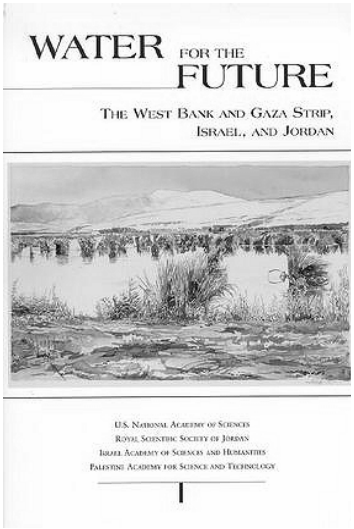
Water for the Future: The West Bank and Gaza Strip, Israel, and Jordan

By David Policansky, Sheila David, and Laura Ehlers

On March 2, 1999, at a news conference in Ramallah, West Bank, committee chairman Gilbert White introduced a new report from the WSTB and the Board on Environmental Studies and Toxicology entitled *Water for the Future: The West Bank and Gaza Strip, Israel, and Jordan.* The report recommends that Israel, Jordan, and the Palestinian Authority work together to preserve aquatic ecosystems in the region to ensure that an adequate supply of fresh, high-quality water is available for current and future generations. The report recommends further that water planning in the region: a) be based on regional/hydrologic boundaries, and not national boundaries; b) integrate water quality and water quantity considerations; and c) consider the entire range of options available to address the region's water problems. It was written by a committee of scientists from Israel, Jordan, the West Bank and Gaza, the United States, and Canada, and was a joint activity between the National Research Council, the Israel Academy of Sciences and Humanities, the Palestine Academy for Science and Technology, and the Royal Scientific Society of Jordan.

Fresh water in the arid and semi-arid regions of the Middle East is in short supply, and it is "barely sufficient to maintain a quality standard of living," according to Dr. White. "As the population in this region continues to grow and economic development increases, water supplies will be strained even further. Fortunately, there are many tested, effective measures available for conserving and protecting water and its sources. These countries must work together to ensure that ecosystems are preserved and adequate water supplies are sustained, not only for the near term, but also for generations to come."



Approximately 12 million people live in study area of the report, which includes Israel, Jordan, and the West Bank and Gaza Strip. The population is increasing by an average of 3 percent or more each year, which is problematic for a region that receives less than 250 millimeters of rainfall annually. Total water use, estimated to be about 3,183 million cubic meters in 1994, has been increasing steadily as economic and agricultural development continues.

One result of this increased pressure on freshwater water resources is the deterioration of water quality in current supplies. The report states that some 97 percent of the region's wetlands, which are important for water purification and flood and erosion control, have been drained to support human activity. As agricultural activities expand, rivers, aquifers, lakes, and streams are being polluted with runoff containing fertilizers and pesticides. Reversing these trends by preserving natural ecosystems is essential to the future availability of fresh water in the region, according to the report.

The significant contribution of ecosystem services to the sustainability of water supplies is stressed throughout the report. The term "ecosystem services" refers to any attribute of natural systems (both terrestrial and aquatic) that is beneficial to human society, nature, and wildlife. Vegetation controls stormwater runoff and filters polluted water, and it reduces erosion and the amount of sediment that makes its way into water supplies. Streams assimilate wastewater, lakes store clean water, and surface waters provide habitat for many plants and animals. The role of ecosystems in sustaining water supplies has largely been overlooked in the context of the region's water supplies. For example, large river-management projects that divert water to dry areas have promoted intensive year-round agriculture and urban development. This has resulted in declining river water quality and quantity.

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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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The report suggests that water managers take stock of renewable water resources that might be lost if land is developed and identify precise objectives for maintaining water-dependent ecosystems. "Without the services provided by natural ecosystems, it will be extremely difficult and expensive—perhaps impossible—to sustain high-quality water supplies for the people in the study area" said the report.

Regardless of national boundaries, the study area is hydrologically interconnected. Thus, the report recommends that responsible national and international agencies take a regional approach to water resources planning by acquiring data on water use and water availability using consistent methods, techniques, and protocols and by encouraging open exchange of scientific research relevant to these shared water resources. For example, before tapping into ground water that underlies Israel and the West Bank, water managers across the region should first plan the location of wells to enhance efficient and equitable water distribution.

The report offers a range of findings and observations on water resource management options for the study area. Most of the options relate to improving the efficiency of water use—that is, they involve conservation and better use of proven technologies. For each option, the report asks how effective the options will be in enhancing available water supplies, whether the options are technically and economically feasible, what the environmental impact of the options will be, and what the implications for present and future generations will be. The report considered two demand management options: conservation and appropriate pricing policies, and a host of supplies augmentation alternatives.

Conservation. The report examines voluntary, domestic water conservation measures include adopting water-saving plumbing fixtures; limiting outdoor uses of water; and adopting water-saving practices in commerce. Involuntary domestic water conservation measures are suggested, such as repairing leaking distribution and sewer systems; metering all water connections; and rationing, restricting, and recycling water use. The report suggests designing new water systems to reduce use and treatment costs by incorporating dual water systems to use nonpotable water for toilet flushing, garden irrigation, and similar applications.

