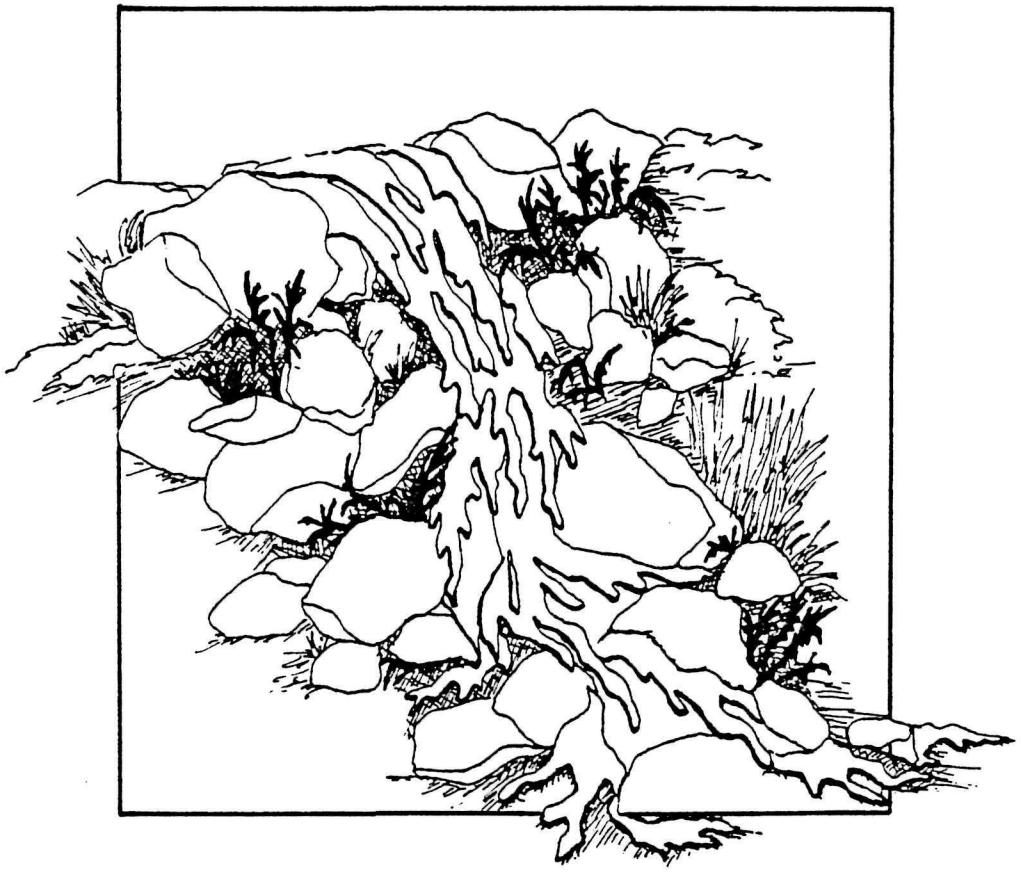
ANNUAL REPORT 1990



WATER RESOURCES DIVISION

FORT COLLINS • DENVER • WASHINGTON

NATURAL RESOURCES REPORT NPS/NR/NRWRD/NRR-91/01

U.S. Department of the Interior
National Park Service

The National Park Service Water Resources Division is responsible for providing water resources management policy and guidelines, planning, technical assistance, applied research, training and operational support to units of the National Park Service. Program areas include water rights, water resources planning, regulatory guidance and review, hydrology, water quality, watershed management, watershed studies and aquatic ecology.

Natural Resources Reports

The National Park Service disseminates reports on high priority, current resources management information, with managerial appliction for managers, through the Natural Resources Report Series. Technologies and resource management methods; "how to" resources management papers; popular articles through the yearly Highlights report; proceedings on resource management workshops or conferences; and natural resources program recommendations and descriptions and rsource action plans are also disseminated through this series. Documents in this series usually contain information of a preliminary nature and are prepared primarily for internal use within the National Park Service. This information is not intended for use in open literature.

Copies of this report are available from the following:

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Natural Resources Report NPS/NRWRD/NR-91/01

April 1991

U.S. DEPARTMENT OF THE INTERIOR
National Park Service
Washington, D.C.

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Cover design: Jacqueline V. Nolan

A WORD FROM THE ASSOCIATE DIRECTOR, NATURAL RESOURCES

by F. Eugene Hester

This annual report is designed to provide you with up-to-date information on significant accomplishments of the Water Resources Division during 1990. The Water Resources Division, which has been headquartered in Fort Collins, Colorado for 10 years, prides itself on the wide array of services it provides to park managers and to park scientists in the area of water resources management. Many of our park units with natural resource values are involved with a variety of water resource activities including water quality, watershed protection, floodplains, wetlands, water rights, data analysis and management, and research. The Division has a strong commitment to providing water resource services to the parks, Regions, Washington Office, and NPS organizational units.

I appreciate the strong support of Regional and park staff throughout the Service during this past year which has provided an environment for this level of success in our natural resources program.

COMMENTS FROM THE DIVISION CHIEF

by Stan Ponce

The repeating themes this year in the Division are growth and continued development. Our budget, responsibilities, and cadre of experts grew to meet many new challenges facing the Division, the parks, and the Service. We increased our capabilities to address water resource initiatives in the fields of wetlands inventory and research, water quality protection and enhancement, and assessment of effects of hazardous materials on water resources. We improved our ability to solve problems by enhancing program management and product accountability. We added new people to expand our technical assistance capabilities. We initiated an in-house Water Resources Division (WRD) report series that is a component of the Natural Resources series. Finally, we provided parks and Regions with new project dollars to conduct research and implement water resources projects.

Significant increases were realized in project support monies this year. WRD prioritized projects received $720,500; this is an increase of $63,500 over last year's allocation and includes 16 continuing and 3 new projects. The watershed protection initiative includes new monies for water quality ($218,600) and wetland ($156,100) projects. The Division also secured $395,000 in its base funding for support of the watershed studies research program, an extension of the Acid Precipitation Studies at four NPS areas, and received $500,000 for water resources studies at Everglades NP. In addition, the Applied Research Branch obtained $165,000 for park-related research and the Division is funding studies totaling $290,000 in support of water rights needs. In sum, the Division provided $2.6 million in direct support of water resources studies at parks; this is approximately 50-percent of our annual operating budget.

The professional capability of the WRD grew significantly this year. Each of the four branches hired new professionals, all of which complement our existing skills and add a new dimension to our capabilities. Two professionals were added to the Branch of Water Operations. Dean Tucker provides us with GIS expertise and Larry Martin enhances our stream and riparian management capability. Two new hydrologists joined the Water Rights Branch. Paul Christensen's expertise is in hydrogeology and Dan McGlothlin will serve as one of the Branch's technical team leaders. The Planning and Evaluation Branch welcomed Dave Sharrow with his expertise in water resource management planning. Dr. Gerald Walsh, the new Branch Chief for the Applied Research Branch, brings to the Division a strong background in environmental research. Dr. Robert Stottlemyer, a research ecologist, transferred to the Applied Research Branch this year from the Midwest Region. Also, Janice Taylor and Peggy Matti joined the Division and provide secretarial support.

The Office of the Division Chief has a liaison position located in Washington, D.C., designed to assist the Division Chief in all aspects of the Water Resource Program. This position, the Water Resource Program Coordinator, was recently filled by Pam Matthes, who provides daily contact with members of the Directorate and Secretariat and addresses a wide range of water resource issues.

Not only has the Division raised the visibility of the expertise available from within the National Park Service to the Department, it also increased its capability to make technical assistance available to park managers. We helped parks solve site-specific water resource issues and enhanced our commitment to service by responding to approximately 750 requests for technical assistance, commonly provided at no cost to the park or other NPS organizational units. Many of the entries that follow in this report highlight the support role that the Division plays in critical natural resource management decisions facing many units of the National Park System. You will read about our role in settling an age old water rights dispute on the boundaries of Yellowstone National Park, in predicting whether high elevation aquatic systems are at increased risk from acidic deposition due to global or regional changes in climate, and in developing new methodologies to quantify and predict for decision-makers the impacts on natural water flows from conflicting land and water uses. You also will read about our role in nominating sections of the Colorado River for the added protection accorded it under the State of Arizona's unique waters status, and in providing Servicewide policy and guidance in the management of floodplain resources. You will see that the work of the Division can be found in parks located anywhere in the United States and that this work represents a broad range of technical water resource issues. As we move forward through the 1990s, the Division will continue to search for innovative and efficient ways to help meet the challenges in protecting and managing water resources of the National Park System.

WASHINGTON LIAISON HIGHLIGHTS

by Pamela A. Matthes
Program Coordinator

Through this liaison position, the Division has increased its capability to respond to priority actions affecting the water resources of the NPS initiated by the Department, the White House, or the Congress. In 1990, significant issues included the following.

National Water Quality Assessment Program (NAWQA) - After years of developing the concepts and approaches for performing an assessment of the quality of the nation's surface and ground waters, the U.S. Geological Survey (USGS) was authorized, in 1989, to expand its pilot program in 1991 to a fully funded national program. As part of this program, study-unit investigations will be conducted in 60 areas throughout the nation to provide a framework for national and regional water quality assessments. These study-unit investigations will be the basis upon which regional and national syntheses can be integrated and performed. The Division assisted the Department and the USGS in setting research priorities, by Region as well as by issue, for each of the study areas.

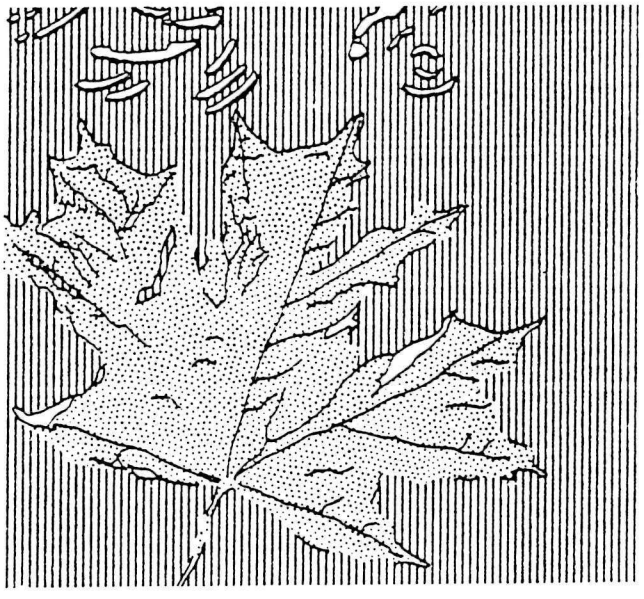
Wetlands - The President's "No Net Loss" initiative in 1989 raised many questions from the Department and the White House about Federal wetlands programs. The Domestic Policy Council requested the Federal community to evaluate existing and recommend needed Federal non-regulatory measures to protect wetlands and help achieve "no net loss" of wetlands. Five subgroups were formed, three of which were actively supported by the Water Resources Division (Education/Outreach, Federal Land Management, and Research). Also, the Division actively supports the Department of the Interior's Working Group on Wetlands Policy by helping set a coordinated wetlands protection action agenda for Interior land management bureaus.

Geothermal - The Congress recently revised the Geothermal Steam Act to provide extra protective measures for thermal features located in units of the National Park System. Site-specific studies in several areas known as promising geothermal development areas are required to assist in future geothermal development impact determinations and leasing decisions. The Division provides technical and policy support to the Directorate in addressing Congressional and industry inquiries regarding the progress of the reports, the status of the geothermal leasing program, and effects data on park resources. This year the Division assisted Crater Lake and Yellowstone National Parks in reporting to the Congress on the character of thermal features located in those units and recommending measures necessary to protect these significant thermal features from being adversely impacted during the development of adjacent geothermal resources.

PLANNING AND EVALUATION BRANCH HIGHLIGHTS

by Dan Kimball
Branch Chief

The Planning & Evaluation Branch (PEB) of the WRD was involved in a number of major projects and technical assistance in support of Park, Region, and Servicewide needs during 1990. Activities included assistance in the preparation of water resources and natural resources management plans, evaluation of complex regulatory issues, and assistance in the implementation of regulatory programs, technical review and advice, and general guidance and training. Some specific examples of these activities include involvement in the preparation of Water Resources Management Plans for over 15 units of the National Park System; evaluation of the proposed Windy Craggy Project, a proposed copper mine in British Columbia, Canada, upstream of Glacier Bay National Park and Preserve; preparation of a Unique Waters Nomination to the State of Arizona in order to protect waters of Glen Canyon National Recreation Area (see highlight article following); participation in the Great Lakes Water Quality Initiative; assistance in preparation of regulations to prohibit solid waste disposal facilities in units of the National Park System; and development of the water resources component of NPS-77 - Natural Resource Management Guideline. The PEB also reviewed more than 200 documents (e.g., Environmental Impact Statements, NPS planning documents, and proposed regulations). Comments were prepared on over 30 percent of these documents. Another major activity of the PEB involved the development of an implementation strategy for the wetlands component of the NPS Watershed Protection Program (see highlight article next page).



Development of Water Resources Management Plans

by Mark Flora
Hydrologist

Water resources constitute a particularly important and sensitive ecosystem component. Its physical availability and quality are often critical determinants not only of aquatic resources, but of a park's overall natural resource condition. In seeking to provide proper resources protection and management, the park manager is often confronted with a broad array of water resources-related issues. A recent system-wide natural resources assessment identified several hundred unit specific water resources concerns which include the degradation of water quality due to external activities, the alteration of natural flow regimes and groundwater levels, and the lack of secure water rights. The assessment also identified numerous other water resources-related issues such as the disruption of hydrologic resources due to mineral extraction and geothermal development, impacts of urbanization, water supply and drought management, visitor use impacts on backcountry park resources, and the lack of basic data necessary to understand park resources and threats to them.

