

Colorado Water

Newsletter of the Colorado Water Resources Research Institute, Fort Collins, Colorado 80523

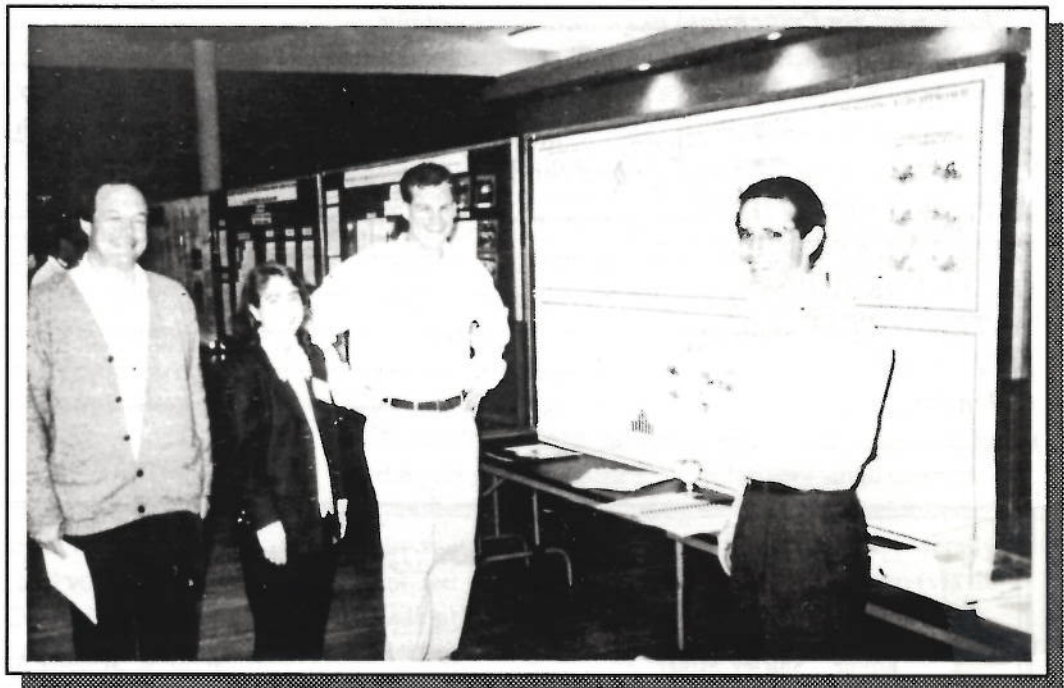
JUNE 1997

**POSTER SESSIONS AT
HYDROLOGY DAYS '97
WERE BOTH FUN AND
INFORMATIVE!**

See page 18

*Chris Neale, Professor
Of Biological and Irrigation
Engineering, Utah State
University (far left), and
M.S. student Greg Crosby
Of Utah State (3rd from left)*

*Luis Garcia, Professor of
Chemical and Bioresource
Engineering, Colorado State
University (far right) and
M.S. student Claudia Engelmann
Of Colorado State (2nd from
Left)*



MEETINGS AND CALLS FOR PAPERS

AWRA/UCOWR ANNUAL SYMPOSIUM -- Water Resources Education, Training and Practice: Opportunities For the Next Century -- June 29-July 3, 1997 Page 34

WATER PARTNERSHIPS: Can Competing Users Cooperate to Manage and Vital Resource...And Live Happily Ever After? COLORADO WATER WORKSHOP -- July 30-August 1, 1997 Page 33

GROW WITH THE FLOW: Growth and Water in the South Platte Basin -- 8th Annual South Platte Forum, October 29-30, 1997 Page 31



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Robert C. Ward, Director

(Please note that all 1996 issues of *COLORADO WATER* should be Vol. 13 and all 1997 issues should be Vol. 14.)



EDITORIAL



PEER REVIEW AND PUBLIC REVIEW

by Robert C. Ward, Director

The Colorado Water Resources Research Institute (CWRRI) is a university research institute that is authorized by both Congress and the Colorado legislature. Congressional authorization of CWRRI, first established in 1964, was renewed in 1996 as part of the National Water Institutes Program reauthorization via P.L. 104-147. CWRRI has been authorized by the Colorado legislature since 1981. CWRRI's Colorado authorization was due to expire on July 1, 1997; thus, it had to seek reauthorization in this past session of the Colorado legislature, which ended in May.

With assistance from members of Colorado's academic community, water community, and the legislature, CWRRI's reauthorization bill, HB 97-1218, was introduced into the Colorado House of Representatives by Rep. Steve Johnson of Fort Collins and was carried in the Senate by Senator Don Ament of Iliff. The legislative session provided a number of opportunities to discuss with legislators CWRRI's efforts to connect higher education's water expertise with the education and research needs of Colorado's water users and managers.

While interacting with legislators and legislative committees, I had the opportunity to observe public debate on a number of controversial water management issues as a variety of water bills were debated and voted on. There is no shortage of water debates in Colorado. As Colorado faces the challenge of increased population growth, new recreation industries, and expanding animal feeding operations on the eastern plains, I see many opportunities for Colorado's academic expertise to serve the research and education needs of water users and managers, as provided for by HB 97-1218.

The legislative process of reauthorization also provided CWRRI an opportunity to undergo a "public review" of its past activities and accomplishments. While higher education utilizes a "peer review" process to document the scientific and/or disciplinary relevance and quality of research, the reauthorization process requires another form of review - one that is conducted by representatives

and senators elected by taxpaying citizens. There must be support in the legislature for the past activities and accomplishments of CWRRI as well as its future potential to help Colorado water users and managers.

The legislative process requires a ye or nay vote on CWRRI's future as a legislatively authorized institute, and legislators, in determining how to cast their votes, ask questions and make a judgment using the answers they receive. These questions may take many forms and address a wide variety of topics. Some questions deal with specific water problems in a legislator's district. Others deal with past research projects that did not produce the results expected by a legislator. The discontinuity between the 'real world' and university research is of concern to a number of legislators. The ability of highly specialized disciplinary research to generate recommendations for integrated management problems is openly questioned. In addition, a concern over emphasis on theoretical research as opposed to 'what is really needed' has been expressed.

These discussions, however, also reveal some surprise on the part of legislators at the relatively small amounts of money that CWRRI has provided to research efforts in the past. The loss of CWRRI's state-based, federally funded water research program two years ago (via the federal appropriation process) is an area of concern. Recent efforts on the part of CWRRI to develop teams of researchers and water managers to solve problems is recognized and supported. Having students learn while working on CWRRI research projects is appreciated.

During the reauthorization process, CWRRI received the support of many people and many Colorado water organizations. I am truly thankful for this support. HB 97-1218, signed by Governor Romer on May 16, 1997, authorizes CWRRI until 2007 and establishes a new advisory committee to guide its connections between university expertise and the research and education needs of Colorado water users and managers.



I came away from the legislative reauthorization process with a better understanding of the water concerns of Colorado's elected representatives. I also came away with an appreciation of the need to open more avenues of communication between Colorado's legislators and the water expertise in the academic community. While higher education may feel the peer review process is the ultimate way to value university research, there is a need to develop, maintain, cultivate and operate a "public"

review process that keeps water faculty in touch with the water research and education needs of Colorado water users and managers. A balance between peer and public review is needed. CWRRI has been charged, via reauthorization, to assist in seeking this balance and will now strive to make the connections between higher education and Colorado water users and managers as strong as possible.

RESEARCH

WESTERN REGION PROPOSALS TO BE EVALUATED AT JUNE 5 LAS VEGAS MEETING

As noted in the February issue of *COLORADO WATER*, The FY1997 State Water Institutes Program will operate under a Regional Water Resources Competitive Grants Program. The Wyoming Water Resources Center, lead center for the Western Region, has received 21 proposals from Western Region Institutes or Centers (AK, AZ, CA, CO, ID, NM, NV, OK, OR, TX, UT, WA, WY). The Western Region Selection Panel (Steven P. Gloss WY, Thomas Bahr NM, Roy Mink ID, Robert Ward CO, Kenneth Williamson OR and William Funk WA and Ron Oulette, Office of External Research, Water Resources Division, U.S. Geological Survey) will evaluate and rank

proposals at a June 5 meeting in Las Vegas. Colorado State University is the lead institution for one proposal, "Adaptive Management of Hydrologic Regimes to Benefit Native Stream Fish: Integrating Hydrology and Ecology in Western Water Management," and co-leader for a second proposal, "Platte Basin Instream Flow Transfer Model Investigation." Proposal synopses are provided below. The University of Colorado at Boulder also is co-leader for a project with Arizona State University titled, "Field Investigations of Wetlands/Soil-Aquifer Treatment Systems for Indirect Water Reuse." This proposal was not available for review.

Adaptive Management of Hydrologic Regimes to Benefit Native Stream Fish: Integrating Hydrology and Ecology in Western Water Management

Like most stream species, fish are adapted to naturally variable flow regimes, including a combination of high and low flows. Critical reproductive events, such as spawning and larval development, often depend on specific flow conditions. Knowledge of relationships between flow patterns and fish reproduction will allow managers to time water delivery and release schedules so that adequate instream flows are available at times that will maximize reproductive success. Researchers will conduct field studies in rivers and streams in Colorado, California and Oregon to determine relationships between flow quantity and timing and the reproductive success of native fishes. Field study results will be used to develop a modeling framework integrating hydrology and ecology

to predict effects of alternative water delivery schedules on fish reproductive success. For example, irrigation diversions could be timed to avoid stream dewatering during spawning or early development. The same quantity of water would still be available for irrigation, but delivery would be delayed during days when fish are spawning or larval states are most vulnerable. In this way, water delivery could be adjusted according to the needs of fish as well as crop irrigation schedules. The project leader is Kurt Fausch, Department of Fishery and Wildlife Biology, Colorado State University. Co-leaders are Peter Moyle, University of California, Davis; and Hiram Li and Philippe Rossignol, Oregon State University.