Conservation measures have already been highly effective in reducing the study area's substantial agricultural water use. However, as regional nonagricultural water demand increases, the role of agriculture in the economy of the study area may need to be reevaluated. The report suggests harvesting local runoff and floodwaters to increase water supplies for dryland agriculture, and cropping intensively within closed environments. Brackish water, abundant in the study area's dryland aquifers, can also be used for irrigating salinity-resistant crops and for intensive aquaculture in deserts. Finally, treated local or transported wastewater for subsurface drip irrigation of orchards and

forage can dramatically increase the production of the area's drylands in a sustainable manner.

Prices and Pricing Policies. Pricing policies that emphasize economic efficiency are appropriate for regions of increasing water scarcity, such as the study area. Pricing policies that encourage conservation, including marginal cost pricing, time-of-use pricing, and water surcharges, generally work best where the quantity of water demanded is reasonably responsive to price.

Augmenting Supplies. Despite the best efforts to reduce water demand through conservation and economic policies, the report states that the available freshwater sources in the study area will probably have to be augmented by other sources to meet future needs. There is a premium for storage of rainfall runoff when it occurs. In more arid parts, subsurface water storage has been and should continue to be used extensively. Additional regional water supplies can be obtained by reclaiming wastewater, by developing sources of lower quality water, by importing water from outside the study area, by transferring unused water within the study area, and by attempting to increase the renewable amount of water available.

The needs of future generations should be taken into account, according to the report. Water resource managers are encouraged to explore a variety of measures to ensure that adequate water supplies will be available, such as monitoring water quality, assessing long-term implications of various water projects, and maintaining investments in dams, sewage treatment plants, and water systems.

As a follow up activity to the report, a colloquium is being planned on Improving Water Management and Water Quality in the Middle East Region. The colloquium's objective is to begin developing more concrete plans for improving water management and quality in the Middle East. Experts from the region will be convened by the four scientific academies to:

1. Assess available information on the status of water supplies and pollution in the study region to determine the scope and gravity of the problems and to identify those areas for which information is lacking.
2. Identify appropriate water supply and water pollution control concepts and organize a framework for conducting research necessary to expand upon these concepts.
3. Prioritize and organize specific studies, planning activities, research, and monitoring activities that could be pursued by scientists and engineers in the region.

The three-day colloquium will be an opportunity to present reports, review information on existing and proposed plans for water supply improvements and pollution control, and plan a research and development program for pursuing specific projects in the region. The primary researchable topics will be identified and multinational-working groups will outline a program of collaborative study and research, including an educational component, that will likely lead to action programs for governments and international agencies.

Sheila David and David Policansky were the NRC study directors for the Committee on Sustainable Water Supplies for the Middle East. A copy of the report can be ordered from the National Academy Press at 800-624-6242.

NEW REPORTS

New Directions in Water Resources Planning for the U.S. Army Corps of Engineers

by Jeffrey Jacobs

Prior to 1986, funding for Army Corps of Engineers studies and projects was usually provided entirely by the federal government. The ground rules of project financing changed greatly with the passage of the Water Resources Development Act of 1986 (WRDA), which required local sponsors to provide cash contributions for most types of projects. Along with the greater financial commitment required of local sponsors came a greater voice in project planning and review of alternatives. As local stakeholders have become more involved in project planning, some have become impatient with the Corps' planning procedures and have lodged complaints about the cost and time requirements of Corps planning.

The length of the typical Corps planning study is roughly 5.6 years, which includes reconnaissance and feasibility studies. The Corps' planning procedures do not take significantly longer than the planning of similar private sector water projects, according to a new report from the WSTB entitled *New Directions in Water Resources Planning for the U.S. Army Corps of Engineers*. Though the report identifies several ways in which the Corps might reduce the time required in water project planning, the report concludes that the duration and cost of the Corps' planning procedures are generally reasonable.

The report also recommends that the federal Principles and Guidelines for Water and Land Resources Implementation Studies (P&G) be thoroughly reviewed and modernized. This document is an important guide to Corps planning that has not been modified since 1983. The NRC report recommends that the P&G be amended to reflect updates in analytical techniques and shifts in public values and federal agency programs. In the past, the federal Water Resources Council, a now defunct organization, would have updated the P&G. To help update the P&G, and to provide better federal-level coordination of the nation's water policies, the report recommends that a new body within the Executive Office of the President be created to provide federal oversight of the nation's water resources and programs.

Due largely to the cost-sharing provisions mandated by the WRDA, the Corps has shifted attention away from larger,

river basin planning perspectives toward local projects and concerns. This has resulted in a conundrum for the Corps, which, as a federal steward of the nation's waters, must promote projects consistent with the nation's economic and environmental goals. These larger concerns, however, are not always consistent with the interests and goals of the Corps' local project sponsors. Resolving such national/local tensions will be a serious challenge to the Corps in the early 21st century.

Some of the report's recommendations would actually lengthen the Corps' planning process, such as more analyses of the downstream and basinwide implications of proposed flood damage reduction projects. The Corps' planning studies are lengthy due to federal, state, and local regulations and the Corps' own stringent requirements. To maintain the quality of its studies, the Corps must keep abreast of updates in analytical techniques and continue to incorporate input from local sponsors and interests. Thus, while there may be ways in which the Corps may further streamline its planning procedures, the report concludes that further shortening those procedures will not necessarily result in better water resources planning.

The study was funded by the U.S. Army Corps of Engineers and was chaired by David Moreau of the University of North Carolina, Chapel Hill. A limited number of copies of the report will be available in late March from the WSTB on a first come-first served basis, at 202-334-3422. Thereafter, the report will be available from the National Academy Press at 800-624-6242 for $42.00.

