of water supplies for a broad spectrum of compounds, both known and unknown. Innovations in immunoassays and nanotechnologies hold promise for rapid screening of chemical and biological agents. We should not overlook time-tested methods like increased chlorine demand, taste and odor, turbidity, and other measures as useful surrogate indicators in conjunction with new procedures.

How can water supply system operations be reconfigured to provide greater interconnectedness among source water supplies and among potable water distribution systems? What might be the potential for groundwater or irrigation water resources shoring up contaminated surface supplies on an emergency basis? Interconnectedness means that in-place conduits allow the transfer from one water supply system to another. Interconnecting water supply systems offers greater assurance that if one component of the water supply system is lost then other water supplies may be put online to transfer water through stand-by conduits. Similarly, water distribution systems could be interconnected so that one locality may help another under emergency conditions. Mutual aid pacts could include water supply, laboratory resources, operating assistance, and repair response. Aside from the technical issues, how this systems approach, often called "regionalization," would work in practice requires cooperation on a regional (often watershed) basis. Historically, because of the fragmented nature of the water supply industry, there has not been as much attention to design for interconnectedness unless prompted after the fact by a chemical spill or natural disaster. Our nation has experienced sabotage of local water supply systems with alternative water supply being brought in while the system was flushed or repaired. Greater interconnectedness results in inherently greater stability and flexibility, as networks more resilient to upset than monolithic systems. In the arid west, separate water supply systems are in place for agriculture and domestic use. Since so much more water is used in agriculture than by municipalities, conceivably interconnecting the agricultural water supply or groundwater systems could augment the domestic supply in an emergency. Again, there are many questions, both technical and institutional, on how this would work.

What changes in system operations and what new technologies may provide a safeguard against chemical or biological agents? How may multiple barriers be incorporated in treatment plant operations and in the distribution system to ensure greater safety in our domestic water supply? As mentioned above, we should think of new ways of supplying and treating water. Examples include the installation of robust, stand-by systems that could deal with chemical or biological threats. New technologies and augmented conventional technologies are needed. Fortunately, advances in membrane, sorptive, and oxidative technologies can be brought to bear on this problem. In water reuse, a fundamental design paradigm is to install multiple barriers that provide adequate safeguards in converting wastewater to potable water. Such systems are not dependent on one process but several in a train that provide backup protection. Similarly, we need to extend the multiple barrier concept to create a series of hurdles that guarantee greater assurance that we can cope with chemical and biological agents. These barriers may extend from the water treatment plant to include the distribution system and point of use. Multiple barriers comprising storage capacity, enhanced treatment systems, and mutual aid provide the means and time to address a problem.

Are our water supply systems vulnerable to cyber attack and what can be done to safeguard against such threats? Historically most of the concerns for the safety of the water supply system have focused on natural phenomenon. Not to be overlooked, however, is the realization that essentially every component of the water supply system is highly automated. This includes electronic control of water pumping and storing, water treatment operations, and water transmission. Although these operations are backed up by manual controls, great damage could be done if the control of these systems were lost for a period of time due to cyber attack. Electronic security and emergency control backup capabilities of the water supply system need careful analysis and possible re-engineering. This concern could be just as real as chemical or biological threats.

Among the items listed, top priority should be given to protect physical structures for water storage that serve large populations and that would be very difficult to replace, and to maintaining water quality through better monitoring and new treatments and incorporating the concept of multiple barriers.

In conclusion, the issues discussed above are crosscutting among disciplines and institutions. Answers to these questions and designing effective solutions to key problems will require broad-based studies comprising university and governmental research establishments, professional organizations, practitioners, and operators, as well as advice from groups like the National Research Council. The challenges are great but so are the resources to make our water safer than ever before.

Richard G. Luthy is Chair of the Water Science and Technology Board and Professor of Environmental Engineering at Stanford University.

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Interview With Rita Colwell

What has kept you interested in the same organism for so many years?

When I studied the strains of *Vibrio cholerae* provided me by Dr. John Feeley, then at NIH, these strains turned out to be salt requiring, marine/estuarine *Vibrios*. It was then my interest became heightened, as it occurred to me that it was in fact an estuarine/marine bacterium and, probably, a native inhabitant of the riverine, estuarine, and marine environments. The more I studied the organism, the more intriguing it became. We made some remarkable discoveries, namely, that it is autochthonous to the marine environment, and that it is widely distributed throughout the world in temperate, semi-tropical, and tropical riverine, estuarine, and marine environments. We were also able to develop molecular tools, including monoclonal antibodies fluorescentally labeled and gene probes to detect the bacterium in samples without the need for culturing.

That led us to another discovery, namely, that its host, the copepod (another discovery of ours), undergoes diapause (i.e., a slow-down of animal's metabolism). We were able to show that *Vibrio cholerae*, like other marine *Vibrios*, goes into a dormant state between epidemics in cholera-endemic countries, notably under conditions adverse to active growth and cell division.

Wouldn't that make it very difficult to prevent from spreading, especially in the developing world?

We developed a mechanism for providing protection against the disease in developing countries, where drinking water is taken directly from local bodies of water, without treatment. We were able to show that because of its association with copepods, the *Vibrio cholerae* bacteria could be removed from drinking water by simply filtering it through very inexpensive cloth used by women in rural Bangladesh for their dresses. Thus, we were able to show that sari cloth, folded eight or ten times, provided a very nice filter.

This simply reinforces what we already know, namely, that filtration, coupled with flocculation prior to filtration and, subsequently, with chlorination, provides safe drinking water. The United States has not had a case of cholera in major cities since the turn of the century.

Are there other water-borne diseases that we should be keeping a close eye on for future outbreaks around the world?

Other water-borne diseases that may surprise us are *Helicobacter pylori* and *Campylobacter jejuni* (implicated in stomach infections and diarrhea, respectively) and related species. These organisms are transmitted by water, as we showed very early in our work some years ago. What worries me most, however, are the chlorine-resistant strains of r*ugose Vibrio cholerae*, microbacteria, and related pathogens.