Platte Basin Instream Flow Transfer Model Investigation

The states of Wyoming, Nebraska, Colorado and the Federal Government (U.S. Department of the Interior) are currently negotiating under a Memorandum of Agreement on Platte River flows. If the process is successful, the parties will enter into a three-year "cooperative agreement" to further evaluate and identify options for a habitat recovery program and perform NEPA compliance. This would deter jeopardy decisions against current federal and other projects on the river that could result under Section 7 of the Endangered Species Act. The need for potential additional mechanisms to provide water flows for critical habitat on the Platte is due to the interim and uncertain nature of the cooperative agreement. Market mechanisms offer a range of approaches to reallocate water from agriculture to environmental needs as these needs accrue in the future, but water transfers in the Platte Basin involve a number of uncertainties. This project's interdisciplinary team will define the economic,

hydrologic and institutional characteristics of water marketing-based approaches. An examination of various market solutions to Platte River flow problems will provide decision-making criteria that can weigh hydrologic and institutional factors. The feasibility of transfers, as determined by the ability to move water from one location to another considering conveyance hydrology, will result from this project. The project leader is John Tschirhart, Department of Economics, University of Wyoming. Co-leaders are Don McLeod, Agricultural Economics, University of Wyoming; Luis Garcia, Chemical and Bioresource Engineering, Colorado State University; Ray Supalla, Agricultural Economics, University of Nebraska; Mark Squillace, College of Law, University of Wyoming; Tom Crocker, Economics, University of Wyoming; and Darrell Fontane, Civil Engineering, Colorado State University.

Colorado State is also co-leader on a third proposal with the Water Institute at the University of the Virgin Islands, which will be submitted under that institute's regional competitive program. It is described below also.

Erosion and Sedimentation on St. John, Virgin Islands

Preliminary research on the island of St. John has suggested that erosion from the rapid development of both public and private lands is the single greatest threat to the coral reefs and other offshore marine resources. Effective land use planning can only take place if there is a basic understanding of runoff and erosion rates at the plot, hillslope and small catchment scale. Of particular interest is the highly variable amount of sediment storage on the hillslopes, the different sequences of storms that tend to saturate varying areas of the island, and the very different responses in runoff volumes to different storm sizes. Current prediction tools have been largely developed in agricultural areas in the eastern and central United States, and there is an urgent need to calibrate these models to the dry tropics. Islands tend to have high population densities and land processes linked intimately to the ocean. Very steep slopes and complex geology in

the eastern Caribbean are combined with an exceptionally variable hydrologic regime. These unique environmental conditions mean that much of the existing data and modeling efforts from the mainland United States cannot be directly applied. Building upon preliminary work, this project will evaluate erosion rates and sediment delivery at three spatial scales: A road segment, construction site or hillslope; a sub-catchment scale of approximately 5-50 ha, and a catchment scale of 50-700 ha. A well-documented data set on runoff, erosion and sediment movement at different scales will provide planners with information to evaluate and calibrate new models and predictive tools. The principal investigators are Henry Smith, University of the Virgin Islands; and Lee MacDonald, Department of Earth Resources, Colorado State University.





ESTIMATING THE BENEFITS OF URBAN STREAM RESTORATION

Summarized by *Laurie Schmidt*

The following is a summary of research conducted by Carol F. Streiner, an economist with Integrated Utilities Group in Denver, and John B. Loomis, Professor of Agricultural and Resource Economics at Colorado State University. The research was partially funded by the Colorado Agricultural Experiment Station and the California Department of Water Resources, and was part of Streiner's master's thesis at Colorado State University, Department of Agricultural and Resource Economics, under the direction of Dr. Loomis. The research results were published in the October 1995 issue of Rivers (volume 5, no. 4).

Urban streams can be assets to a community; however, flooding, erosion, streambank instabilities, and basic environmental degradation along urban creek channels pose significant threats to privately owned land adjacent to these creeks. Problems with urban streams arise from changes in natural stream corridor characteristics, often brought about by urbanization itself. Properties and buildings are often endangered by such changes, and despite efforts to remedy the effects, problems can recur or can cause damage downstream from the site.

Historically, structures such as concrete channels were typically constructed to stabilize streambanks and protect properties. Currently, the trend is toward restoration of the natural attributes of the stream in addition to structural improvements. The benefits of returning a stream to its more natural state are more stable streambanks, restoration of the riffle-pool sequences enhancing fish and other aquatic habitats, and a more aesthetically pleasing ecosystem with riparian vegetation restored and wildlife habitats protected. While these benefits are identifiable, they are difficult to quantify in dollar terms comparable to the cost. Measuring homeowners' value of such benefits is important in documenting the economic contribution of an urban stream restoration program and allowing comparison to the costs of such a program (U.S. Water Resources Council 1983).

Estimating residents' willingness to pay (WTP) for improvements in urban streams can be accomplished by using the hedonic price method (HPM). Hedonic pricing uses residential property value differentials to measure

changes in WTP for environmental amenities in two stages. The authors used this technique in a study of stream restoration efforts in California. Their results indicated that for measures such as establishing an education trail, maintaining fish habitat, and acquiring land and/or easements along a stream, the one-time increase in property value ranges from about \$15,570 to \$19,120 per single family residence. For stabilizing streambanks (which includes cleaning obstructions, revegetating streambanks, and cleaning up the stream) and reducing flood damage, property values increase about \$4,480 to \$7,800 per single family residence.

The advantage of these property value increases is that they benefit not only individual property owners, but also the community as a whole. In California, using the Proposition 13 tax rate of 1.25% of property value, an increase in property value of \$19,078 would provide about \$240 per house in additional property tax to the community annually. Considering the large number of single family homes in the funded areas, the present value of the added tax money over the life of the restoration project is likely to contribute far more revenue than the cost of the project (which in our study has a median value of \$34,920).

These values are specific to the sample of projects in this study, which reflects the San Francisco Bay area and Santa Cruz. It may not be appropriate to generalize these values to other geographic areas. However, the basic method would be applicable.



**CSU PROFESSOR RECEIVES \$1.115 MILLION GRANT
TO AID IN INDONESIAN IRRIGATION PROJECT**

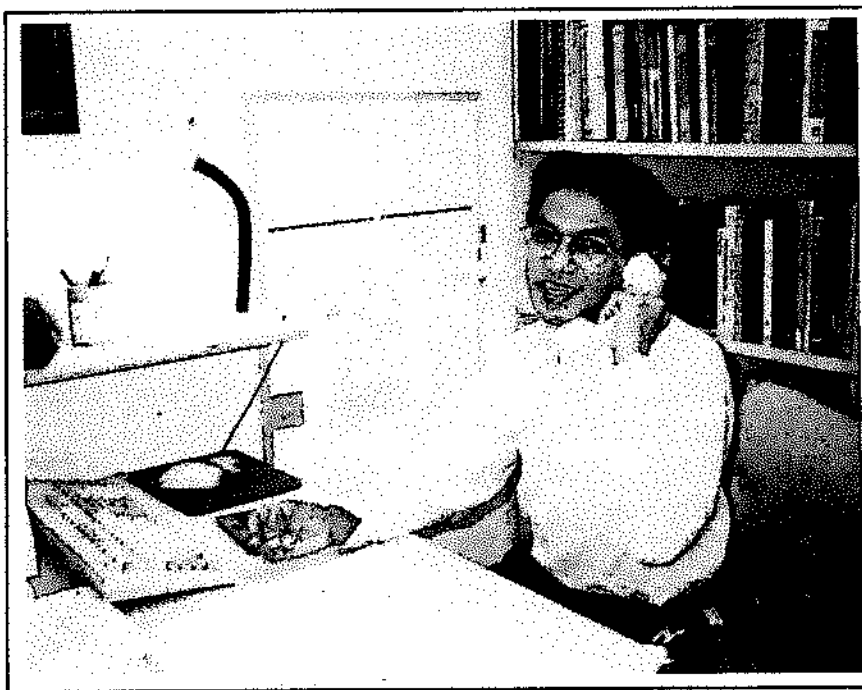
by Laurie Schmidt

A research team led by a Colorado State University (CSU) professor has received a \$1.115 million grant to study irrigation planning in Indonesia. Ramchand Oad, Associate Professor in the Department of Chemical and Bioresource Engineering, will be joined by sociologist William Robert Laitos and economist/policy analyst Robert C.G. Varley. Seven Indonesian national consultants representing various fields of specialty will also join the international team.

Indonesia, an archipelago nation of more than 3000 islands, has a total irrigated land area of approximately

analysis of their policies for managing irrigation facilities. Laitos will examine how farmer groups operate and maintain irrigation systems, and the entire research group will analyze an irrigation-turnover program, a process through which local farmers take control of government irrigation systems.

The project is being funded by the Asian Development Bank (ADB) and the Indonesian government. The ADB, which has invested more than \$25 billion in the Indonesian irrigation sector during the past 20 years, is sponsoring the project through the Consortium for International Development (CID).



Ramchand Oad, Professor of Chemical and Bioresource Engineering

5.5 million hectares (ha). The research team will study Indonesian irrigation practices over the past 25 years and suggest strategies for the future. According to Oad, the project will focus on future sustainable irrigation in Indonesia from a physical, economical, and environmental point of view. It will include a review of past irrigation investments by the Indonesian government and an

The CID is a non-profit, non-government organization comprised of 12 universities, including CSU, in the western United States. Some of the world's foremost experts on water policy and planning are members of CID universities. CSU is especially well known for offering outstanding training opportunities for international students in water policy and planning. In addition, the Colorado Institute for Irrigation Management at CSU is one of four programs within the CID that is especially relevant to the needs of developing countries.

Over the past half-century, CID specialists have been involved in research and field trials of techniques to improve on-farm water use. CSU has been one of the leaders in transferring these research findings and practices to other countries. From 1982 to 1986, Oad was involved in an irrigation water management synthesis project in developing countries, including India and Indonesia. According to Oad's estimates, it will take up to a year to produce final reports from the research. These reports will be presented to the ADB and to Indonesian government officials, many of whom graduated from CSU. Oad will also use much of the knowledge gained in Indonesia to enhance course material for the irrigation and water management classes that he teaches at CSU.



**UNIVERSITY CONSORTIUM
SOLVENTS-IN-GROUNDWATER RESEARCH PROGRAM
HOLDS PROGRESS MEETING AT CSU**

by Laurie Schmidt

On May 6-7, 1997, the University Consortium Solvents-in-Groundwater Research Program held its semi-annual progress meeting at Colorado State University. Approximately 60 representatives of the member universities and industries attended the Fort Collins meeting.