Improving American River Flood Frequency Analyses
by Mark Gibson

Sacramento is one of America's most floodprone cities, lying at the confluence of the Sacramento and American Rivers. Having struggled with flooding issues for over 150 years, the city is dependent upon reliable flood-frequency estimates to reduce flooding risk. An evaluation of such estimates forms the core of a new WSTB report, *Improving American River Flood Frequency Analyses*.

This report marks the second time that the WSTB has provided advice to the Army Corps of Engineers on how to decrease the risk of American River floods. A major flood in 1986 served as the initial impetus for identifying an acceptable and feasible set of measures to decrease flood risk. Due to the controversial nature of the problem, Congress directed the Corps to engage the NRC as an independent advisor. And in 1995, the WSTB issued *Flood Risk Management and the American River Basin: An Evaluation*, outlining a flood risk reduction strategy for the city.

Subsequent to the release of the first report, and in the midst of technically and politically difficult decision-making regarding flood risk, in January 1997 the American River experienced a major flood, suggesting that it would be necessary to recompute flood flow frequency relationships. In February 1998, the Corps published a controversial revised flood flow frequency analysis for the American River at Fair Oaks. That analysis produced a flood frequency curve indicating that large floods are more likely than previously thought. Based on the newly estimated 100-year flood discharge, the levees protecting Sacramento no longer provide protection against the 100-year flood. The revised flow frequency relationships had immediate policy implications and also reduced the estimated level of protection provided by the flood control alternatives that were being considered for Sacramento.

In response, the Corps again requested the assistance of the NRC to provide an independent scientific assessment of flood frequency relationships. Eight months of intense analyses by the committee produced a report that (1) evaluates the usefulness of various kinds of data, including historical and paleoflood data; (2) recommends a flood flow frequency distribution for the American River; and (3) reviews recent scientific literature on climate variability and flood frequency.

The recommended flood distribution is based on both the systematic record of three-day rain flood flows estimated for Fair Oaks, California and on the historical record for 1848-1904, which includes an estimated large three-day flow associated with an 1862 historic flood. The method used by the committee is consistent in spirit with the guidelines set forth in Bulletin 17B, a 1981 report that specifies a uniform method for flood frequency analysis. Flood quantiles estimated by the committee are slightly less than those made by the Corps in 1998. If adopted, the 100-year flood estimate recommended in the report could result in removal of some areas of Sacramento from designated risk zones, by a slight margin. However, because the uncertainties in this estimate are so large, it will be difficult to accurately determine the flood risk of certain areas. Thus, the report strongly recommends that authorities expeditiously develop a flood risk management strategy that addresses the significant risk of flooding in Sacramento.

Although flood frequency analysis has been practiced for nearly a century and has seen significant developments in both technological and sociopolitical contexts, much remains to be learned. The report recommends the establishment of a new interagency research effort focused on flood risk assessment and management. The impetus for such action is clear: rising property damages and loss of life; 30 years of experience with the National Flood Insurance Program; aging federal policy and technical guidance; improvements in scientific methods of computing and modeling; new understanding of paleohydrologic and climate variability issues; and a growing data base and availability of information. This effort should emphasize research on coordinated flood risk reduction, including meteorologic, hydrologic and hydraulic, and policy and socioeconomic aspects of flood management.

To order the report, contact National Academy Press at 800-624-6242 or visit their website at *http://www.nap.edu*.

UPDATE: CURRENT PROJECTS

Studies in Land-Surface Hydrologic Sciences

On February 8-9, the NRC's new Committee on Hydrologic Science held its first meeting in Washington, DC. This committee has been established jointly by the WSTB and the Board on Atmospheric Sciences and Climate to (1) help assure the best and most appropriate hydrologic input to U.S. and international programs with hydrologic components and (2) guide the proper development of the field of hydrologic science so as to be of maximum value to the national and international scientific enterprise. This activity builds on a base begun with the WSTB's 1991 report *Opportunities in the Hydrologic Sciences* and other subsequent efforts. It is sponsored by the National Science Foundation, the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, the National Weather Service, the National Aeronautics and Space Administration, and the Army Research Office. Charter members of this continuing committee are: Dara Entekhabi, chair, Massachusetts Institute of Technology; Mary Anderson, University of Wisconsin; Roni Avissar, Rutgers University; Roger Bales, University of Arizona; Eville Gorham, University of Minnesota (retired); Marc Parlange, Johns Hopkins University; Christa Peters-Lidard, Georgia Tech; Kenneth Potter, University of Wisconsin; and Eric Wood, Princeton University.

Following orientation and briefings with several federal agency liaisons, the committee quickly resolved to begin writing a report that will serve as a science plan for forthcoming hydrologic initiatives. The committee anticipates that a beneficial function of this effort will be to consolidate scientific questions from within its disciplinary elements and at the interfaces of other sciences into such a coherent science plan. The committee identified several synergistic "grand challenges" for hydrologic science and developed a workplan to begin writing its report. The next meeting has been scheduled as a writing workshop for April 6-8 in Washington, DC with the goal of producing a report by summer. For information, contact WSTB director Stephen Parker at 202-334-3422 or *sdparker@nas.edu*.

