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WATER SCIENCE AND TECHNOLOGY BOARD
ANNUAL REPORT 1987

Water Science and Technology Board
Commission on Engineering and Technical Systems
Commission on Physical Sciences, Mathematics, and Resources
National Research Council

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MASTER

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

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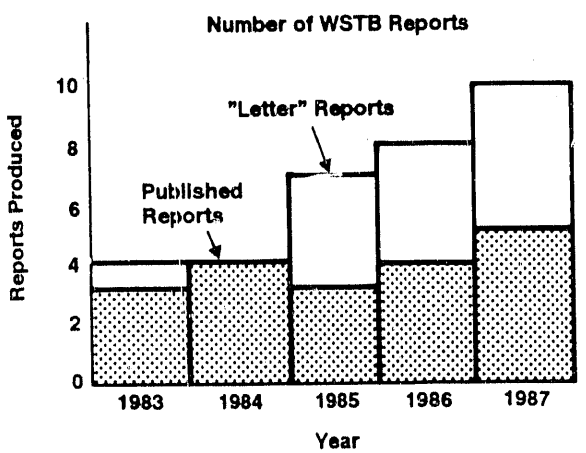
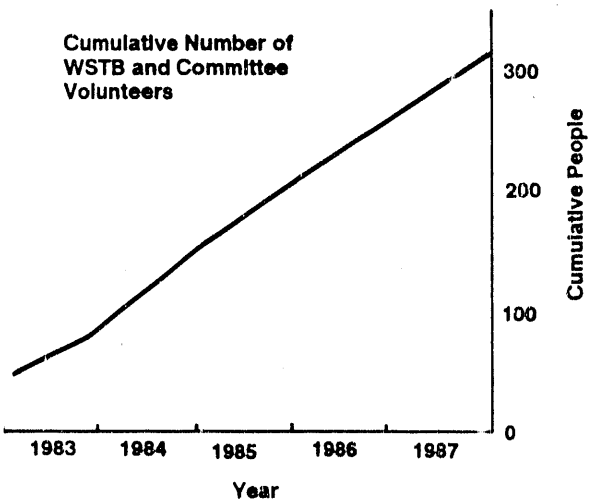
WATER SCIENCE AND TECHNOLOGY BOARD OVERVIEW

In 1982, the National Research Council chose to recognize the importance of water resource issues by establishing the Water Science and Technology Board (WSTB). During the five years since its first meeting in November 1982, the WSTB has grown and matured. The WSTB has met 14 times to provide guidance and plan activities. Under the WSTB's direction, committees of experts have conducted approximately 30 studies on a broad array of topics, from dam safety to irrigation-induced water quality problems to ground water protection strategies. Studies have ranged in scope from the oversight of specific agency projects and programs to broader scientific reviews, such as a disciplinary assessment of the hydrologic sciences initiated in 1987. In all cases, studies have the general theme of ultimately improving the scientific and technological bases of programs of water management and environmental quality. Several hundred people have played active roles in these studies. WSTB reports have had and are having important effects, and the WSTB's credibility and visibility have increased with each successive project during its five-year history. The WSTB has proven itself to be a thorough and credible source of advice for the water resources community.





The WSTB is a unit of the National Research Council (NRC), the operating arm of the National Academy of Sciences. One of the Academy's principal purposes, as defined by Congress in 1863, is to provide scientific and technological assistance to the federal government. The WSTB, like all of the NRC, is independent of the federal government, and participants in its activities serve without compensation. Participants include some of the nation's most experienced and knowledgeable scientists, engineers, resource managers, industry representatives, and citizens. The expertise and resources available to the WSTB extend across many disciplines and types of organizations concerned with water science, technology, and policy. The WSTB's independence and the resources available to it afford a unique and effective forum for addressing cohesively important issues on the national water resources agenda.

Aside from its significance as a fifth anniversary year, 1987 was marked by several events and achievements. Among projects completed were the review of Glen Canyon Dam environmental studies and a study of techniques for estimating probabilities of extreme floods. Both of these activities, the WSTB believes, should improve the scientific basis for problem-solving and decisionmaking. Of those studies initiated in 1987, the assessment of the entire discipline of scientific hydrology and the review of ground water modeling approaches and applications should produce important results.

While the WSTB's scope covers the traditional scientific and engineering aspects, it stresses as well the economic, institutional, legal, educational, and social aspects of water resources. The WSTB is accountable to and supported by two commissions of the National Research Council because of its broad and diverse interests. These are the Commission on Engineering and Technical Systems and the Commission on Physical Sciences, Mathematics and Resources. Responsibility for the WSTB's general oversight is shared equally by the two commissions; specific technical projects and administrative activities are generally assigned to one or the other commission as appropriate.

The Board strives to accomplish its mission through the following means:

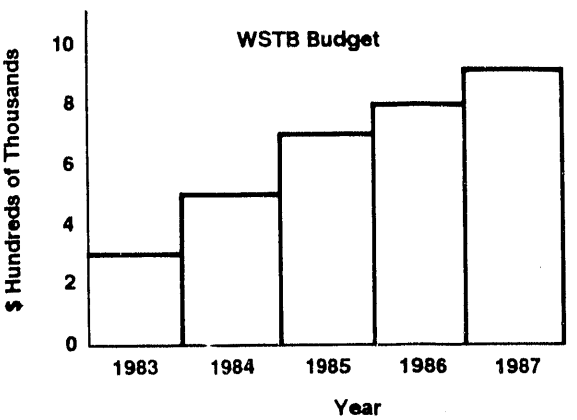
1. responding to specific requests by government agencies and others;
2. reviewing and evaluating water-related research and scientific, engineering, and technological developments;
3. initiating investigations of issues considered to be appropriate by the WSTB, its parent commissions, and the Governing Board of the NRC;
4. reviewing research and the state of the art in science, engineering, and technology related to the development and management of water and related resources, especially in relation to national objectives and priorities;
5. projecting future needs for and capabilities of multidisciplinary water-related research and education in the sciences, engineering, and technology;

6. disseminating the results of its studies, serving as a repository of scientific and engineering knowledge, and providing a forum for the exchange of information on water science and technology;
7. fostering communication among members of the professional community in the United States on national and international water resources issues; and
8. articulating water-related educational issues, including undergraduate, postgraduate, continuing education, and public education programs and their related needs for equipment and facilities.

The WSTB, comprising between 15 and 19 members from academia, industry, government, and other water-related areas, meets three times each year. At meetings, issues and research needs are considered, new initiatives are developed, and ongoing projects are monitored. Meetings of the Board serve as a mechanism for communication within the water resources community. The WSTB enjoys a productive relationship with the federal government, and most federal agencies with water resources responsibilities have active liaisons. The WSTB's staff publishes a widely distributed, bimonthly "WSTB Newsletter" and this annual report as additional ways to foster communication. Board and staff members also meet informally with federal agency representatives to discuss program needs and plan appropriate activities.

The WSTB establishes special committees and panels to conduct issue-specific studies when these are requested by federal agencies and others. Ad hoc work groups of WSTB members often are established to conduct activities such as issue evaluation, project development, committee nominations, and report reviews.

In 1987, financial support for the WSTB's general and specific project activities was provided by the U.S. Geological Survey, Federal Emergency Management Agency, Bureau of Reclamation, U.S. Department of Energy, U.S. Environmental Protection Agency, National Science Foundation, U.S. Nuclear Regulatory Commission, the State of California, the Electric Power Research Institute, the Ford Foundation, and National Research Council internal funds. The budget for general activities and special studies during 1987 totaled almost $900,000, approximately triple that of 1983.



To fulfill its goals, the WSTB is supported by a small staff, which is critical to the effective and timely performance of every Board work group. The staff helps to ensure that work group tasks are clearly understood and carefully formulated in accordance with NRC policies, that the appropriate professional communities are adequately surveyed in the selection of work group members, and that expert staff or consultant assistance is available during studies and preparation of reports.

This fifth annual report of the WSTB summarizes the Board's accomplishments during 1987, its current activities, and its plans for the future. The report also includes information on Board and committee memberships, program organization, and the reports produced. The report should provide the reader with a basic understanding of the WSTB's interests, achievements, and capabilities. The WSTB welcomes inquiries and suggestions concerning its activities and will provide more detailed information on any aspect of its work to those interested.

2

ACTIVITIES COMPLETED IN 1987

Techniques for Estimating Probabilities of Extreme Floods

In late 1985 in response to a request from the U.S. Nuclear Regulatory Commission, and as a follow-up to several previous studies related to dam safety, the WSTB undertook a study of the techniques available to estimate the probabilities of extreme floods. Estimates of the magnitudes and associated probabilities of extreme floods are required for a variety of planning and design purposes. However, since streamflow records of more than 100 years are meager in the United States, statistical analyses of historical data do not often produce credible flood estimates for much greater than the 100-year flood. Although a variety of other approaches are sometimes applied, none is widely accepted and decisions involving potential large floods are often debated. This project was carried out by a study committee (listed in Appendix A) and the charge was to (1) review and critique various approaches to estimate extreme flood probabilities, (2) identify and assess a preferred approach, and (3) identify specific research required to further develop and implement such approaches. The committee met on several occasions in 1986 and 1987 to deliberate on issues and to work on its report. The report was published by the National Academy Press in February 1988.

The committee's report (see Appendix C for an abstract and information on ordering) should serve as an important reference for people interested in the science of rare-flood hydrology. Briefly, the committee concluded that advances in the probabilistic modeling and statistical analysis of extreme events have been made and can be applied to make estimates of the probability of extreme hydrologic events possible and that research can enhance these estimates further.

The report recommends a framework for rare flood estimation based on both statistical and rainfall-runoff modeling methods. This will produce estimates for a range of floods and their probabilities rather than an estimate of a single, large flood. Developing a comprehensive statistical model would make it possible to determine the relationships between probability estimates based on flood statistics and estimates

based on rainfall-runoff modeling. This would allow joint use of all available rainfall and flood flow data in statistical estimation.