Many international water problems seem to have political or economic, rather than scientific solutions. Are our national or international water institutions up to the task?

We need to focus very sharply on availability of safe drinking water for populations, especially in developing countries. Safe drinking water is becoming an endangered resource. We certainly will find international water problems deeply embedded in political, economic, and international security issues. It would be appropriate to begin considering safe drinking water an internationally endangered resource, especially as the population of Planet Earth moves closer toward the predicted ten billion or so in the future. Abundant water supplies need to be cherished and protected.

2002 Abel Wolman Distinguished Lecture is free and open to the public. The program will begin at 11:00 a.m. in the Auditorium of the National Academies, 2101 Constitution Avenue, NW, Washington, DC. A reception will follow the Lecture in the Great Hall. If you wish to attend the lecture, please RSVP to Anita Hall at the WSTB at either 202-334-3422 or *ahall@nas.edu.*

Those who cannot attend the lecture are invited to participate by listening to a live audio Webcast. The Webcast link will become available at the time of the event at *http://national-academies.org.*

WSTB is Hiring

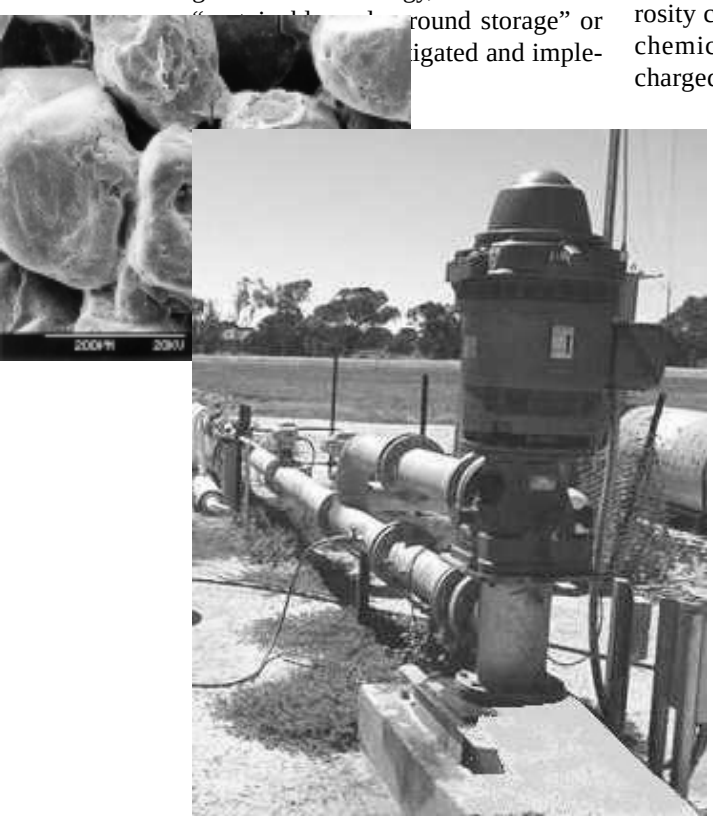
To accomodate its increasing workload, the WSTB is preparing to "staff up." Candidates will be considered at several levels, i.e., project assistant, research assistant/associate, and junior-level staff officer. This could be an ideal entry level position for individuals newly degreed (any level) in a relevant field or for others with a few years of experience. WSTB staff work with expert committees on water science and technology studies of importance to the nation. Roles vary from administrative and research support to project management. Strong interpersonal and oral and written communication skills are essential. If you are interested in being considered for one of these positions, please contact WSTB Director Stephen Parker via e-mail (sdparker@nas.edu), and include a brief biographical profile for further consideration.

Opportunities for Sustainable Underground Storage of Recoverable Water

William Logan and Richelle Allen-King

Freshwater supplies in the US may be hard pressed to meet future needs, for many reasons. Population increases, particularly in semi-arid regions, will raise demands for water. Instream ecological uses are becoming more and more important. Global warming may decrease snowpack in the western US. And climatic variability may increase the frequency of both droughts and floods. Clearly, new strategies for water management on a broad geographic scale will be required.

However, options for increasing freshwater supply are few. An increasingly popular option has been temporary detention and storage of surface water during times of excess for release during times of need. Due to problems associated with storage in aboveground reservoirs, including evaporative losses, land consumption and ecological impacts, there is increased demand to store recoverable water underground. This strategy, which we term "[illegible]round storage" or [illegible]igated and implemented from California to Florida, and from Israel to Australia. While most projects involve injection at a rate of a few million gallons per day (gpd), total injection rates associated with restoration of the Everglades are envisioned to be as high as 1.6 billion gpd.



Injection bore with pump. SOURCE: Bolivar ASR Project Steering Committee (Adelaide, Australia).

While SUS holds great promise, there remain many questions about the hydrogeologic and geochemical conditions under which it is both safe and technologically feasible. These issues include the following:

- The consequences of mixing between recharged and resident water may be difficult to predict. If the recharged water is contaminated in any significant degree, the quality of the entire reservoir may be compromised for long periods of time.
- Chemical or physical reactions between recharged water and existing groundwater and aquifer materials may diminish aquifer storage, increase porosity causing subsidence, or alter the chemical characteristics of the recharged water. Natural contaminants also may be mobilized in the process.
- The physical processes underlying the movement and mixing of recharged and resident water may be poorly understood, especially for karstic, stratigraphically heterogeneous, or fractured aquifers.
- The physico-chemical conditions under which pathogens such as bacteria, viruses, and protozoa may survive and be transported in the subsurface are not entirely understood.
- Impacts on riparian zone ecosystems due to withdrawing water from streams, or cutting back on return flows to those streams, may be substantial.
- Water rights issues and legal issues associated with damages from underground storage need to be identified and addressed. Who owns the water that is put into the storage reservoir? Who owns it when it is extracted? If an aquifer is contaminated by the "artificial recharge" project, what are the rights of affected users?

Biofilm clogging of aquifer materials in column experiment. SOURCE: Bolivar ASR Project Steering Committee.