Workshop on Emerging Drinking Water Contaminants

The November/December 1998 newsletter summarized a new WSTB report, *Setting Priorities for Drinking Water Contaminants*, written by the joint WSTB/Board on Environmental Studies and Toxicology Committee on Drinking Water Contaminants. The focus of the report, which was requested by the EPA, is the legally mandated and quickly evolving Drinking Water Contaminant Candidate List (CCL). The report recommends a decision framework and related criteria for determining which contaminants already on a CCL are ready for a rulemaking decision, which are ready for guidance development, which need additional occurrence data, and which are a priority for additional health effects, treatment, or analytical methods research.

As a follow up activity to the report, on December 2-3, 1998, the committee convened a workshop on emerging microbiological and chemical drinking water contaminants, associated analytical and treatment methods, and existing and proposed environmental databases. Following the workshop, the committee met to develop consensus-based recommendations for the EPA regarding the creation of future Drinking Water Contaminant Candidate Lists. These recommendations and the presented papers will be published together as workshop proceedings in late spring of 1999.

The initial report is available from the National Academy Press at 800-624-6242. The committee was chaired by Warren Muir of the Hampshire Research Institute. For more information, contact Mark Gibson at 202-334-3422 or *mgibson@nas.edu*.

Committee on Grand Canyon Monitoring and Research

The Committee on Grand Canyon Monitoring and Research is reviewing the Grand Canyon Monitoring and Research Center's (GCMRC) Long-Term Strategic Plan and annual plans. The GCMRC, established in Flagstaff, AZ by the U.S. Department of the Interior in 1995, is responsible for monitoring the Colorado River ecosystem between Glen Canyon Dam and Lake Mead. Monitoring and research information collected by the GCMRC is provided to several stakeholders as part of the larger Adaptive Management Program (AMP) established for the Colorado River in Grand Canyon by the Department of the Interior. Stakeholders include Native American tribes, federal and state natural resource managers, conservation groups, and private entities and individuals. The committee held its third and final meeting in Tempe, AZ on February 11-12. The committee is revising its draft report, which it intends to send to external review in early April. James Wescoat of the University of Colorado, Boulder chairs the committee. For more information, contact study director Jeffrey Jacobs at 202-334-3422 or *jjacobs@nas.edu*.

Committee on Subsurface Contamination

The Board on Radioactive Waste Management (BRWM) and the WSTB have formed a fast-track committee to advise the U.S. Department of Energy (DOE) on a science plan for subsurface contamination research sponsored by the Department's Environmental Management Science Program. This science plan will describe the significant subsurface contamination problems at DOE sites that cannot be addressed with current technologies, identify the knowledge gaps relevant to these problems, and develop a research plan

to help fill these gaps. This plan will take account of research being sponsored by other federal and state agencies and will identify research opportunities where the Environmental Management Science Program can make significant contributions to DOE's hazardous waste site remediation.

The first and second meetings were held in Fall 1998. The third meeting of the committee was held December 15-17, 1998 in Richland, WA and included briefings on the western sites and a tour of the Hanford Site. A fourth meeting was held in Washington, DC on January 28-29, 1999 and included presentations from federal agencies that have similar research programs such as the USGS, the EPA, and the Department of Defense.

In early December 1998 the committee published an interim report. This report, which offered advice to DOE on the technical content of their FY99 call for proposals, can be ordered from the National Academy Press at 800-624-6242. For additional information, contact study director Kevin D. Crowley at 202-334-3066 or *kcrowley@nas.edu*.

Risk-Based Analyses for Flood Damage Reduction Studies

The U.S. Army Corps of Engineers is the federal agency primarily responsible for constructing the nation's flood damage reduction projects. In order to account for uncertainties in fundamental data and statistical relationships, the Corps has begun using risk-based analysis (RBA) to make decisions regarding project performance and design parameters. A WSTB study committee is reviewing the Corps' use of RBA and its implications regarding project formulation, economic justification, value added, and engineering and safety implications. It is also reviewing Corps studies that have used RBA, examining both the scientific validity of RBA and implications of its use for Corps policies and procedures. The committee held its first meeting in Washington, DC, on December 14-15 and its second meeting in Davis, CA, on February 25-26. Gregory Baecher of the University of Maryland chairs the committee. For further information, contact study director Jeffrey Jacobs at 202-334-3422 or *jjacobs@nas.edu*.

Committee on Eutrophication, Coastal Processes, and Watershed Management

At its third meeting, held January 27-28 in Irvine, CA, the Committee on Eutrophication, Coastal Processes, and Watershed Management, focused attention on monitoring and assessment activities, macrophyte communities, the differences between the Chesapeake Bay and the San Francisco Bay, and the causes of significant eutrophication. The group also heard about the ongoing total maximum daily load-setting process of the Newport Bay area.

The purpose of this joint WSTB/Ocean Studies Board effort is to assess how coastal and watershed processes affect eutrophication of coastal ecosystems; recommend ways to improve coordination and effectiveness of research, monitoring, and management being conducted at the federal, state, and local levels; and identify means to remove barriers that impeded implementation of techniques to reduce coastal eutrophication. It will also evaluate the effectiveness of strategies for monitoring watersheds, atmospheric deposition, and coastal areas. To date, the committee has focused on gathering information about the wide range of eutrophication-related research and monitoring activities that are underway. The committee is working on its report and is on schedule for completion in late 1999. The study is chaired by Robert Howarth of Cornell University. Sponsors include NOAA, EPA, USGS, and the Electric Power Research Institute. For more information, contact study directors Dan Walker (OSB) at 202-334-1798 or Chris Elfring (WSTB) at 202-334-3422.