Three guiding principles were identified to improve extreme flood estimation, applicable to both statistical analysis of flow and hydrometeorological modeling: (1) substitute space for time (regionalization), (2) introduce more structure into the models, and (3) focus on extreme events.

The committee reports that precipitation-runoff models have considerable potential to provide estimates of very rare flood probabilities. The models allow separation of meteorological data and watershed processes. Of the various types of models, those that simulate the physical processes that will occur during very large events are preferred. To develop rainfall inputs, the committee recommends a synthetic-storm approach which includes storm transposition methods.

With development and research, our ability to estimate probabilities of rare floods using runoff models should improve. Research should continue on stochastic rainfall models and storm transposition methods. A key item for development is expansion of a "storm catalog," maintained cooperatively by the National Weather Service and U.S. Army Corps of Engineers. Research is necessary to determine just how this can be done most effectively.

Glen Canyon Environmental Studies

Since the turn of the century, water issues in the southwest have centered on the use of irrigation and, more recently, the generation of hydroelectric power. In recent years, however, water quality issues have drawn greater attention. Other water uses, such as, recreation and urban water supply, have gained more legal and political standing. As a result, laws are changing and the Bureau of Reclamation now is adjusting to major changes in responsibility. The agency is moving from irrigation development and power generation to operations planning and environmental management.

In 1986, a committee was appointed (see Appendix A) in response to a request from the Bureau of Reclamation for assistance in evaluating and interpretating a number of studies being conducted concerning the lower Colorado River and the operations of the Glen Canyon Dam. The government's Glen Canyon Environmental Studies (GCES) were to evaluate relationships between dam operations and the natural resources of the Grand Canyon. The WSTB was eager to conduct this review of the GCES, since the Colorado River presented a special opportunity to examine a set of investigations designed to evaluate the effects of storage and power dam operation on basic earth science phenomena. Furthermore, the WSTB saw this study as an opportunity to examine the integration of science and technology with economic, political, and legal institutions, and to bring thinking from diverse disciplines to bear on procedures used to investigate large rivers.

The committee's work began in July 1986 and ended in December 1987 when it issued its report to the Department of the Interior. The

report (see Appendix C for an abstract and information on ordering) reviews the findings and recommendations found in the July 1987 Draft Glen Canyon Environmental Studies Report prepared by the Bureau of Reclamation scientists and the planning and work leading to this document. The Department of the Interior hopes to use the GCES, which were initiated in 1982, to assist them in making decisions about long-term operational criteria for Glen Canyon Dam, opportunities for managing the Colorado River, and legal requirements for environmental protection.

In its review, the committee also took on the task of advising the Bureau on how such a large environmental/ecosystem study of the Colorado River or any large river should be approached. Specific suggestions to improve the administration of such a study include: (1) establish clear and specific objectives and set proper study boundaries; (2) complete a thorough review of existing knowledge in the planning phase; (3) include senior scientists at the beginning of environmental studies and establish a scientific oversight group; (4) separate agency administration from scientific oversight; (5) establish a report integration team at the beginning of such a project; (6) assume complexity, interactions, and indirect effects in future studies and treat monitoring as experimental data collection; (7) solicit scientific talent for the work based on a research plan; and (8) use merit competition to select researchers, including a peer review system outside the agency or agencies conducting the study.

Although the final draft GCES report recommends several options, the committee concluded that only those calling for additional work are justified. These are options 1 and 2 of the final GCES report: (1) initiate a feasibility study of possible changes in dam operations and non-operations alternatives for protecting downstream resources, and (2) continue research and monitoring of the resources.

The committee's findings provide advice to the Department of the Interior not only on specific components of the GCES but also for the design and conduct of future environmental studies of a similar nature. Although the committee does not believe that the Bureau of Reclamation can make any long-term decisions concerning the management of Glen Canyon Dam based on the Bureau's GCES, the studies have produced some excellent information, and many research results represent new knowledge that will contribute to the information base about the Colorado River.

Environmental studies of the Glen Canyon Dam will continue in 1988 and possibly beyond. As discussed in Chapter 4, a reorganized WSTB committee will continue in an advisory capacity. Its main purpose will be to help implement the recommendations of the Committee on Glen Canyon Environmental Studies.

Colloquium on Hazardous Waste Site Management: Water Quality Issues

The third in the on-going series of WSTB colloquium, "Hazardous Waste Site Management: Water Quality Issues, was held in February 1987. It addressed the emerging scientific, engineering, and

institutional issues associated with setting cleanup levels at hazardous waste sites, a major public policy question that is frequently referenced as "How clean is clean?" The colloquium provided a forum to consider the current limits of the scientific and technical data base and to debate the nonquantitative issues from the differing perspectives of the affected parties.

A steering committee of board members, working with WSTB staff, organized and hosted the colloquium. Nine papers were presented by experts affiliated with federal and state regulatory agencies, environmental and citizens' groups, and industries that generate, store, or dispose of hazardous waste. The presenters included scientists and regulators involved in setting cleanup levels, as well as the affected parties. Appendix A contains a list of principal participants.

The report (see Appendix C) resulting from the colloquium has two major sections: an overview and the background papers by individual authors. The contributors address the current methods used by regulatory agencies and the U.S. Department of Defense for establishing water quality cleanup levels. Perspectives on the adequacy of these methods are provided by representatives from water utility, industry, and environmental groups. Discussions held during the colloquium indicate that progress toward a unified approach to setting cleanup levels at hazardous waste sites has occurred, but that further advances in our understanding are urgently needed.

This colloquium was sponsored by The Ford Foundation which supplemented the WSTB's core funds from federal government agencies.

3

CURRENT PROGRAM

Assessment of Opportunities in the Hydrologic Sciences

After many months of planning, in the fall of 1987 a new WSTB study committee (see Appendix A) began an important study of opportunities in the hydrologic sciences. This includes: a review of the current status of the subfields of hydrology and of their coupling with related geosciences and biosciences, the identification of promising new frontiers and opportunities for the hydrologic sciences to help improve water and environmental management, and the development of a framework for hydrologic education and research (including funding needs). This study results from an increased awareness by the hydrologic community of the need for fundamental advances in hydrologic science to generate solutions to emerging complex problems of water technology, and from the realization that the time has come for hydrology to become better established as a science alongside other recognized geosciences.

The study will assess our understanding of the natural reservoirs and fluxes involved in the global hydrologic cycle. The focus is on continental waters and the physical, chemical, and biological processes interacting with the continental waters, such as erosion, sedimentation, vegetation growth, and chemical weathering. Oceans, lakes, the atmosphere, glaciers, and icesheets will be considered only to the extent that they interact with the hydrologic cycle. The spatial scales of concern vary from the micro-processes of soil moisture to the global scale of hydroclimatological change. The time scales of concern will also vary broadly.

The committee's product will be a report distributed by the National Academy Press. The report will provide guidance for the development of the hydrologic sciences in support of solution of emerging problems in water technology and to secure acceptance for hydrology within the science establishment on a par with other geosciences. While the report will be written for a broad audience, from the informed lay public to research scientists and university educators, the principal audience will be science policy makers and research managers

in government agencies and other organizations having geoscience programs. The model for this ambitious project is the report, "Opportunities in Chemistry," National Academy Press, 1985. The WSTB expects to publish the report in late 1989 or early 1990.

This project is being supported by the National Research Council, U.S. Geological Survey, National Weather Service, National Science Foundation, National Aeronautics and Space Administration, and the Department of the Army.

Water Resources Research

In response to a request from the U.S. Geological Survey, a standing multidisciplinary Committee on U.S.G.S. Water Resources Research was established in January 1985. Initially, the committee's principal purpose was to assist the U.S. Department of the Interior through the Geological Survey in carrying out provisions of the Water Resources Research Act of 1984 (Public Law 98-242). This law authorized the Secretary of the Interior to make grants to support (1) one water resources research institute in each state and (2) water-resources-related research by the state institutes and others. The committee assists in evaluating institute effectiveness, setting research priorities, and providing advice to the Department of the Interior relevant to this legislation. This committee is also charged with helping the Geological Survey and the WSTB with other water resources research-related activities as appropriate.

While in 1985 most of the committee's attention focused on Public Law 98-242, in 1986 its attention began to shift to other programs of the Geological Survey's Water Resources Division. Most notably, in 1986 the committee considered the agency's National Research Program and the proposed National Water Quality Assessment Program (NAWQA). In 1987, the committee dealt with NAWQA in greater detail. First, in March the committee hosted a workshop to examine the treatment of biology in the NAWQA context. Several subgroups of the committee were also created to visit and advise on "pilot" NAWQA basins and to help develop the ground water quality elements of NAWQA.

The full committee met twice in 1987. At these meetings the committee continued to attend to matters of the extramural research (PL 98-242) activities of the Geological Survey, NAWQA, and the National Research Program. The committee also began to evaluate and assist with USGS plans for new initiatives related to climate change and hydrology. This topic and the agency's National Research Program are priority committee activities in 1988.

One issue of continuing concern to this committee is the depressed state of funding for water resources research in general. The members suspect they have observed decreasing enrollment in water resources graduate education programs and perceive somewhat less than adequate training of government agency policymakers in some cases. The committee is very concerned about the eventual effect on the ability of our universities to provide competent and ample numbers of water resources professionals and may plan for some type of committee-led study initiative in this area.

In January 1988, the terms of appointment for many members expired and several new members were appointed. Appendix A lists both retired members and the roster as it stands following reorganization in January.

Assessment of Ground Water Models

During the past few years, considerable attention has focused on understanding, mitigating, and preventing ground water contamination incidents. The expense involved in establishing monitoring programs and performing sample analysis has created a need for an examination of analytical techniques applied in understanding transport and environmental fate processes within ground water flow systems. As a result, ground water models increasingly are being scrutinized by regulatory agencies, industry, and the courts. A better awareness of the adequacy and limitations of models is necessary if modeling results are to be used to determine responsibility for costly clean-up efforts.