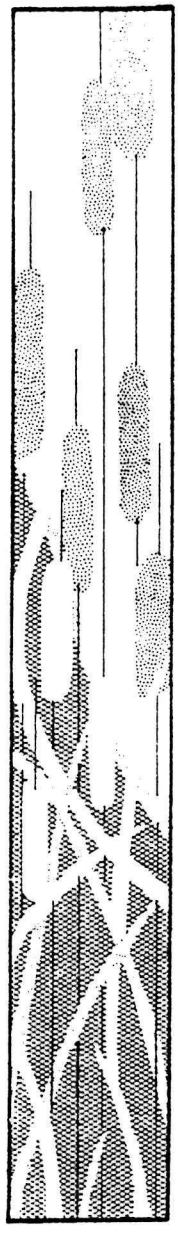
In parks where water resources issues are sufficiently important, complex or controversial, the development of a Water Resources Management Plan (WRMP) may be warranted. A WRMP supports the NPS's decision-making process related to the protection, conservation, use, and management of a park's water resources. The WRMP structures and uses information available about a park's hydrologic resources to assist management in evaluating alternatives to address water resources issues. It is a dynamic document that is revised periodically, but if properly structured, the WRMP will provide a blueprint for the resolution of park water resources issues over a three to seven year period.

To date, WRMP's have been completed for 10 National Park Service units. In 1990, WRMP's for three additional units (Delaware Water Gap National Recreation Area, Organ Pipe Cactus National Monument, and Capitol Reef National Park) neared completion while work began on WRMP's for Great Basin National Park, Colonial National Historic Park, and Grand Teton National Park.

In 1990, the Water Resources Division and resources management staffs in several parks also undertook "scoping" studies designed to identify water resources concerns, evaluate the state of existing hydrological information, and provide management with a recommendation pertaining to the need for a WRMP or addressing straight-forward water resources issues through the Resources Management Plan process. In 1990, "scoping" reports were completed for Great Basin National Park and Acadia National Park and scoping activities were begun in a number of additional units.

Wetlands Activities of the NPS Watershed Protection Program

by Joel E. Wagner
Hydrologist



The WRD established a new Watershed Protection Program to protect NPS water resources from degradation and to address existing impacts to these resources. The specific focus of the program is on water quality and wetlands protection.

The wetlands protection activities of the program are designed to (1) broaden awareness of wetland values and the importance of effective wetlands management throughout the NPS, (2) update guidance and develop supporting handbooks and other materials to enhance NPS wetlands protection and management, and (3) support wetlands inventories, restoration, research, and protection efforts on NPS-managed lands. These goals will be achieved via the following components:

Inventory. The program will support NPS wetlands inventories for planning, compliance, resource management, and research purposes. The U.S. Fish and Wildlife Service's (FWS) National Wetlands Inventory (NWI) is expected to play a significant role in this effort, although other inventory methods will be supported as well. An NPS-FWS Interagency Agreement is being developed to establish equal cost sharing for standard NWI mapping. The FWS will also provide a digitizing service.

Wetlands Database. An NPS wetlands database is being established. Next year, the emphasis is on the status of wetlands inventory information (by park), including availability of digital data. Later entries may include threats, known impacts, and project status.

Technical Support. The program will supplement existing WRD wetlands technical support to parks via increased project funding and technical assistance. The Division will also expand support to the Associate Director for Natural Resources on wetlands issues.

Wetlands Guidance. The WRD will revise existing wetlands protection guidance to assure a minimum goal of "no-net-loss" of wetlands on NPS-managed lands.

Planning and Compliance. The program will expand WRD planning and compliance support on wetlands issues via consultation with NPS planners, continued development of wetlands management handbooks, and document reviews.

Training. Wetlands training will be offered as part of WRD's Water Resources Management Planning course and as part of the NPS Resource Management Trainee Program. Informal wetlands inventory and compliance training sessions will be held for Denver Service Center staff.

Public Awareness. A pamphlet illustrating wetland types, wetland functions, and NPS wetlands management, research, interpretation, and education programs will be developed.

Funds are available for wetlands-related projects in two categories: (1) inventory, and (2) restoration, protection, and applied research. The program will fund such projects in at least three Regions per year on a competitive basis. The longer-range goal is to fund at least one project in each category for each Region over a 3 to 5 year period.

Arizona Unique Waters Nomination for Glen Canyon National Recreation Area

by Barbara West
Environmental Protection Specialist

With the participation and cooperation of the resources management staff of Glen Canyon National Recreation Area (GLCA), the WRD prepared a nomination for unique waters status for the waters of the Colorado River below Glen Canyon Dam. Unique waters in the State of Arizona are waters where, under the State's antidegradation policy, no degradation of water quality is permitted in high quality waters that constitute an outstanding public resource or critical habitat for a threatened or endangered species. Also eligible for designation are waters of exceptional recreational, ecological, or educational significance.

The nomination was developed to implement one of the primary recommendations of the recently prepared Water Resources Management Plan for GLCA. The plan proposed that NPS seek special protection for the high quality waters of the park through the State's water quality regulatory process.

The nomination includes narrative justifications for 6 of the 10 criteria for designation specified by the Arizona water quality standards. The criteria addressed include the fact that the nominated waters are part of the national land system as a unit of the National Park System and can, therefore, be managed in ways that are compatible with the unique waters designation. Also addressed were the recreational, scientific, and educational uses and opportunities available in the nominated waters; the significant variety of flora and fauna, including at least one endangered species; and the fact that designation as a unique water would be wholly consonant with Federal and local comprehensive plans.

Included as part of the nomination were proposed water quality criteria for the nominated segment. WRD derived the proposed criteria from U.S. Geological Survey water quality data that have been collected at Lees Ferry since 1961. The proposed criteria are intended to describe the existing water quality in the nominated segment to at least the 90th percentile for each water quality parameter for which data were available. The 90th percentile was selected to provide the degree of certainty required to adequately describe the water quality that currently exists.

After formal submission to the State, the Arizona Department of Environmental Quality will review and evaluate the proposal and will make recommendations to the Arizona Water Quality Control Council, which is the body that rules on the nomination after public notice and hearing. This is the first such nomination that NPS has submitted to a State. WRD believes that such programs offer significant opportunities to protect park water resources and water-dependent environments through State-Federal cooperation.

WATER OPERATIONS BRANCH HIGHLIGHTS

by William L. Jackson
Branch Chief

In 1990, the Water Operations Branch (WOB) operated under a new and expanded role and function. The WOB now provides National program leadership and operational support in five "activity" areas: Floodplain Management and Surface Water Hydrology, Ground Water Protection and Development, Water Quality Management, Watershed Management (including Urban Hydrology), and Information Management (including Geographic Information Systems (GIS) applications). The WOB provided technical assistance to all ten NPS Regions on over 95 park-specific issues. Several staffing additions and the acquisition of funds to develop and implement the WRD's new Watershed Protection Program (Water Quality Management Activity) have greatly enhanced the WOB's ability to serve its Park, Region, and Denver Service Center customers.

This was a productive year for all Branch Activity Areas. Under Gary Smillie's leadership, over eight floodplain assessments were conducted and new survey and computer technologies were acquired to enhance productivity in this area. Gary Rosenlieb was selected to head WOB's newly expanded Water Quality Activity. In addition to securing additional professional and financial support for park-based programs, the Water Quality Activity has provided technical assistance on numerous park issues, including the design of water quality monitoring projects for Canaveral National Seashore and Katmai National Park, the successful protesting of a permit for a non-discharging sewage lagoon on the border of Coulee Dam National Recreation Area, and water quality data analyses for Indiana Dunes National Lakeshore and Assateague Island National Seashore.

This past year found the WOB addressing many ground water issues. Bill Werrell and Rick Inglis have provided strong support to the WOB Ground Water Activity, including water supply investigations and ground water resource monitoring activities. Technical assistance has been provided in locating potable ground water at several areas, including Great Basin and Yosemite National Parks. Ground water monitoring programs have successfully been implemented at Pipe Spring National Monument, Olympic National Park, and Dinosaur National Monument. In addition, the WOB assisted in designing ground water monitoring programs for Gettysburg National Military Park, and Montezuma Castle and Death Valley National Monuments. The WOB also is working with Grand Canyon National Park and the Glen Canyon Environmental Studies Program to assist in assessing relationships between fluctuating river stage, bank-stored ground water, and beach erosion in the Grand Canyon.

Two new employees are making important contributions to the WOB program. Dean Tucker is providing leadership in development of WOB's Information Management Activity, including management and analysis of water quality data and identification and implementation of water resources

applications in GIS. Larry Martin recently joined the WOB to provide support to its Watershed Management Activity. Larry has a broad background in watershed hydrology, riparian management, ground water modeling, and GIS technology. The Watershed Activity has, among other things, assisted in analysis of stream restoration issues at Yosemite National Park, Glen Echo Park, and Valley Forge National Historic Park, and in riparian rehabilitation issues at Dinosaur National Monument.

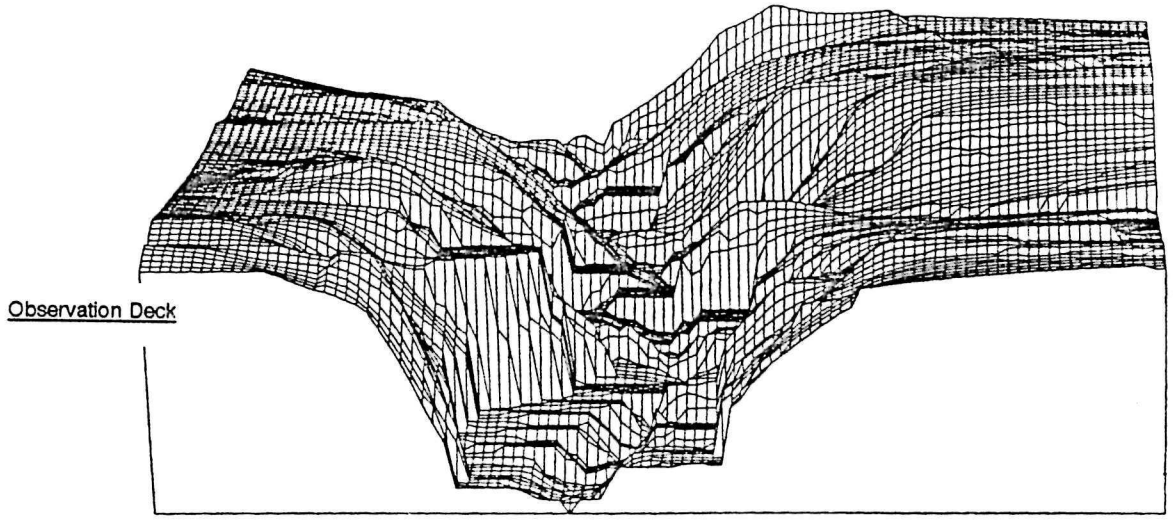
Finally, Jacquie Nolan, WOB's cartographer and computer assistant, initiated and developed the WRD's official NPS Natural Resources publication series, thereby providing a permanent, referencable outlet for the many substantive technical accomplishments of the WRD.

In the short articles that follow, you will read about the WOB's enhanced computer and GIS capabilities, the way in which the Water Quality Protection Program is being designed and implemented, and the many accomplishments of the WOB's floodplain management and surface water hydrology activity area.

MINNEHAHA CREEK

Glen Echo Park, George Washington Memorial Parkway

Perspective plot viewed from the east



Water Resources Division Now GIS Literate

by Dean Tucker
Research Associate - CSU

With the assistance of the NPS-GIS Division, many national park units have acquired Geographic Information System (GIS) technology in order to better manage park-based natural and cultural resource information, including inventory and monitoring data. As a result, national park units are increasingly requesting assistance from WRD personnel regarding treatment of hydrologic data in a GIS. Recognizing the trend towards GIS-based natural resource management, and to better respond to these requests, the WRD initiated its Information Management Activity Area (IMAA). One of the objectives of IMAA is to identify and develop GIS water resources applications.

As a consequence of this effort, the WRD is aggressively enhancing its ability to assist Parks and Regions in the development of GIS water resources themes and the application of the GIS analytical capabilities to resolve complex water resources management issues. Significant accomplishments of this effort included the addition of GIS expertise to the WRD, acquisition of some GIS hardware and software, ongoing compilation of an annotated bibliography of water resources GIS applications, and technical assistance in developing several park-based GIS applications.

1990 NPS-WRD GIS Tools: During 1990, the WRD began to obtain the necessary hardware and software to manipulate spatial data and to work more closely with the NPS-GIS Division. The initial hardware acquisition included a powerful 486-based microcomputer, 24" x 36" digitizing tablet, and a tape backup unit. GIS-related software acquisitions include AutoCAD, the leading microcomputer computer-aided design program; CivilCADD, software that extends the basic capabilities of AutoCAD to surveying, contour mapping, digital terrain modeling, and hydrologic modeling; and ATLAS*GIS, an inexpensive, easy-to- use mapping system and database management system. In the near future, the WRD hopes to acquire hardware and software to run GRASS, the NPS-supported GIS, and ARC/INFO, the GIS presently used by most Federal agencies working in water resources, including the U.S. Geological Survey (USGS) and the Environmental Protection Agency (EPA). Some uses to which the WRD's present systems have been applied are described briefly below.

Automated Drafting: Every year the WRD produces a variety of publications which document, discuss, or resolve significant water resource problems. Usually incorporated in each publication is one or more graphics depicting the location of a particular study area or illustrations of complex research designs or methodologies. Traditionally, these figures have been hand drafted. The WRD is beginning to produce these graphics using AutoCAD. Although not usually considered a true GIS, the AutoCAD system affords several benefits. These include the ability to draft, edit, and update graphics more quickly. Additionally, existing park digital data can be imported into AutoCAD to serve as a base map for many figures. The

system also allows better archival storage and retrieval of these graphics if needed for subsequent reports.