New York City's Watershed Management Strategy

The WSTB Committee to Review the New York City Watershed Management Strategy held its fifth meeting January 14-16 in Clearwater, FL. This study, which was requested by the New York City Office of the Comptroller, involves a scientific evaluation of the New York City Watershed Memorandum of Agreement. This document establishes a comprehensive watershed protection program to protect drinking water reservoirs in the Catskill/Delaware watershed and enable New York City to avoid filtering its drinking water supply. The entire fifth meeting was spent in closed session evaluating the report chapters and debating conclusions and recommendations. The final meeting will be held April 8-10 in Woods Hole, MA during which the committee will review a completed second draft of its report. A prepublication version of the final report should be available in early fall 1999. Charles O'Melia of the Johns Hopkins University chairs the committee. For information, contact study director Laura Ehlers at 202-334-3422 or visit our website at *http:/www2.nas.edu/nywtrshd*.

Committee on USGS Water Resources Research

The Committee on USGS Water Resources Research is currently making plans for its next meeting, to be held in Tucson, AZ on April 19-20. With its report *Hydrologic Hazards Science at the U.S. Geological Survey* published and disseminated in January, this committee has shifted gears to the subject of regional ground water assessments. The Tucson meeting will focus on further development of the Committee's next report, *Investigating Ground Water Systems on Regional and National Scales,* to be published in the year 2000. Several rotations in the membership of this long-time committee occurred in the fall but were not

reported in the November/December issue of *WSTB*. The current roster is: Kenneth R. Bradbury, chair, Wisconsin Geological and Natural History Survey, University of Wisconsin; Victor R. Baker, University of Arizona; Ana Barros, Pennsylvania State University; Michael E. Campana, University of New Mexico; Kimberly A. Gray, Northwestern University; C. Thomas Haan, Oklahoma State University; David H. Moreau, University of North Carolina; Stuart Schwartz, Hydrologic Research Center, San Diego; Donald I. Siegel, Syracuse University; Mary W. Stoertz, Ohio University; and Kay D. Thompson, Washington University, St. Louis. For additional information, contact study director Stephen D. Parker at 202-334-3422 or *sdparker@nas.edu*.

Natural Attenuation of Subsurface Contaminants

The Committee on Intrinsic Remediation held its fifth meeting December 10-11 in Irvine, CA. The meeting was a writing session focused on revising the committee's draft report. The report is scheduled to be released in the fall of 1999, after further work by the committee and peer review. The report will assess current scientific understanding of natural processes that can lead to contaminant degradation or immobilization in soil and ground water and evaluate current protocols for use of natural attenuation. Included in this scientific assessment will be discussion of the use of models for predicting the fate of contaminants under conditions of natural attenuation. The report will also recommend strategies for involving affected communities at sites where natural attenuation is proposed as a remedy. The committee is chaired by Bruce Rittmann of Northwestern University. For additional information, contact study director Jackie MacDonald at 202-334-3422 or *jmacdona@nas.edu.*

Indicators for Monitoring Aquatic and Terrestrial Environments

The Committee to Evaluate Indicators for Monitoring Aquatic and Terrestrial Environments is assessing a range of issues surrounding the selection of indicators useful for monitoring ecosystems. This study was requested by the EPA, which, given its responsibility for protecting the nation's natural resources, needs accurate information about environmental conditions and trends. The committee is addressing the potential value of biological indicators and indices, key ecosystem properties for establishing indicators, and different sources and methods used in identifying useful indicators. The study is managed jointly by WSTB and the Board on Environmental Studies and Toxicology (BEST) and is chaired by Gordon Orians of the University of Washington. After completing all meetings last fall, the report is currently undergoing external review. For more information, contact David Policansky at 202-334-2234 or Jeffrey Jacobs at 202-334-3422.

Environmental Remediation at Naval Facilities

Since the dissemination of its first report, *Environmental Remediation at Naval Facilities: Risk-Based Methods*, the Committee on Environmental Remediation at Naval Facilities has developed new study topics to pursue during a possible second phase. These include (1) developing a quantitative framework for evaluating the cost and effectiveness of remedies, (2) describing how and why to conduct long-term monitoring of contaminated sites, and (3) providing advice on how to reduce uncertainty through the use of formal uncertainty analyses and other mechanisms. While Navy officials deliberate on the most appropriate issue to pursue, the committee chair and study director are disseminating information from the first phase during several conference appearances in Spring 1999, including lectures for Navy remedial project managers at all Naval Division Headquarters. Edward J. Bouwer of the Johns Hopkins University chairs the committee. For more information, contact study director Laura Ehlers at 202-334-3422 or *lehlers@nas.edu*.

Riparian Zones: Functions and Strategies for Management

The joint WSTB/BEST study of the functions of riparian zones and strategies for improved management of these areas will be commencing shortly. Unlike wetlands and waterbodies, riparian zones are not specifically regulated. And because they are frequently well oxygenated, they do not qualify for categorization as wetlands. This study will describe the nature and functions of riparian zones and assess the condition and trends of riparian habitats with respect to water quantity and quality. It will also review criteria for the improved management of riparian lands and for mitigation of impacts on such habitats by identifying conflicting policies or objectives and suggesting methods for resolving them. Funding has been secured from EPA, USDA, USGS, the Bureau of Reclamation, and the National Science Foundation. The study is likely to include 4 meetings over 18 months. Nominations are now being gathered for committee membership, and the first meeting is scheduled for August, 1999. To suggest nominations for the committee, contact study director Laura Ehlers at 202-334-3422 or *lehlers@nas.edu*.