In January of 1986, the U.S. Army requested the assistance of the WSTB in assessing ground water contaminant transport modeling at an Army installation. The WSTB concluded the work scope, focusing on a specific site, was not appropriate from a NRC perspective. However, the WSTB proposed two questions: "To what extent can the current generation of ground water models accurately predict complex hydrologic and chemical phenomena?" and "Given the accuracy of these models, is it reasonable to assign liability for specific ground water contamination incidents to individual parties or make regulatory decisions based on long-term predictions?" As a result of further planning and negotiations for financial support, the Committee on Ground Water Modeling Assessment (see Appendix A) was assembled in the summer of 1987 to examine the current state of knowledge in ground water models and the role of contaminant transport models in the regulatory community.

The 18-month study period, beginning June 1987 and ending December 1988, is supported by the Electric Power Research Institute, the U.S. Nuclear Regulatory Commission, the U.S. Environmental Protection agency, the U.S. Army and the National Science Foundation. Issues to be addressed in the report are: 1) physical, chemical and biological processes, 2) model formulation, 3) model application, 4) scientific, engineering and policy trends, 5) the role of models in decisionmaking, and 6) recommendations and guidelines. Case studies will be included throughout the report to illustrate modeling applications, ground water processes, and regulatory issues.

The committee's report should be a constructive contribution to the literature, forming a blueprint for development of future models. The primary audience will be individuals in the regulatory community involved in using ground water models, however, researchers and students should also find the report useful.

Committee on Irrigation-Induced Water Quality Problems

The events at Kesterson National Wildlife Refuge in California's San Joaquin Valley in 1982 were dramatic -- fish disappeared, waterbirds died, hatchling birds were deformed, and other eggs never hatched. The subsequent discovery that the Kesterson reservoir was contaminated with toxic levels of selenium was a reminder of the problems that irrigation can cause in arid regions.

The contamination problems encountered at Kesterson Reservoir precipitated a multi-agency research effort designed to study the effects of irrigation drain water and search for methods to reduce the problems caused by contaminated drainage water. Responding to a request from the State of California and the U.S. Department of Interior (USDI), the WSTB established a Committee on Irrigation-Induced Water Quality Problems in April 1985. The committee was formed initially to provide oversight to the San Joaquin Valley Drainage Program (SJVDP), however, the committee quickly concluded that its task should encompass a broader, west-wide perspective. Drainage from irrigated agriculture is causing problems in many parts of the arid western United States, and decisionmakers can learn from this experience so they are better prepared to deal with future irrigation-induced water quality problems.

To accomplish this double task, the committee has met 10 times since 1985 and, together with its several subcommittees, has issued 10 letter reports (Appendix C). The committee has played an active role in providing oversight for the SJVDP, critiquing study plans, and reviewing program documents. The committee also has become involved in advising the National Irrigation Drainage Program (NIDP), a USDI effort to identify and study similar irrigation-induced problems at other sites in the West.

To highlight the important issues they have encountered during their tenure, the committee has begun writing a report. Publication is expected in the late fall of 1988.

All but one of the committee's six subcommittees met during 1987, and like the committee they provided guidance to the SJVDP on various aspects of its research planning. The Subcommittee on Economics and Policy remains the most active subcommittee, having met for the fourth time December 3-4, 1987 to review a major report issued by the SJVDP and plan a letter report.

In the future, the committee will devote increased attention to the national perspective on irrigation-induced water quality problems, especially as activities at the SJVDP wind down over the next two years. The original three-year agreement supporting the committee's work expires March 31, 1988, but a new agreement has been negotiated and all parties see a continued need for the oversight this committee has provided. Some committee membership changes are expected, but the general purpose and tasks of the committee will remain unchanged through March 1990.

Colloquium on Great Lakes Water Levels: Shoreline Dilemmas

The fourth colloquium in the WSTB series will be held in Chicago on March 17-18, 1988 and will address hydrometeorological, engineering, and land management issues related to Great Lakes water level fluctuations. The WSTB believes that the record high lake levels of 1986 provide an excellent opportunity to study coastal zone management. This topic is of increasing importance as we consider the possibilities of a rising sea level and the impacts of climate change on hydrology.

A steering committee met twice in 1987 to plan this project (see Appendix A). The committee designed seven presentations on various aspects of the lake level fluctuations, including hydrometeorological and engineering aspects of lake fluctuations, shoreline impacts of water level changes, alternative solution strategies, policy conflicts in existing laws, multi-jurisdictional issues, and private sector roles and responses. In addition, two panel discussions will focus on climate change and state coastal erosion management programs.

Funding for this activity is being provided in part by The Joyce Foundation, in addition to WSTB core funding from government agencies. The proceedings should be available in the fall of 1988 and are likely to provide a valuable background document for further in-depth NRC studies dealing with coastal zone management.

4

NEW ACTIVITIES BEGINNING IN 1988

Review of the U.S.G.S. National Water Quality Assessment Pilot Program

In response to a request from the Assistant Secretary of the Interior, beginning in April 1988 the WSTB will be evaluating the U.S. Geological Survey's (USGS) Pilot National Water Quality Assessment Program (NAWQA). Congress provided the Department of the Interior (DOI) with $2.4 million to develop detailed plans and begin implementing a NAWQA program during FY 1986. DOI decided to conduct a three to five year pilot NAWQA program to test and refine methods and determine if the concept warrants full-scale implementation. A key element of this effort will be an external evaluation of the program to be carried out by the WSTB.

The NAWQA program is designed to develop a nationally-consistent set of data and interpretive information that would improve the quality of decisions made regarding broad water resources policy, as well as certain site-specific actions. The full-scale program will require about $50 million per year and about 500 personnel. It is designed to document the status and trends of the physical, chemical, and biological quality of surface water and ground water resources of the nation and explain the causes of these conditions. As envisioned, it would involve extensive new data acquisition and analysis efforts to fill significant information gaps, especially in the areas of organic and trace elements. The program focus would be evenly divided between flowing surface water and ground water systems. DOI has also initiated a program of policy and economic studies that will be performed in concert with the USGS pilot program.

The WSTB will undertake a two-year evaluation of the NAWQA Pilot Program. A committee of approximately ten experts will be formed to evaluate technical aspects of the program and the value and application of NAWQA-type information. Periodic letter reports will be issued, and a final report expected in March 1990 will recommend whether the full-scale NAWQA program, or an alternative, should be implemented.

Coastal Erosion Zone Management and the National Flood Insurance Program

In the summer of 1987, the Federal Emergency Management Agency (FEMA) asked the NRC to undertake an assessment of options for coastal erosion zone management to incorporate into the National Flood Insurance Program (NFIP). Using the resources of the NRC's Marine Board (MB) and the WSTB, the NRC has proposed an assessment that will review existing state coastal erosion management programs (including technical support requirements) and assess strategy options for FEMA's consideration in incorporating erosion into the NFIP.

As a result of the effects of fluctuating levels of the Great Lakes, experiences on East coast barrier islands, and concern for the potential effects of rising sea levels, legislation passed in late 1987 by Congress will expand the NFIP by authorizing insurance payments in advance of a loss. This procedure would enable structures in imminent danger of collapse due to erosion to be demolished or relocated. The legislation also specifies that relocated structures meet certain risk-based set-back requirements as a way to reduce future losses.

Thus, the NRC's advice has been sought to enable FEMA to meet its responsibilities within the existing legislation and to provide guidance on how best to respond to new legislative requirements. The committee will be under the joint oversight of the WSTB and MB and will draw on resources developed by recent MB studies of rising sea level and the WSTB colloquium on Great Lakes water level fluctuations. Specific topics to be reviewed include:

- existing and proposed NFIP legislative requirements relative to coastal erosion;
- existing coastal erosion management programs on the Great Lakes and the oceans surrounding the United States, particularly those administered by the states, that are potentially applicable under the NFIP;
- technical standards, methods, and data for support of existing management programs that are potentially applicable under the NFIP;
- the relationship between the structural and other opportunities for erosion control and the land use "management" and zoning approach used under the NFIP. This would allow consideration of risk assessment, economics, and impacted party perceptions.

The committee will have about 10 experts from disciplines including coastal processes and engineering, geomorphology, and sediment transport, geography, law, and economics. The committee is expected to begin its work in March 1988 and a report should be completed in the spring of 1989.

Glen Canyon Environmental Studies - Scientific Oversight

Since the issuance of a WSTB report to the Bureau of Reclamation titled River and Dam Management: A Review of the Bureau of

Reclamation's Glen Canyon Environmental Studies, the Department of the Interior has requested that the committee's work be continued. The Bureau of Reclamation feels it would be beneficial for all agencies involved in future GCES research to have continued scientific program review and oversight.

In response to this request for continued advice, the committee is defining an expanded scope of work and the contract will be extended for one year (through 1988). The committee will assist the Bureau in implementing recommendations made in its final report by helping set priorities among the recommendations made in its December 1987 report, acting in a scientific advisory capacity, and providing reviews of work plans and products of the GCES program. The committee expects to issue several letter reports to the Bureau of Reclamation during the year.

5

FUTURE PLANS

Water Marketing Initiative: An Assessment of the Effects of Future Changes in the Use of Western Irrigation Water Supplies on Economic Growth and Environmental Quality

The WSTB hopes to pursue a study in cooperation with the Board on Agriculture (BA) on water markets and the transfer of irrigation water from agricultural use to municipal and industrial needs. This study could have important implications: a high percentage (80 to 90 percent) of the total water used in the western United States is devoted to agriculture. Because surface water resources in the West are now almost fully developed and because municipal and industrial water demands are anticipated to increase, the transfer of water from agriculture uses has increased appeal to water managers. Reduced federal funding for water development projects and farmers seeking additional revenue sources in a depressed agricultural economy are also factors to consider. A joint WSTB/BA planning session was held January 1987 in Denver to discuss the issues, opportunities, and problems associated with water marketing. There was a consensus that the NRC could play a vital role in understanding the legal, institutional, and environmental policies associated with the development of water markets, and that it could complement the work of others in moving this concept toward broader acceptance.