The University Consortium Solvents-in-Groundwater Research Program is a comprehensive, long-term research program that focuses on the behavior, fate, and remediation of chlorinated solvents in the subsurface. Launched in the mid-1980s, it has produced pioneering research that has contributed to the current state-of-science relevant to subsurface contamination by chlorinated solvents and other dense, non-aqueous phase liquids (DNAPLs).

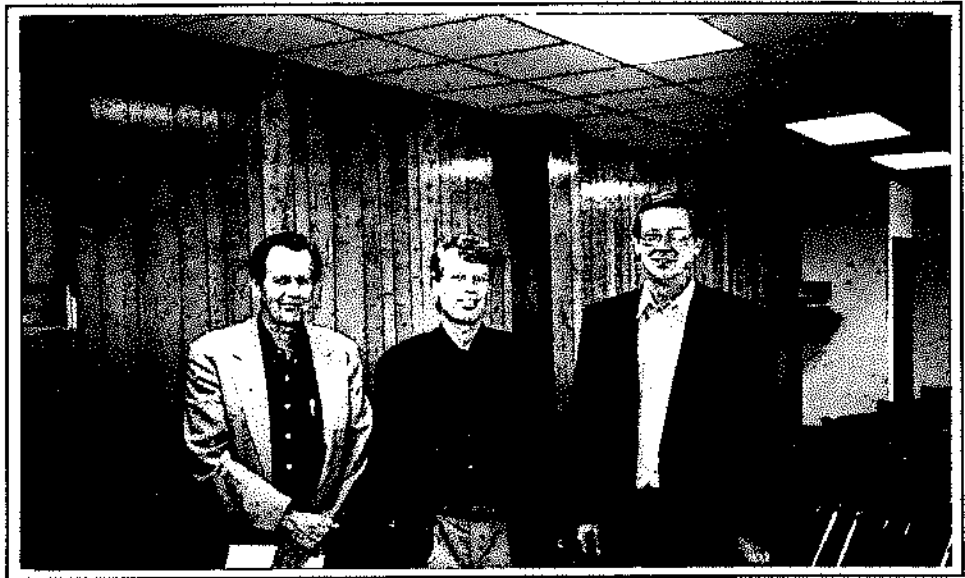
The multi-disciplinary program includes researchers from engineering, environmental, groundwater, and mathematical sciences. At any given time, there are between 20 and 30 active research projects, many of which receive supplementary funding from sources other than the program.

The projects involve various combinations of laboratory and field experiments, computer modeling studies and, where opportunities exist, on-site research. In May, 1997, with the commencement of Phase IV, the program entered its tenth year. The research program in Phase IV will encompass activity in the following six general areas:

- Behavior processes and conceptual models
- Monitoring techniques and site characterization
- Site stabilization and plume control

- Source zone renovation
- Applied science for remediation decision making
- Preparation of books

The program has a formal commitment to advanced educational opportunities for graduate students. Since



From left: David McWhorter, John Cherry and Robert Gillham, recent recipients of research chair positions funded by the University Solvents-in-Groundwater Research Program

1988 more than 90 graduate degrees, including 24 Ph.D.s, have been awarded at the principal and participating universities for research theses and dissertations related to solvents in groundwater.

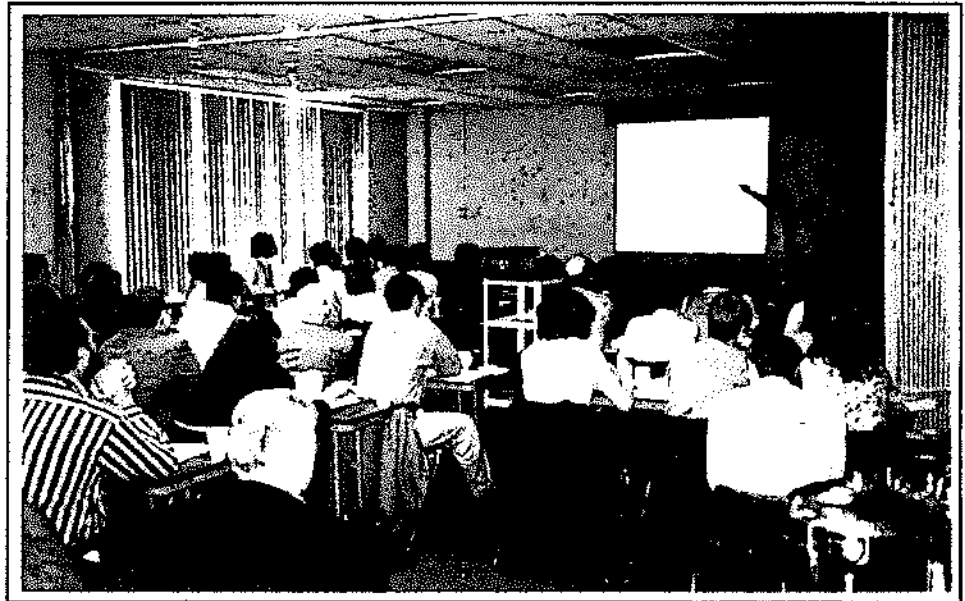
Short courses for groundwater professionals in industry, government, and consulting are another important educational initiative of the program. Two short courses have been conducted annually for the past several years. The first deals with dense, non-aqueous phase liquids in groundwater; the second with the behavior and



remediation of dissolved organic contaminants in groundwater. These courses have attracted 70 – 150 attendees per offering, including a significant number of regulators as well as industry professionals.

The Consortium operates as a large, multi-university, multi-sponsor program, with the University of Waterloo (UW) acting as lead institution. Other principal institutions include Colorado State University (CSU), the Oregon Graduate Institute (OGI), and Queen's University (QU)

Sponsors of the program currently include The Boeing Company, Ciba Geigy Corporation, General Electric Company, Eastman Kodak Corporation, Motorola, Inc., PPG Industries, Inc., and United Technologies Corporation. These corporate sponsors provide \$150,000 (\$US) annually for the duration of their sponsorship. Beginning in 1996, three of the sponsors arranged to re-direct their annual sponsorship fee to the establishment of research chairs with a solvent-related focus at two of the principal institutions. Dr. David McWhorter, professor in the Department of Chemical and Bioresource Engineering at CSU, received a three-year funding commitment from the



The room was filled to capacity for the recent progress meeting of the University Consortium Solvents-in-Groundwater Research Program

Boeing Company to act as one of three research chairs. Dr. John Cherry, Chair of Contaminant Hydrogeology in the Department of Earth Sciences (UW), and Dr. Robert Gillham, Chair of Groundwater Remediation in the Department of Earth Sciences (UW), were also appointed as chairs, funded by General Electric Company and Motorola, Inc., respectively.

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RESEARCH EXPERIENCES FOR UNDERGRADUATES

The National Science Foundation has funded a proposal to establish a three-year Research Experiences for Undergraduates Program at Colorado State University. The program will emphasize multidisciplinary research in water resources science and engineering and environmental and agricultural sciences. Fifteen juniors and seniors, selected from CSU and five other Colorado institutions, each will undertake an individual research project in water resources under the supervision of a Colorado State faculty member during an eight-week summer period. In addition, there will be weekly seminars and discussions on topics in water resources, and field excursions to introduce students to some of Colorado's water issues. Students also will be required to present papers or posters on their research at the two-day Water Center Student

Symposium during Fall Semester 1997 and to attend Hydrology Days during Spring Semester 1998.

The three-year program will be administered through the CSU Water Center. Colorado State placed its water programs under the umbrella of the Water Center in the early '90s to give coordinated and focused attention to society's water problems by both faculty and students. Housing, transportation, and a stipend of \$2,000 will be provided for each selected student. The first year of the program began in early June. Co-principal investigators for the Research Experiences for Undergraduates Program are Jorge A. Ramirez, Civil Engineering Department; Judy Hannah, Earth Resources Department; and Dan Smith, Department of Soil and Crop Sciences.



RESEARCH AWARDS

Simulation of Nitrates in a Regional Subsurface System: Linking Surface Management with Ground Water Quality

Author Maurice D. Hall has received Honorable Mention from the Universities Council on Water Resources for his 1996 dissertation which was submitted in the UCOWR annual Dissertation/Thesis Award competition. His dissertation provided a scientifically sound contribution to the understanding of the spatial/temporal evolution of nitrate concentrations in ground water associated with agricultural practices and the redemption of localized "hot spots" through changes in agricultural and pumping practices. Hall worked closely with Colorado State faculty and graduate students in the Departments of Chemical and Bioresource Engineering and Soil and Crop Sciences as well as with staff in the Agricultural Research Service of the U.S. Department of Agriculture. This integration, which brings the latest scientific understanding to management decision making associated with irrigated agriculture, was a highlight of Hall's work. This research was partially funded as a CWRRI/U.S. Geological Survey research project under the State Water Institute Program.

Determining Vegetation Density and Its Impact on Channel Capacity

This paper, by Steven Abt, Syndi J. Dudley, Charles D. Bunham and J. Craig Fischerich, received the "Most Distinguished Technical Paper Award" by the 1997 International Erosion Control Association. The paper resulted from a cooperative study between the U.S. Army Corps of Engineers and Colorado State University to develop a method of characterizing vegetation to determine its resistance to water flow in open channels or floodplains. For more than 60 years ecologists have used the point quadrat technique for vegetation surveys because of its many desirable features and its applicability to both small and large-scale vegetation surveys. This research developed and presented a horizontal point frame which allows the traditional point quadrat technique to be adapted to estimate flow resistance in vegetated channels.



FEATURES



THE PARK CITY PRINCIPLES A New Paradigm for Managing Western Water

Summarized by *Laurie Schmidt*

In May, 1991, the Western Governor's Association (WGA) and Western States Water Council (WSWC) organized the first in a series of three workshops to address changing needs in water management in the West. The workshops were held in Park City, Utah, and attendees included a broad, representative mix of water managers, water interest groups, and academics. The outcome of this effort was agreement on a set of six principles, known as the *Park City Principles*, which should be considered in western water resources management and policy development. These have come to be known as the "Park City Principles" among the water resources community. Following the Park City workshops, the WGA passed a resolution endorsing the Park City Principles at their June 23, 1992 conference.