Surveying and Hydrologic Modeling: Another attraction of the AutoCAD system is its open architecture, which has spawned a plethora of useful add-in software that extend AutoCAD's capabilities into the areas of "true" GIS, surveying, hydrologic modeling, and landscape architecture, just to name a few. The WRD has been using CivilCADD, an add-in software package that enables WRD personnel to download surveyed terrain or boundary data automatically from a total surveying station and quickly generate contour maps and three-dimensional models of the surveyed area. Another useful part of the CivilCADD package is AutoHEC2, an implementation of the U.S. Army Corps of Engineers HEC-2 program designed to operate in AutoCAD. This system can calculate water surface profiles and determine flood hazard zones based upon terrain and other input factors. CivilCADD has been used to help delineate flood-prone areas in Wild Basin in Rocky Mountain National Park and to examine beach sediment deposits and ground water levels along the Colorado River in the Grand Canyon.

Water Quality Database Management: The analysis of water quality data has also benefitted from the application of GIS technology. Each year many megabytes of water quality data is collected within or adjacent to national park units. In addition to ongoing data collection efforts, volumes of water quality data exist in national water data banks such as the USGS's WATSTORE or the EPA's STORET. Water quality, like all natural resource data, varies in time and space as a function of a variety of physical, chemical, and biological variables. Spatial variability of water quality is ideally suited for mapping and analysis in a GIS. The WRD has been working with Indiana Dunes National Lakeshore's Research Division to establish an easy-to-use park-based water quality monitoring and mapping system that works in conjunction with the park's GIS to allow researchers to examine explicitly the spatial distribution of water quality in conjunction with other layers of information such as vegetation, soil type, or proximity to roads.

Watershed Protection Program Focuses Resources on Park's Water Quality Management Issues

by Gary W. Rosenlieb
Hydrologist

WRD obtained funds to implement the Water Quality Management Activity (WQMA) of the Watershed Protection Program in 1991. The WQMA is designed to augment the NPS's ability to respond to and resolve critical water quality issues in two ways: (1) creation of a Water Quality Section within the WRD that will provide increased technical assistance to the parks in matters related to water quality, and (2) distribution of competitive funds to parks that will assist with initiation or continuation of water quality management programs. The WQMA is administratively within the WOB of

the Division, but is designed to coordinate closely with the water quality, planning, and regulatory activities of the Planning and Evaluation Branch and water quality research activities of the Applied Research Branch.

The NPS faces a large number of water quality issues. A recent inventory of threats to park resources identified over 480 water quality issues in 170 NPS units. While many of the issues result from activities within park boundaries, the majority of issues result from land use outside park boundaries, but within watersheds or ground water basins that discharge into NPS units. Roughly 70 percent of all identified water quality issues are classified as "non-point sources" of pollution, and involve degradation of water quality from activities such as mining, agriculture, timber harvesting, livestock grazing, and urbanization. In addition, a large number of serious NPS pollution issues stem from mishandling hazardous substances and wastes. In most cases, the States maintain primary responsibility for development and enforcement of water quality standards within the parks. Thus, development that address these critical pollution issues of park water quality programs must be generated within the context of state-based strategies for protecting or enhancing water quality.

The ultimate goal of the WQMA is to provide funds, personnel, training, and national guidance for development of a national water quality management program that addresses the large array of NPS water quality issues. Long-term program objectives include development of: (1) a national program of water quality information management, including GIS applications, (2) park-based water quality Inventory and Monitoring programs, (3) improved coordination with agencies that support national water quality programs, and (4) management guidance-- both technical and regulatory--for dealing with water quality issues. To achieve these objectives, expertise in the physical, chemical, biological, and data management aspects of water quality will be added to the WOB for the primary purpose of assisting parks with water quality issues. In addition, there will be about $220,000 available in 1991 to parks through the competitive funding component of the WQMA for the purpose of developing park-based water quality management programs.

The primary intent of the competitive funding component is to make funds available to cover one-time costs associated with implementation, continuation, or rejuvenation of water quality management programs. Management is the key component of this. The program can support a wide array of efforts in areas of prevention, identification, and elimination of surface and ground water quality threats and issues. For example, in the area of prevention, the program will support proposals and projects which seek to acquire information and data to support the legal reclassification of a park's water resources for the purposes of obtaining a higher degree of protection through State law. Within the area of identification, the program will support well designed water quality inventory and monitoring efforts, including acquisition of necessary equipment. Finally, the program will support efforts to eliminate sources of water quality contamination such as implementation of a Best Management Practice or development of a strategy to obtain a regulatory remedy.

WRD's Floodplain Management and Surface Water Hydrology Activity

by Gary M. Smillie
Hydrologist

The purpose of the Floodplain Management and Surface Water Hydrology activity area is to (1) provide servicewide policy and guidance in the management of floodplain resources, (2) ensure that NPS planners and managers have available the information required for compliance with EO 11988 and NPS Floodplain Management Guidelines, (3) provide training and technical information to build awareness of NPS floodplain management responsibilities and opportunities, and (4) provide general surface water hydrology, hydraulics, and sediment transport expertise to the NPS. Technical services in this activity area can usually be provided to NPS units at considerably less cost than would be incurred by using outside sources.

The floodplain component of the activity area functions on a servicewide and individual park basis. Servicewide activities include development, modification, and interpretation of NPS Floodplain Management Guidelines and development of technical references and training information. Individual park functions include projects and technical assistance that range from on-site appraisals of flood hazard to full hydrologic or hydraulic design studies. Additionally, technical review of existing floodplain studies, Statements of Findings, and projects contracted to outside sources is provided.

In 1990, the NPS Floodplain Management Guidelines were reviewed critically, and areas that needed clarification or improvement were identified. A draft revision of the Guidelines is being developed and will be circulated for review in 1991. The intents are to make the Guidelines a more concise and easily understandable reference, and to modify procedural requirements for the development and approval of floodplain Statements of Findings.

Also, the WOB was involved in more than 20 floodplain management technical assistance activities in 7 Regions, including complete floodplain evaluations at Canyon De Chelly National Monument and Grand Teton, Rocky Mountain, Glacier, and Petrified Forest National Parks. In the Canyon De Chelly study, for example, 100-year, 500-year, and probable maximum flood discharges were quantified. Next, corresponding water surface elevations and hydraulic characteristics were estimated for the area being considered for development by applying an open-channel flow computer model. When it was learned that the area was within the 100-year floodplain, hypothetical levees were added to the model and evaluated for effectiveness in reducing flood hazards.

The surface water hydrology component of the activity area consists of an array of activities that include statistical analysis of hydrologic records, hydraulic facility design, sediment transport modeling, field instrumentation,

and computer modeling of streamflow. An example of WOB involvement in this area is participation in a study of effects of gravel removal from streams in Grand Teton National Park. Gravel is needed as road base material for extensive highway rehabilitation in the park. The NPS is interested in determining whether the gravel replenishing capabilities of several park streams may permit the streams to be used as a source of the needed road base material. It has been suggested that if extraction techniques are carefully designed, fewer long-term impacts to park resources may occur using stream channel sources than upland gravel sources.

The floodplain management and surface water hydrology activity area continues to evolve in an attempt to improve the ability of the WOB to respond to NPS needs in these areas. The program was enhanced by acquisition of an integrated total station survey set-up and a computer aided design (CAD) system. By enabling direct downloading of field survey data into CAD-based hydraulic modeling and cartographic routines, this equipment has facilitated rapid turn-around time and allows certain projects to be performed in-house that heretofore were beyond the scope of WOB capabilities.

WATER RIGHTS BRANCH HIGHLIGHTS

by Owen R. Williams
Branch Chief

1990 has been a time of transition for the Water Rights Branch (WRB). The pace of water development and court activity has been steadily increasing since the Branch's inception, but 1990 was a period of accelerated increase. While it reached its full complement of staff this year, the Branch has been hard pressed to keep up with the rapid pace of change in the water rights arena. The issues discussed below by WRB staff members illustrate the scope of WRB activities, as well as the increasing complexity of the issues the Branch must respond to with little or no forewarning.

As you read these discussions, you will see how a dispute over water rights in Reese Creek (Yellowstone National Park) was settled after years of negotiation only when the parties were faced with imminent, court-mandated deadlines. You will read of the NPS's preparations to reenter court to quantify the water right which the court recognized for Black Canyon of the Gunnison National Monument reservation purposes in 1982. You will also read of the NPS's efforts in Nevada (Death Valley National Monument, Great Basin National Park, and Lake Mead National Recreation Area) to protect its water rights and water-dependent resources from increasingly common urban attempts to capture rural water for transfer to and use in rapidly growing water-scarce population centers.

Environmental, social, and economic consequences of water development become more alarming every year. Within the context of the NPS mandate, the potential cost to water-dependent resources of water development beyond unit boundaries may become catastrophic.

In 1991, the WRB will face even more activity in water rights. Litigation is likely in Nevada (4 cases), Colorado (4), Idaho (2), and Oregon (2); it is quite possible in Utah (1), Oklahoma (1), California (1), Wyoming (1), Arizona (2), South Dakota (1), Alaska (1), and Montana (2).

Settlement Reached on Reese Creek

by Kenneth Czarnowski
Hydrologist

Reese Creek is the northernmost tributary of the Yellowstone River in Yellowstone National Park (YELL). This stream flows approximately 7.2 miles from its headwaters to the confluence with the Yellowstone River just inside the Park boundary. The original portion of Yellowstone reserved from public domain contained only about the upper half of the stream. Congress included the remainder of Reese Creek in the 1926 boundary extension, which was eventually purchased from private parties.

In the early 1980's, the Royal Teton Ranch (RTR), also known as the Church Universal and Triumphant, purchased land adjacent to Yellowstone's northern boundary. Shortly thereafter, they moved their headquarters to the area along with several hundred members and began intensive cultivation of the river bottomlands. During most of the irrigation season, RTR, using an alleged senior water right, diverted most, if not all, of the water from Reese Creek (within the Park) by means of two ditches. Another adjacent landowner diverted the remaining water for additional irrigation. Thus, the issue became one of excess demand for limited water in Reese Creek. Private parties were diverting water to which they felt they had entitlement, while the NPS believed these diversions were excessive and injured its alleged senior water rights. Specifically, YELL was interested in maintenance of the scenery, preservation of wildlife, protection of a natural ecosystem, and preservation of a viable cutthroat trout fishery.

The NPS and other water users were eventually drawn to the negotiating table by the Montana Statewide Water Rights Adjudication. The RTR filed about 30 claims with the Water Court for use of the water of Reese Creek, other irrigators filed 6 claims, and the NPS filed 5 claims for the same water for instream flows. All parties filed objections to each other's claims and legal fees escalated. Issues to be resolved included late claim filings, charges of inflated acreage claims, water claims for nonexistent power plants and industries, allegations of forfeited water rights associated with abandoned mining operations, water for "ghost" towns, water for railroads whose tracks were removed decades earlier, and instream flows which are not recognized as a beneficial use of water by the state. As allegations countered allegations, Reese Creek remained dry during most of the irrigation season.

A multitude of reasonable options were considered during settlement discussions, including purchase of all Reese Creek water rights by the NPS, changing RTR's point of diversion to pump from the Yellowstone River, and requesting the state to invoke the Public Trust Doctrine. As deliberations continued, it became clear that the claimed water rights of all parties would be subject to significant risk if the waters of Reese Creek were apportioned by the Montana Water Court because of uncertainty which surrounded the most senior water rights. As time passed, the

Watermaster became increasingly impatient with the apparent lack of progress and set a date in early July 1990 for trial. However, after nearly 5 years of discussions, a stipulated settlement was reached on July 6, 1990, just days before the parties were to appear in court. The agreement was crafted by the Solicitor's Office, the WRD, and legal counsel for the RTR. Although concessions were made by all parties, it was not until a "sharing of risk" was assumed by the water users that a settlement became possible. To accomplish this, the parties combined a number of water rights with early priority dates and agreed to share the first 3 cubic feet per second on a pro-rata basis. In this way, during dry years, some water would always be available for instream flow while irrigators would still receive a portion of the flow for crops.

The Reese Creek settlement was described by counsel for the RTR as one of the most complex and unique to be submitted to the court. The process of negotiation, albeit protracted and laden with risk, allowed parties to explore options that might not be possible through litigation. As such, a win-win agreement was reached saving years of work and thousands of dollars in litigation costs while protecting important fisheries, defining the status of water rights for each claimant, removing a cloud from the title to their land and water, and helping to create a spirit of cooperation among neighbors.
The WRD is continuing to assist YELL with this issue through the installation of monitoring equipment and new headgates on the stream. The WRD will also assist Yellowstone in preparing and implementing a monitoring plan to insure that all parties receive water as agreed in the stipulated agreement.

Water Rights Quantification for Black Canyon of the Gunnison National Monument

by Chuck Pettee
Hydrologist

A Colorado Water Division 4 adjudication decree declares that a Federal reserved water right exists for Black Canyon of the Gunnison National Monument (BLCA). The decree directs the United States to quantify this right for final review and approval by the Court. To meet the requirements of the Court decision and function within the scope of its agency mission, the NPS is developing analyses to assess the role of water in maintaining park resources under existing and hypothetical hydrologic regimes. Results from these analyses will be presented in the quantification claim to assess the potential for impairment by altered flow regimes.

The Water Rights Branch of the WRD, with the assistance of Rocky Mountain Region and Black Canyon of the Gunnison National Monument, is conducting studies to determine, subject to the limits of current science, the quantity of water that is necessary to fulfill the purposes for which BLCA was established. The studies characterize existing conditions for specific aspects of selected water-related resources within BLCA. In

addition, the studies will attempt to identify the hydrologic flow regime (quantity and timing) required to maintain the water-related resources in an unimpaired condition.

BLCA encompasses a portion of the Gunnison River and adjacent lands characterized by steep cliffs falling as much as 2,200 feet to a narrow, rocky, river bottom. The monument was created by Presidential Proclamation "for the preservation of the spectacular gorges and additional features of scenic, scientific, and educational interest." The obstacles of cliffs and swift water which frustrated many early explorers also required extraordinary measures on the part of NPS field crews as they gathered data on the canyon floor. Helicopters were necessary to move field equipment into the canyon. The NPS worked cooperatively with the Bureau of Reclamation (BOR) to schedule prescribed releases from upstream reservoirs to enable data collection for a range of flow conditions. Field data collection for the studies was completed in 1990.