The board feels that the timing is excellent for a study on this topic. There are enough systems in place such that information on system performance is becoming available. Additional science is being done for the many additional projects that are in the pipeline. And this technology will probably be used even more widely in the future. A study at this time would provide an overall assessment of the interrelated technical and institutional issues that arise with the adoption of this method, and would provide guidance to prevent development of systems founded on unsubstantiated assumptions or poorly conceptualized models.

We are seeking funding for this proposed new study. It would be conducted over about an 18-month period. For further information on funding opportunities, please contact Will Logan at (202) 334-3422 or *wlogan@nas.edu.*

William Logan is a Senior Staff Officer with the Water Science and Technology Board.

Richelle Allen-King is a professor at Washington State University.

CURRENT PROJECTS

Assessment of the Corps Methods of Analysis and Peer Review Procedures

The Water Resources Development Act of 2000 mandated this study to review the Corps' planning and analytical methods and to review the Corps' independent peer review procedures for water resources project planning. It is being conducted in cooperation with the Ocean Studies Board, with input from the Transportation Research Board and the Board on Environmental Science and Toxicology. The study is composed of a Coordinating Committee and four panels on (1) Peer Review Procedures, (2) Methods of Techniques of Project Analysis, (3) River Basins and Coastal Systems, and (4) Resource Stewardship and Adaptive Management. The coordinating committee and peer review panel have been appointed.

Leonard Shabman, Virginia Polytechnic Institute and State University, chairs the Coordinating Committee. The other members are: Gregory B. Baecher, University of Maryland; Donald F. Boesch, University of Maryland Center for Environmental and Estuarine Studies; Robert W. Howarth, Environmental Defense; Geraldine Knatz, Port of Long Beach; James K. Mitchell, Virginia Polytechnic Institute and State University; Peter P. Rogers, Harvard University; A. Daniel Tarlock, Chicago-Kent College of Law; Victoria J. Tschinkel, Landers and Parsons; James G. Wenzel, Marine Development Associates, Inc.; and M. Gordon Wolman, Johns Hopkins University. The first meeting of the Coordinating Committee was held September 24-25 in Washington, DC. During the meeting, they heard from representatives of the Corps and congressional staff members regarding study expectations and discussed details of the Corps water resources project planning process.

The Peer Review Panel met on October 29-30 in Washington, DC. The committee heard presentations from the Corps regarding their peer review process. Ronald Kostoff, Office of Naval Research gave a presentation on peer review concepts and process. James K. Mitchell, Virginia Polytechnic Institute and State University chairs the committee. The other members are: Melbourne Briscoe, Office of Naval Research; Stephen J. Burges, University of Washington; Linda Capuano, Honeywell, Inc.; Denise Fort, The University of New Mexico; David H. Moreau, University of North Carolina; Craig Philip, Ingram Barge Company; John T. Rhett, private consultant; Richard E. Sparks, Illinois Water Resources Center; and Bory Steinberg, Steinberg and Associates.

The other three panels will be appointed by the end of 2001, and will begin their studies in early 2002. For more information, contact Jeffrey Jacobs at 202-334-3422 or *jjacobs@nas.edu*.

Bioavailability of Contaminants in Soils and Sediments

The committee on bioavailability of contaminants in soils and sediments will assess broadly the current scientific understanding of processes—both in the environment and in the human body—that affect whether chemical contaminants present in soils and sediments at contaminated sites are bioavailable to humans, animals, and plants. The committee's fifth meeting (August 23–25 in Stanford, CA) was held entirely in closed session to revise the draft report. The final meeting is scheduled for December 17–18 in Irvine, CA. The committee is chaired by Richard G. Luthy of Stanford University. For more information, contact Laura Ehlers at 202-334-3422 or *lehlers@nas.edu*.

Environmental Remediation at Navy Facilities

The fourth meeting of the Committee on Environmental Remediation at Navy Facilities–Phase 2 was June 28–29, 2001, in Washington, DC. This committee is advising the Navy as it proceeds with the cleanup of contaminated soils, sediments, and groundwater at naval bases and other relevant defense facilities. This phase of work will focus on the latter stages of hazardous waste site management. At its meeting, the committee heard about the MAROS optimization system for groundwater monitoring from Chuck Newell of Groundwater Services, Inc. and it revised its draft report. The committee held its fifth meeting on October 18–19, 2001 in Woods Hole, MA. The committee chair is Edward J. Bouwer of Johns Hopkins University. For more information, contact Laura Ehlers at 202-334-3422 or *lehlers@nas.edu*.

Missouri River Ecosystem Science

The U.S. Army Corps of Engineers constructed and operates six mainstem dams on the Missouri River. Partly because of concerns related to ecological degradation, the Corps is currently revising its Master Manual, the guidance document, which helps define operations policies for these dams. This WSTB committee has been charged to characterize the historical and current ecological status of the Missouri River and floodplain ecosystems, and to review scientific research on river-floodplain ecosystem while also recommending institutional arrangements for improving ecosystem monitoring and research, and for enhancing adaptive management. The committee's report is currently in review and will be completed by the end of the year. Steve Gloss of the Grand Canyon Research and monitoring Research Center in Flagstaff, AZ chairs the committee. For more information, contact Jeffrey Jacobs at 202-334-3422 or *jjacobs@nas.edu*.

Opportunities to Improve the National Water Quality Assessment (NAWQA) Program

The committee's report entered external review in late September and should be ready for subsequent release in November 2001. The report provides recommendations for improvements as the NAWQA Program enters its second 10-year cycle of nationwide monitoring and will be featured in the next edition of the WSTB Newsletter. The USGS National Water Quality Assessment program is a perennial program, launched in the early 1990s, to describe the status of, trends in, and factors affecting the water quality conditions throughout the United States. The

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WSTB has provided advice to the USGS regarding the establishment and development of this program on four previous occasions. George Hallberg of the Cadmus Group, Inc. chairs the committee. For more information, contact Mark Gibson at 202-334-3422 or *mgibson@nas.edu*.