As this study is envisioned, it would incorporate considerable case study analysis; the specific case studies would be chosen to illustrate the wide variation from state-to-state that currently exists. Insofar as possible, each case study would be developed to include: a review of western water use patterns and prospective changes in the use of water; a detailed analysis of relevant federal irrigation and agricultural policies/programs and their influence on regional economies and environmental quality; a description of the institutional and political realities which affect the development of mechanisms for the transfer of water rights; and, a summary of opportunities to incorporate environmental quality goals into the mechanisms established to change the use of irrigation water.

The study would be carried out by a multidisciplinary committee with a practical appreciation of the complexities associated with transferring water rights and reallocating water supplies. The study process would require about three years and would be structured to complement on-going related activities of the Committee on Irrigation-Induced Water Quality Problems and others such as the Western Governors Association. Careful synthesis of the case study results would clarify the critical issues associated with the development of water markets/transfers and, in doing so, contribute to the development of mechanisms to allow a change in the use of western irrigation water. It is expected that the study would aid the federal government's (i.e., the Departments of Interior and Agriculture) current efforts to define its position and role on this important topic.

The Lake Tahoe Water Quality Monitoring Program

In January 1987, the Tahoe Regional Planning Agency (TRPA) approached the WSTB and requested an objective, scientific review of their water quality monitoring program. At the time, the TRPA was progressing toward a settlement of a 3-year lawsuit and the request was the result of a mandate from a 1986 consensus-building workshop held as part of the effort to settle the litigation.

Lake Tahoe, renowned for its clarity, is the tenth-deepest lake in the world (505 meters). Nutrient input to the lake from the natural environment is low due to the high altitude, limited drainage area, and relatively sterile soils. However, over the last few decades development and consequent population increase in the Tahoe basin has been significant, and the lake has begun to change. The growth of attached algae around the margins of the lake, the increasing density of algae, and steadily declining transparency result from nutrient loading.

The Tahoe Regional Planning Compact was adopted by the legislatures of California and Nevada and ratified by the Congress and the President in 1980 (PL 96-551, 94 Stat.3233, "Compact"). As part of TRPA's mission, a monitoring program was developed consisting of in-lake monitoring, tributary monitoring, ground water monitoring, atmospheric deposition monitoring, and surface runoff monitoring. Baseline data for the above monitoring elements are sparse and it is difficult to detect trends and statistically significant changes; several agencies and universities are involved in collecting and interpreting the data. TRPA seeks a coordinated monitoring program that will produce continuous, long-term data as a base for effective land use planning decisions.

The WSTB sees this involvement as a broad scientific opportunity and plans to assist TRPA by establishing a committee that will review the current water quality monitoring program and address the following questions:

1. What data are being collected and by whom?
2. Are these data appropriate for questions being asked and to the objectives/responsibilities of the regulatory agencies?
3. Are the data being properly managed and used?
4. Is there a conceptual model to guide the monitoring program, interpretation of data, and the understanding of cause-effect relationships?

A planning session was held in May 1987 with TRPA staff representatives to discuss the proposal and identify committee candidates. The committee will include approximately 10 experts from various fields including limnology, aquatic ecology, sediment transport/geomorphology, soil science, hydrogeology, atmospheric deposition, environmental engineering, land use planning, and data management. The committee's efforts will result in a final report to the TRPA approximately one year after the project is underway sometime in 1988.

Improving Water Resource Project Operations

The nation has made substantial investments in the development of its water resource infrastructure. However, opportunities for further development are limited and the WSTB has long believed that significant improvements in resource management are possible and in fact will be key to our future ability to satisfy water demands. For the past few years, agencies such as the Bureau of Reclamation have begun to plan for improved systems-driven surface water storage project management.

A planning session in the fall of 1987 revealed the WSTB's strong interest in this area, and WSTB members believe it is time to develop methods that will permit us to examine the operation of existing water resource projects and identify areas where operating improvements might be achievable. Such methods view project operation within a total system framework that includes institutional, economic, and physical constraints. Issues to be addressed include: forecasts and the reliability of forecasts used in project operation; decisions and operational impacts resulting from forecasts on water supply for various purposes; the institutional setting, structure, and constraints; the physical facilities; techniques for operation (including various models); and the information data base.

Significant opportunities exist to explore the importance of different types of forecasts in evaluating project operation and this study would focus on that topic within the systems framework. The study would examine the various types of forecasts related to project operation that are made, assess the state-of-the-art of forecasts over various time horizons, and examine the use of forecasts in project operation decision making.

While the study would be general, it could provide guidelines for determining if a particular project's operation could be improved and how any improvements should be implemented. Examples drawn from existing projects would be used to illustrate methods. No single

project would be used as a case study because each has unique features and there will be insufficient time to explore any one case fully. The methods would be developed to ensure applicability at all scales of projects, from single reservoirs to multiple element systems.

Other

The Board's agenda of activities is developed in a variety of ways. For example, the Board is often approached by a federal agency for a specific and appropriate service. Other times, a period of negotiation is required to structure an activity on terms that are acceptable to both the NRC and sponsor. Other studies, most often those of a generic, scientific character (e.g., the current study of opportunities in the hydrologic sciences) are self-initiated; these studies generally have long developmental periods and require great efforts to identify those agencies who might benefit from such activity and to garner adequate levels of funding. This last category of study, however, has the greatest potential to produce the broadest and most significant contributions to science and technology. At the fourteenth meeting in November 1987, a new initiatives planning session was held, and the "seeds" of several new activities were planted. Over the coming year(s) the Board will be attempting to develop several studies based on the discussions at that meeting. Some of these self-initiated activities are as follows: a global evaluation of intermedia (soil, air, water) transfers for major contaminants of health concern; future directions in water treatment technology; the role of water bodies in global cycles with the objective of environmental damage reduction; a study of technologies for ground water flow system management; preservation and management of wetlands ecology; natural processes in reservoirs; the revolution of information technologies such as geographic information systems and remote sensing in water resources management; and international activities drawing on U.S. experiences.

APPENDIX A

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APPENDIX B

TERMS OF REFERENCE
WATER SCIENCE AND TECHNOLOGY BOARD
(Adopted November 29, 1982)

Introduction and Purposes

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

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

The Board's scope covers the traditional scientific and engineering aspects of water resources and the economic, institutional, legal, educational, and social aspects, as well.

Areas of Interest

To pursue its objectives, the Board is concerned with:

- Basic hydrologic and related sciences and their applications in water resource systems, including analyses of ground water movement and the hydrologic cycle, measurement of water quantity and quality, data analysis, and forecasting.
- Planning, analysis, and operation of water systems, including resource management, water quality and quantity for all uses, public health and environmental protection, aquifer and watershed protection and management, economic analysis, design standards, modeling methods, risk assessment, system analysis techniques, and management systems.

- Nonstructural water resources issues, such as floodplain management, supply-demand relationships, water reallocation and reuse, effects of human activities on water resources, legal-institutional issues, ecosystem effects, and cultural and aesthetic values.
- Structural and traditional engineering aspects of water projects, such as dams, levees, renovation-retrofit technologies, and treatment processes.
- The health and vitality of the nation's water-related science and engineering establishment, including its educational aspects.

General Activities

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

1) Responding to specific requests by government agencies and others;
2) Reviewing and evaluating water-related research and scientific, engineering, and technological developments;
3) Initiating investigations of issues considered to be appropriate by the Board, its parent Commissions, and the Governing Board of the National Research Council;
4) Reviewing research and the state-of-the art in science, engineering, and technology related to the development and management of water and related resources, especially in relation to national objectives and priorities;
5) Projecting future needs for and capabilities of multi-disciplinary water-related research and education in the sciences, engineering, and technology;
6) Disseminating the results of its studies, serving as a repository of scientific and engineering knowledge, and providing a forum for the exchange of information on water science and technology;
7) Fostering communication among members of the professional community in the United States on national and international water resources issues; and
8) Articulating water-related educational issues, including undergraduate, postgraduate, continuing education, and public-education programs and the related needs for equipment and facilities.

Organization and Management

Governance and Relationship with Parent Bodies

The Board, although responsible for its own immediate governance, is accountable to and supported by two Commissions of the National Research Council--the Commission on Engineering and Technical Systems (CETS) and the Commission on Physical Sciences, Mathematics, and Resources (CPSMR). CETS is primarily concerned with the development and application of engineering disciplines to technological systems and

their relationship to societal problems, while CPSMR is primarily concerned with basic sciences and their relation to resource identification and development and environmental management. For each of its specific technical, project, or administrative activities, the Board or its study groups will be responsible to and supported by either CETS or CPSMR.

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

The Board may recommend to the Chairman of the National Research Council and to the Commissions such changes in the purposes, responsibilities, size, and functions of the Board as it believes desirable.

Board Membership

To meet its broad need for expertise, the Board consists of not fewer than 15 and not more than 18 members in addition to its Chairman. Members are chosen for their background and experience as well as for their familiarity with appropriate scientific, technological, and policy issues. While serving on the Board, each member, insofar as possible, participates in at least one study conducted under the auspices of the Board.

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

When appropriate, the Board may invite federal agencies and organizations to nominate individuals to serve as non-voting liaison representatives to the Board.

Study Group Activities

The principal operating units of the Board are its separately appointed and individually mandated study groups. The Board, assisted by its staff, manages the activities of these units.

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

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

The Board Chairman, with the approval of the Chairman of the appropriate Commission and the Chairman of the National Research Council, appoints chairmen and members of committees of the Board.

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

Report Review

The Board reviews all reports that develop from its program in accordance with procedures and requirements established by the appropriate Commission and by the Report Review Committee of the National Research Council.