The following summarized report, entitled *The Park City Principles: A New Paradigm for Managing Western Water*, was published by the Powell Consortium. The Powell Consortium is an alliance of seven water resources research institutes and centers from the states of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming. The alliance was formed to work on water resources problems in the Colorado River/Great Basin region.

The report includes five papers reprinted from *The Land and Water and Water Law Review*, Volume 31, Number 2, 1996. The following is a summary of each paper:

RETOOLING WESTERN WATER MANAGEMENT: THE PARK CITY PRINCIPLES

by *D. Craig Bell, Jo S. Clark, Julia Doermann, and Norman K. Johnson*

Western water management faces increasingly difficult challenges due to changing demands for water resources, including rapid urban growth, quantification of American Indian water rights, concern for instream and other environmental values, and protection of endangered species. Related challenges spring from the lack of support for new water projects, scarce public funds, conflicting and overlapping laws and programs, and polarized positions among competing parties.

Participants in the Park City workshops sought to improve water management systems' responses to complex and competing demands and consideration of the public interest. The group authored a set of guiding principles, an outline of effective water policies and institutions for implementing the principles, and criteria that should guide inquiries into the public interest. The aggregate product is called the "Park City Paradigm," and represents a broadly supported vision of what western water management should look like and how it should function.

It appears that the Park City Principles apply beyond the

challenges of western water management. They validate some fundamental truths about management and decision-making more generally.

First, there is often a need to look at things in a new way. Putting more chairs at the table will give all interested parties an opportunity to participate and be heard. Defining the issues and problems as inclusively as possible from the start, particularly noting cross-cutting issues, may seem like a formula for wasting time and money while nothing gets done. But there are many examples of how failure to do this has resulted in protracted litigation and other expensive, inconclusive outcomes. Some of the best examples of successes today have come from inclusive processes.

Second, it is important to anticipate the future as much as possible. Leadership that includes both vision and responsibility will influence people to look to that leadership for guidance and trust in reaching solutions.



Third, an integrated approach to analysis and decision making is desirable because it compares the risks, impacts, trade-offs, costs, and benefits of various options.

Fourth, holistic consideration of resources will lead to solutions that measurably improve the operation of current systems.

Fifth, cooperation among those with influence on the outcome is vital. This requires a change in

the traditional top-down paradigm, with a concomitant increase in responsibility for those most affected by the problems.

Thus, although the Park City Paradigm emerged from efforts to improve the West's capacity to deal with the increasingly complex challenges of western water management, it contains tenets with broader application.

These are the principles, along with a brief discussion of their context:

1. **There should be meaningful legal and administrative recognition of diverse interests in water resource values.**

This principle recognizes that the context for water management decisions is changing faster than the traditional system can accommodate. In particular, water has growing values for new uses such as ecosystem integrity, for new economic uses such as recreation and tourism, and for aesthetic purposes and traditional uses. This principle calls for the system to formally acknowledge these values.

2. **Problems should be approached in a holistic or systemic way that recognizes cross-cutting issues, cross-border impacts and concerns, and the multiple needs within the broader "problemshed", the area that encompasses the problem and all the affected interests. The capacity to exercise governmental authority at problemshed, especially basin-wide, levels must be provided to enable and facilitate direct interactions and accommodate interests among affected parties.**

This principle recognizes that problems or issues rarely limit themselves to the tidy institutional boundaries that have evolved. Too often an agency perceives and reacts to a situation only through the lens of its mission and scope of authority. The same can be said for many professionals who define issues within the narrow context of their own disciplines, for example, water quality, engineering, law, or biology. If a problem is fully defined with the full range of relevant aspects identified, the jurisdictional and interest group implications are likely to be very complex, crossing levels of government, agencies, disciplines, and interests. Parties will need forums to share ideas and, ultimately, ways to cooperatively exercise jurisdiction, pool information, and share resources.

3. **The policy framework should be responsive to economic, social, and environmental considerations. Policies must be flexible and yet provide some level of predictability. In addition, they must be able to adapt to changing conditions, needs, and values; accommodate complexity; and allow managers to act in the face of uncertainty.**

This principle recognizes the complex implications of the holistic approach to water management. Policies, and the managers who implement them, must provide flexibility to adjust as needed while ensuring predictability for those involved in and affected by water decisions. As decisions become more complicated, managers may want better and more certain information and guidelines. That will not always be possible, and the system must recognize and allow managers to act in the face of uncertainty.

4. **Authority and accountability should be decentralized within policy parameters. This includes a general federal policy of recognizing and supporting the pivotal role of states in water management as well as delegation to states and tribes of specific water-related federal programs patterned after the model of water quality enforcement.**



This principle recognizes that decentralized, close-to-the-ground approaches work best because they accommodate site-specific variations and local needs and values. However, the principle also acknowledges that there are overriding national interests and goals that states and local decisions should recognize. Thus, states are the bridge between necessary grassroots activities and federal interests and goals. Authority and accountability should go together and are key aspects of program delegation.

1. Negotiation and market-like approaches, as well as performance standards, are preferred over command and control patterns.

This principle does not reject all command and control approaches, but it recognizes that such approaches have been overused, are often ineffective because of lack of funding or enforcement, and can cause unintended adverse consequences. Negotiation, market-like approaches, and performance standards are appropriate and often preferable alternatives that empower decision makers and complement delegation of authority.

2. Broad-based state and basin participation in federal program policy development and administration is encouraged, as is comparable federal participation in state forums and processes.

This principle recognizes that improved awareness of and participation in each other's efforts can improve coordination and reduce duplication and friction. With approaches as complex as watershed, ecosystem, and integrated resource management, the system must recognize that each of the players holds part of the solution, and all need to be involved.

APPLICATION OF PARK CITY PRINCIPLES TO FEDERAL-STATE CONFLICTS

by Charles T. DuMars

This article applies the Park City Principles to typical water management institutions that have evolved to address three federal/state areas of conflict arising from the United States Constitution. The first federalism conflict is between states over aliquot shares of common river systems. It is based upon the principle of state sovereignty under the Tenth Amendment. The second federalism principle is established by the Commerce Clause of the Constitution and addresses the balance of federal and state regulatory power when water resources

are allocated as market or quasi-market commodities. The third issue involves litigation over federal Indian reserved water rights.

This discussion paper addresses all of these issues by first stating the respective Park City Principle, providing a hypothetical scenario typical of the circumstances where conflicts may arise, and then analyzing the institution and its response in terms of the Park City Principles.

WATER QUALITY POLICY AND THE PARK CITY PRINCIPLES

by Lawrence J. MacDonnell

The Park City Principles are presented as fundamental attributes for good water policy. Numerous elements of the federal Clean Water Act appear to be at variance with these principles. The apparently inevitable conclusion is that the Clean Water Act is seriously flawed. The failings of the Clean Water Act in reflecting the policy characteristics of the Park City Principles may well indicate areas in which changes are needed at this time.

This discussion suggests that the Park City Principles fail to consider the substantive objectives of water policy and to factor in the effectiveness by which policies reflecting

these principles would achieve these objectives. With the possible exception of recognizing diverse interests, none of the Park City Principles appears to represent some absolutely essential policy attribute. Rather they seem to be developed more in reaction to what exists now, suggesting the needed or desired direction of change. In short, they are relative, not absolute. Thus, if the objective of the Park City Principles is to establish some basic touchstones for policy formation they probably do not succeed. If, on the other hand, they are understood as one consensus about the directions in which changes of water policy are needed, they seem to be on point.



Indeed, changes in the Clean Water Act in the direction of the Park City Principles appear to have considerable

support in the Congress as well as in the West.

**APPROACHING A GORDIAN KNOT:
THE ONGOING STATE/FEDERAL CONFLICT OVER HYDROPOWER**
by George William Sherk

Given the multitude of expectations associated with rivers and the institutional structures that have developed to fulfill those expectations, conflict is inevitable. At an institutional level, one of the more significant conflicts is between the states and the Federal Energy Regulatory Commission (FERC). Historically, states have held primacy over the management and allocation of water resources. Under federal law, the FERC has jurisdiction over hydroelectric power, the development of which requires the utilization of water resources.

This institutional conflict has become progressively more acrimonious as an increasing number of federal and state requirements affect the management and allocation of water resources. Irrespective of how the state/FERC

conflict is approached, it should be resolved. An application of the Park City Principles demonstrates the inconsistency of current FERC policies and procedures with those Principles. Legislation amending the Federal Power Act of 1935 (FPA) to bring FERC policies and procedures into compliance with the Principles should be considered. Absent such legislation, the ongoing state/FERC conflict over hydropower can only intensify.

This paper addresses the ongoing state/FERC conflict over hydropower, including a background of the conflict and illustrative cases, specific conflict areas, an examination of the conflict in the context of the Park City Principles, and a proposal of potential solutions.

APPLYING THE PARK CITY PRINCIPLES TO THE ENDANGERED SPECIES ACT
by Mark Squillace

Historically, the protection of endangered and threatened species has been the province of the federal government. In recent years, however, many states have enacted endangered species protection laws and expanded the mandate of state fish and wildlife management agencies to encompass non-game species, including endangered species. Nonetheless, the federal Endangered Species Act (ESA) remains the focus of endangered species protection in the United States, and since such protection frequently implicates water resource management, it is appropriate to ask how well the current federal regime for managing endangered species comports with the Park City Principles.

The ESA offers a useful model for testing the Park City Principles, because while the management of listed species frequently impacts water resources, such management commonly affects other natural resources as well.

This paper seeks to apply the Park City Principles to various relevant aspects of the ESA, to describe how well the ESA fits into the policy framework established by those Principles, and to consider how modest administrative or statutory changes to the ESA might better accommodate those Principles.

Because of the limited margin for error in achieving the ESA's goals of conserving species at risk of extinction, implementation of the ESA has sometimes been controversial. Much of that controversy, however, seems to arise from a misunderstanding of the law and from the failure of affected parties to avail themselves of the many opportunities for its flexible application. If and when these problems are overcome, the ESA, perhaps with some modest changes, might be seen as a model for adherence to the Park City Principles.