Privatization of Water Services in the United States

The committee is tasked to assess issues associated with various forms of ownership and operation of drinking water supply and wastewater systems in the United States, i.e., economic and fiscal, regulatory, public service and public health, environmental, and water quality implications. Ownership and operations of these systems used to be privately owned and operated in many U.S. cities. With the growth of large cities and stronger governments, local government entities eventually assumed ownership and operations of

U.S. water service privatization is not clear.

The committee's report is currently in review and will be available at the end of the year. Charles Howe of the University of Colorado chairs the committee. For more information, contact Jeffrey Jacobs at 202-334-3422 or *jjacobs@nas.edu*.

Restoration of the Greater Everglades

The Committee on the Restoration of the Greater Everglades Ecosystem (CROGEE) is tasked to provide a scientific overview and technical assessment of the many complicated, interrelated activities that are occurring at the federal, state, local and non-governmental levels. In addition to strategic assessment and guidance, the committee provides more focused advice on technical topics of importance to restoration efforts. Their September 16-18 meeting was rescheduled to November 29-30 in Fort Myers, Florida. This meeting will include a workshop on exploring strategies for incorporating adaptive assessment and monitoring into the restoration project. A major committee report is be generated as a result of p.

Walters of Virginia Polyitute and State University appointed to the committhr of the University of Wiss the committee. For more contact William Logan at 2 or *wlogan@nas.edu*.

Members and WSTB staff of the Committee on Restoration of the Greater Everglades Ecosystem (CROGEE) at Royal Palm Visitor Center, Everglades National Park. Front row (left to right): Jean Bahr, Linda Blum, Steve Sanderson, Wayne Huber, Scott Nixon, Pete Loucks, Steve Parker. Center row: John Vecchioli, Steve Humphrey, John Adams, Tricia Kershaw. Back row: Will Logan, David Policansky, Rebecca Sharitz, Ken Potter, Pat Brezonik, Frank Davis, Larry Robinson. Foreground: committee mascot. Background, in tree: anhingas. Photo courtesy of Nick Aumen, National Park Service.

Review of the Florida Keys Carrying Capacity Study

The joint Ocean Studies Board (OSB)/WSTB committee was formed in December 2000 in response to a request by the U.S. Army Corps of Engineers (Jacksonville District) to review the Florida Keys Carrying Capacity Study (FKCCS) and the accompanying Carrying Capacity Analysis Model (CCAM) that is under development by the State of Florida. More specifically, the committee is tasked to evaluate the scientific methods, principals, and data that form the basis for the FKCCS and CCAM. The goal of the FKCCS is to "determine the ability of the Florida Keys ecosystem to withstand all impacts of additional land development activities." The FKCCS examines three study categories: 1) natural resources, including ecosystems, species of concern, and water quality; 2) the social environment, including regional economic impacts, quality of life, community character, and sustainable tourism; and 3) human infrastructure, including hurricane evacuation, water supply and other needed services such as schools, law enforcement, etc. It will also create a planning tool in the form of the CCAM to attempt to determine the level of land development activities that will avoid further adverse impacts to the Florida Keys ecosystem. The committee attended a 2-day meeting on the FKCCS and the unveiling of the draft CCAM in Key Largo on January 9-10 and met in closed session on January 11 to form the basis of an interim ("letter") report that was released in early March 2001. The interim report will be followed by a more thorough examination of the draft CCAM once it is completed late in 2001. In this regard, the committee will likely meet again in Florida during early Winter 2002 to deliberate and prepare a final report on the revised FKCCS and CCAM. The committee is chaired by Scott Nixon of the University of Rhode Island. For more information, contact Mark Gibson at 202-334-3422 or *mgibson@nas.edu*.

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Riparian Zones: Functions and Strategies for Management

The joint WSTB/BEST Committee on Riparian Zones held its fifth and final meeting in Washington, DC on February 22–23. The committee's charge is to describe the nature and functioning of riparian zones and assess the condition and trends of riparian habitats with respect to water quantity and quality. The study is reviewing criteria for the improved management of riparian lands and for mitigation of impacts on such habitats. The committee's report will be sent to external review imminently and should be complete by the end of 2001. Mark Brinson of East Carolina University chairs the committee. For further information, contact Laura Ehlers at 202-334-3422 or *lehlers@nas.edu.*

Risks from Toxicants and Pathogens in Biosolids Applied to Land

The Board on Environmental Studies and Toxicology and WSTB formed the Committee on Toxicants and Pathogens in Biosolid Fertilizers in early 2001 to review the risks and risk-assessment methods used by EPA for establishing regulatory standards for chemical pollutants and pathogens in biosolids (sludge) applied to land. The study will consider whether approaches for assessing risks from chemical and pathogenic pollutants should be integrated and, if so, approaches for integration will be recommended. It will also build on the 1996 WSTB report *Use of Reclaimed Water and Sludge in Food Crop Production*. The committee held its second and third meetings on June 3-5 in Irvine, CA and October 3-4 in Woods Hole, MA, respectively. The fourth committee meeting is scheduled for December 10-11 in Irvine, California. A fifth meeting will be scheduled if needed and the committee's report should be released in Spring 2002. Thomas Burke of The Johns Hopkins University chairs the committee. For further information, contact Susan Martel of BEST at *smartel@nas.edu.*

FUTURE PROJECTS

Assessment and Control of Nonpoint Source Pollution

As a follow-up activity to the recently completed Total Maximum Daily Load study, the WSTB is again planning its study on nonpoint source pollution originally proposed in 1999. Nonpoint source (NPS) pollution has become the major threat to water quality in the nation's waterbodies, both coastal and inland. The consequences of NPS pollution range from minor to very severe, depending on the intensity of activity, the vulnerability of the natural systems where the activity occurs, and the technologies that are used to mitigate the adverse effects on water quality and aquatic ecosystems. This proposed study would investigate (1) the sufficiency of knowledge about sources of NPS pollution, including land use change and other factors, (2) the state of modeling to predict pollutant loads from these sources, and (3) the effectiveness of regulatory and management approaches in controlling NPS pollution. An initial increment of funding has been secured from EPA and additional sources are being sought. To suggest funding sources or possible committee membership, contact Laura Ehlers at 202-334-3422 or *lehlers@nas.edu.*