The position of BLCA within the Colorado River Basin and Congressional approval of agreements and facilities implementing water distribution have added constraints to those identified in the enabling proclamation. Because the Colorado River Basin encompasses portions of Mexico and seven of the United States, distribution of the river's flow is the focal point of both international treaty and interstate compact. Additionally, the BOR has developed a network of large reservoirs on the Colorado River and its tributaries. Individual reservoirs within this network depend upon each other for water deliveries to meet flood control, hydropower, irrigation, municipal and other water use needs. These international, interstate, and intrabasin dependencies have resulted in a very complex system for apportioning the amount and timing of flow within the Basin. The intent of these Congressional actions must be interpreted consistently.

BLCA is situated immediately downstream from a series of three reservoirs on the Gunnison River, a tributary of the Colorado River. As the NPS determines the quantity of the United States Federal reserved water right for BLCA, it is faced with the task of interpreting the intent of Congress in creating this monument in the midst of a complex system of other Congressionally created water control and distribution facilities. To accomplish this task, a team consisting of NPS and BOR personnel has been created to assist Department of Justice (DOJ) attorneys. This team will work to prepare a consolidated quantification of Federal water rights interests for BLCA to be submitted to the Water Court by the DOJ.

Water interests other than those in place by Congressional intent also play a role in determining what flow will occur in the Gunnison River through the Black Canyon. As the United States quantification is reviewed by the Water Court, other Gunnison River water users will have an opportunity to object to or support the quantification.

Las Vegas Valley Water District Applications in Nevada

by Alice E. Johns
Hydrologist

In October 1989, Las Vegas Valley Water District (LVVWD) filed with the Nevada State Engineer 146 water right applications to divert more than 800,000 acre-feet of ground water and 60,000 acre-feet of surface water in four Nevada counties--Clark, Lincoln, Nye, and White Pine. The diversion points proposed in LVVWD's applications are located on Bureau of Land Management (BLM) and U.S. Fish and Wildlife Service (USFWS) lands in a 20,000 square mile area of southern and east-central Nevada. The water would be developed for future domestic and municipal uses in Las Vegas and surrounding areas. The population of Las Vegas has been growing at an estimated 6,000 people each month for the past couple of years, and LVVWD has projected that water need will exceed supply early in the next century.

Ground water development of this magnitude is unprecedented in Nevada and most other western states. The issue involves two distinct processes. First, LVVWD seeks to obtain water permits from the Nevada State Engineer. Then, LVVWD will make application to the BLM and USFWS for rights of way for diversion and delivery systems. Since LVVWD has not applied for rights of way and does not plan to do so until its water permits are secured, the NPS is currently focussing its efforts on preparations for state hearings concerning the water permits. It is likely that any decision by the Nevada State Engineer will be appealed, and may ultimately be decided in Federal court.

Water would be diverted from a complex interbasin regional ground water flow system which extends into Utah and California. Withdrawal of large quantities of water is expected to lead to an overdraft of ground water which could dry up natural discharge points such as wetlands and springs.

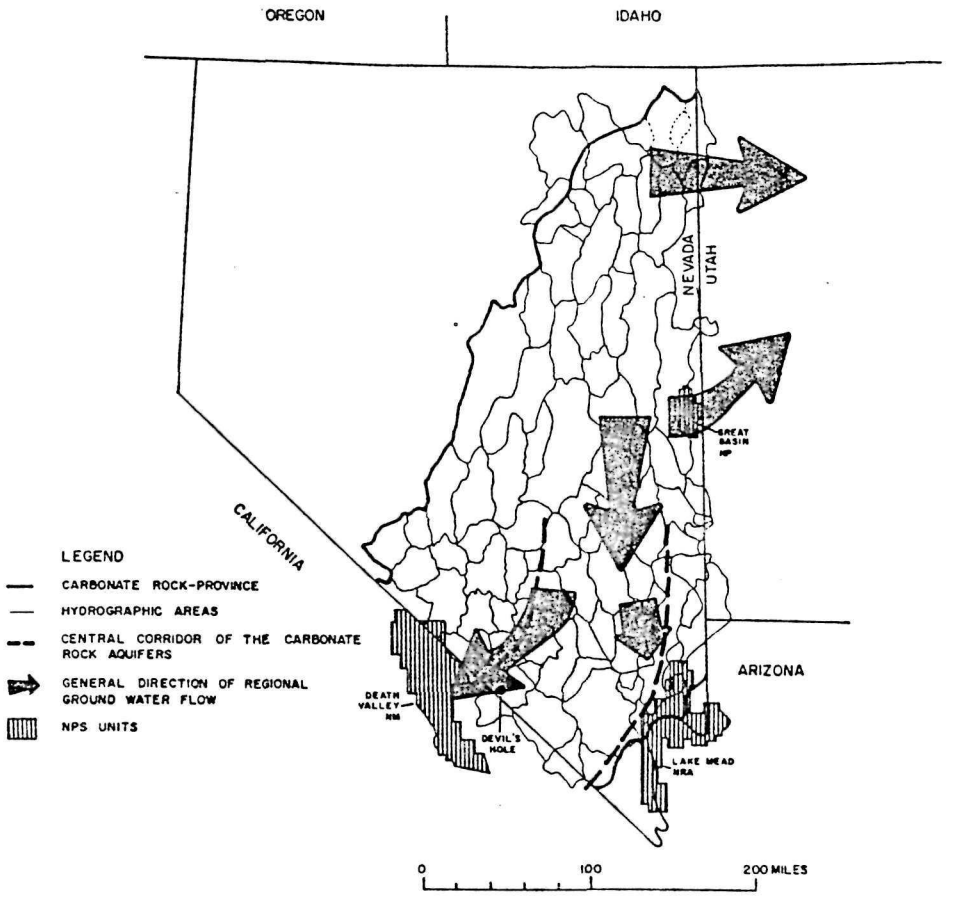
These discharge points include springs in Death Valley National Monument (DEVA), the Ash Meadows area (including Devil's Hole, a detached unit of DEVA, for which Federal reserved water rights have been decreed), and certain springs in Lake Mead National Recreation Area. Ground water occurrence in Lehman Caves, in Great Basin National Park, and at an NPS administrative site in Baker, Nevada, could also be affected. Therefore, on July 6, 1990, the NPS submitted protests to 130 of the applications. (The Nevada State Engineer's office received a total of 3,612 protests.)

Under the direction of legal counsel, the NPS is preparing for upcoming hearings by the Nevada State Engineer. The WRD has assisted the Western Region and involved NPS units in this effort by coordinating the formation of a technical strategy and the other preparations necessary for hearings. Along with other Department of the Interior bureaus (BLM, USFWS, and Bureau of Indian Affairs), the NPS plans to fund studies to examine the potential effects of LVVWD's diversions upon the bureaus' water, water rights, and water-related resources.

A broad-level study by the U.S. Geological Survey will address potential cumulative hydrologic effects. Site-specific studies, to be contracted, will address potential hydrologic effects of selected diversions upon water rights and water resources. Potential effects to water-related resources, such as wetlands, desert bighorn sheep, and desert fish, will be addressed by in-house or by contracted experts. Due to short time frames, the studies will rely primarily upon existing data. Experts will both conduct studies and provide expert witness services during the hearings.

The NPS, in conjunction with the other bureaus, is working to secure the funds needed to conduct these studies. This joint funding approach will avoid duplication and unnecessary expenditures. It will also expedite hearing preparations, necessary in view of the extremely rapid pace of the permit application/review/approval process.

GENERAL DIRECTION OF REGIONAL GROUND WATER FLOW IN THE CARBONATE ROCK-PROVINCE OF NEVADA, UTAH, AND CALIFORNIA



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HARRILL, J.R., GATES, J.S., AND J.M. THOMAS, 1988, MAJOR GROUND-WATER FLOW SYSTEMS IN THE GREAT BASIN REGION OF NEVADA, UTAH, AND ADJACENT STATES: U.S. GEOLOGICAL SURVEY HYDROLOGIC INVESTIGATIONS ATLAS HA-694-C, SHEET 1

APPLIED RESEARCH BRANCH HIGHLIGHTS

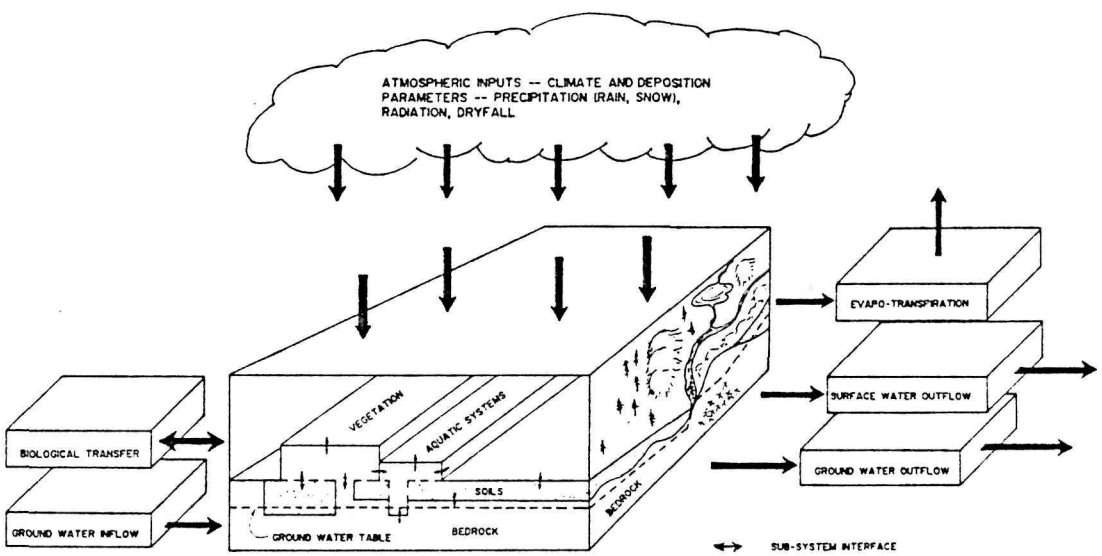
by Gerald E. Walsh
Branch Chief

The Applied Research Branch (ARB) conducted research on aquatic resources in several national parks in 1990. The purpose of the research was to aid park managers in decisions that relate to recreational use of water resources and its consequences, regulation of water flows, gain or loss of resources, biogeochemical processes that govern concentrations of solutes in water, and evaluation of water quality.

These issues are addressed in a number of ways: by research on long-term geochemical processes in park watersheds to predict effects of natural and human induced change, by identification of harmful and potentially harmful effects of pollutants on park aquatic ecosystems through risk analysis, by providing models for effective management of aquatic resources, and by technical assistance to parks in areas such as inventory and monitoring and geothermal studies.

ARB researchers prepared, submitted, or had published 33 scientific papers or research reports in 1990. These products related to NPS concerns with regard to climate change, acid rain, effects of solute movement from snow into streams, composition of benthic macroinvertebrate communities in perturbed and unperturbed streams, non-point sources of nutrients and pollutants, toxicity studies, inventory and monitoring, modeling with regard to recreational use of parks, modeling of instream flows, etc. These publications demonstrate the wide variety of critical areas of park science addressed by the Branch researchers.

CONCEPTUAL MODEL OF THE WATERSHED APPROACH



Watershed Research/Biogeochemical Cycling

by Jill Baron, *Research Ecologist*
Robert Stottlemyer, *Research Ecologist*
and Raymond Herrmann, *Unit Leader, WR-CPSU*

Watershed-level research and monitoring projects on biogeochemical processes were conducted in eight parks and in the Soviet Union during 1990. All of these projects continued from previous years and will extend into 1991 as long-term programs. A primary objective of these watershed-scale programs has been to increase our understanding of natural versus unnatural controls on water quality, so that we may turn this understanding into a tool for planning and managers of NPS water resources. Rocky Mountain (ROMO), Denali, Lake Clark, Isle Royale, and Sleeping Bear Dunes National Parks; Apostle Island and Pictured Rocks National Lakeshores; and Cuyahoga Valley National Recreation Area have a strong interest in preservation or enhancement of existing water quality. All but one have headwater drainages where atmospheric deposition constitutes the major threat to water quality. Research in these parks ranges from reconnaissance or synoptic scale spatial analyses at Lake Clark National Park to long-term ecosystem-scale research in ROMO and Isle Royale National Parks.

Loch Vale Watershed Project - 1990 was a transition year for the long-term ecological research program in Loch Vale Watershed in ROMO. Research since 1981 has addressed biogeochemical process questions related to potential effects of acidic deposition. Continuous monitoring of atmospheric and aquatic parameters was initiated in 1982 as part of that work. Acid deposition transport and effects research was completed in 1990 to coincide with the final year of the National Acid Precipitation Assessment Program (NAPAP). Findings from the Loch Vale Watershed project were included in the NAPAP documents, and have been favorably reviewed. In addition to journal articles, many of which are still in press or in preparation, a synthesis of these first years was completed in this year and will be published by Springer-Verlag in 1991. The monitoring part of the Loch Vale Watershed study will continue into the future as part of the ARB Watershed Program. A new research direction was established this past year with a focus on the regional biogeochemical and ecological effects of global change. Funds were obtained from the NPS Global Change Program and the U.S. Geological Survey Water, Energy, and Biogeochemical Budgets (WEBB) programs to pursue this work.