Copies of the report entitled *The Park City Principles: A New Paradigm for Managing Western Water* may be purchased from the Powell Consortium. The cost is \$15.00 per copy. Please contact:

Arizona Water Resources Research Center, 350 N. Campbell, University of Arizona, Tucson, AZ 85721
Phone (520) 792-9591 FAX (520) 792-8518




**UPPER COLORADO RIVER
NATIONAL WATER QUALITY ASSESSMENT (NAWQA) PROGRAM**

by Laurie Schmidt

In 1991 the U.S. Geological Survey (USGS) implemented the National Water-Quality Assessment (NAWQA) Program. The long-term goals of the program are to (1) describe current water quality conditions for U.S. fresh-water streams, rivers, and aquifers; (2) describe how water quality is changing over time; and (3) improve understanding of the natural and human factors that affect water quality conditions. To help reach these goals, 60 study units representing the most important river basins and aquifers in the country are being investigated.



Program Manager Nancy Driver enjoys a sunny lunch break with attendees at the April 17 UCOL Liaison Meeting in Keystone, Colorado

One of the units being studied is the Upper Colorado River Basin (UCOL) in Colorado and Utah. The UCOL study unit is made up of two nearly equal physiographic provinces - the southern Rocky Mountains and the Colorado Plateau. It has a drainage area of about 17,800 square miles and encompasses the Colorado River, the major supplier of water to the southwestern United States, and its tributaries in Colorado. The UCOL was chosen as a study unit to examine the effects of (1) increasing urban development, (2) hydrologic modifications, (3) metal mining, (4) non-point and point source agricultural contaminants, and (5) salinity from natural, agricultural, and municipal sources.

On April 17, 1997, the sixth UCOL Liaison Committee Meeting was held at the Keystone Science School in Keystone, Colorado. The purpose of the meeting was to provide an update on the preliminary findings for the UCOL study unit. NAWQA Program Manager Nancy Driver presented an overview of the UCOL Program and

a review of current and upcoming UCOL publications. This was followed by presentations by NAWQA team members Lori Apodaca, Jeff Deacon, Norm Spahr, and Kirby Wynn. Summarized below are some of the findings presented at this meeting and at previous UCOL Liaison Committee meetings.

Trace Metals in Bed Sediment

To assess the occurrence and distribution of trace metals in bed sediment in the southern Rocky Mountains, bed sediment from 35 sites was analyzed for 25 trace elements. Guidelines are based on Probable Effect Level (PEL). Concentrations that exceed the PEL are expected to have adverse effects on aquatic organisms. Preliminary findings are:

- Geology can affect metal concentrations; therefore, it is important to establish background concentrations.
- Zinc, cadmium, copper, and lead exceeded bed



sediment guidelines at many sites associated with mining.

- Zinc and lead were the metals that exceeded guidelines at the largest number of sites. Cadmium was next, followed by copper.
- Zinc levels exceeded guidelines at all French Gulch/Upper Blue River sites and at all but one site in the Upper Uncompahgre River Basin.
- Lead exceeded bed sediment guidelines at all French Gulch/Upper Blue River and Upper Uncompahgre River Basin sites.
- Metal concentrations in bed sediment decreased with distance away from mining activities.

Integrated Study of Trace Metals in Areas Impacted by Mining

This study was conducted in areas impacted by mining in the Uncompahgre and Blue River Basins. Samples were collected at 15 sites during a low flow and a high flow period. Concentrations of trace metals were determined in various sampling media, including suspended sediment, bed sediment, brown trout liver tissue, and total and dissolved concentrations in the water column. The preliminary findings are:

- Loadings of trace metals in suspended sediment were higher in the Upper Uncompahgre River Basin than in the French Gulch/Upper Blue River sites.
- Concentrations of metals in suspended sediment were typically higher during low flow for both basins.
- Zinc concentrations in suspended and bed sediment were similar in both basins, and concentrations were higher in French Gulch.
- Zinc in the dissolved phase was much higher in French Gulch/Blue River than in the Uncompahgre River Basin.
- Zinc in fish tissue was similar in both basins, but cadmium was higher in the Blue River Basin.
- Arsenic and iron exceeded bed sediment guidelines for aquatic organisms in both basins; cadmium exceeded bed sediment guidelines in the Blue River, and copper exceeded guidelines in French Gulch and the Uncompahgre River Basin.

Surface Water-Monitoring Network

In September, 1995, 14 water quality sampling sites were established at selected stream-gaging stations in the

basin. The network includes six integrator sites with mixed land uses; two indicator sites each for agricultural land, urban/recreation areas, and mining areas; and two reference sites. Sampling began in October, 1995, and will continue at least through September, 1997, representing a two-year study period. During 1996, 223 water samples were collected.

The UCOL staff has implemented a quality assurance (QA) program for surface water field activities. This program is important in interpreting the bias, variability, and accuracy of the data acquired during sampling. Some preliminary results from the data collected at the surface water-monitoring network include the following:

- Field conductance and total dissolved solids were high at the Reed Wash site.
- The Colorado Plateau registered higher alkalinity values than the southern Rocky Mountains.
- Chloride levels were highest at the Reed Wash site, while iron levels were highest at the Baker Gulch site.
- All 14 basic fixed sites had a pH level of high 7/low 8, with the exception of the French Gulch and Baker Gulch sites where the pH level was approximately 7.
- Nitrite plus nitrate values were highest at agricultural sites.
- Total phosphorus concentrations were highest at the Gore Creek site.

Historical Surface Water Salinity Data

Surface water salinity data for seven sites in the Colorado River Basin above Cameo, Colorado, and for four sites in the Gunnison River Basin were analyzed. An important part of the analysis was to determine whether decreasing salinity trends found at the Cameo site were also observed upstream. Important findings of the analysis include the following:

- Trends in dissolved solids concentrations and loads upstream of Cameo partially agreed with the downward trends observed at Cameo.
- In the Gunnison River Basin, trends were detected in 50% or less of the site/time-period combinations.
- Most trends detected in the Gunnison River Basin indicated decreasing dissolved solids concentrations and loads.
- Trends may be affected by channel evolution and



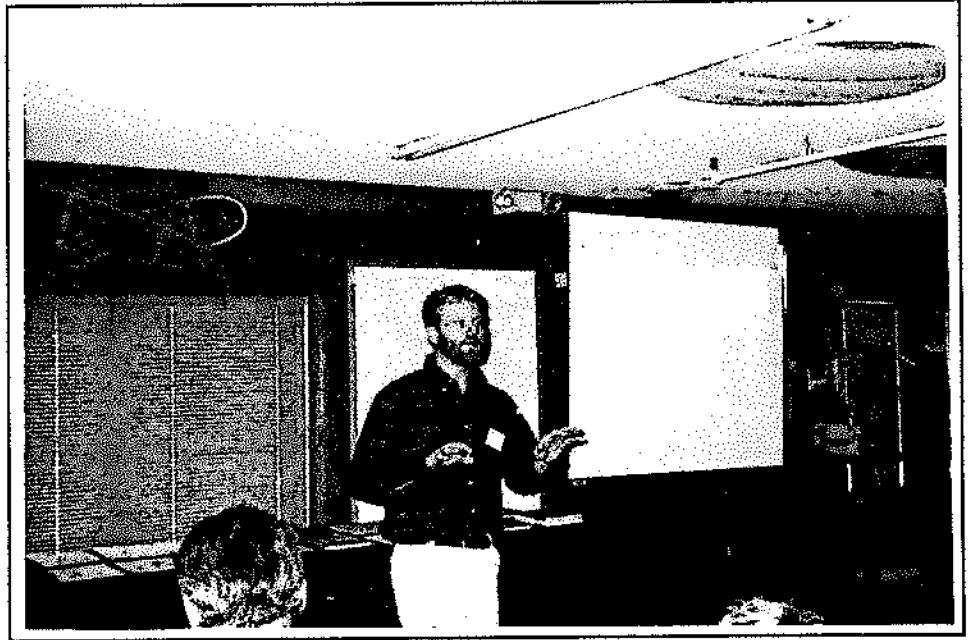
hydrologic variation, water quality and flow rate of ground water discharges and springs, characteristics of the dissolved solids data, and changes in land use in the basin.

Low Flow Water Quality in East River Basin during Peak Ski Season

In December, 1996, an East River synoptic study was done to (1) determine nutrient and chemical characteristics of the Slate and East Rivers during cold weather low flow conditions, and (2) look at how water quality may be affected by peak recreational use. The results of the study are:

- Nutrient concentrations were low throughout the system. Although nutrients increased below the town of Crested Butte, concentrations were relatively low.
- Dissolved oxygen was near saturation at all sites during the sampling period.
- State standards were not exceeded for any of the constituents measured during the sampling period.
- During peak winter recreational use, the streams assimilated the loadings.
- A relationship between algae and nutrients was observed. When nutrients increased and sunlight was present, algae increased. When sunlight was blocked by ice cover, the algal community did not respond to increased nutrient concentrations.

Geographic Information Systems (GIS) and the World Wide Web are both used in the UCOL NAWQA Program. GIS is used as a visual and analytical tool based on geo-referenced data. The UCOL homepage is used as a distribution tool to keep the public informed on UCOL



USGS NAWQA team member Jeff Deacon presents findings in the UCOL study unit at the April 17 Liaison Committee Meeting in Keystone, Colorado

activities and findings, to provide short publications and to describe their status, and to provide links to other related topics. The homepage address is:

http://webserver.cr.usgs.gov/nawqa/ucol/ucol_home.html

For further information on the UCOL NAWQA Program, or to order publications, contact:

Nancy Driver, Program Manager, Upper Colorado
NAWQA
U.S. Geological Survey
Box 25046, M.S. 415
Denver, CO 80225
(303) 236-2101, ext. 224



MEETING BRIEFS



HYDROLOGY DAYS '97

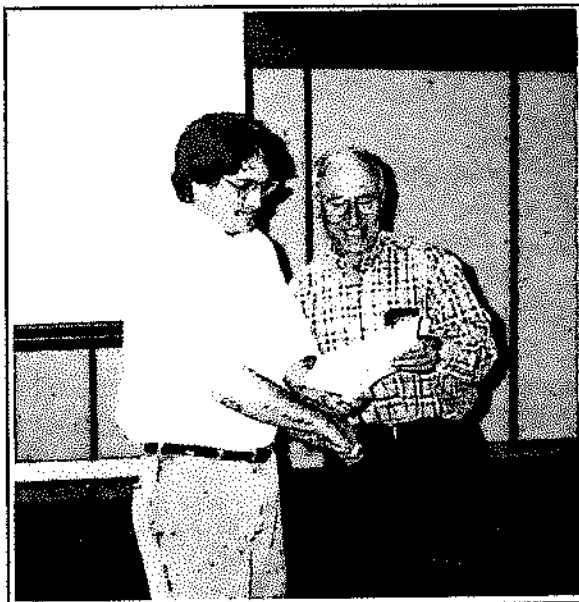
by Hubert J. Morel-Seytoux

The 17th annual **Hydrology Days** meeting was held April 14-18 at Colorado State University in Fort Collins. The meeting honors individuals or groups who have contributed to the development of hydrology as a science and practice. The 1997 meeting was dedicated to Herman Bouwer, Donn G. DeCoursey, and Jan van Schilfgaarde, all with the U.S. Department of Agriculture; and Glendon Gee of Battelle Pacific Northwest Laboratories. The honorees presented state-of-the-art papers on conjunctive use, practical recharge methods, recharge estimation in arid climates, and a perspective on the pros and cons of irrigation and drainage practices.