This committee is advising the Navy as it proceeds with the cleanup of contaminated soils, sediments, and groundwater at naval bases and other relevant defense facilities. This phase of work will focus on the latter stages of hazardous waste site management. The fifth meeting of the Committee on Environmental Remediation at Navy Facilities—Phase 2 was October 18-19 in Woods Hole, MA. The committee will discuss the completion of the report. Edward J. Bouwer, Johns Hopkins University, chairs the committee. For

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Studies in Hydrologic Science

This joint WSTB/BASC committee reviews and provides advice on scientific activities of US federal agencies and US contributions to international programs in hydrologic science including research, observation systems, and data collections; and provides guidance to the development of the hydrologic science field. During their October 8-9 meeting in Washington, DC they discussed response to review for the committee's report *Predictability and Limits-to-Prediction in Hydrologic Systems*. The committee also discussed the upcoming workshop on *Groundwater Fluxes Across Interfaces*, which is scheduled on May 12-14, 2002. A brief agency forum was held during the second day of the meeting. The committee will also, in collaboration with the NRC Climate Research Committee, assess and advise the U.S. Global Change Research Program on implementation of the Water Cycle Initiative Plan. Dara Entekhabi, Massachusetts Institute of Technology chairs the committee. For more information, please contact William Logan at 202-334-3422 or *wlogan@nas.edu*.

USGS Water Resources Research

The Committee on USGS Water Resources Research advises the U.S. Geological Survey on its water resources research programs and other developing programs where sound or innovative science is an issue. During their last meeting on October 18-19 in Washington, DC, the committee finalized the review draft of their report on the National Water-Use Information Program. They also heard presentations from USGS staff on droughts and trends and streamflow statistics related to the National Streamflow Information Program (NSIP), which is the current study focus of the committee. This study on NSIP is evaluating appropriate design characteristics for, and minimum national streamflow information needs to be met by a national streamflow-monitoring network. David Maidment, Univ of Texas at Austin, chairs the committee. For more information, contact William Logan at 202-334-3422 or *wlogan@ nas.edu.*

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more information, contact Laura Ehlers at 202-334-3422 or *lehlers@nas.edu.*

Indicators for Waterborne Pathogens

To help ensure high quality drinking water in the United States, regulators have traditionally used indicator microorganisms to determine the possible presence of microbial contamination from human waste. Enumeration of total coliforms in water samples has proved to be a useful method for assessing sewage contamination of water, and with chlorination to reduce coliform levels, has led to a decrease in diseases such as cholera and typhoid fever. However, an increased understanding of the diversity of waterborne pathogens and their physiology has resulted in a growing concern that traditional total coliform tests do not indicate the presence of other important classes of pathogens such as parasites and viruses, or of bacterial pathogens that do not have their origins in human waste. Several other limitations of relying on total coliforms as indicators for waterborne pathogens have been reported.

Acknowledging recent advances in microbiology and molecular biology and in response to recent rules and legislation concerning microbial contamination of water (e.g., the Long-Term 2 Enhanced Surface Water Treatment Rule), EPA's Office of Water contacted the NRC's Board on Life Sciences (BLS; administrative lead) and WSTB to undertake a study of indicators of microbial pathogen contamination in U.S. recreational waters (excluding coastal marine water and marine/estuarine water) and source water (including groundwater). Full funding for this study has been recently obtained and the BLS/WSTB is currently forming a committee of experts that should meet for the first time in early 2002. The study will result in a report that suggests candidate indicators and/or indicator approaches that are deemed scientifically defensible and practical to monitor. The committee will consider the strengths and weaknesses of the candidates and how a list of candidates might change with future technological developments. As part of this effort, the committee will also review and provide perspective on the current and future importance and public health impact of waterborne pathogens both in terms of drinking water and recreational contact activities. For more information, contact Mark Gibson at 202-334-3422 or *mgibson@nas.edu*.

Services and Values of Aquatic and Related Terrestrial Ecosystems

Aquatic and related terrestrial ecosystems include lakes, rivers, streams, estuaries, wetlands, adjacent riparian systems, and upland areas together with their associated flora and fauna. They perform numerous environmental functions, such as recycling nutrients, purifying water, attenuating floods, recharging groundwater, and providing habitats for wildlife. In addition, aquatic and related terrestrial ecosystems often form the basis of economic livelihood and are widely used for recreational purposes. But human activities of all kinds have increasingly led to pollution, adverse modification, and devaluation of these valuable natural resources. While ecosystem functions may be useful markers for studying the physical, biological, and chemical processes at work in aquatic resources, they are seldom experienced directly by users of the resource. In contrast, economists find it more helpful to think of the "services" of a resource—the things that create value for human users. Thus for aquatic and related terrestrial ecosystems, the intrinsic value of hydrologic, biogeochemical, and biological services can be more readily assessed.

The WSTB held a planning workshop with an internal grant from the Academies in late 1999 to identify major issues, important literature, potential experts, and sponsors for such a study. The workshop deliberations indicated that a full committee-based NRC study that focused on the value of aquatic ecosystem (and to a lessor extent, related terrestrial ecosystem) services, rather than functions, was both warranted and timely. Following the workshop, the WSTB received approval from the National Academies to organize a study to identify and assess existing methods for defining and assigning economic values to the services of aquatic ecosystems. The assessment will also include consideration of the errors and biases characteristic of such methods and whether their increased use will lead to improved decision-making with respect to the environmental decision-making. At present, funding efforts for the study are complete and a committee of experts is being formed that will meet four or five times during an 18-month study period to gather information, deliberate critical issues, and write its report. The newly formed committee should meet for the first time in early 2002. For more information, contact study director Mark Gibson at 202-334-3422 or *mgibson@nas.edu.*