Prospects for the Privatization of Water Services in the United States

The WSTB has approved an initiative that would evaluate the prospects for and likely effects of privatization of water services (water supply and sewage and wastewater treatment) systems in the U.S. There are several possible privatization arrangements, ranging from the contracting of some services and repairs to the private sector, to the sales of entire public water systems to a private vendor. Though

interest in the theories and practices of privatization of public water utility systems in the U.S. is high, studies of the long-term implications of privatization of these systems have been few. The likelihood of full funding for a committee study as planned appears high. For further information, contact Jackie MacDonald at 202-334-3422 or *jmacdona@nas.edu*.

Site (Seeing Into the Earth)

A committee overseen by the Board on Earth Sciences and Resources (BESR), with assistance from the WSTB, should soon be completing a two-year study of noninvasive methods for characterizing the shallow subsurface of the earth. The ability to characterize the shallow subsurface is essential for many environmental and engineering concerns. The committee is evaluating new and improved noninvasive characterization methods as well as addressing technical and institutional barriers to implementing new methods. Recently, the committee's report, titled *Seeing Into the Earth: Characterization of the Shallow Subsurface for Environmental and Engineering Applications*, was sent to external reviewers. The report should be published and disseminated by late Spring. Phillip Romig of the Colorado School of Mines chairs the committee. For information, contact study director Thomas Usselman at 202-334-2744.

PREVIEW: FUTURE PROJECTS

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

The U.S. Geological Survey (USGS) has recently requested that the NRC convene a committee to review the National Water Quality Assessment Program (NAWQA). This seven-year-old, $70 million/year national program was designed to describe the status of, trends in, and factors affecting surface and ground water quality in the U.S. The WSTB has provided advice to the USGS regarding NAWQA on three occasions in the past. The current effort would focus on four particular areas of NAWQA and make suggestions for improvement. First, it will suggest methodologies to improve understanding of the causative factors affecting water quality conditions. Second, it will assess whether information produced in the program can be extrapolated to allow inferences about water quality conditions in areas not studied intensely under NAWQA. Third, the project will examine current priority issues (e.g., pesticides, nutrients, volatile organic compounds, and trace elements) selected for broad investigation under NAWQA for completeness. It will suggest other pollutants, e.g., microbial pathogens, that might be studied on a national basis in addition to those already under investigation. Finally, the project will make recommendations on aggregation and presentation of information generated at the study unit scale so that it is meaningful at the regional and national levels.

The study will be carried out over a 16-month period, during which the committee will meet four times. For more information and to suggest committee membership, contact study director Laura Ehlers at 202-334-3422 or *lehlers@nas.edu.*

Bioavailability of Contaminants in Soil and Ground Water

The WSTB is preparing to launch a new study of processes that affect availability of contaminants in soils and sediments to humans and ecosystems. A variety of mechanisms–from sorption on solid materials to biological and chemical transformations–can render environmental contaminants present virtually harmless to human and ecological systems. Yet existing risk assessment tools do not adequately account for these mechanisms. This study will provide a review of tools for assessing bioavailability of contaminants and how to use them in risk assessment. It will also examine how to assess the effects of contaminant treatment methods on bioavailability.

The proposal for the study was developed subsequent to a November planning workshop chaired by WSTB member Richard Luthy of Carnegie Mellon University. The workshop involved approximately two dozen scientists with expertise in bioavailability from academia, government agencies, consulting firms, and industry. The WSTB is now seeking funds to support the study. If you are interested in sponsoring this project or have questions about the study, contact WSTB associate director Jackie MacDonald at 202-334-3422 or *jmacdona@nas.edu*.

Assessment and Control of Nonpoint Source Pollution

Nonpoint source (NPS) pollution has become the major threat to water quality in the nation's waterbodies, both coastal and inland. NPS pollution is associated with a wide variety of human activities that involve changes in vegetative cover, disturbance of soil, or alteration of hydrology. In September 1997, a strategic planning session of the WSTB proposed a new study that would evaluate several important aspects of nonpoint source pollution. The 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. The study would complement the ongoing efforts of the Committee on Eutrophication, Coastal Processes and Watershed Management by focusing more on inland nonpoint sources of pollution and considering a broader

range of pollutant types. It would result in a written report that should have broad appeal to state and federal regulatory agencies.

On February 23, six federal agency representatives attended a workshop at the NRC which was intended to introduce the study proposal and gauge interest in its content. The response from the agencies was enthusiastic, and more formal proposals are being sent to those organizations. To suggest additional funding sources or possible committee membership, contact study director Laura Ehlers at 202-334-3422 or *lehlers@nas.edu*.

Functions and Values of Aquatic Ecosystems

Plans are still developing for a WSTB study of methods for assessing functions and values of aquatic ecosystems. Aquatic ecosystems perform numerous valuable environmental functions, such as recycling nutrients, purifying water, attenuating floods, recharging ground water, and forming habitats for wildlife. In some cases, those functions provide services that benefit people, making them valuable to society. Unfortunately, increasing use and demands on aquatic ecosystems have often resulted in their devaluation through pollution, channelization, and development.