The Colorado Rockies Global Change program will be conducted in collaboration with scientists from ROMO and Colorado State University. One part of this program will explore changes in climate which may be expected given global or regional scale climatic or land use changes. Emphasis will be placed on predicting changes in regional precipitation patterns, including changes in the amount of annual precipitation, direction of atmospheric moisture, changes in precipitation intensity, and prediction of changes in amount of snow versus rain. Another part of this program

will attempt to predict how changes in climate will affect Rocky Mountain aquatic ecosystems. This has been divided into three subprojects. The first will predict how changes in hydrologic patterns will influence high elevation lake and stream properties. The second will be to understand, and thus predict, changes in fluvial geomorphologic processes given changes in storm intensity and amount. This understanding will be used to prepare for ecological changes. The third will be to predict, given the possibility of changes in directional sources of precipitation, if high elevation aquatic systems are at increased risk from acidic deposition. Interestingly, this takes us back to our initial concern in 1981 for Rocky Mountain lakes and streams. ROMO's aquatic ecosystems are still extremely vulnerable to acidic deposition. An increase in the proportion of precipitation received from the Gulf of Mexico versus the north Pacific Ocean may cause acidification of these ecosystems, with accompanying changes in aquatic biota.

Primary responsibility for the WEBB project is with the Colorado and Wyoming District office of the U.S. Geological Survey. This project will attempt to quantify hydrologic processes and mechanisms of geochemical weathering. Loch Vale will be the centerpiece of this research, but an important product of WEBB will be increased understanding of regional-scale processes affecting water quality and quantity.

The result of increased understanding of biogeochemical processes will be the ability to apply this understanding to managing water resources. A major accomplishment in 1990 was to build a solid working relationship with ROMO resource managers and scientists. ROMO is a good example of a park whose natural resources are not degraded, but which may become so through neglect. Long-term ecological information can be used, and we will attempt to do so, for long-range planning purposes. In 1990, discussion was initiated on how to incorporate data from Loch Vale Watershed and other aquatic systems into the park's geographic information system. Also discussed was where to include Loch Vale Watershed in the park's natural resource management plan, currently under revision. These processes are only beginning, and we hope to use ROMO as a model for long-term water resource management through ecological understanding.

Environmental Resources Decision Making

by Marshall Flug
Research Hydrologist

Decisions relating to water resources management in the NPS often pertain to selection of the best flow pattern while minimizing impacts upon sensitive resources. Natural resource issues inevitably create conflict between special interest groups, each trying to protect or enhance only one resource. Included among these natural and recreation resources are issues concerning white water boating, fish habitat, aesthetics of free flowing water, shoreline protection, beach erosion, vegetation growth, etc.

These conflicts in management for the diverse mix of resources are truly multi-attribute problems. This is particularly true in water issues related to instream and riparian resources where flow regulation from an upstream dam is available. Applications of Multi Criterion Decision Analysis (MCDA) for water resource decision making was demonstrated for application at Grand Canyon National Park, Glen Canyon National Recreation Area and the Glen Canyon Environmental Studies; Voyageurs and Everglades National Parks; and New River Gorge National River. One important step in this process requires some quantification of natural and recreation resources of concern. A functional relationship between water levels or flows is defined, thereby creating a utility function for each resource. These predictive resource utility functions are used to measure the relative gain or loss of resource for any flow pattern of concern. A tradeoff analysis of benefits or impacts resulting from different flow alternatives is evaluated with a multi-criterion decision making technique in a spreadsheet personal computer based model. An overall best flow alternative option is selected after ranking the importance of each identified resource relative to the other resource issues. This tradeoff analysis approach was described by the U.S. Corps of Engineers and presented to their Environmental Advisory Board; the U.S. Bureau of Reclamation maintains this methodology in the form of an available Multi Attribute Tradeoff System for the personal computer; and the U.S. Fish & Wildlife Service has some experience with this approach as part of the overall Habitat Evaluation Procedure. The graphic displays provided as output from the analysis are an important component to help arrive at compromise water management alternatives. A most important benefit from this systems approach is that a quantitative analysis is provided as decision making tool which can trace through the analysis to identify each resource and the response as defined by the respective utility function. Each decision maker or special interest group can see the significance of any flow alternative upon an opposing or conflicting resource concern and use this to choose less damaging water management option.

NPS Risk Analysis

by Del Nimmo
Environmental Chemist,
and Terry Boyle
Research Ecologist

Formulation of strategies to determine ecological risk to natural resources within the NPS is dependent on a multidisciplinary effort. Assessment of risk can be made with knowledge of chemical characteristics and activity, toxicity analysis with a group of representative organisms, and ecological analysis of the various components of impacted resources. A first step in risk analysis is to devise a system to identify and inventory natural resources. Although nationally accepted guidelines are lacking, this inventorying process is occurring at several NPS units. As an example, the St. Croix National Scenic Riverway has been the focus of a study to identify the status or environmental health of the natural resources within

the river. The NPS owns and administrates the river corridor, but anticipates that the threats to natural resources will come from the watershed outside the park boundaries. The benthic macroinvertebrate community was used as a community level biological indicator to assess the status of 'environmental health' at the mouths of a number of major tributaries to the St. Croix. Data from these studies will be the foundation for an environmental monitoring effort involving state and Federal agencies. Specific impacts from cranberry bog releases are being assessed through a series of toxicity tests adapted for field use. Procedures for identifying the toxic agents in these sources which contain pesticides has been a continuing research effort.

In another program that involves determination of ecological risk using resource inventory and monitoring techniques, six small parks in the prairie region with aquatic natural resources have been organized into a program to address the resource status and risk. This program features detailed analysis of the stream ecosystem in the Niobrara River at Agate Fossil Beds National Monument to aid in development of monitoring strategies in similar streams at Pipestone National Monument, Herbert Hoover National Historic Site; Homestead National Monument of America, George Washington Carver National Monument, and Wilson's Creek National Battlefield. This program primarily uses benthic macroinvertebrates as community level biological indicators of environmental health, but also uses the fish community at selected parks. In Wilson Creek NB, where monitoring of aquatic communities has been continuing, comparative toxicity tests have also been conducted to address the sources of toxicants that affect water quality in the watershed.

Although fish species assemblages differ regionally, indices, such as the index of biotic integrity (IBI), which use community structure to characterize the chemical, physical, and biological condition of the aquatic ecosystem, can aid in management of aquatic resources. The major advantage of using fish communities to indicate environmental health is that they reflect direct and indirect effects of environmental impacts on the entire aquatic ecosystem. The IBI has been adapted for use in a number of National Parks (St. Croix National Scenic Riverway, Agate Fossil Beds National Monument, Ozark National Scenic Riverway, and Wilson's Creek National Battlefield) to aid in resource inventory and in management of aquatic resources. In these cases the index appears to be responsive to land use practices in adjacent watersheds that are affecting the biological integrity of the aquatic ecosystem.

Research is in progress for documenting ecological risk from non-point sources of toxicants or sedimentation from land use practices, such as agricultural or urban runoff, landfills, or mine drainage which often occur outside Park boundaries. These sources of pollutants are from diffuse areas and by definition are not regulated through existing programs. Non-point sources are generally non-discrete and their effects are not easily recognized or are difficult to measure. Tests are being developed or modified to address various non-point source pollutants. Parks where such research is in progress are three landfills with one adjacent to Ft. Darling unit of the Richmond National Battlefield, Virginia; South Dade

County Landfill adjacent to Biscayne National Park, Florida; and a landfill that is now listed as a Superfund site adjacent to the Upper Delaware National Scenic and Recreational River, New York. Other non-point issues where tests are being validated include sources of metals from a Superfund site adjacent to the Grant-Kohrs National Historic Site, Montana, and DDT in soils and sediments in Bandelier National Monument, New Mexico.

Summary of Watershed Research
WR-CPSU Colorado State University

by Raymond Herrmann
Unit Leader, WR-CPSU

The WR-CPSU and Colorado State University Watershed Research Studies Program is aimed at developing a hydrologically, geologically, and ecologically sound program for collection of long-term baseline data on the state of park ecosystem health. The program is developing a network of representative long-term watershed research sites compatible with and complementary to other agency efforts. Quantification of the hydrologic cycle and chemical flux are major objectives of the NPS watershed program. Such measurements, when combined with other geographic resources data (e.g., geology, land-use, topography, historic and pre-historic records), permit a better understanding of ecosystem-level processes and of how park watershed-ecosystems respond to various natural and human-induced stimuli, and allow one to interpret environmental change as an early indicator of resources impairment for improved management of NPS watersheds.

From the period 1982-1989, the NPS watershed research program provided information to detect actual and potential impacts from changing atmospheric chemistry. 1990 was a transition year, where emphasis was on finishing those commitments required by the National Acid Precipitation Assessment Program and preparing for implementation of new program emphases. Resources questions currently of direct concern to park resources management may be local, regional, or global. They result from today's modern technological world and can be broadly categorized into four areas: biogeographic changes including translocation, fragmentation, migration and invasion; land-use changes owing to recreation, industrial development and resource exploitation; climate changes, including temperature change, mean sea level change, and change of precipitation patterns and amounts; and, biogeochemical changes such as those caused by acid rain, increased carbon dioxide, and increased concentrations of trace contaminants.

The research strategy is to address these complex experimental issues of the Park Service through a pilot 10-year program involving multi-institutional, interdisciplinary, and integrated watershed research studies. The program is meant to develop, test, and implement state-of-the-art science methods and procedures for application to future water and land

resource management at the national and international levels. Five broad study goals are being pursued: (1) develop and implement example procedures and protocols to identify, collect, organize, analyze, and synthesize selected watershed data within representative watersheds and to interpret for park management the current status and trends in the condition of the park natural resources contained therein; (2) establish baseline conditions for watershed processes against which change can be measured and evaluated, including those related to climate change and pollution levels and trends; (3) seek to identify similarities or differences in watershed responses to stress, make this knowledge available to the scientific community, and report to management on its significance to the management of park resources; (4) provide protected watersheds in the parks to be part of a national, and possibly international, series of sites for ecological and pollutant studies of national and global trends, and (5) assess at four study parks a GIS-based watershed condition theme to be implemented within the context of NPS Inventory and Monitoring. Information being developed will permit a methodical description and quantification of the watershed and will be organized to represent key data categories, specific data elements, and their relationship to the watershed.

For the period 1991-2000, program expansion provides for enhanced understanding of watershed processes within the context of comprehensive natural resources inventory and monitoring. Presently, the watershed program under direction of the WR-CPSU is implemented at four geographically diverse research watersheds (Sequoia, Rocky Mountain, Isle Royale, and Olympic National Parks). There are also similar cooperating programs at or planned in Shenandoah, Great Smoky Mountains, Everglades, Crater Lake, and Denali National Parks. By providing basic site support, including research coordination and cooperation, data management, and scientific and managerial review, the program has attracted external research expertise, and research funding greatly exceeding NPS's own investments.

During 1990, the watershed level research and monitoring site activities have contributed to accumulation of important baseline information on deposition, meteorology, hydrology, ecosystem functioning, and biology. In some cases, important information on biological diversity and biogeochemical processes have been obtained. Activities have ranged among needs identification, reconnaissance or synoptic analyses, long-term monitoring, and long-term ecosystem research. Activities were carried out in 13 parks (Apostle Island, Pictured Rocks, and Sleeping Bear Dunes National Lakeshores; Crater Lake, Denali, Great Smoky Mountains, Isle Royale, Lake Clark, Rocky Mountain, Sequoia, and Shenandoah National Parks; Noatak National Monument) and in the Oka and Caucasus Reserves of the Soviet Union.

SUPPORT PROVIDED TO REGIONS, PARKS, AND OTHER NPS ORGANIZATIONAL UNITS

ALASKA REGION

Planning and Evaluation Branch

Cape Krusenstern NM	• Assessment of Red Dog Mine
Glacier Bay NP and PRES	• Evaluation of Proposed Windy Craggy Mine
Katmai NP and PRES	• Water Resources Management Plan
Yukon Charley NPRES	• Water Resources Management Plan Scoping Report

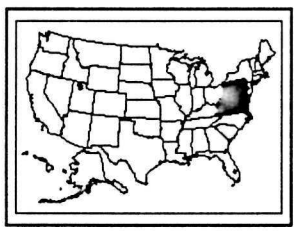
Water Operations Branch

Denali NP and PRES	• Evaluation of the Cause of Reduced Well Yields
Glacier Bay NP and PRES	• Literature Search on Jet Boat Wakes and Stream Habitat
Katmai NP and PRES	• Sandia National Labs Drilling Proposal Review
	• Jet Boat Wake Effects on Salmon Habitat
	• Literature Search on Jet Boat Wakes and Stream Habitat
Kenai Fjords NM	• Review of Floodplain Statement of Findings
Lake Clark NP and PRES	• Literature Search on Jet Boat Wakes and Stream Habitat
Yukon Charley PRES	• Assistance in Scoping Water Resources Management Issues
Miscellaneous	• Participation in Inventory and Monitoring Workshop

Applied Research Branch

Cape Krusenstern NM	• Provide Sample Analyses of Surface Water in Vicinity of Red Dog Mine
	• Consultation and Provision of Technical Material on Baseline Monitoring Program for Kotzebue Sound
Denali NP and PRES	• Determination of Natural Regulation of Headwater Stream Chemistry
Lake Clark NP and PRES	• Baseline Determination of Physical and Chemical Characteristics and Nutrients Limiting Primary Productivity

Noatak NPRES	• Described Relationship of Surface Water Chemistry to Geomorphology



MID-ATLANTIC REGION

Planning and Evaluation Branch

Colonial NHP	• Water Resources Management Plan
Delaware Water Gap NRA	• Water Resources Management Plan
Regionwide	• Wetland Regulatory Compliance Manual

Water Operations Branch

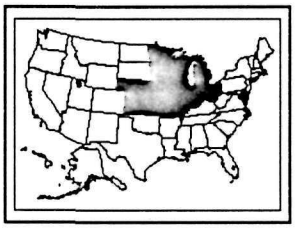
Assateague Island NS	• Water Quality Monitoring Program
Gettysburg NMP	• Review Final USGS Report "Geohydrology and Water Quality in the Vicinity of the Gettysburg National Military Park and Eisenhower National Historic Site, Pennsylvania"
	• Review Ground Water Monitoring Proposal Submitted by Westinghouse Elevator
	• USGS Geohydrologic Report Review Future Ground Water Monitoring Needs Assessment
	• Monitoring Well Recommendations
Hopewell Furnace NHS	• Surface Water Quality Problem Analysis
New River Gorge NR	• Assistance with Contract Specifications for a USGS Flood Study
Valley Forge NHP	• Review of Biological Survey Plan
	• Colleague Review for Valley Creek Hydrology Report
	• Valley Creek Erosion and Water Quality Issue Analysis