Source Removal of Contaminants in the Subsurface

The WSTB is seeking nominations for new committee to study the effectiveness of source removal as a strategy for cleaning up contaminated groundwater and soil at hazardous waste sites. Source removal, which encompasses such remedies as *in situ* chemical oxidation, thermal treatment, and solvent or surfactant flushing is increasingly being debated and considered for remediating recalcitrant contaminants (e.g., dense nonaqueous phase liquids) in heterogeneous subsurface environments. This effort would involve literature reviews and analysis of existing data on source removal activities. Later efforts would use the criteria and information generated initially to evaluate the effectiveness of source removal activities at several Army installations. The study would be carried out by a committee of approximately 15 members that would meet six times over a 27-month period with a start date planned for early 2002. To nominate committee members or submit relevant materials, please contact Laura Ehlers at 202-334-3422 or *lehlers@nas.edu.*

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Future Projects

Water Disinfection Issues and Alternatives

WSTB staff is seeking funding for a new initiative that will broadly assess our current scientific understanding of water and wastewater disinfection processes and their alternatives. For a broad suite of chemical and physical disinfectants—including chlorine, ozone, and UV irradiation—this study would explore the mechanisms of microbial inactivation via disinfection and inactivation kinetics, and it will critically evaluate the methods used to quantify disinfection efficacy. In addition, it will examine how well emerging and existing disinfectants provide for residual maintenance within distribution systems and it will describe how disinfectant residuals should be managed to protect against microbial regrowth. A workshop was held March 28, 2000, in Washington DC to bring together public and private stakeholders, generate interest in the study, and identify potential sponsors and committee members. Although several organizations expressed interest in the project, funding has not yet been committed. For more information or to suggest funding sources, contact Laura Ehlers at 202-334-3422 or *lehlers@nas.edu.*

Water Quality Improvement for the Pittsburgh Region

Thousands of residents of southwestern Pennsylvania, particularly in rural areas, lack clean and reliable water supplies, adequate wastewater systems, or both. Moreover, nearly all of the region's residents receive water from surface and groundwater sources that are periodically compromised by inadequate sanitation (i.e., contain unacceptable levels of potentially harmful microbial pathogens).

The cost of the improvements necessary to correct this regional water quality program are large (projected to cost between $8-9.5 billion). However, the cost of letting the water quality problem continue unabated may be greater over time in terms of adverse impacts on public health, the environment, and economic growth. Regardless of the funding approach ultimately taken, for many communities a significant gap will remain between what is needed and what can be afforded. Thus, infrastructure investment must be strategic. Such a proactive approach will help obtain infrastructure how and where it is needed rather than where it is forced through regulatory actions or as a result of protracted and expensive litigation.

The Water Science and Technology Board has been contacted by the Allegheny Conference on Community Development and The Pennsylvania Economy League to undertake a study of the wastewater and water quality problems of the Pittsburgh, PA area and make recommendations on how these issues and needs of the region can be best addressed by the multiple jurisdictions on a cooperative basis. The study should help the public and private organizations of the Pittsburgh region develop public awareness of the issues and the need for collaborative strategies for water quality improvement and management. It is envisioned that such a WSTB study can provide an instructive model for the EPA and other urban areas where a regional cooperative approach to wastewater management can be considered. Efforts to obtain necessary funding are nearing completion and the WSTB hopes to form a committee of experts and initiate the study in early 2002. For more information, contact Mark Gibson at 202-334-3422 or *mgibson@ nas.edu*.

Water Resources Research for the Nation

The Water Science and Technology Board has begun planning for a new study of water resources research funded by the federal agencies and by significant non-federal organizations. The Congress has directed the Academy to examine the level and allocation of resources that are currently deployed in water research programs, and provide recommendations for a national research program that maximizes the efficiency and effectiveness of existing programs. The primary focus of this study will be the existing research agenda, but Congress has also asked whether the present level of national investment in water resources research is adequate.

This study follows on from the recent report of the WSTB titled *Envisioning the Agenda for Water Resources Research in the Twenty-first Century*, preparation of which was led by recent past WSTB chair Henry Vaux. It will examine some of the same issues as this report, but in more depth. For more information, contact WSTB Director Stephen D. Parker at 202-334-3422 or *sdparker@nas.edu*. Readers who would like to contribute at this juncture are invited to suggest prospective committee members.

NRC MEETINGS

November 28-30, 2001
Committee on Restoration of the Greater Everglades Ecosystem
Fort Myers, FL

December 17-18, 2001
Committee on Bioavailability
Irvine, CA

December 18-19, 2001
Committee to Assess the U.S. Army Corps of Engineers Methods of Analysis and Peer Review for Water Resources Project Planning: Coordinating Committee
Washington, DC

January 10-11, 2002
Committee to Assess the U.S. Army Corps of Engineers Methods of Analysis and Peer Review for Water Resources Project Planning: Peer Review Panel
Washington, DC

Assessing the TMDL Approach to Water Quality Management
2001
This report reviews the scientific basiss underlying the development and implementation of Total Maximum Daily Loads progam for water pollution reduction. Available for $28.25 *(see order form)*.

Classifying Drinking Water Contaminants for Regulatory Consideration
2001
This report presents new conceptual approach to the generation of future Candidate Contaminant Lists and explores the feasibility of developing and using mechanisms for identifying emerging microbial pathogens for research and regulatory activities. Available for $42.00 *(see order form)*.

Envisioning the Agenda for Water Resources Research in the Twenty-first Century
2001
This report discusses the future of the nation's water resources and appropriate research needed to promote sustainable management of those resources. Available from the WSTB at 202-334-3422.

Inland Navigation System Planning: The Upper Mississippi River-Illinois Waterway
2001
This report reviews the Corps' draft feasibility study that gauges the economic viability of extending several locks on the Upper Mississippi River-Illinois Waterway. Available for $29.75 (*see order form*).

Aquifer Storage and Recovery in the Comprehensive Everglades Restoration Plan
2001
This report evaluates pilot projects for ASR in the Everglades. It makes recommendations for studies of regional impacts, water quality , and system performance. Available from the WSTB at 202-334-3422.