This study would begin with an analysis of existing functional assessment systems for aquatic ecosystems, such as those used by state and federal agencies to evaluate wetlands. The study would identify and evaluate existing economic methods to quantitatively determine the intrinsic value of aquatic ecosystems. The outcome would be a report similar to the WSTB's report *Valuing Ground Water*, except that it would focus on surface water systems instead of ground water.

The effort to develop this study is being led by WSTB vice chair Carol Johnston of the University of Minnesota and WSTB member Bill Lewis of the University of Colorado. The WSTB is in the process of developing a proposal and funding for the project. For information or if you are interested in sponsoring the study, contact WSTB associate director Jackie MacDonald at 202-334-3422 or *jmacdona@nas.edu*.

WATERMARKS

New NAE Members Luthy and Schnoor

Recently, 46 new members were elected to the National Academy of Engineering, including Richard G. Luthy and Jerald L. Schnoor. Luthy is a member of the WSTB and the Committee on Intrinsic Remediation, while Schnoor is currently serving on the WSTB committee studying New York City's watershed management strategy. Luthy, from Carnegie Mellon University was elected for his leadership in the treatment of industrial wastewaters, contaminated soils, and aquifers. Schnoor, of the University of Iowa, was elected for his research and engineering leadership in development, validation, and utilization of mathematical models for global environmental decision-making. Hearty congratulations to Dick and Jerry from the WSTB staff.

Update: Progress Made on Addressing Alluvial Fan Flooding

In 1996 the WSTB released *Alluvial Fan Flooding*, a report that explored ways to increase our understanding of flooding on alluvial fans and improve the way FEMA addresses such flooding in the context of the National Flood Insurance Program. FEMA has great influence over how communities manage and mitigate flood hazards, in large part because of its role enforcing NFIP regulations. When FEMA designates an area as subject to alluvial fan flooding, a particularly catastrophic type of flooding, rather than ordinary riverine flooding, it sets in motion specific, restrictive federal regulations. Because such a designation can affect development opportunities, it can be controversial, especially in the western United States where alluvial fans are most often located.

The WSTB report recognized the complexity of the issue with regard to both the technical and regulatory aspects and made several conclusions and recommendations regarding alluvial fan flood hazards. But when the report was released in 1996, there was limited attention to the study's findings. Now, however, as one of its FY99 Technical Services Division priority objectives, FEMA is actively evaluating how the committee's conclusions and recommendations can be incorporated into an approach for mapping and management of alluvial fan flood hazards. Two key constituencies have highlighted the need for better mapping and management of alluvial fan flood hazards: the Technical Mapping Advisory Council and the Western Governors Association. Implementation will involve (1) better documentation of current procedures for evaluating and mapping alluvial fans based on the FAN computer program and related alternative methods, (2) incorporation of additional methods for evaluating and mapping alluvial fan flood hazards including those recommended by the NRC, and (3) overall clarification and guidance with regard to the criteria and approaches used to evaluate and map alluvial fans. For more information, contact Mike Grimm at *michael_grimm@fema.gov*.

David Schindler Wins 1998 Volvo Environment Prize

David Schindler of the University of Alberta, Canada received the 1998 Volvo Environment Prize on October 27, 1998 in Brussels, Belgium. He shared the prize with Professor Malin Falkenmark of The Stockholm Water Institute. Schindler and Falkenmark were awarded the prize

for their pioneering achievements in water supply and water quality research. Schindler was the first recipient of the Stockholm Water Prize in 1991 as well. David Schindler has contributed his expertise to the WSTB program through committee service and we congratulate him.

America's Best Beaches

Dr. Steve Leatherman, Director of the International Hurricane Center at Florida International University and former WSTB committee member, has published a new book titled *America's Best Beaches*. Beaches are regionally rated by category–best swimming, walking, wilderness, sports, city, novelty, and surfing beaches, and a best overall beach is selected in each region. Leatherman developed 50 criteria to rate each beach, and two years were needed to complete the survey of the 650 major public recreational beaches in the U.S. Some of the questions answered in the book are: Is the water warm enough to go swimming at Charleston beaches in May? Where is a good hard-packed sandy beach for walking in New England? What makes the water a beautiful emerald green color in the Florida panhandle? This book should pique your interest in exploring our nation's great beaches and serve as a guide for beach lovers. To order the book, contact *http://www.topbeaches.com* or 1-888-topbeaches. The price is $17.95 plus $2.00 shipping and handling.

WSTB REPORTS

Water for the Future: The West Bank and Gaza Strip, Israel, and Jordan

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. The report is available from the National Academy Press for $35.00 *(see order form)*.

New Directions in Water Resources Planning for the U.S. Army Corps of Engineer

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. By late March 1999, the report will be available from the WSTB at 202-3343422.

Hydrologic Hazards Science at the U.S. Geological Survey

This report provides advice to the U.S. Geological Survey in respect to its research, interpretive studies, and data collection efforts in the area of hydrologic hazards, which includes droughts, flooding, and related phenomena. The report is available in limited quantities from the WSTB at 202-334-3422.

Improving American River Flood Frequency Analyses

This report is a followup study on flood frequency relationships for the American River. It evaluates the usefulness 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. The report is available in limited quantities from the WSTB at 202-334-3422.