Water Rights Branch

Colonial NHP	• Assist with Water Resources Management Plan

Applied Research Branch

Shenandoah NP	• Assistance in Watershed Monitoring Program



MIDWEST REGION

Planning and Evaluation Branch

Sleeping Bear Dunes NL	• Evaluation of Proposed Gravel Pit
Miscellaneous	• Great Lakes Water Quality Initiative

Water Operations Branch

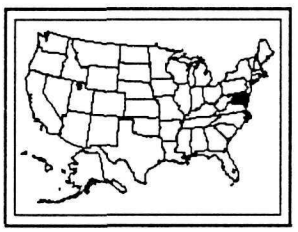
Agate Fossil Beds NM	• Reconnaissance Level Flood Hazard Assessment for Area of Proposed New Visitor Center
Cuyahoga Valley NRA	• Water Quality Monitoring Workshop and Review of Bacterial Water Quality Monitoring Plan
Indiana Dunes NL	• Water Quality and GIS Linking
Sleeping Bear Dunes NL	• Technical Proposal Evaluation Committee for the Evaluation of Proposals to Conduct Research on Hydrocarbon Contamination

Water Rights Branch

Fort Larned NHS	• Kansas Abandonment
	• Private Diversion

Applied Research Branch

Isle Royale NP	• Role of Modeling in Better Design of Inventory and Monitoring
	• Characterization and Mapping of the Soils
	• Assistance with Watershed Studies
Isle Royale NP and Pictured Rocks NL	• Long-term Study of the Effects of Anthropic Atmospheric Deposition on Lake/Watershed Ecosystems and Biosphere Reserve
Miscellaneous	• Long-Term Study of Snowpack Nutrient Dynamics in Watershed Ecosystems, Lake Superior Basin
	• Effect of Ecological Factors on Forest Vegetation Patterns in National Parks of the Great Lakes Basin
	• Effects of an Air Pollution Gradient on Northern Hardwood Forests in the Upper Great Lakes Region



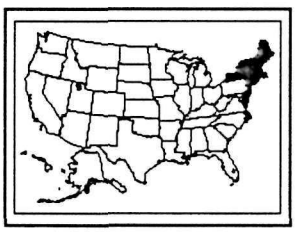
NATIONAL CAPITAL REGION

Planning and Evaluation Branch
Rock Creek Park
- Water Resources Management Plan

Water Operations Branch
Glen Echo Park, GWMP
- Stream Reconstruction Plan

Chesapeake & Ohio Canal NHP
- Flood Warning System Design

Harpers Ferry NHP
- Study Design for Virginius Island Paleoflood Analysis



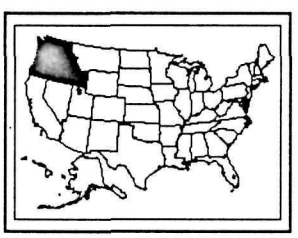
NORTH ATLANTIC REGION

Planning and Evaluation Branch
Acadia NP
- Water Resources Management Plan Scoping Report

Water Operations Branch
Appalachian NST
- Develop a Request for Proposal to Conduct a Hazardous Materials Investigation

Water Rights Branch
Acadia NP
- Assist with Water Resources Management Plan Scoping Report

Miscellaneous
- Farmington Wild & Scenic River



PACIFIC NORTHWEST REGION

Planning and Evaluation Branch
Coulee Dam NRA
- Evaluation of Celgar Pulp Mill Expansion

Water Operations Branch

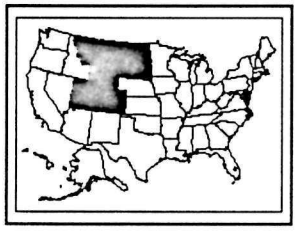
Coulee Dam NRA	• Assist with the Mitigation of a Protest of a Permit Issued to a Non-Discharging Wastewater Lagoon
Crater Lake NP	• Ground Water Supply Evaluation
Olympic NP	• Evaluation of Ground Water Conditions in a Sitka Spruce Grove

Water Rights Branch

City of Rocks National Reserve	• Snake River Adjudication
Crater Lake NP	• Klamath Adjudication • State Water Right Reports
Craters of the Moon NM	• Snake River Adjudication
Olympic NP	• Elwah River Diversions
Miscellaneous	• Oregon Stream Procedures • Snake River Negotiations

Applied Research Branch

Crater Lake NP	• Participated in the Peer-Review Panel for Crater Lake Studies • Technical Support and Peer Review of the Geothermal Studies
Olympic NP	• Supported Watershed Studies (WR-CPSU)
Miscellaneous	• Provided Instruction at NPS Course on Aquatic Resources Management • Assistance with Development of the Draft Backcountry Human Waste Management Plan



ROCKY MOUNTAIN REGION

Planning and Evaluation Branch

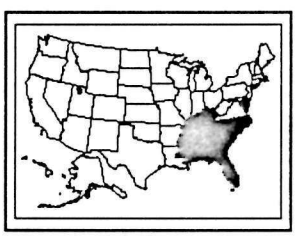
Capitol Reef NP	• Evaluation of Proposed Fremont River Dam • Water Resources Management Plan
Dinosaur NM	• Wetlands Investigation
Glen Canyon NRA and Rainbow Bridge NM	• Development Concept Plans
Glen Canyon NRA	• Arizona Unique Waters Nomination
Grand Teton NP	• Water Resources Management Plan
Pipe Spring NM	• Evaluation of Waste Tech Incinerator
Yellowstone NP	• McLaren Mill Tailings Removal Action
Miscellaneous	• Western Area Power Administration Power Marketing Environmental Impact Statement

Water Operations Branch

Canyonlands NP	• Reconnaissance Level Flood Hazard Assessment for Lathrop Canyon Campground
Capitol Reef NP	• Review of Fremont River FERC Application
Dinosaur NM	• Review of Hog Canyon Riparian Conditions and Management Opportunities
Glacier NP	• Evaluation of Flood Characteristics and Opportunities for Flood Mitigation for Divide and Wild Creeks
Glen Canyon NRA	• Reconnaissance Level Flood Hazard Assessment for the Proposed Copper Canyon Marina Site • Review of a U.S. Geological Survey Draft Report "Evaluation of the Flash Flood at San Juan Marina at Paiute Farms Wash"
Grand Teton NP	• Investigation of the Effects of the Removal of Gravel from Streams to Provide a Source of Road Base Material • Review of Jackson Hole Flood Protection EIS • Flood Study for Highlands Ranch Area
Pipe Spring NM	• ASCE Presentation on Evaluating Spring Flow Trends • Supervised Installation of Ground Water Flow Monitoring Equipment and Evaluated Sudden Reduction of Spring Flow • Presented Water Resources Assessment for Proposed Waste Incinerator Plant
Rainbow Bridge NM	• Review of Planning Document that Incorporated Flood Information Provided by WOB in 1989
Rocky Mountain NP	• Develop Project for Ground Water Supply Investigations in the Hidden Valley Area • Evaluate Water Diversion within the Park Boundary • Flood Study for North St. Vrain Creek Along Wild Basin Trailhead Road Corridor • Professional Consultation for Ski Area Snow Making Diversion
Yellowstone NP	• Reconnaissance Level Flood Hazard Assessment for the Roosevelt Ranger Station and East Entrance Areas

	• Participation on Northern Range Riparian Review Committee
Water Rights Branch	
Bent's Old Fort NHS	• Water Right Filing
Black Canyon of the Gunnison NM	• A-B Lateral • Quantify Water Rights
Bryce Canyon NP	• Water Rights Inventory • Ground Water Study
Canyonlands NP	• Water Right Filing
Capitol Reef NP	• Assist with Water Resources Management Plan • Review FERC Application
Dinosaur NM	• Acquire Stream Flow • Protest Applications
Florissant Fossil Beds NM	• File for Changes in Water Rights
Fossil Butte NM	• Register Well
Glacier NP	• Adjudication Study
Glen Canyon NRA	• Colorado River Adjudication
Grand Teton NP	• Assist with Water Resources Management Plan • File for Changes in Water Rights
Grant-Kohrs NHS	• Montana Adjudication Basin 76G
Great Sand Dunes NM	• Well Registration • Dune Core Study
Mesa Verde NP	• Adjudication Study
Pipe Spring NM	• Spring Decline Study
Rocky Mountain NP	• Respond to Court • Snow Making Study • Water Rights Plan • Pickrell Diversion • Replacement Wells • Protest Girl Scouts Diversion • Adjudication Study
Wind Cave NP	• Assert Vested Rights
Yellowstone NP	• Reese Creek Settlement • McLaren Mill Tailings • Montana Adjudication Basin 43B • Greater Yellowstone Ecosystem Document Review
Zion NP	• Adjudication Study • Adjudication Studies • Flanigan Ditch Claim • Review Municipal and Industrial Water Use Report • Review Water Supply Index
Miscellaneous	• Montana Temporary-Preliminary Decrees
Applied Research Branch	
Dinosaur NM	• Technical Assistance to the Multi-Agency Cooperative Agreement, CSU, on Potential Impacts of Pesticides on Fishes

Grand Teton NP	• Assisted in Evaluation of Hydrology, Sediment Transport, and Data Needs for Assessing Gravel Supplies in Creeks
Rocky Mountain NP	• Continued Support of Watershed Studies • Co-edited the "Lawn Lake Flood Monograph" • Reviewed and Gave Assistance in Development of Natural Resources Management Plan and the Inventory and Monitoring Plan • Technical Advice and Scientific Data Supplied at Air Quality Division for Prevention of Significant Deterioration Permit Applications of Nitrogen Oxide-Emitting Industries East of ROMO
Yellowstone NP	• Assistance with Interagency Coordination and Review Yellowstone NP and Corwin Springs Known Geothermal Area Research Reports
Miscellaneous	• Technical Assistance to USFWS/CSU, Non-Point Sources-Water Quality Survey for San Luis Valley, Colorado Wildlife Refuges • Provided Overall Direction/ Supervision of Joint USFS-NPS Water, Plant Tissue, and Soils Analysis Laboratory, Rocky Mountain Forest and Range Experiment Station



SOUTHEAST REGION

Planning and Evaluation Branch

Big South Fork NR	• Natural Resources Management Plan
Cumberland Gap NHP	• Permitting for National Pollutant Discharge Elimination System
Great Smoky Mountains NP	• Natural Resources Management Plan
Natchez Trace Parkway	• Natural Resources Management Plan
Miscellaneous	• Support to Southeast Region on Issues Related to State Water Quality Regulation, including the Lawsuit (U.S. v. South Florida Water Management District, et al.)

Water Operations Branch

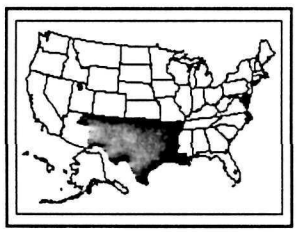
Big Cypress NPRES	• Review of Floodplain Statement of Findings
Biscayne NP	• Review Remedial Program for the South Dade County Landfill
Cape Hatteras NS	• Review of Study Proposal • Ground Water Withdrawal Study Proposal Review • Review Water Quality Monitoring Plan for Bodie Island and Buxton Woods
Canaveral NS	• Develop Study Plan for an Inventorying and Monitoring Program on Mosquito Lagoon
Chattahoochee River NRA	• Evaluate Fecal Coliform Contamination in the Chattahoochee River • Review of Floodplain Statement of Findings
Everglades NP	• Review of Floodplain Statement of Findings • Review of Everglades Draft SWIM Plan
Mammoth Cave NP	• Review of two Unsolicited Research Proposals • Review the Parks Water Quality Monitoring Plan
Natchez Trace Parkway	• Hydrologic Review of Resources Management Plan
Virgin Islands NP	• Influence of Watershed Processes on Marine Resources

Water Rights Branch

Big South Fork NR	• Assist with Natural Resources Management Plan
Great Smoky Mountains NP	• Assist with Natural Resources Management Plan
Natchez Trace Parkway	• Assist with Natural Resources Management Plan

Applied Research Branch

Biscayne Bay NP	• Water Quality Study of Biscayne Bay
Everglades NP	• Water Quality Study of Water Entering Park from a Waste Dump
Great Smoky Mountains NP	• Assisted with Coordination of USSR Bilateral Delegation Visit



SOUTHWEST REGION

Planning and Evaluation Branch

Arkansas Post NM	• Evaluation of Corps of Engineers Proposal
Bandelier NM	• Water Resources Management Plan
Big Bend NP	• Water Resources Management Plan Scoping Report
Buffalo NR	• Water Resources Management Plan
Chickasaw NRA	• Water Resources Management Plan

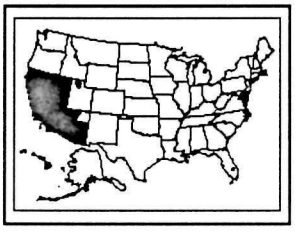
Water Operations Branch

Big Bend NP	• Review Final Draft of "Hydrogeology, Geochemistry, and Quality of Water of the Basin and Oak Spring Areas of the Chisos Mountains, Big Bend National Park"
	• Water Resources Management Plan Scoping Report
	• Review of USGS Geohydrologic Report for Chisos Basin/Oak Spring
Canyon De Chelly NM	• Floodplain Analyses for Garcia's Trading Post
Carlsbad Caverns NP	• Rate and Calibrate Parshall Flumes at Rattlesnake Springs
Chaco Culture NHP	• Analysis of Effects of Well Pumping for Water Supply
Chickasaw NRA	• Review of an Application to Inject Brine Waters into Regional Aquifer
Guadalupe Mountains NP	• Evaluate Possible Causes of Well-Yield Decline
Lyndon B. Johnson NHP	• Water Resources Inventory Preparatory Work
White Sands NM	• Prepared Ground Water Monitoring Plan
	• Field Implementation of Ground Water Quality Monitoring Project