Board Meetings

The Board normally meets three times each year, twice at the NRC headquarters in Washington, D.C., and once elsewhere in the United States. Additional meetings are held as the Board deems necessary to carry out its responsibilities for planning, oversight, and review including, but not limited to, review and assessment of current activities; consideration and approval of new projects, proposals, and proposed memberships; technical and programmatic briefings; and discussions with government decision-making and policy personnel.

Program Planning

The Board, with the aid of WSTB staff, annually prepares a general plan of its proposed program of activities and projects for submission to the two Commissions, accompanied by a request for authorization to receive outside funds for the support of these activities. The Board prepares reports on its activities as may be requested or required by the Commissions or the Governing Board of the National Research Council.

The Board Chairman and Staff Director present the Board's program plan and budget to the Commissions. New projects, approved by the Board, that do not appear in the approved plan and authorized budget are brought to the appropriate Commission for action. The Chairman and Director also report periodically to the Commissions on any issues and problems of particular concern to the Board and any issues of broader scope that may require a response of the National Research Council.

The Board formulates programs and requests funds in support of undertakings deemed to be logical, appropriate extensions of its approved program plan, subject to appropriate approvals.

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

Proposed projects are evaluated by the Board according to the following criteria: (a) the importance of the issue to the nation

relative to its water needs; (b) the availability of expert volunteers who can ensure that the Board's contribution will be appropriate, effective, and timely; (c) the relevance of the work to the Board's areas of interest and competence, and (d) the involvement of policymakers of sufficient stature to ensure that the Board's response will have a significant impact.

Staff

The senior staff officer of the Board is its Director who is responsible to the Chairman for the general management of the Board's program and to the Executive Directors of CETS and CPSMR. The Director has the authority to hire additional staff members and or consultants necessary to assist in the overall management of the Board's program, subject to the constraints and approvals of National Research Council policies and the administrative budget of the Board.

Expenses

Expenses of the Board and its study groups, including support of its staff and meetings, are ordinarily financed by grants or contract funds.

APPENDIX C

REPORTS ISSUED BY THE WATER SCIENCE AND TECHNOLOGY BOARD (1983-1987)

Hazardous Waste Site Management: Water Quality Issues

1988, 224 pp. (W88-3)

The definition of cleanup levels is one of the most controversial and difficult decisions facing policymakers and regulatory agencies responsible for remediating contamination at hazardous waste sites. This report, a collection of papers from a colloquium sponsored by the WSTB, discusses ground and surface water cleanup levels at hazardous waste sites and evaluates whether the scientific, technical, and regulatory methods currently used for setting cleanup levels are adequate. It addresses current methods used by regulatory agencies and the U.S. Department of Defense to establish water quality cleanup levels, and provides insight from representatives of water utilities, industry, regulatory agencies and citizens groups. The report also reviews the use of models and other methods for estimating health risks at hazardous waste sites, and looks at the roles of hydrogeology, engineering, risk assessment, and toxicology, and regulatory strategies in hazardous waste site management.

Michael Kavanaugh, James M. Montgomery Consulting Engineers, chaired the colloquium. The report is available for $24.50 from the National Academy Press, 2101 Constitution Avenue, NW, Washington, D.C. 20418.

Estimating Probabilities of Extreme Floods: Methods and Recommended Research

1988, 144 pp. (W88-2)

Estimating the probabilities of extreme floods is a challenging problem with important implications in long-term planning and engineering. Records going back longer than 100 years are uncommon. Thus, predictive techniques must rely on extrapolation, hydrometeorological modeling, paleoflood data, and other statistical procedures.

Estimating Probabilities of Extreme Floods is a scientific examination of a variety of techniques available for characterizing very rare floods. The authors conclude that opportunities exist to improve the practice and science of rare flood hydrology, and they provide a general approach to flood estimation that incorporates the best aspects of existing methods. They also make suggestions for further research to improve our capability to estimate extreme floods.

This report provides both a general overview and looks in detail at statistical and runoff model techniques. It covers uncertainty analysis, such as the determination of standard errors and combining errors into net uncertainty statements, and various statistical analyses, use of rainfall-runoff models, and data needs and availability. The authors hope the techniques described will aid in the implementation of more sophisticated applications of risk-based decisionmaking in water management. The study committee was chaired by Jared L. Cohon, The Johns Hopkins University. The report is available for $15.95 from the National Academy Press, 2101 Constitution Avenue, NW, Washington, D.C. 20418.

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

1988, 203 pp. (W88-1)

Glen Canyon Dam is one of several high-head, multipurpose storage projects in the Colorado River system and over the years a number of issues have been raised concerning its impacts on the environmental resources of the Grand Canyon. Thus the Bureau of Reclamation conducted a series of approximately 30 studies to evaluate the relationships between dam operations and the natural resources of the Grand Canyon. These analyses, it was hoped, would lead to improvements in reservoir operating policies.

This WSTB report provides recommendations to the Department of the Interior (DOI) concerning the performance and results of these Glen Canyon Environmental Studies (GCES). It reviews the Bureau of Reclamation's planning and management of this project; the integration of the GCES results into a decisionmaking report; and the utility of the GCES results for management of the Colorado River, the Grand Canyon, and the operations of the Glen Canyon Dam.

During its 18-month review of the GCES, the committee found that the Bureau of Reclamation paid insufficient attention to early planning and careful articulation of GCES objectives; gave inadequate consideration to management options; was uncertain in its ability to convert research results into management options; and failed to identify the rationale for assigning values to downstream resources so management goals could be set. Although the Bureau of Reclamation's final report recommends several options, the NRC committee believes that only those calling for additional work are justified.

The committee's findings and recommendations provide advice to the Department of the Interior not only on specific components of the GCES but also for the design and conduct of similar environmental studies in the future. Although the committee does not believe that the Bureau of Reclamation can make any long-term decisions concerning the management of Glen Canyon Dam based on the GCES, the studies have yielded excellent information about the Colorado River. The study committee was chaired by G. Richard Marzolf, Kansas State University. The report is available in limited quantities from the Water Science and Technology Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

Letter Report of the Committee on Irrigation-Induced Water Quality Problems (July 28, 1987)

1987, 3 pp. (W87-7)

This letter report is the fourth issued by the Committee on Irrigation-Induced Water Quality Problems (CIIWQP) in its efforts to provide continuing advice to the San Joaquin Valley Drainage Program (SJVDP). In this review of the SJVDP's efforts to date, the committee saw some signs of progress, including the program's effort to better define goals and objectives; initial steps taken to consider economic, legal, and institutional factors; and the establishment of a Citizens Advisory Committee. However, the committee also highlighted some important shortcomings: they recommended that the SJVDP review its research schedule and the scope of the intended projects and add an experienced research biologist and a Quality Assurance/Quality Control manager to its staff.

The committee believes the SJVDP gives inadequate attention to comprehensive integrated planning and stressed that they must consider all the options available to solve the valley's drainage problems, even those that are politically unplatable. They also encouraged the Department of the Interior, which is responsible for a West-wide effort to study similar problems, to begin developing policy on how to mitigate the degradation and loss of habitat resulting from contaminated irrigation drainage. The study committee chairman is Jan van Schilfgaarde, USDA-ARS, Fort Collins, Colorado. The report is available from the Water Science and Technology Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

Letter Report of the Committee on Irrigation-Induced Water Quality Problems (July 28, 1987)

1987, 7 pp. (W87-6)

This is the first letter report issued by the Subcommittee on Economics and Policy of the CIIWQP. Overall, the subcommittee was encouraged that the San Joaquin Valley Drainage Program (SJVDP) had

begun to consider economic, social, legal, and institutional issues in their evaluation of alternative solutions. However, they reminded the SJVDP that the interactions between human activities and the natural environment cannot be ignored and that technology must be seen in light of evolving social and economic systems.

The subcommittee advised the SJVDP that certain topics should be addressed in more detail, including: develop an analytical methodology for identifying the diverse and often conflicting environmental and economic considerations involved; examine the equity issues raised by alternative solutions; and broadly evaluate the general public policy issues involved in the alternatives being investigated. The subcommittee also stressed the importance of addressing legal issues. The subcommittee was pleased to see a Citizens Advisory Committee established because public participation can be an effective process for developing a range of options as well as for building public confidence in the decision-making process. The study committee chairman is Jan van Schilfgaarde, USDA-ARS; the subcommittee chairman is Margriet Caswell, University of California-Santa Barbara. The report is available from the Water Science and Technology Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

Letter Report of the Committee on U.S.G.S. Water Resources Research (July 13, 1987)

1987, 2 pp. (W87-5)

This report supplements report W85-5, issued by the U.S.G.S. Water Resources Research Committee, November 26, 1985. It provides the Committee's current assessment of the Section 105 extramural research grants program focus and minor comments intended to improve focus in the Geological Survey's program announcement for fiscal year 1988. The committee chairman was Betty H. Olson of the University of California, Irvine. The report is available from the Water Science and Technology Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

Water Science and Technology Board Annual Report 1986

1987, 60 pp. (W87-4)

The fourth annual report of the Water Science and Technology Board (WSTB) discusses the Board's interests, achievements, and capabilities. It contains an overview, descriptions of project activities completed by the Board in 1986, its current program, and plans for the future. The year's highlights included an assessment of environmental studies of the Glen Canyon Dam; a study of techniques for estimating probabilities of extreme floods; the third WSTB colloquium, which debated hazardous waste site management and water quality issues; and the continuing efforts of the U.S.G.S. Water Resources Research Committee. In the future, the WSTB plans an assessment of the

hydrologic sciences, a water marketing study, and a study dealing with the transport and environmental fate of contaminants in ground water (see Chapter 4). John J. Boland, The Johns Hopkins University, was WSTB chairman. The report is available in limited supply from the Water Science and Technology Board, 2101 Constitution Avenue, Washington, D.C. 20418.