Investigating Groundwater Systems on Regional and National Scales
2000
This report makes recommendations concerningthe USGS Ground Water Resources Program, which is designed to do regional groundwater assessment and science. Available for $29.00 *(see order form)*.

Clean Coastal Waters: Understanding and Reducing the Effects of Nutrient Pollution
2000
This report assesses how coastal and watershed processes affect nutrient overenrichment of coastal ecosystems and recommends ways to improve research, monitoring, and management at the federal, state, and local levels. Available for $54.95 *(see order form)*.

Risk Analysis and Uncertainty for Flood Damage Reduction Studies
2000
This report reviews and assesses the U.S. Army Corps of Engineers risk analysis techniques in its flood damage reduction studies. The prepubli-cation form is available from the WSTB at 202-334-3422.

Seeing Into the Earth: Noninvasive Characterization of the Shallow Subsurface of Environmental and Engineering Application
2000
This report examined new and improved noninvasive methods for characterization of the shallow subsurface of the earth. Available for $35.00 *(see order form)*.

Natural Attenuation for Groundwater Remediation
2000
This report examines natural attenuation issues about such as public concerns, scientific bases, and the criteria for evaluating its potential for success or failure. Available for $47.95 (*see order form*).

Watershed Management for Potable Water Supply: Assessing the New York City Strategy
2000
This report evaluates the New York City watershed management plan that is allowing the City to avoid filtration of its large upstate surface water supply. A broad range of conclusions and recommendations are made, many of which are applicable to surface water supplies across the country. Available for $56.00 *(see order form)*.

Ecological Indicators for the Nation
2000
The report provides a framework for selecting ecological indicators, and also provides recommendations on several specific indicators for gauging the integrity of the nation's ecosystems. Available for $39.95 *(see order form)*.

Hydrologic Science Priorities for the U.S. Global Change Research Program: An Initial Assessment
1999
This report makes recommend-ations for the U.S. Global Change Research Program. Two broad science areas—predictability and variability of regional and global water cycles and coupling of hydrologic systems and ecosystems through biogeochemical cycles—are identified that could augment the current hydrologic sciences content of the USGCRP. Available from the WSTB at 202-334-3422.

Downstream: Adaptive Management of Glen Canyon Dam and the Colorado River Ecosystem
1999
This report evaluates the strengths and weaknesses of the Long-Term Monitoring and Research Plan of the Grand Canyon Monitoring and Research Center. Available for $41.50 *(see order form)*.

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WSTB Reports

Identifying Future Drinking Water Contaminants
1999
This report summarizes a workshop based on prioritizing potential drinking water contaminants for inclusion on future Drinking Water Contaminant Candidate Lists. Available for $45.00 *(see order form)*.

Water for the Future: The West Bank and Gaza Strip, Israel, and Jordan
1999
This report recommends that Israel, Jordan, and the Palestinian Authority work together to preserve aquatic ecosystems in the Middle East to ensure that an adequate supply of fresh, high-quality water is available for future generations. The report offers a range of findings and observations on water resource management options for this area. Available for $35.00 *(see order form)*.

New Directions in Water Resources Planning for the U.S. Army Corps of Engineers
1999
This report identifies several ways in which the Corps might reduce the time required in water project planning. The report also recommends that the federal Principles and Guidelines for Water and Land Resources Implementation Studies be thoroughly reviewed and modernized. Available for $39.00 *(see order form)*.

Hydrologic Hazards Science at the U.S. Geological Survey
1999
This report provides advice to the U.S. Geological Survey with respect to its research, interpretive studies, and data collection efforts in the area of hydrologic hazards, which includes droughts, flooding, and related phenomena. Available from the WSTB at 202-334-3422.

Improving American River Flood Frequency Analyses
1999
This report evaluates the useful-ness of various kinds of data, including historical and paleoflood data; recommends flood flow frequency distribution for the American River; and reviews recent scientific literature on climate variability and flood frequency. Available from the WSTB at 202-334-3422.

New Strategies for America's Watersheds
1999
This report provides a timely and comprehensive look at the rise of "watershed thinking" among scientists and policymakers and recommends ways to steer the nation toward improved watershed management. Available for $49.00 (*see order form*).

Setting Priorities for Drinking Water Contaminants
1999
This report provides a phased decision process for determining which contaminants on the Contaminant Candidate List are appropriate for regulatory decisions and which will require research or monitoring. Available for $35.00 (*see order form).*

Environmental Cleanup at Navy Facilities: Risk-Based Methods
1999
This report reviews and critiques risk-based cleanup methods, including those developed by the EPA and the American Society of Testing and Materials, and identifies eleven criteria that must be part of any risk-based methodology adopted by the Navy. Available from the WSTB at 202-334-3422.

Issues in Potable Reuse: The Viability of Augmenting Drinking Water Supplies With Reclaimed Water
1998
This report looks at the issues involving the use of reclaimed water to supplement drinking water supplies. It discusses issues of water treatment technology, monitoring, and testing of reclaimed water to ensure public safety. Available for $44.95 (*see order form*).

Hydrologic Sciences: Taking Stock and Looking Ahead
1998
The WSTB used the opportunity of its 1997 Abel Wolman Distinguished Lecture to assess the vitality of the hydrologic sciences by the hydrologic community. This report is a compilation of the Wolman Lecture and four invited papers, preceded by a summarizing overview. Available for $35.00 (*see order form)*.

Innovations in Ground Water and Soil Cleanup
1997
This report provides a compre-hensive review of the status of innovative technologies for subsurface cleanup. It also recommends strategies for increasing market demand for innovative remediation technologies, standardizing the collection of pilot and field test data on these technologies, and evaluating cost data. Available for $44.95 (*see order form*).

Valuing Ground Water
1997
This report examines approaches for assessing the economic value of groundwater and the costs of contaminating or depleting this resource. It suggests a framework for policymakers and managers to use in evaluating tradeoffs when there are competing uses for groundwater. Available for $39.95 (*see order form*).