Complementing these presentations was a discussion by John Nimmo, U.S. Geological Survey, on his agency's research on arid-region hydrology. Torkil Jonch-Claussen, Chair of the World Bank Task Committee on "Global Water Partnership," presented a thorough, challenging and sober summary of the progress made in providing safe water to the developing world. Geoffrey Matthews of the World Bank described a new applied hydrology called "hydroinformatics" and the changing role of hydrologists as the "economic value" of water becomes a key issue.

Awards were presented for the best oral and poster presentations by students. In the M.S. category, two awards were given. One went to Lyn Benjamin of Utah State University for "Hydrologic Analysis of Upper Henry's Fork Basin, Idaho, and Probabilistic Assessment of Island Park Reservoir Fill." Kevin Williams of Utah State University received the other award for "A Model for the Spatial Distribution of Snowmelt Based on Topography and Point Melt Measurements."

In the Ph.D category, the awards went to Tom Sale of Colorado State University for "Field-Scale Mass Transfer from Subsurface Nonaqueous Phase Liquids (DNAPL)," to Frank Barranco, Colorado School of Mines, for "Lab Parameterization of Multiphase Flow Properties for a DNAPL-Contaminated Site;" and to Alexandra Kravchenko of the University of Wyoming for "Applying Restricted Kriging for Estimating the Annual Maximum Precipitation."



H.J. Morel-Seytoux presents award to Tom Sale

At the April 15th luncheon William P. Stanton, Chief of the Project Planning and Construction Section of the Colorado Water Conservation Board, discussed the development and management of Colorado's water resources.

Karen Hamilton, Watershed Administrator for the Environmental Protection Agency's Region VIII in Denver, was the luncheon speaker on April 16th and described EPA's watershed approach to environmental management.

To obtain a copy of the proceedings for Hydrology Days '97 contact: H.J. Morel Seytoux, 57 Selby Lane, Atherton, CA 94027, Phone and FAX 415/365-4080.

Pictures on page 19, clockwise: Karen Hamilton, Geoffrey Matthews, Bill Stanton, Stephen Nix, Torkil Jonch Claussen, Bill Stanton, Bill Lane, Jan van Schilfgaarde and Marvin Jensen.

Hydrology Days '98 will be held March 30-April 3, 1998 at Colorado State University, Fort Collins, Colorado.







WATER RESOURCES, HYDROLOGY AND THE WORLD BANK

by Geoffrey Matthews
Presented at Hydrology Days '97

The Dublin Statement, the concept of the economic value of water and water resource stress in many regions of the world, presents an opportunity for hydrologists to take their place in the investment risk business and thereby make an important contribution to sustainable development from a water resources management perspective.¹ Investment institutions, such as the World Bank and national and international markets, will increasingly rely on the judgment of hydrologists to assist them with critical financial and economic decision making during the next few decades. To demonstrate its commitment to the importance of water, the World Bank has formed a partnership with the World Meteorological Organization to create a global water information infrastructure, based on the concept of hydroinformatics, that is designed to provide a non-threatening information-sharing environment for water allocation decision makers. The challenge for hydrologists is considerable, but the tools are there and the investment market is waiting.

Introduction

Before Dublin¹ and Rio,² there was very little interest in water resources management and hydrology at the World Bank. This was because water was relatively abundant, there was tremendous pressure to build massive infrastructure projects, the environmental movement was just beginning, and, most importantly, water was considered to have no economic value. Because of its relative abundance, water was a non-tradable commodity and, therefore, a free good. Due to the perceived trend towards relative water scarcity, Dublin/Rio changed all this. The World Bank responded by publishing its first "Water Resources Management Policy" in 1993, followed by "A Guide to the Formulation of Water Resources Strategy." It is now pursuing a policy of networking with hydrologic and water resource management centers of excellence which can assist it to implement this policy.

Concerns

Poverty alleviation is a concern of the World Bank, especially in rural areas of developing countries where

the majority of the population lives on less than \$2 per day. The accent of future bank activities will therefore be on rural development. From a water resource management perspective, this is very fortuitous because the majority of the planet's freshwater is in rural areas. Therefore, rural development will become a very important market for the hydrologic profession, with the possibility of hydrology becoming a very high-profile profession in the eyes of the investment community. Water in rural areas is an essential resource for the well-being of residents in that sector. It also enables rural communities to act as stewards of the environment and to provide food for the world's increasing population, via irrigated and rainfed agriculture. Managing water in the rural sector is the key to addressing the issues of global food security, conservation of natural resources, coastal zone management and the survival of the urban sector. Rural populations must be held accountable for these issues; this is the real payoff for poverty alleviation in the rural areas.

Food production is another concern because global water stress, combined with the probability that during the next 30 years there will be another 30 billion extra mouths to

¹ The Dublin Statement evolved from the International Conference on Water and the Environment held in Dublin, Ireland in January 1992.

² The United Nations Conference on Environment and Development was held in Rio de Janeiro, Brazil in June 1992.



feed, will pressure countries to abandon national food self-sufficiency and seed food security involving international trading partnerships. The problems are enormous, and it has already been recognized that the top-down approach will not work. The consequence of inaction with regard to improving water resource management could well create environmental refugees. These concerns and recommended actions are summarized in the United Nations document, "Comprehensive Assessment of the Fresh Water Resources of the World." It was published in early 1997 and can be accessed on the World Wide Web at: <http://www.un.org/dpcsd/dsd/freshwat.htm>

Role of the Hydrologic and Water Resources Community

The concerns and issues noted above can be summarized in two words: "water allocation." However, to determine allocation rights, water markets, and responsibilities, it is necessary for the hydrologic community to accurately monitor the behavior of the hydrologic cycle all over the world, so that countries can appreciate the hydrologic context of their economies from both the national and international perspectives. This is particularly important for those who share river basins and aquifers. It is important that decision-makers understand that when the limits of water resources are reached, it is necessary to begin thinking in terms of what we can do with what we have rather than what we would like to do. This is where the concept of the "economic value" of water becomes a key issue.

Planning authorities need to know when they are reaching the limits of water resource supplies so that they can begin planning interbasin water transfers or implementing economic incentives to encourage industry to recycle water and agriculture to use water more efficiently. To make these decisions, those responsible for economic and financial analysis must be provided with scientifically accurate hydrologic information whenever it is required. Therefore, hydrologic services and water management agencies must have the technical means and institutional capacity to monitor and assess water resources quantitatively and qualitatively. Billions of decision-making dollars rest upon this new demand for market information.

This is the challenge for the hydrologic profession and the

justification for developing the art of applied hydrology for water resources management or - per the Dublin Statement - "hydrology with economics in mind." However, water management is a very complex operation requiring new approaches to information exchange between sectors for risk analysis. The objective of this information exchange would be to ensure that all socio-economic activities within a river basin can maximize their capacity to produce wealth without detriment to the environment and without reducing their capacity to attract investment and service debt.

The questions are:

- How will the data to be gathered in a timely manner?
- Who will process, integrate, disseminate, and exchange the information and evaluate water resource management risk for investors?

It is suggested that the answer to these questions is the technical and institutional application of a new applied hydrology called "hydroinformatics." Hydroinformatics is an applied science that studies the ability of water to capture, store and communicate information about all the socio-economic and environmental activities it irrigates. The technical application of hydroinformatics consists simply of networks of automatic data collection and transmission systems and will not be described further. The institutional application of hydroinformatics, however, is not simple. Institutional issues regarding the processing and dissemination of water information are highly sensitive in any part of the world and can only be resolved by governing authorities through the traditional formal and informal cultural decision-making processes of their country. Therefore, no solution will be prescribed here, but rather a suggestion for a process, based on the principles of hydroinformatics, to facilitate an evolutionary process of institutional cooperation between sectors.

Generic Water Resources Management Risk Information

The first step is to create a non-threatening information exchange environment in which all interested parties can discuss the water allocation and risk management issues informally. This is being done by the World Bank in partnership with the World Meteorological Organization by setting up Hydrological Cycle Observing Systems



(HYCOS) covering river basins or regions of the world. This provides the authorities and the community with sufficient hydrologic information that enables them to understand the hydrologic context in which they live. This information is then shared via the World Wide Web with all decision makers (<http://www.wmo.ch/web/homswwhykos.html>). Decision makers are encouraged to communicate with one another to discuss water allocation and risk management informally on the basis of this information about the behavior of the hydrological cycle, the limits to total demand, and the environmental demand to protect the natural resource capital base. These discussions hopefully will produce informal intersectoral partnerships which can evolve into formal partnerships for information exchange.

An example of water resource risk management information is the Total Discharge Charge Curve of a river at any point in its basin in terms of Quantity against Time. This curve represents the Total Water Resource Availability during non-flood flows, which could be used by socio-economic sectors and the environment. The behavior of this water quantity curve is vital information for the authorities who have the responsibility for allocating water among those sectors. Another way of looking at this curve is to consider it the boundary of a hydrologic envelope within which we live.

Diagram A shows total water resource availability for a typical river basin. The environmental demand curve is shown following the upper total water resource curve. The amount of water below the environmental curve is the quantity that is available for development of all socio-economic activities. In this case, the socio-economic demand curve is shown climbing up toward the environmental demand curve. This indicates a river basin that still has potential for further development and investment in wealth creation from the water resource perspective.