New Strategies for America's Watersheds

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. The volume defines important terms, identifies fundamental issues, and discusses why now is the time to bring watersheds to the forefront of ecosystem management. The report is available from the National Academy Press for $42.95 (*see order form*).

Setting Priorities for Drinking Water Contaminants

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. The report is guided first and foremost by concerns about public health and concludes that there is no replacement for policy judgments by the EPA. The report is available from the National Academy Press at 800-624-6242 or online at *http://www.nap.edu* for $30.00 (*see order form).*

Environmental Cleanup at Navy Facilities: Risk-Based Methods

The fiscal and technological limitations associated with cleaning up hazardous waste sites to background conditions have prompted responsible parties to turn to risk-based methods for environmental remediation. This report reviews and critiques risk-based methods, including those developed by the EPA and the American Society of Testing and Materials. These critiques lead to the identification of eleven criteria that must be part of any risk-based methodology adopted by the Navy, a responsible party with a large number

of complex and heavily contaminated waste sites. The report is available from the National Academy Press for $34.25 *(see order form)*.

Hydrologic Sciences: Taking Stock and Looking Ahead

Hydrologic science is an important, interdisciplinary science dealing with the occurrence, distribution, and properties of water on Earth. The WSTB used the opportunity of its 1997 Abel Wolman Distinguished Lecture to assess the vitality of the hydrologic sciences by the hydrologic community. *Hydrologic Sciences: Taking Stock and Looking Ahead* is a compilation of the Wolman Lecture and four invited papers, preceded by a summarizing overview. The proceedings stress a number of needs for furtherance of hydrologic science: development of a coherent body of transferable theory and an intellectual center for the science; communication across multiple geological and environmental science disciplines; appropriate measurements and observations; and the provision of central guidance for the field. The report is available from the National Academy Press for $35.00 (*see order form)*.

Issues in Potable Reuse: The Viability of Augmenting Drinking Water Supplies With Reclaimed Water

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. The report is available from the National Academy Press for $44.95 (*see order form*).

Innovations in Ground Water and Soil Cleanup

This report provides a comprehensive 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. Hardbound copy available for $39.95 (*see order form*).

Valuing Ground Water

This report examines approaches for assessing the economic value of ground water 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 ground water. Available for $37.95 (*see order form*).

Building a Foundation for Environmental Research

This report outlines a new framework for organizing the research program at EPA's Office of Research and Development (ORD). The report calls for the establishment of two kinds of research at ORD: *problem-driven* research and *core* research. In addition, recommendations are made about how EPA can leverage its limited resources by working with the other agencies and organizations involved in environmental research. Available upon request from the WSTB at 202-334-3422.

Watershed Research in the U.S. Geological Survey

This report is intended to assist the USGS in improving its overall strategy for watershed research. The report identifies opportunities for further scientific research and emphasizes the importance of collaboration with others in maximizing the effectiveness of the agency's research efforts. Available from the WSTB at 202-334-3422.

Alluvial Fan Flooding

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.

Safe Water from Every Tap: Improving Water Service to Small Communities

This report assesses the quality of drinking water in small communities and recommends a three-part strategy for improving it. Available for $39.95 (*see order form*).

Freshwater Ecosystems: Revitalizing Educational Programs in Limnology

This report provides an overview of the status of inland waters, reviews the history of limnology, describes the key future problems that may face water resource managers, and recommends changes in limnology education and research funding to meet the needs of water resource management. Available for $49.95 (*see order form)*.

A New Era for Irrigation

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

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

This report assesses the achievements and shortcom-ings of the Bureau of Reclamation's Glen Canyon Envi-ronmental 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

This report reviews the current state-of-the-practice, public health concerns, existing guidelines and regulations, and implementations issues of using municipal wastewater and sludge in food crop production. Available for $29.00 (*see order form*).

Wetlands: Characteristics and Boundaries

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 $37.95 (*see order form*).

Flood Risk Management and the American River Basin: An Evaluation

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

This bilingual report addresses the technical, health, regulatory, and social aspects of ground water with-drawals, 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

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

This report provides guidance on how the nation can balance public health and technological realities when addressing ground water contamination. Included is a listing of nearly 80 contaminated sites that the committee reviewed and detailed case studies for several of the sites. Available for $39.95 *(see order form).*

Ground Water Recharge: Using Waters of Impaired Quality

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 ground water recharge projects. Available for $39.00 (*see order form*).

Managing Wastewater in Coastal Urban Areas

This report examines the problems of wastewater and stormwater management in coastal urban settings, recommending a system of integrated coastal management. Available for $49.95 *(see order form).*

In Situ Bioremediation: When Does It Work?

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 $29.95 *(see order form).*

NATIONAL RESEARCH COUNCIL MEETINGS

April 6-8, 1999 Committee on Hydrologic Science.
Washington, D.C.

April 7-9, 1999 Committee on Intrinsic Remediation of Subsurface Contaminants.
Irvine, CA.

April 8-10, 1999 Committee to Review the New York City Watershed Management Strategy.
Woods Hole, MA.

April 19-20, 1999 Committee on USGS Water Resources Research.
Tucson, AZ.

May 10-11, 1999 Committee on Risk-Based Analyses for Flood Damage Reduction.
Irvine, CA.

May 12-13, 1999 Committee on Eutrophication, Coastal Processes, and Watershed Management.
Woods Hole, MA.