Letter Report of the Committee on Irrigation-Induced Water Quality Problems (March 30, 1987)

1987, 3 pp. (W87-3)

This is the second letter report issued by the Subcommittee on Quality Assurance and Quality Control (QA/QC) of the CIIWQP. The three-page letter report to the San Joaquin Valley Drainage Program (SJVDP) strongly recommends that the SJVDP acquire a knowledgeable and experienced QA/QC manager as soon as possible; the manager should be autonomous from the participating federal and state agencies and answerable only to the SJVDP manager. Another key recommendation is that data management must be performed in a manner that ensures useful information is not lost due to stringent criteria for entry in the data base. The subcommittee was also concerned that the QC protocol for plant tissue appeared to lack the rigor of other protocols (water, soil, sediment, and animal tissue) described by SJVDP staff. The study committee chairman is Jan van Schilfgaarde of the Agricultural Research Service; the subcommittee chairman is Robert R. Meglen, University of Colorado. The report is available from the Water Science and Technology Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

Letter Report of the Committee on Irrigation-Induced Water Quality Problems (February 17, 1987)

1987, 1 p. (W87-2)

This is a one-page supplement to the first letter report of the Subcommittee on Public Health (dated June 9, 1986). The supplement recommends that as the San Joaquin Valley Drainage Program evaluates the feasibility and desirability of potential actions to resolve agricultural drainage problems in the San Joaquin Valley it should explicitly address the public health concerns that might be raised by such actions. The study committee chairman is Jan van Schilfgaarde of the Agricultural Research Service; the subcommittee chairman is Edwin H. Clark of The Conservation Foundation. The report is available from the Water Science and Technology Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

National Water Quality Monitoring and Assessment

1987, 108 pp. (W87-1)

This is a report on the second WSTB colloquium, held on May 20, 1986 in Reston, Virginia, which discussed the need for a national water quality monitoring and assessment program for the United States. Although the participants were far from unanimous, they concluded that a national water quality monitoring and assessment program, in some form and at some level of effort, is warranted in order to improve the comprehensiveness and reliability of the information available for decisionmaking.

Participants cited numerous areas where a national program might bring improvements, including:

- better understanding of the general quality of the nation's water resources;
- better understanding of water quality trends, specifically changes showing improvement or worsening;
- better understanding of the extent, nature, and causes of water pollution, which would lead to ways to protect human health and the environment;
- improved ability to set standards and assure compliance with regulations;
- improved ability to develop water quality control technology;
- better quality assurance/quality control efforts to ensure greater consistency, compatibility, and reliability of data collection;
- improved data base management and information exchange;
- increased understanding of aquatic phenomena; and,
- better predictive capability.

The colloquium report concludes by stressing that a well planned, reliable water quality monitoring and assessment program needs to be an integral part of any acceptable water resource management strategy. The colloquium chairman was Richard S. Engelbrecht of the University of Illinois. This report is available in limited supply from the WSTB office or the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. NTIS Accession Number: PB 87 157467. Cost: $18.95.

A Review of the U.S. Army Construction Engineering Research Laboratory Program for Recycling and Reuse of a Laundry and Shower Wastewater

1986, 104 pp. (W86-8)

The objective of this study was to evaluate the U.S. Army's Construction Engineering Research Laboratory (CERL) program on recycling and reuse of field laundry and shower wastewater. The study

looks at technical and scientific merit, and recommends additional research needs necessary to achieve the goals of the program.

In general, the committee found that the CERL studies paid the greatest attention to the technical feasibility of treatment systems, with only limited attention to the water-quality constituents and health concerns. The committee recommended that CERL proceed with its program on laundry/laundry recycling and reuse, but with some additional testing. The committee concluded that more research on shower wastewater recycling and reuse was essential before CERL implements this program. Specifically, two major routes of exposure should be addressed: inhalation and topical contact. Because of the importance of the inhalation route, the committee recommended additional modeling work for any chemical that appears to be present at sufficient concentrations in the recycled wastewater. Explicit consideration is necessary of the concentration of chlorine and its by-products in air in the laundry room or shower.

The chairman of the committee was Richard S. Engelbrecht, University of Illinois at Urbana-Champaign, Illinois. The report is listed with the National Technical Information Service. Accession Number: PB 87 151726.

Letter Report of the Committee on Irrigation-Induced Water Quality Problems (September 5, 1986)

1986, 2 pp. (W86-7)

This is the third letter report issued by the Committee on Irrigation-Induced Water Quality Problems reviewing research and related programs addressing the agricultural drainage problems in the San Joaquin Valley, California. The letter report recommends that the U.S. Bureau of Reclamation assess a proposal for the cleanup of Kesterson Reservoir made by the Lawrence Berkeley Laboratory (LBL) of the University of California. The LBL proposal hypothesizes that maintaining flooded conditions at Kesterson Reservoir using low-selenium water will create an anaerobic environment in the pond sediments. It is believed that an anaerobic environment would create conditions where selenium is immobilized in a reduced form and, thus, unavailable to biologically cycle in the environment. The committee recommends that basic studies of the biological cycling of selenium in saline, alkaline aquatic ecosystems be given high priority. They recommend that a thorough monitoring system be established to assess the impacts of this management approach on plants, animals, sediments, and water. The study committee chairman is Jan van Schilfgaarde, USDA-ARS, Fort Collins, Colorado. The report is available from the Water Science and Technology Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

Letter Report of the Committee on Irrigation-Induced Water Quality Problems (July 8, 1986)

1986, 6 pp. (W86-6)

This is the first letter report issued by the Subcommittee on Quality Assurance and Quality Control of the CIIWQP reviewing a draft quality assurance plan for the San Joaquin Valley Drainage Program (SJVDP). The letter report is critical of the plan and provides many suggestions to improve the document. Among the areas highlighted by the subcommittee are: (1) quality assurance policy and management; (2) data quality objectives and sampling procedures; (3) analytical procedures; (4) data reduction, validation, and reporting; and, (5) performance and system audits. The subcommittee states that a well designed QA plan can be effective in accomplishing a coordinated program that ensures the overall objectives of the SJVDP while preserving the independence and flexibility that the individual participating agencies require. The study committee chairman is Jan van Schilfgaarde, USDA-ARS; the subcommittee chairman is Robert R. Meglen, University of Colorado. The report is available from the Water Science and Technology Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

Letter Report of the Committee on Irrigation-Induced Water Quality Problems (June 12, 1986)

1986, 4 pp. (W86-5)

This is the first letter report issued by the Subcommittee on Public Health of the CIIWQP reviewing the research proposed by the Ad Hoc Committee on Public Health of the San Joaquin Valley Drainage Program (SJVDP). Generally, the subcommittee was impressed with the breadth and quality of the proposed studies, but some deficiencies were identified. The subcommittees' comments fall into five categories: (1) the need for a more coherent conceptual approach; (2) identification of hazards; (3) exposure assessment; (4) integration of public health delivery services; and (5) the establishment of a public health subcommittee within the SJVDP. The study committee chairman is Jan van Schilfgaarde of the Agricultural Research Service; the subcommittee chairman is Edwin H. Clark of the Conservation Foundation. The report is available from the Water Science and Technology Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

Ground Water Quality Protection: State and Local Strategies

1986, 309 pp. (W86-4)

This report reviews ground water protection strategies in ten states and three local areas of the United States. A study committee

initiated its effort in November 1984 after the U.S. Environmental Protection Agency requested a review of state and local ground water programs, focusing on prevention of ground water contamination. The review considered these programs with respect to their scientific bases, performance over time, administrative requirements, and their legal and economic frameworks. The states and local areas reviewed were: Arizona, California, Massachusetts and Cape Cod, Colorado, Connecticut, Florida and Dade County, Kansas, New York, Long Island, New Jersey, and Wisconsin.

The committee found that no program had all the elements necessary to a comprehensive ground water protection program: (1) clearly defined goals, objectives, scope, and priorities; (2) an adequate information base to allow proper definition of the resource and the problems; (3) a sound technical basis; (4) elimination or reduction of the sources of ground water contamination; (5) intergovernmental and interagency linkages; (6) effective implementation and adequate funding; (7) studies on the economic, social, political and environmental impacts of ground water protection; and (8) public support and responsiveness.

The report emphasizes the need to eliminate or reduce the sources of ground water contamination and recommends ways to deal with both hazardous and nonhazardous waste. Other recommendations focus on preventing pesticide contamination; the need for state and local programs to obtain hydrogeological information; the use of a classification system to identify critical areas and resources for special protection; water quality standards and EPA's proposed RMCL's and MCL's for all inorganic and organic chemical compounds commonly found in ground water; land use controls; adequate legal authority and funding for ground water protection programs; and political mobilization and public participation in support of ground water protection programs.

The report states that the essence of prevention is anticipation, planning, assessing, and preventive action. These preventive efforts anticipate adverse effects from chemical and land use practices and the disposal of waste. The emphasis is on prevention of pollutants at the source. The study committee chairman was Jerome B. Gilbert, East Bay Municipal Utility District, Oakland, California. The report is available from the National Academy Press, 2101 Constitution Avenue, N.W., Washington, D.C. 20418. List price: $24.50.

Drought Management and Its Impact on Public Water Systems

1986, 127 pp. (W86-3)

This report--the first in the WSTB's series of colloquia to focus attention on emerging issues in water science, technology, and policy--addresses drought management and its impact on public water systems. The colloquium was held September 5, 1985 in Boulder, Colorado.

The report concludes that there is substantial need for continued research on drought and its impacts. Key research topics include the causes of drought, developing effective drought alert mechanisms, probability analysis of drought, quantifying of the consequences of system failure during drought, and identifing of the institutional environment necessary for successful implementation of drought management plans. According to the report, the key to adequate drought management in public water systems lies in predrought preparation. The colloquium chairman was Robert L. Smith of the University of Kansas. The report is available from the National Academy Press, 2101 Constitution Avenue, N.W., Washington, D.C. 20418. List price: $7.50.