Water Rights Branch

Aztec Ruins NM	• Water Rights Assessment
Bandelier NM	• Assist with Water Resources Management Plan
Big Bend NP	• Scoping Report
Buffalo NR	• Arkansas Ground Water Management Act

	• Assist with Water Resources Management Plan
Carlsbad Caverns NP	• Private Diversion
	• Prepare State Forms
Chickasaw NRA	• Spring Monitoring
San Antonio Missions NHP	• Acquired Water Rights Assessment
White Sands NM	• Assert Water Right
Applied Research Branch	
Bandelier NM	• Identification and Analysis of DDT Contamination



WESTERN REGION

Planning and Evaluation Branch	
American Memorial Park	• Wetlands Investigation
Casa Grande NM	• Natural Resources Management Plan Scoping Report
Death Valley NM	• Evaluation of High-Level Radioactive Waste Repository
	• Assessment of Bond Gold Mining Proposal
Golden Gate NRA	• Water Resources Management Plan
Grand Canyon NP	• Glen Canyon Environmental Studies
Great Basin NP	• Water Resources Management Plan
Haleakala NP	• Natural Resources Management Plan
Organ Pipe Cactus NM	• Water Resources Management Plan
Tonto NM	• Natural Resources Management Plan Scoping Report
Walnut Canyon NM	• Natural Resources Management Plan Scoping Report
Miscellaneous	• Colorado River Jurisdictional Study
Water Operations Branch	
Death Valley NM	• Geologic/Hydrologic Workshop on Yucca Mountain Nuclear Repository
	• Review of Denver Service Center Flood Mitigation and Environmental Assessment for Scotty's Castle
	• Evaluation of the Bond Gold, Inc., Ground Water Monitoring Program
	• Flow Monitoring Station Establishment at Keane Wonder Springs

Golden Gate NRA	• Review Aquatic/Water Resources Management Plan
Grand Canyon NP	• Review of Environmental Consequences of a Proposal to Develop Ground Water on South Rim of Park • Springflow Monitoring Assessment for Bright Angel Creek/Roaring Springs • Beach Erosion Study Technical Support • Review a Background Paper for Long-Term Water Quality Monitoring • Preparation of Glen Canyon Environmental Studies Research Project Plans • Assistance on Ground Water and Beach Erosion Project • Implementation of Glen Canyon Environmental Studies Ground Water Monitoring Project
Great Basin NP	• Review Consultant's Report on Developing Water and Sewer Systems in the Baker, Nevada Area
Kalaupapa NHP	• Develop Project Statement for Natural Resources Management Plan
Lake Mead NRA	• Review of Draft Environmental Impact Statement, Flood Control Master Plan, Clark County Regional Flood Control District
Lassen Volcanic NP	• Evaluation of Alternatives for Water Supply Development
Montezuma Castle NM	• Assistance in Development of Water Resources Project Proposal
Organ Pipe Cactus NM	• Assistance in Preparation of a Water Resources Management Plan
Petrified Forest NP	• Final Report for a Flood Study done in the Rainbow Forest Area
Sequoia/Kings Canyon NP	• Review of Aquatic Resources Management Program
Yosemite NP	• Field Investigations at El Capitan Picnic Area Dump • Study of the Effects of a Change in Base Level of the Merced River and Opportunity for Restoration • Evaluation of Ground Water Development Potential at Big Meadow • Field Assessment of Stream Channel • Respond to Questions Concerning the Flood Hazards of the Merced River at El Portal, California Conditions, Merced River

Water Rights Branch

Casa Grande NM	• Assist with Natural Resources Management Plan • Adjudication Study
Death Valley NM	• Monitor Bond Gold's Permit(s) • Monitor Devil's Hole Water Level • Monitor U.S. Nevada Gold Search Joint Venture Permit(s) • Monitor U.S. Department of Energy Permit(s) • Protest Marsh Water Rights Application(s) • Protest Risinger Water Rights Application(s) • Protest Industrial Mineral Ventures Water Rights Application(s) • File Reports/Changes • Protest Phoenix Inn Water Rights Application(s) • Protest Selbach Water Rights Application(s) • Protest Las Vegas Valley Water District (LVVWD) Water Rights Application(s) • Protest Nevada Water Rights Within Same Ground Water System as LVVWD Applications
Fort Bowie NHS	• File for Apache Springs
Golden Gate NRA	• Assist with Water Resources Management Plan • Protect Redwood Creek
Grand Canyon NP	• Tusayan Request for Water • Glen Canyon Environmental Studies • Review North Rim Proposal • Review Unsolicited Ground Water Proposal
Great Basin NP	• Protest LVVWD Water Rights Applications(s) • Protest Nevada Water Rights Within Same Ground Water System as LVVWD Applications • Review Garrett Claim • Administrative Site Withdrawal • Assist with Water Resources Management Plan • Review Water and Sewer Feasibility Study
Kaloko-Honokohau NHP	• Assist with Water Resources Management Plan
Lake Mead NRA	• Protest LVVWD Water Rights Application(s) • Protest Nevada Water Rights Within Same Ground Water System as LVVWD Applications • Review Applications

	• Basin Designation
Lassen Volcanic NP	• Replacement Water Supply
Montezuma Castle NM	• Review Water Rights
	• Assist with Management Plan EA
	• Adjudication Study
Organ Pipe Cactus NM	• Monitor Mexico Ground Water Pumping Impacts
	• Assist with Water Resources Management Plan
Point Reyes NS	• File Reports/Changes
Redwood NP	• Protect Requa Well 3
Saguaro NM	• U.S. Forest Service Water Use
Walnut Canyon NM	• Walnut Canyon Flows
	• Protest Santa Fe Dam
	• Assist with Natural Resources Management Plan
Yosemite NP	• Assist with Water Resources Management Plan
Miscellaneous	• San Pedro, Arizona Adjudication
	• Monitor Nevada Applications
	• Little Colorado, Arizona Adjudication
	• Hawaii Water Code Review
	• Basin Closure
	• Declare Water Rights
Applied Research Branch	
Grand Canyon NP	• Reviewed USGS Proposals for Long-Term Studies
Lassen Volcanic NP	• Review and Coordination with USGS on Geothermal Studies
Sequoia/Kings Canyon NP	• Provided Complete Laboratory Analyses of Approximately 1,500 Samples for a Long-Term Ecosystem Study
	• Supported Watershed Studies (WR-CPSU)

SERVICEWIDE

The Water Resources Division, as a whole, contributed to many projects of Servicewide scope this year. Examples are provided below under the categories of legal and policy assistance, regulatory guidance, publications, technical assistance, and programmatic coordination.

We provided Servicewide *legal and policy assistance* to the Directorate and the Secretariat by reviewing and preparing implementation plans for the Service's existing water rights policy. We conducted a water rights workshop to assist park managers with the complexities of participating in water rights hearings and adjudications. Also, the Division reorganized the water rights docket information to assist with its preservation as well as with its usefulness in the future.

In the arena of Servicewide *regulations and guidelines*, we prepared regulations to implement a ban on solid waste disposal facilities in units of the National Park System, reviewed the NPS floodplain and wetland management guidelines for adequacy and recommended that they be revised soon, reviewed the draft guidance for Section 319 of the Clean Water Act, and prepared a guidance paper on outstanding national resource waters. The Division reviewed over 25 regulatory initiatives potentially affecting waters of the National Park System.

Contributions to Servicewide *publications* included initiating a water resources NPS publication review, maintaining an annotated bibliography of GIS water resource applications, writing articles for the Natural Resources Highlights, contributing to the TRENDS issue on preserving natural resources, and preparing sections of NPS-75 and NPS-77. Also, WRD prepared a discussion paper on water rights in wilderness areas and provided technical review for the interim report entitled, "Comprehensive Analysis of the Kissimmee-Okeechobee-Everglades-Florida Bay Drainage System" and assisted in determining its suitability for additional funding through the Servicewide Man of the Biosphere program.

WRD provided Servicewide *technical assistance* by investigating and distributing our findings on the behavior and characteristics of river eddies. WRD also provided leadership to the CAD/GIS efforts by: specifying and coordinating the acquisition of CAD and GIS hardware; assisting with the review of GIS and data management components of research projects, proposals, and reports; and, assisting with solving computer hardware and software problems in the Division. WRD has also provided technical and program assistance to the Servicewide Global Climate Change Committee and its Program initiatives and served as a consultant to the Service's Inventory and Monitoring Program. The Division reviewed over 30 NEPA-related documents and over 100 NPS planning documents.

We *integrate Servicewide water resource program goals with other Servicewide or Departmental program goals* by contributing to working groups, coordinating councils, and other intradepartmental and interdepartmental forums. Examples of this year's WRD participation include our contributions for the Service in: the NAWQA, WEBB, Benchmark and Global Change Programs under the administration of the U.S. Geological Survey; the Coastal America Initiative of the Federal Government; the Interior Department Working Groups dealing with water quality and quantity issues and wetlands policy; the Wetlands Interagency Task Force formed by the President's Domestic Policy Council; the Interagency Geothermal Coordinating Council; Interagency Subcommittees on Sedimentation and Water Quality; the Interagency Fresh Water Coordinating Council Initiative; and the Interagency Advisory Committee on Water Data. The Division also provided support to the Glen Canyon Environmental Studies effort and participated in the Facility Managers Training and Hazardous Materials Training courses.

PUBLICATIONS

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FINANCIAL STATUS OF THE WATER RESOURCES DIVISION

by Stan Ponce
Division Chief
and Debi Cox
Program Analyst

FY91 base funding for the Water Resources Division is $4,935,000. In addition, the Division has received $158,000 from the Directorate to support Water Rights studies in southern Nevada. Figure 1 illustrates the distribution of total WRD funds among technical assistance, project, and administrative overhead costs. Technical assistance, which is predominately day-to-day operational support to the parks, regions and other NPS organizational units, includes staff salaries, travel, and associated expenses. Administrative overhead includes program management costs, administrative support, equipment (such as staff computers) and supplies and materials Divisionwide. The project category includes funds supporting WRD sponsored projects, such as WRD prioritized projects, water rights studies, and our research program; staff salaries and associated overhead are not included. Tables 1, 2, and 3 summarize WRD sponsored projects and studies.

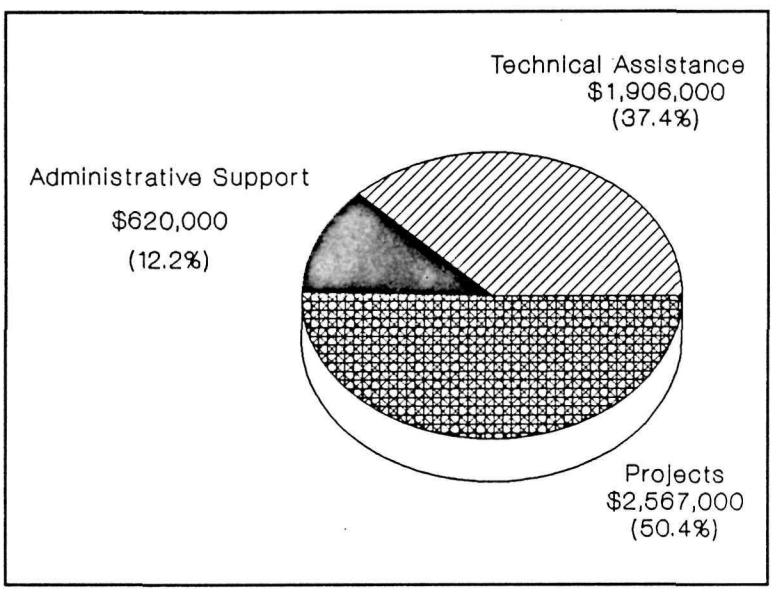


FIGURE 1. Distribution of WRD Program FY91 Funding.