Diagram B shows a river basin that has developed all the water resources for satisfying socio-economic demand. Note that in order to create wealth and protect investment, it is important that water for socio-economic activities is not taken from the water supply for the environment. That would deprive the natural resources of the water they need to maintain their production capacity. An extreme case would occur when all the water is used for socio-economic activities, resulting in the river basin becoming a desert. In such a case, the

impact on the economy and investors would be devastating. Under normal river flow conditions, decision makers should have little problem in maintaining the socio-economic demand curve below the environmental demand. However, when a river basin is developed to its maximum, there are two cases when monitoring for water allocation decision making becomes vital for the survival of the economy.

The first case is pollution, which makes water unusable for irrigation and drinking water and its treatment very expensive for industry. Diagram C illustrates the effect of pollution on the socio-economic demand curve. This curve is obliged to descend, because sufficient water must be left in the river to dilute the pollution in an attempt to minimize the damage to the environment and the aquatic life, and to prevent overloading of the water treatment plants which supply industry and domestic drinking water. This diluting water would probably come from the irrigation allocation so as to protect the soil. This demonstrates how pollution reduces productivity in all sectors and threatens the health of the natural resource capital. It also shows how important it is to have the monitoring capacity to detect pollution disasters at an early stage before they disrupt production and reduce investment potential, obliging the authorities to spend money on cleaning it up — money which has been hard-earned and probably is needed for new investments.

The second case is drought. Its effect is illustrated in Diagram D. Again, the first priority is to protect the environment and the natural resources capital so as not to exacerbate the desertification effect of the lack of water. For this particular case, a monitoring system with simulation capacity for forecasting or predicting drought probability would be a very useful tool for the decision makers.

Finally, the most important service that this type of monitoring system can provide is a continuous assessment, in time and space, of the availability of water resources throughout the country for the planning authorities. It is absolutely essential that authorization for water use does not exceed the amounts that are naturally available. If this is permitted to occur, the environment will become less productive, investment risk will increase both for attracting new investment and protecting existing development, and wealth that has been created through hard work would have to be used to repair the damage.