Building a Foundation for Environmental Research
1997
This report outlines a new framework for organizing the research program at EPA's Office of Research and Development. The report calls for the establishment of two kinds of research *problem-driven* research and *core* research. Available from the WSTB at 202-334-3422.

Watershed Research in the U.S. Geological Survey
1997
This report is intended to assist the

USGS in improving its overall strategy for watershed research. Available from the WSTB at 202-334-3422.

Safe Water from Every Tap: Improving Water Service to Small Communities
1997
This report assesses the quality of drinking water in small communities and recommends a three-part strategy for improving it. Available for $44.95 (*see order form*).

Alluvial Fan Flooding
1996
This report provides an updated regulatory definition of alluvial fan flooding, presents criteria for assessing whether an area is or is not subject to such flooding, and provides examples of applying the definition and criteria to real situations. Available from the WSTB at 202-334-3422.

Freshwater Ecosystems: Revitalizing Educational Programs in Limnology
1996
This report provides an overview of the status of inland waters, the history of limnology, and key future problems that may face water resource managers. It recommends changes in limnology education and research to meet the needs of water resource management. Available for $54.95 (*see order form).*

A New Era for Irrigation
1996
This report explores the impacts of changing supply and demand conditions, assesses current and potential technologies that might help water users adapt to changing conditions, and considers how to mitigate short- and long-term problems associated with irrigation. Available for $39.95 (*see order form*).

Hazardous Materials in the Hydrologic Environment: The Role of the U.S. Geological Survey
1996
This report attempts to help shape the overall framework of the U.S. Geological Survey's research in hazardous materials science and technology and identifies general areas of scientific opportunity. Available from the WSTB at 202-334-3422.

River Resource Management in the Grand Canyon
1996
This report assesses the achievements and shortcomings of the Bureau of Reclamation's Glen Canyon Environmental Studies and reviews the final research done under the program. Available for $35.00 (*see order form*).

Use of Reclaimed Water and Sludge in Food Crop Production
1996
This report reviews the current state-of-the-practice, public health concerns, existing guidelines and regulations, and implementation issues of using municipal wastewater and sludge in food crop production. Available for $34.00 (*see order form*).

Wetlands: Characteristics and Boundaries
1995
This report analyzes present regulatory practice related to wetlands delineation and recommends changes that should bolster the objectivity and scientific validity of wetlands delineation and identification. Available for $42.95 (*see order form*).

Flood Risk Management and the American River Basin: An Evaluation
1995
This book reviews the U.S. Army Corps of Engineers' investigations of flood control options for the American River basin and evaluates flood control feasibility studies for the watershed. Available for $29.00 *(see order form).*

Mexico City's Water Supply: Improving the Outlook for Sustainability
1995
This bilingual report addresses the technical, health, regulatory, and social aspects of groundwater withdrawals, water use, and water quality in the Mexico City metropolitan area and recommends ways to improve the balance of water supply, demand, and conservation. Available for $30.00 *(see order form).*

Review of EPA's Environmental Monitoring and Assessment Program: Overall Evaluation
1995
This final review of EPA's Environmental Monitoring and Assessment Program (EMAP) evaluates whether EMAP's goals of assessing the status of and trends in the nation's ecosystems are achievable, given the difficult scientific, practical, and management challenges of implementing them. Available for $35.00 *(see order form).*

Alternatives for Ground Water Cleanup
1994
This report evaluates the efficacy of pump and treat systems at nearly 80 contaminated sites, providing detailed case studies for several of the sites. Available for $64.75 *(see order form; print on demand).*

Ground Water Recharge: Using Waters of Impaired Quality
1994
This report examines the use of waters of less-than-ideal quality, such as treated municipal wastewater and urban stormwater runoff, as sources for artificial groundwater recharge projects. Available for $59.25 (*see order form; print on demand*).

Managing Wastewater in Coastal Urban Areas
1993
This report examines the problems of wastewater and stormwater management in coastal urban settings, recommending a system of integrated coastal management. Available for $54.95 *(see order form).*

In Situ Bioremediation: When Does It Work?
1993
This report provides direction for decision-makers and offers detailed explanations of the processes involved in *in situ* bioremediation, circumstances in which it is best used, and methods for evaluating the results of bioremediation projects. Available for $34.95 *(see order form)*

USGS Ambassador for Science Award

Stephen D. Parker, WSTB Director received the 2001 Ambassador for Science Award from the U.S. Geological Survey for his significant contributions to science policy on a wide range of important national issues and his specific assistance to USGS regarding the technical quality of the Agency's water resources programs. As Director of the Water Science and Technology Board (WSTB), Steve works with hundreds of technical experts from academia, state and federal agencies, and local agencies and the scientific community. Steve has been with the Academy for almost 20 years.

NRC Staff Award

Anita Hall was among the recipients of the 2001 Distinguished Service Awards from the National Academies at a ceremony held on October 1. Anita has been on staff at the Water Science and Technology Board for over 14 years. In her award, Dr. Bill Colglazier commended Anita as the epitome of quiet competence and a wealth of institutional knowledge. In one of four nominations that Anita received for the award, a WSTB staff member expressed his appreciation for the way she "helped me figure out what I was supposed to be doing." Anita is an administrative assistant at WSTB.

NRC Community Service Award

Patricia Jones Kershaw was awarded the very first 2001 Community Service Award by the National Academies for her dedication and commitment to extending her support and time to numerous community service efforts. Tricia not only coordinates an *Annual Christmas Adopt-A-Family* program but she also personally delivers the donated goods and funds to the adopted families. She also coordinates *Race for the Cure* and several other activities that directly benefit small and large causes. Patricia is a research/study associate at the Natural Disasters Roundtable.

Water Science and Technology Board

The Water Science and Technology Board (WSTB) is a unit of the National Research Council, which serves as an independent advisor to the federal government on scientific and technical questions of national importance. The National Research Council, jointly administered by the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine, brings the resources of the scientific and technical community to bear on national problems through its volunteer advisory committees.

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