TABLE 1. LISTING OF WRD PRIORITIZED PROJECTS
January 1991

I. FUNDED PROJECTS - FY 91

PRIORITY DATE	REGION	PARK	PROJECT TITLE	PROJECT STATUS	TOTAL FUNDING LEVEL	PREVIOUS FY'S FUNDING	FY 91	FY 92	FY 93
Sep 87	SER	MACA	Groundwater Study	C	155.0	55.0	50.0	50.0	
Sep 87	AR	NOAA	Water Resources Inventory	C	135.0	75.0	60.0		
Sep 87	SER	CAHA	Water Quality Study	C	120.0	80.0	40.0		
Sep 87	MAR	RICH	Ft. Darling Landfill Monitoring	C	35.0	25.0	10.0		
Sep 87	SWR	BITH	Water Quality Monitoring	C	66.0	44.0	22.0		
Sep 87	SWR	PAIS	Water Quality Monitoring	C	35.0	25.0	10.0		
Sep 87	MWR	SLBE	Water Quality Inventory	C	75.0	25.0	25.0	25.0	
Sep 87	NCR	RWIDE	Urban Stream Improvements	C	75.0	25.0	25.0	25.0	
Sep 87	WR	GRBA	Water Resources Management Plan	C	66.0	22.0	22.0	22.0	
May 89	WR	MOCA	Identify/Inventory Water Related Resources	C	150.0	50.0	50.0	50.0	
May 89	MAR	DEWA	Develop and Test Water Quality	C	70.0	30.0	20.0	20.0	
May 89	MWR	OZAR	Water Resources Management Studies	C	110.0	50.0	45.0	15.0	
May 89	NAR	ACAD	Estuarine Impacts from Overboard Discharges	C	160.0	65.0	55.0	40.0	
* May 89	SWR	ELMA	Survey Water Resources Status	C	69.0	0.0	49.0	20.0	
May 89	AR	KATM	Water Resources Baseline	C	135.0	15.0	60.0	60.0	
** May 89	SER	CANA	Sewage Effluent, Mosquito Lagoon	C	100.0	15.0	42.5	42.5	
May 89	NCR	MANA	Stream Quality and Sedimentation Study	N	95.0	0.0	35.0	30.0	30.0
May 89	MAR	COLO	Water Resources Management Plan	N	80.0	0.0	40.0	40.0	
***May 89	PNR	CRLA	Crater Lake Ecosystem	N	120.0	0.0	60.0	60.0	

* Redistribution of funds approved Feb 90 by Division Chief
** Redistribution of funds approved Feb 90 by Division Chief
*** Reprogrammed per ADNR, Jan 91

II. PRIORITIZED PROJECTS AWAITING FUTURE FUNDING

PRIORITY	REGION	PARK	PROJECT TITLE	TOTAL FUNDING LEVEL	YR 01	YR 02	YR 03
1	SWR	BUFF	Water Quality Monitoring	81.0	27.0	27.0	27.0
2	AR	GAAR	Water Resources Baseline	110.0	10.0	50.0	50.0
3	SER	VIIS	Effects of Sedimentation on Nearshore	80.0	20.0	40.0	20.0
4	PNR	MORU	Jokulhlaup Prediction Study	120.0	40.0	40.0	40.0
5	RMR	GLCA	Water Resources Monitoring	62.0	31.0	31.0	

TABLE 2. SUMMARY OF WATER RIGHTS PROJECTS SUPPORTED BY WRD FUNDS (FY 1991)

REGION	PARK	PROJECT	AMOUNT ($/000)
WR	DEVA LAME GRBA	Las Vegas Valley Water District	218
RMR	BLCA	Quantification Reserved Rights	8
PNR	CRLA	Klamath Adjudication	17
WR	DEVA	Phoenix Inn Protest Hearings	3
RMR	MEVE	Adjudication Water Division 7	18
WR	ORPI	Monitoring Mexican Pumping	11
RMR	ZION	Virgin River Adjudication	25
RMR	GLAC	Statewide Adjudication	53
RMR	ROMO	Adjudication Water Division 1	50
WR	DEVA	Monitoring Plan Enforcement	15
WR	KALA	Inventory Rights, Requirements	11
		TOTAL	429

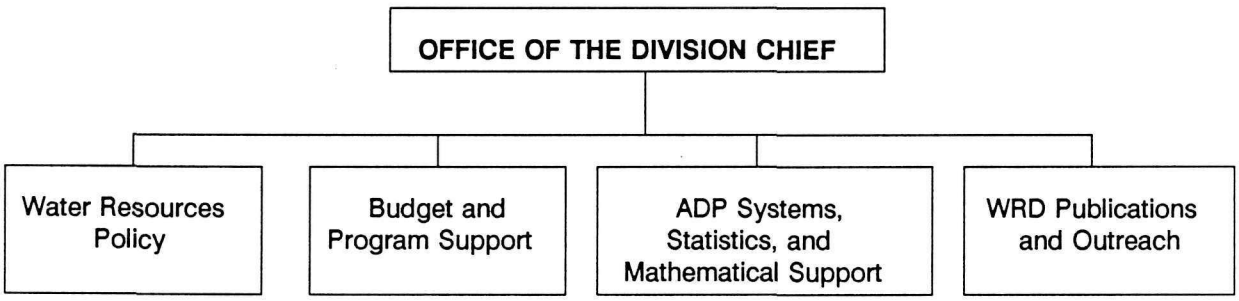
TABLE 3. SUMMARY OF OTHER PROJECT AREAS SUPPORTED BY WRD FUNDS

Watershed Protection Program - Water Quality Activity	$218,600
Watershed Protection Program - Wetlands Activity	$156,100
Water Resources Studies at Everglades NP	$500,000
Watershed Research Studies Program	$359,000
Applied Research Branch Program	$165,000

ORGANIZATION AND STAFF

OFFICE OF THE DIVISION CHIEF

Organization and Staff



Stan Ponce: Division Chief, PhD in Civil and Environmental Engineering. Specialty areas include water resources policy, natural resources management, water law, and upland hydrology.

Pam Matthes: Water Resources Program Coordinator, MS in Zoology. Specialty areas include natural resource management policy, environmental law and regulation, wildlife management, and wetlands ecology.

Dave Ryn: Mathematician, MS in Mathematics. Specialty areas include computer and statistical technology.

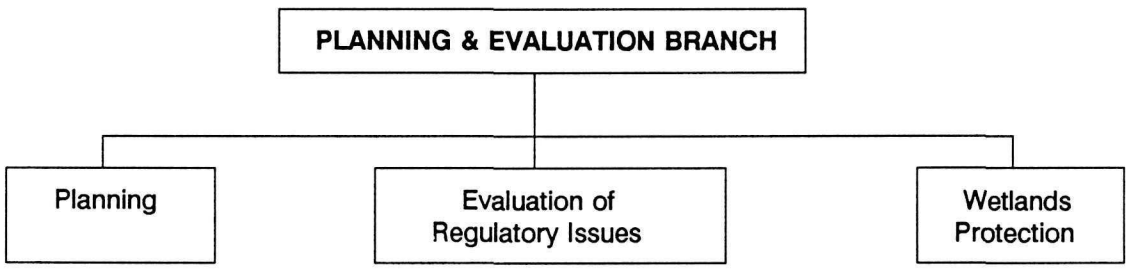
Debi Cox: Program Analyst.

Judy Rouse: Secretary.

Peggy Matti: Clerk/Typist.

PLANNING AND EVALUATAION BRANCH

Organization and Staff



Dan Kimball: Branch Chief, MS in Water Resources Administration. Specialty areas include water and natural resources management planning and evaluation of complex regulatory issues.

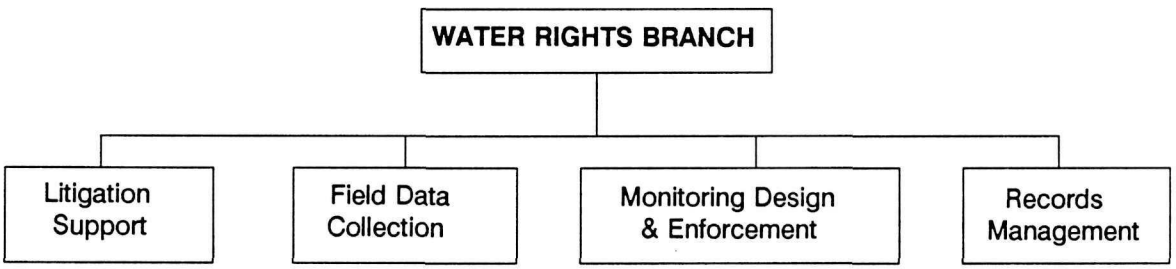
Barbara West: Environmental Protection Specialist, MA in Public Administration. Specialty areas include regulatory support and evaluations.

Mark Flora: Hydrologist, MS in Environmental Science. Specialty areas include water resources management planning.

Joel Wagner: Hydrologist, MS in Environmental Science. Specialty areas include wetlands identification and protection.

David Sharrow: Hydrologist, BS in Watershed Science. Specialty areas include water resources management planning.

Organization and Staff



Owen Williams: Branch Chief, MS in Watershed Sciences. Specialty areas include water law, upland watershed management, fluvial geomorphology, and surface water hydrology.

Chuck Pettee: Team leader, MS in Watershed Science. Specialty areas include surface water hydrology and hazardous materials.

Dan McGlothlin: Team leader, BS in Watershed Hydrology. Specialty areas include surface water hydrology and land resource management.

Ken Czarnowski: Hydrologist, PhD in Watershed Management. Specialty areas include surface water hydrology and Wild and Scenic Rivers.

Paul Christensen: Hydrologist, MS in Geology. Specialty areas include ground water hydrology, hydrogeochemistry, and computer modelling.

Bill Hansen: Hydrologist, MS in Hydrology. Specialty areas include surface water hydrology and watershed rehabilitation.

Alice Johns: Hydrologist, BS in Watershed Sciences. Specialty areas include surface water hydrology and field methods.

Jeff Albright: Hydrologist, MS in Watershed Management (pending). Specialty areas include surface water hydrology, field methods, instrumentation.

Jeff Hughes: Hydrologist, MS in Watershed Sciences. Specialty areas include surface water hydrology, field methods, instrumentation.

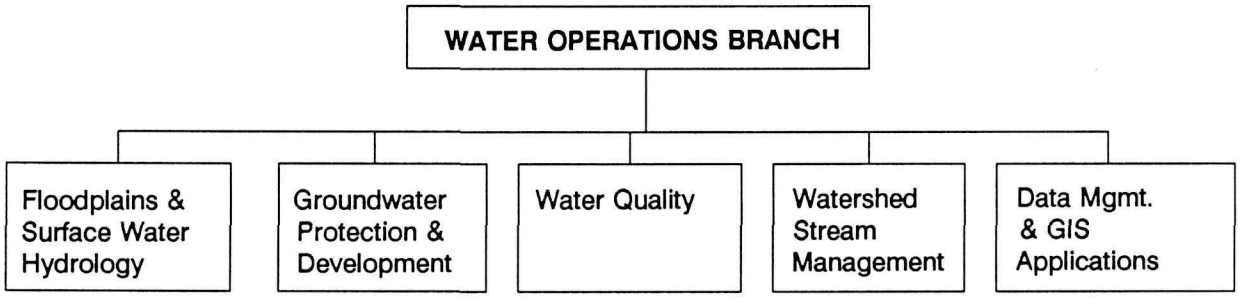
Kathy Chase: Research Associate; CSU; Graduate Student - Civil Engineering.

Mary Hermes: Research Associate; CSU; Graduate Student - Civil Engineering.

Mark Wondzell: Research Associate; CSU; Graduate Student - Civil Engineering.

Janice Taylor: Secretary.

Organization and Staff



Bill Jackson: Branch Chief, PhD in Forest Hydrology. Specialty areas include sedimentation processes, fluvial geomorphology, and riparian rehabilitation and management.

Gary Rosenlieb: Water Quality Program Team Leader, MS in Water Resources. Specialty areas include water quality (chemistry and micro-biology), groundwater quality, and hazardous materials management.

Bill Werrell: Hydrology Program Team Leader, MS in Geology, MS in Hydrology. Specialty areas include well-siting, well design and testing, aquifer analyses, springflow monitoring, and floodplain management.

Gary Smillie: Hydrologist/Hydraulic Engineer, MS in Civil Engineering. Specialty areas include flood-frequency analysis, open-channel hydraulics, floodplain management, and sediment transport.

Larry Martin: Hydrologist, MS in Water Resources. Specialty areas include watershed management, riparian management, ground water modeling, GIS applications in water resources, and hydrologic data analysis.

Rick Inglis: Hydrologist, BS in Watershed Science. Specialty areas include field hydrologic data collection using automated recorders, watershed management, ground water monitoring, and data analysis.

Dean Tucker: Research Associate, PhD (pending) in Natural Resources (GIS). Specialty areas include data management, computer graphics, and water resources applications in GIS.

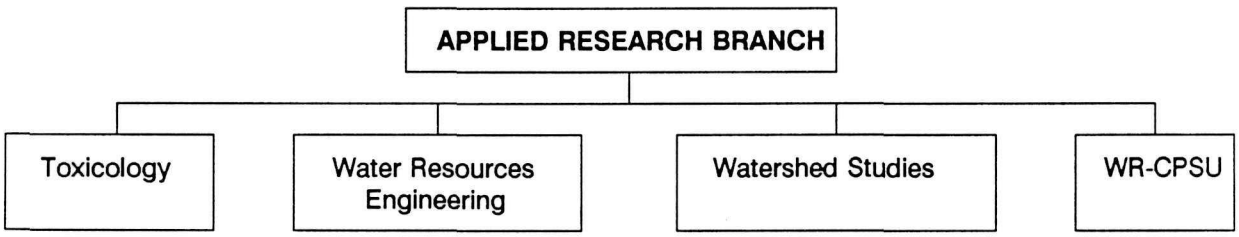
Jacquie Nolan: Cartographer/Computer Assistant, MA in International Relations. Specialty areas inlclude map preparation (including floodplain maps), graphics, and report set-up. Oversees Division Reference Room (which contains comprehensive water resources files for all NPS units).

Water Quality Specialist (Vacant): Specialist in physical-chemical aspects of water quality.

Water Quality Specialist (Vacant): Specialist in biological aspects of water quality (including bio-monitoring).

Mary Anne Atencio: Secretary.

Organization and Staff



Gerald Walsh: Branch Chief, PhD in Zoology/Aquatic Biology. Specialty areas include aquatic toxicology and aquatic ecology.

Marshall Flug: Research Hydrologist, PhD in Water Resource Engineering. Specialty areas include application of computer and mathematical techniques for management of water resources.

Raymond Herrmann: Unit Leader, WR-CPSU, PhD in Geology/Hydrogeology. Specialty areas include long-term ecosystem health, hydrologic cycle, and chemical flux in watersheds.

Robert Stottlemyer: Research Ecologist, PhD in Forest Soils/Biogeochemical Cycling. Specialty areas include long-term effects of anthropic atmospheric deposition in watersheds and long-term studies on snowpack nutrient dynamics.

Terence Boyle: Research Ecologist, PhD in Biological Sciences. Specialty areas include application of biological assessment techniques to water resource problems.

Del Wayne Nimmo: Environmental Chemist, PhD in Zoology/Limnology. Specialty areas include risk assessment related to non-point source pollution.

Jill Baron: Research Ecologist, MS in Land Resources. Specialty areas include long-term studies on effects of climate change on water resources in watersheds.

Terri Craig: Graduate Research Assistant; CSU. Specialty areas include studies on geology, sedimentology, and geomorphology of water resources.

Gustavo Diaz: Research Associate; CSU. Specialty areas include hydrological monitoring.

Robert Edwards: Research Associate; CSU. Specialty areas include long-term studies on effects of climate change in watersheds.

Nancy Hoefs: Research Associate; CSU. Specialty areas include biological assessment of water resources.

Audrey Wayker: Secretary.

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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