Water Science and Technology Board Annual Report 1985

1986, 54 pp. (W86-2)

This is the third annual report published by the WSTB since its creation in 1982. The report contains an overview of the Board's activities, including the introduction of a new colloquium series on emerging issues in water science, technology, and policy; descriptions of project activities; the overview of and conclusions from the Board's first colloquium on Drought Management and Its Impact on Public Water Systems; and planned projects. Research needs in water science and technology are highlighted. Lists of program participants, the Board's Terms of Reference, abstracts of reports published by the Board since 1982, and a list of meetings held by the Board and its committees during 1985 are included. The WSTB chairman was John J. Boland of The Johns Hopkins University.

Letter Report of the Committee on Irrigation-Induced Water Quality Problems (April 2, 1986)

1986, 3 pp. (W86-1)

This is the second letter report from the Committee on Irrigation-Induced Water Quality Problems and it responded to briefings provided by the University of California research program about irrigation drainage problems in the San Joaquin Valley. The letter report notes that a number of recommendations made in the committee's first letter report (October 10, 1985) have been enacted by the San Joaquin Valley Drainage Program (SJVDP), but it urges that other recommendations (such as development of a strong public participation program; full consideration of economic, institutional, and legal factors; investigation of public health concerns; and development of a quality assurance/quality control program and a data management program) be implemented as soon as possible.

The committee praises the research being conducted to address on-farm water and salinity management, transport processes, and trace element chemistry. However, the committee believes the University of

California researchers should be more fully integrated into the overall SJVDP research program. Areas of research requiring attention include public health concerns; economic evaluations of potential alternative solutions, which include social and private impacts; and the long-term impacts on ecosystems. The committee emphasizes that the environmental consequences of various technological alternatives are not being adequately addressed and suggests that the resources available through the university be better used to achieve that end. The study committee chairman was William H. Allaway of Ithaca, New York. The report is available from the Water Science and Technology Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

The Great Lakes Water Quality Agreement: An Evolving Instrument for Ecosystem Management

1985, 224 pp. (W85-6)

This report is a review of the 1978 Great Lakes Water Quality Agreement between the United States and Canada, beginning in 1984 and ending with the issuance of a final report from a binational committee of the Royal Society of Canada and the National Research Council in December 1985. The report covers four major areas concerning the Great Lakes and the agreement: enrichment, toxic contaminants, institutional arrangements and the ecosystem approach, and sustainable development.

The committee found that major progress has been achieved in reducing levels of phosphates and several pollutants in the Great Lakes. However, there remains an "urgency to achieve a reduction of toxic pollutants in the Great Lakes and thereby reduce the risks to the human population using the resources of the basin." One major finding is that people living in the Great Lakes region are exposed to appreciably more toxic chemicals through contaminated drinking water and food products than other similar populations in North America.

Both the 1972 and 1978 Great Lakes Water Quality Agreements are widely recognized as among the world's pioneering international instruments designed to foster intergovernmental cooperation to correct pollution in a large river basin. The committee concluded that the two governments should continue and strengthen the 1978 Agreement. The joint institutions created in the 1978 Agreement, the Water Quality Board and the Science Advisory Board, have proven to be effective means for advancing dialogue between the parties to the agreement (United States and Canada) and among the various states and provinces on technical questions, programs, and expenditures.

To improve accountability in carrying out the agreement, the committee suggested that the U.S. and Canadian governments publish a report every two years on the progress achieved, and that bilateral meetings be held regularly between senior officials to discuss any problems. In addition, the committee believes there needs to be a clearer delineation of the responsibilities of the various institutions in managing Great Lakes water quality. Such clarification would improve the functioning of the various institutions as well as provide

greater accountability for their actions. The committee also wants to see Great Lakes water quality managed more from an ecosystem approach. This means that Great Lakes water quality related programs and policies, and the institutions that implement them, should be guided by the basic ecosystem goals set forth in the 1978 Agreement to "restore and maintain the integrity of the waters of the Great Lakes basin ecosystem."

The committee's final recommendation was that the parties to the Agreement should plan a binational conference on the Great Lakes and establish an action plan to be acted on at the conference, preferably before the end of the decade. In general, the committee found that substantial reforms are still needed in the Great Lakes basin, far beyond the programs specified in the 1972 and 1978 Agreements, and that now is an appropriate time to face the challenge. The study committee co-chairmen were Orie Loucks of the Holcomb Research Institute, and Henry Regier of the University of Toronto. The report is available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. Accession Number: PB 87-186292. Cost: $24.95.

Letter Report of the Committee on U.S.G.S. Water Resources Research (November 26, 1985)

1985, 9 pp. (W85-5)

This report recommends a focus for the research grants program administered by the U.S. Geological Survey and authorized by section 105 of the Water Resources Research Act of 1984. The report reviews the scope of water resources research and previous "prioritization" and research review efforts. It then discusses the committee's criteria and delineates two general areas of research in need of attention and deemed appropriate for the section 105 grants program: (1) science and technology of water quality management, including scientific understanding of hazardous substances in water, applications of biotechnology to water resources, and engineering and technology related to chemical and biological applications for water resources systems; and (2) water resources institutional issues, including water allocation, design of regional water systems, and incentives for regional cooperation. The committee chairman was James J. Morgan of the California Institute of Technology. The report is available from the Water Science and Technology Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

Letter Report of the Committee on Irrigation-Induced Water Quality Problems (October 10, 1985)

1985, 11 pp. (W85-4)

This report--the first of the Committee on Irrigation-Induced Water Quality Problems--followed several days of briefings about the San

Joaquin Valley Drainage Program (SJVDP). The letter report calls for improved coordination of research activities and overall program management of the SJVDP, and it stressed the need for a program of public participation. Other critical areas of concern included the need for data management and the ongoing interpretation of data to provide feedback on the overall research program and clarify future research needs; the importance of establishing sound quality assurance/quality control programs in providing useful and defensible data; the need to consider agricultural chemicals in the design of analytical studies; the significance of economic, legal, institutional, and financial constraints and their influence on the range and ultimate selection of alternatives; and the need to thoroughly consider on-farm management options. The letter report also addresses the research programs proposed by the U.S. Geological Survey, the U.S. Fish and Wildlife Service, and the U.S. Bureau of Reclamation. The report is the first in what is expected to be a series providing timely and constructive guidance to the San Joaquin Valley Drainage Program. The committee chairman was William H. Allaway of Ithaca, New York. The report is available from the Water Science and Technology Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

Letter Report of the WSTB Working Group to Review Plans for a National Water Quality Assessment Program (October 7, 1985)

1985, 3 pp. (W85-3)

This report was written by an ad hoc work group, consisting of Water Science and Technology Board members and members of the Committee on U.S.G.S. Water Resources Research, to react to documents and briefings on the proposed National Water Quality Assessment Program. The report stresses the need for and value of such a program and includes suggestions to improve the design and implementation of the planned program. The workgroup chairman was Walter R. Lynn of Cornell University. The letter report is available from the Water Science and Technology Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

WSTB Review of U.S. Department of Energy (DOE) Report "Transport of Energy-Related Organic Compounds and Mixtures in Subsurface Environments"

1985, 6 pp. (W85-2)

In response to a request from the U.S. Department of Energy (DOE) in October 1984, an ad hoc subcommittee of the WSTB reviewed a DOE report titled "Transport of Energy-Related Organic Compounds and Mixtures in Subsurface Environments" (November 1984). The DOE document was a "concept paper" describing a research plan to be adopted by the department. The WSTB subcommittee's task was to provide a scientific overview of the proposed research and suggest ways to improve the

scientific content of the plan. The subcommittee commented on the need for and importance of the research, the proposed timetable, and the need for controlled field facilities prior to conducting experiments at natural field sites. The subcommittee chairman was Mary P. Anderson of the University of Wisconsin-Madison. The letter report is available from the Water Science and Technology Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20481.

Water Science and Technology Board Annual Report 1984

1985, 48 pp. (W85-1)

The second annual report from the WSTB summarizes activities completed during 1984, ongoing activities, and future plans. It includes information on board and committee memberships, program organization, issues of concern, and reports published. Highlights include the introduction of several new studies on topics such as groundwater protection; a bi-national review of the Great Lakes Water Quality Agreement; and a water resources research committee to assist the U.S.G.S. and the WSTB with water research-related matters. The board chairman was John J. Boland of The Johns Hopkins University. The report is available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. Accession Number: PB 85 204485/AS. Cost: $10.00.

Safety of Dams: Flood and Earthquake Criteria

1985, 321 pp. (W84-5)

This report was prepared in 1984 at the request of the Assistant Secretary of Interior for Water and Science and the Assistant Secretary of the Army for Civil Works. The report concerns the levels of safety to be provided at new and existing dams to withstand extreme floods and earthquakes. The report includes a thorough inventory of safety criteria for dams in use in the United States and internationally, especially as related to design for floods and earthquakes. The report critiques a variety of present practices and recommends alternative safety criteria. Also included are chapters on risk assessment, legal aspects of dam safety, and recommendations for continuing development of hydrologic and earthquake engineering technologies.

The findings and recommendations of the study committee are condensed in an executive summary. Technical appendixes provide discussions on probable maximum precipitation estimates, statistical hydrology, and risk assessment. A glossary of technical terms is also included. The report emphasizes that a principal objective in dam safety evaluations should be to strike a balance among considerations such as project benefits, construction costs, social costs, and public safety, including the possible consequences of dam failure due to major earthquakes and floods. The study committee chairman was George W.

Housner of the California Institute of Technology. The report is available from the National Academy Press, 2101 Constitutation Avenue, N.W., Washington, D.C. 20418. List price: $16.50.

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

1984, 174 pp. (W84-4)

The William H. Donner Foundation, in consultation with the staff of the International Joint Commission (IJC), asked the WSTB to study the Great Lakes Water Quality Agreement in two phases. The first phase, the subject of these proceedings, consisted of a conference to define the details of a major review study. Conference participants were asked to identify those scientific, technical, and institutional issues upon which an in-depth study, in its second phase, should focus. This report contains five formal papers, the discussion that followed each presentation, and a final summary chapter prepared by the Conference Advisory Panel. These discussions are to be used as background information for the phase II effort. The conference chairman was Orie Loucks of the Holcomb Research Institute. The report is available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. Accession Number: PB 85-110807. Cost: $17.50.

Water Science and Technology Board Annual Report 1983

1984, 39 pp. (W84-3)

This was the first annual report published by the WSTB. The report includes an introduction describing the types of issues handled by the WSTB and its committees; a description of the WSTB's place within the NRC structure; project activities completed in 1983; a description of current and planned projects; and a list of research needs in water science and technology as envisioned by WSTB members. Appendixes also list program participants, the WSTB's Terms of Reference, and brief descriptions of all published reports. The board chairman was Walter R. Lynn of Cornell University. The report is available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. Accession number: PB 84-216571. Cost: $8.50.

Water for the Future of the Nation's Capital Area - 1984

1984, 71 pp. (W84-2)

This report is the culmination of a continuing review by the National Research Council (NRC) of the U.S. Army Corps of Engineers

Metropolitan Washington Area Water Supply Study, a study which was initiated in 1977 and completed in 1983.

The committee was charged with reviewing the Corps methods investigating the future water resources needs of the metropolitan Washington area and to report the scientific bases for the conclusions reached. The committee issued five letter reports, one interim report, and one final report to the Corps within a seven-year period.

In its final report, the committee acknowledges and commends the Corps for certain achievements, such as: (1) developing systems management (nonstructural) solutions to problems relative to the metropolitan Washington area future water supply needs, (2) determining and assessing future water demands by the use of improved modeling, (3) developing a wide range of alternative methods of meeting future water resources needs of the metropolitan Washington area, (4) involving the citizens of the metropolitan Washington area in developing design criteria and making recommendations for future actions, and (5) collecting and collating current and historical data to use in the analysis of the metropolitan Washington area study.

However, the committee also highlighted several flaws in the Corps study. These flaws concern: (1) the uncertain reliability of institutional arrangements, (2) the nonpreservation of reservoir sites, and (3) the lack of scientific attention in assessing the drinking water quality available to the metropolitan Washington area. The study committee chairmen were Daniel A. Okun of the University of North Carolina, and Walter R. Lynn of Cornell University. The report is available from the Water Science and Technology Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418, and the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. Accession number: PB 84-195585. Cost: $11.50.

The Potomac Estuary Experimental Water Treatment Plant

1984, 135 pp. (W84-1)

This report is the culmination of an eight-year review by the NRC of the U.S. Army Corps of Engineers study to determine the feasibility of using the Potomac estuary waters as a source of water supply to the metropolitan Washington area. In this connection, a two-year pilot plant project was authorized involving the construction, operation, and evaluation of a small water treatment plant. The NRC committee was requested to provide a review and written report commenting on the scientific bases for the conclusions reached by the Corps from this study. The NRC committee had been reviewing the Corps study since 1976 and issued four letter reports, a panel report, and a final report to the Corps within an eight-year period.

In its final report the committee commends the Corps study for certain outstanding features, including: (1) detailed comparative evaluation of the quality of treated estuary water with that of three major treated water supplies for the metropolitan Washington area, (2) development of a detailed inorganic and organic chemical

characterization of treated estuary water and of local water supplies, (3) development of a data base on microbiological contaminants and toxicological indications, and (4) the demonstrated reliability of advanced treatment processes to provide treated water with relatively consistent quality.

However, the committee also felt that there were important limitations to this study and its conclusions, including: (1) insufficient scientific evidence was provided to adequately evaluate the safety to humans from consumption of treated estuary water, (2) potential changes in the quality of estuary water that might result from biological growth during drought conditions were not adequately addressed, (3) failure to detect viruses in the experimental estuary water treatment plant finished waters cannot be accepted as an indication that they are absent, and (4) the economic evaluation of a Potomac estuary water treatment plant was inadequate because it did not provide a comparative cost with other alternatives. The study committee chairman was Perry L. McCarty of Stanford University. The report is available from the Water Science and Technology Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418 and the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. Accession number: PB 84-195643. Cost: $16.00.

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

1984, 74 pp. (W83-4)

This report is the result of a request from the International Joint Commission (IJC)--United States and Canada--to the NRC to assist in resolving issues associated with the ice boom located at the entrance to the Niagara River, New York and Ontario. The panel's mission was to address whether the ice boom has a climatic effect in the Buffalo/Fort Erie region, and if so, to determine the magnitude of that effect and what alternative ice control strategy could be used that would have less of a climatic effect.

The panel found:

1. no cooling to local climates if the boom is removed when there is 250 mi^2 of ice on Lake Erie;
2. no monitoring program is required;
3. no benefit of the boom to the region after the beginning of April have been demonstrated;
4. no negative impacts of the ice boom on navigation, erosion and fisheries could be demonstrated with available data; and
5. no feasible alternative exists that would produce effectiveness comparable to the present ice boom.

The study panel chairman was Harry L. Hamilton, Jr. of the State University of New York--Albany. The report is available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. Accession number: PB 84-129709. Cost: $11.50.

Safety of Existing Dams: Evaluation and Improvement

1983, 384 pp. (W83-3)

The goal of this report is to enhance dam safety, in particular to provide guidance for achieving improvements in the safety of existing dams within financial constraints. Many dam owners are faced with safety problems of such a nature and extent that they are unable to finance remedial measures. To these owners, as well as to regulatory agencies and others concerned with the engineering and surveillance of dams, the report presents suggestions and guidance for assessing and improving the safety of existing dams. The contents of the report is intended to be informational and not to advocate rigid criteria or standards. The report also contains a glossary for terms used in relating to dam safety and an index. The study committee chairman was Robert B. Jansen, consulting engineer. The report is available from the National Academy Press, 2101 Constitution Avenue, N.W., Washington, D.C. 20418. List price: $19.95.

Letter Report: May 31, 1983 to U.S. Department of Interior, U.S. Geological Survey and Office of Water Policy

This letter report responds to a U.S.G.S. request for comments on an outline for the proposed National Water Summary 1983--Hydrologic Setting of Water-Related Issues. The review was provided in accordance with the WSTB's contract with U.S.G.S. to provide advice and short reports on selected issues. The letter report comments on the need for, expectations, and content of the proposed document. The WSTB endorses the concept of the national water summary as an interim, prototype data base until the needs and contents of a "national assessment" program are more thoroughly reviewed. The board chairman was Walter R. Lynn of Cornell University. The report is available from the Water Science and Technology Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

Cooperation in Urban Water Management, Conference Proceedings

1983, 187 pp. (W83-1)

The WSTB held a conference on October 14-15, 1982, to assess the barriers to efficient management of urban water supplies, titled "Cooperation in Urban Water Management." A steering committee invited 30 participants to the conference. The conferees explored and proposed means for overcoming obstacles envisioned by water supply professionals that prevent or assign low priority to solutions to crises in municipal water supplies. The primary objective of the conference was to decide if a broader and more intense study by the NRC is warranted. A second objective was to provide guidance on research needs, development, and technology transfer regarding municipal water supplies. These

proceedings include the speakers' presentations and a summary of the general discussions. The conference was supported by the National Science Foundation, the Environmental Protection Agency, the American Water Works Association Research Foundation, and the National Academy of Sciences. The conference chairman was David H. Marks of the Massachusetts Institute of Technology. The report is available from the National Technical Information Service, 5285 Royal Road, Springfield, VA 22161. Accession number: PB 83-217992. Cost: $17.50.

APPENDIX D

MEETINGS OF THE WATER SCIENCE AND TECHNOLOGY BOARD AND ITS SUBGROUPS DURING 1987

JANUARY	
15-16	Planning Session to design study of Water Marketing, Denver, Colorado
29-30	Subcommittee on Economics and Policy, Santa Barbara, California
FEBRUARY	
19	Water Science and Technology Board, Washington, D.C.
19-20	Colloquium on Hazardous Waste Site Management: Water Quality Issues
26	Planning Session to design study of Opportunities in the Hydrologic Sciences, Cambridge, Massachusetts
26-27	Subcommittee on Systems Analysis, Corvallis, Oregon
MARCH	
4-6	Committee on Irrigation-Induced Water Quality Problems, Tucson, Arizona
5-6	Committee on Techniques for Estimating Probabilities of Extreme Floods, Tucson, Arizona
9-10	Committee on Glen Canyon Environmental Studies, Tucson, Arizona

16	Workshop on Biological Aspects of the National Water Quality Assessment Program, Washington, D.C.
APRIL	
21-22	Committee on Water Resources Research, Washington, D.C.
MAY	
5	Planning session to design activity relative to Lake Tahoe Water Quality Monitoring Program
JUNE	
2	Committee on Techniques for Estimating Probabilities of Extreme Floods, Washington, D.C.
2-3	Committee on Irrigation-Induced Water Quality Problems, Denver, Colorado
9-10	Subcommittee on Economics and Policy, Washington, D.C.
10-11	Subcommittee on Systems Analysis, Washington, D.C.
JULY	
27-29	Committee on Glen Canyon Environmental Studies, Woods Hole, Massachusetts
AUGUST	
10-11	Subcommittee on Economics and Policy, Sacramento, California
13-14	Water Science and Technology Board, Woods Hole, Massachusetts
17-18	Committee on Ground Water Modeling Assessment, Woods Hole, Massachusetts

SEPTEMBER

14	Committee on Glen Canyon Environmental Studies, Washington, D.C.
28-29	Committee on Water Resources Research, Reston, Virginia

OCTOBER

1-2	Committee on Irrigation-Induced Water Quality Problems, San Francisco, California
28	Steering Committee of Colloquium IV - Great Lakes Water Levels: Shoreline Dilemmas, Washington, D.C.

NOVEMBER

9-10	Committee on Ground Water Modeling Assessment, Washington, D.C.
12-13	Water Science and Technology Board, Washington, D.C.

DECEMBER

3-4	Subcommittee on Economics and Policy, San Francisco, California
21	Planning Session for Study of Coastal Erosion Zone Management and the National Flood Insurance Program, Washington, D.C.

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