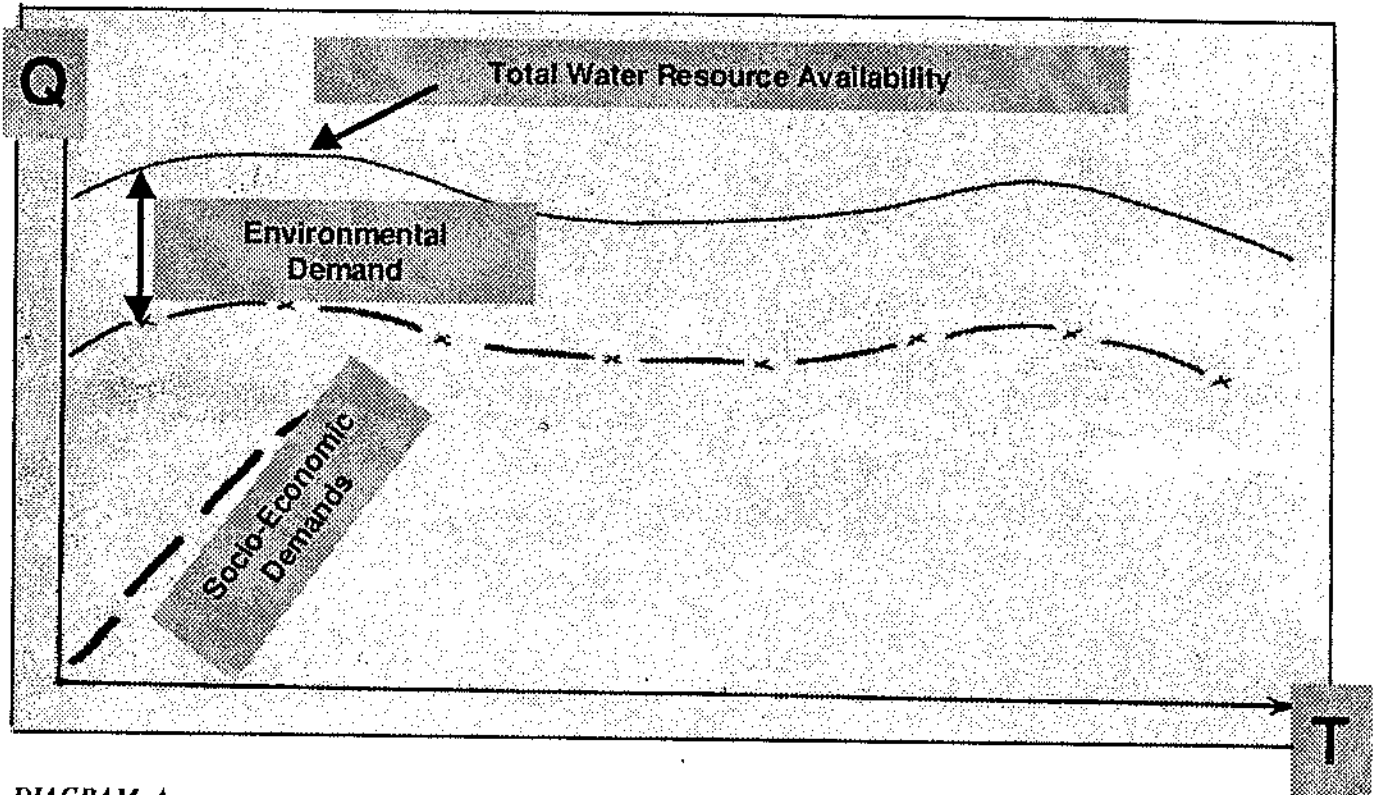


DIAGRAM A

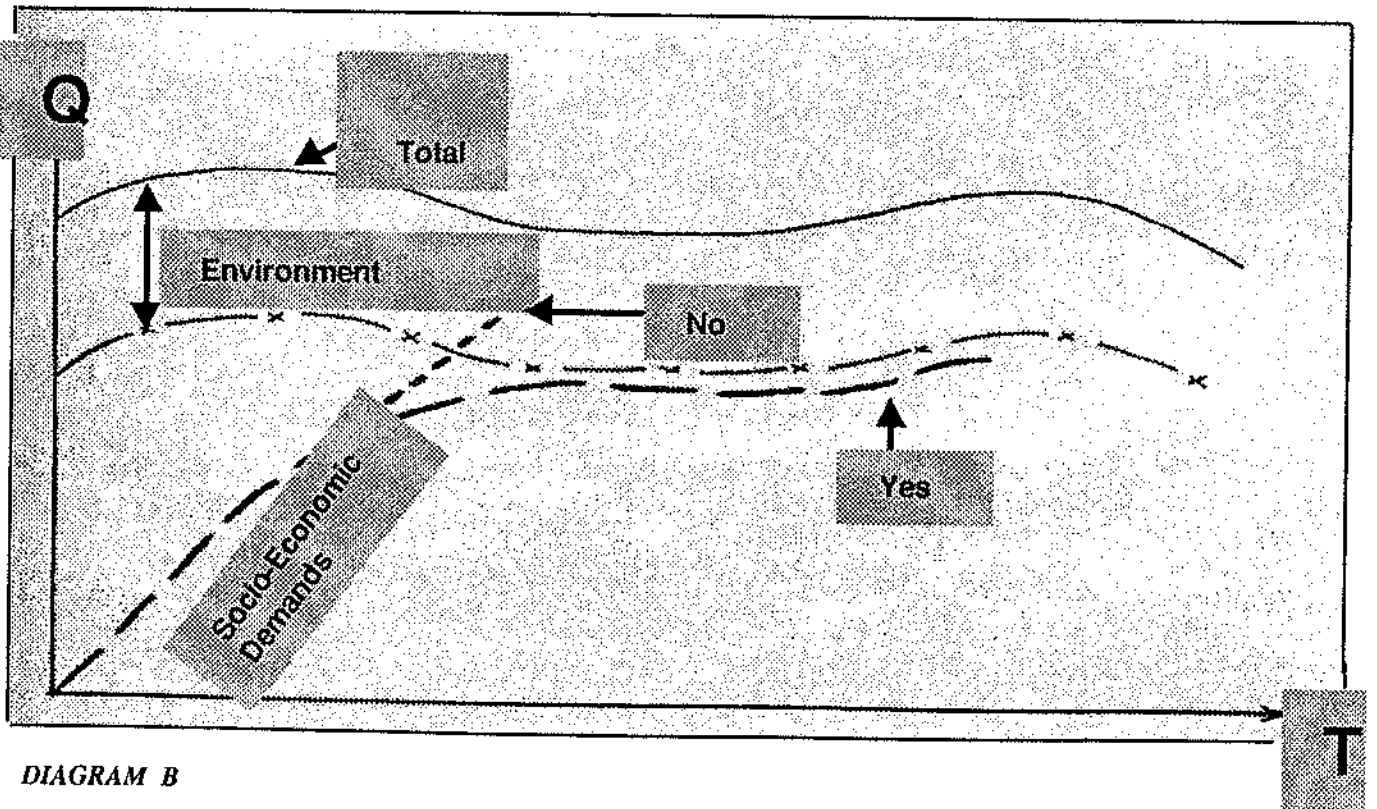


DIAGRAM B



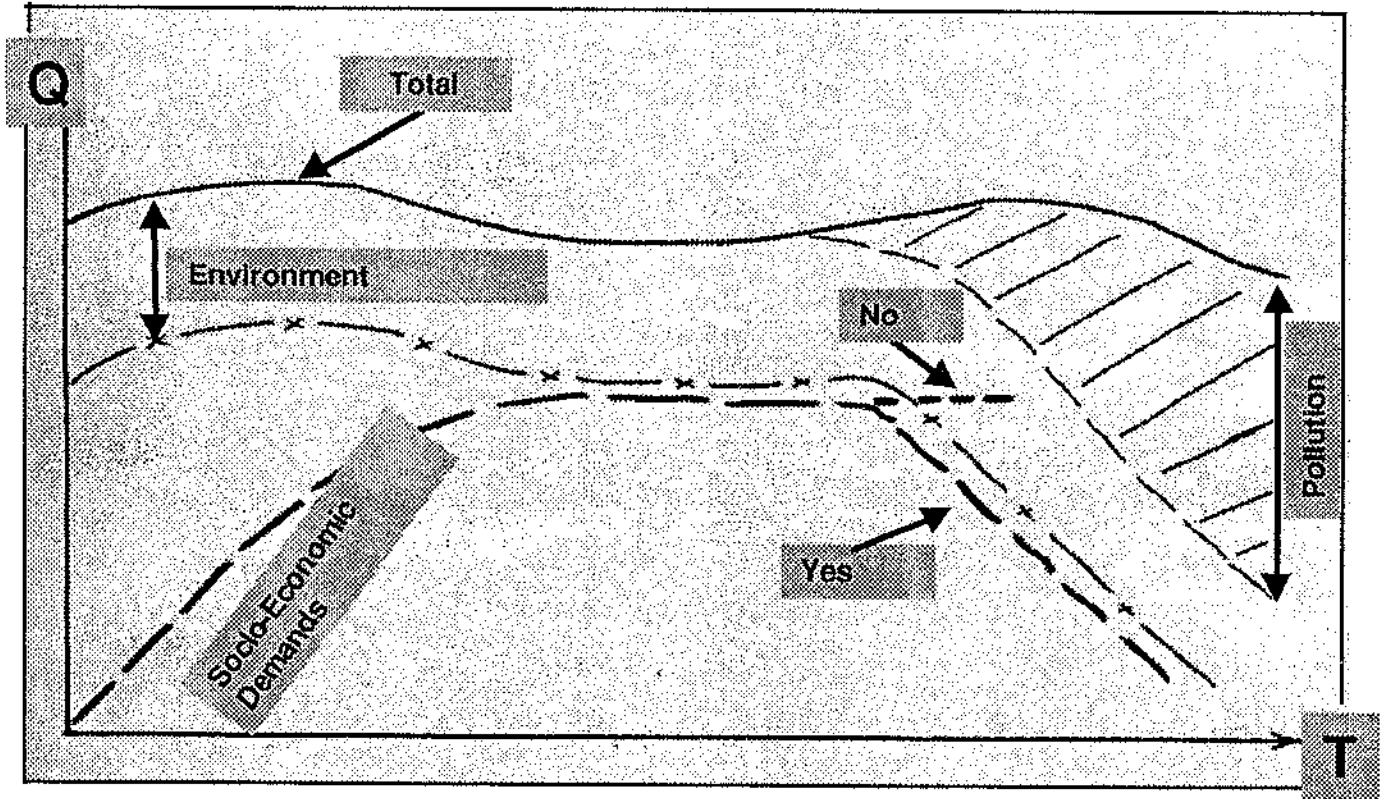


DIAGRAM C

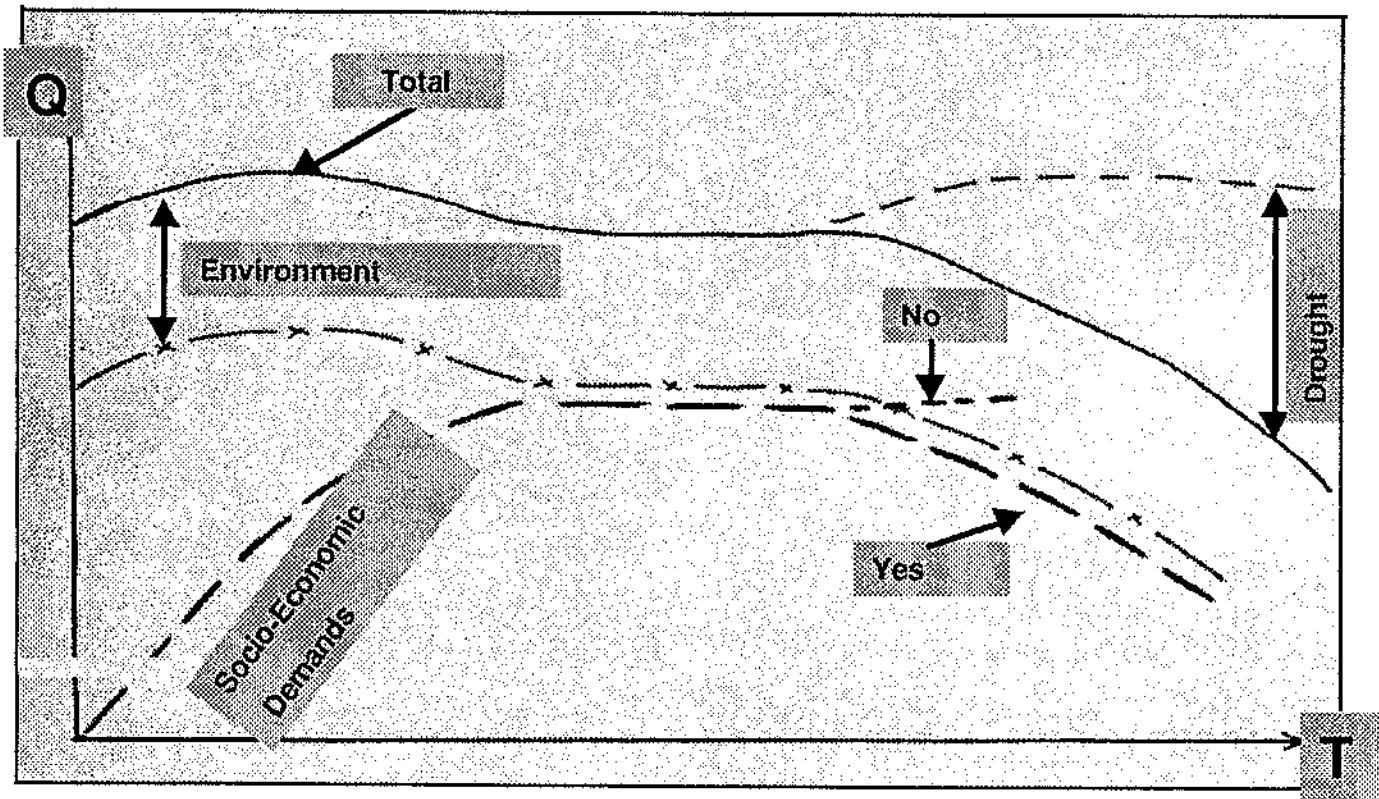
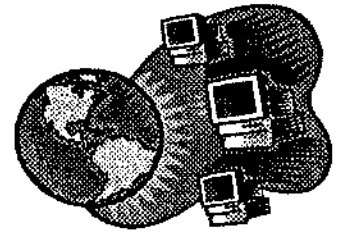


DIAGRAM D



WWW WATER PATHS

Find-Water Related Information Quickly and Easily!



IDS Group — "Visualizing Engineering and Management Solutions." The Integrated Decision Support (IDS) Group at Colorado State University combines advanced modeling techniques with software engineering to create Decision Support Systems for water and natural resources management. Visit the IDS World Wide Web site at: <http://www.colostate.edu/depts/IDS>.

The Water Center at Colorado State University is an umbrella organization for campus water-related programs. For more than a Century, Colorado State's engineers have designed infrastructure and water resources systems that sustain and advance our society - and protect our ecological systems as well. Visit the World Wide Web site at: http://www.engr.colostate.edu/depts/ce/netcape/special_programs/wcenter

Check out the **CADSWES Web Site** (Center for Advanced Decision Support for Water and Environmental Systems). CADSWES is an interdisciplinary research and development center of the College of Engineering and Applied Science located at the University of Colorado at Boulder. Established in 1988, CADSWES performs research under the sponsorship of a number of organizations. <http://cadswes.colorado.edu>

Indiana's **Purdue University** is the home of **WETnet**, a "virtual" water resource that allows users to search for information on water resource projects in three ways — by a person's name, by study area, or by keyword. The page also has links to federal and state agencies and general environmental pages. A sampling of WETnet contents is provided below.

WETnet: Introduction and What's New
<http://ingis.can.purdue.edu:9999/WETnet/intro/intro.html>

WETnet: Doctor's Help — The water doctor found here informs the user about water quality issues.
http://ingis.can.purdue.edu:9999/WETnet/government/doctor_help

WETnet: Water Models — An introduction to modeling and definitions of terms used within this resource.
<http://ingis.can.purdue.edu:9999/WETnet/models/models.html>

WETnet: National Pollution Discharge Elimination Systems (NPDES).
<http://ingis.can.purdue.edu:9999/WETnet/Search/npdes.html>

WETnet: Effluent Limitations and Standards
<http://ingis.can.purdue.edu:9999/WETnet/Search/efflim.html>

WETnet: Educational Resource
<http://ingis.can.purdue.edu:9999/WETnet/education/help.html>

Another wetlands website the new **Texas Wetland Information Network.**
<http://www.tris.state.tx.us/wetnet.html>

A website presenting information on the global hydrologic cycle is named **WetNet Data**. This interdisciplinary NASA project uses data from polar-orbiting satellites. <http://www.unidata.ucar.edu/factsheets/wetnet.html>

The **Groundwater Foundation's** web site is being expanded. The web site will include more information about all the Foundation's programs and events. The site will also feature groundwater basics, the Foundation's catalog of educational products, all the necessary information to become a Groundwater Guardian, and a special section for kids. <http://www.groundwater.org>



WATER NEWS DIGEST



ENDANGERED SPECIES

Protections Sought for Trout Species

According to conservationists, a trout species named after Lewis and Clark is on the brink of extinction because of logging and development that followed explorers into the Pacific Northwest. Environmental groups are urging Endangered Species Act protection for the westslope cutthroat trout, a popular, speckled, sport fish with the scientific name *Onchorhynchus clarki lewisi*. According to one of the groups petitioning the U.S. Fish and Wildlife Service for formal listing of the trout as an endangered species, the fish require pure, cold, clean water, and their drastic decline is telling us that the watersheds of the northern Rockies are hurting. The millions of westslope cutthroat trout that once populated the region have dropped to the thousands, surviving in less than 10 percent of the streams where they once lived in Oregon, Washington, Idaho, Montana, and Wyoming.

Denver Post, 5/21/97 and *Grand Junction Daily Sentinel*, 5/21/97 (Associated Press)

U.S. Department of Interior and States Reach Platte River Accord

The federal government and the states of Colorado, Nebraska, and Wyoming have reached a tentative agreement to protect endangered wildlife along the Platte River. The accord, which was reached after three years of negotiations, would balance the protection of endangered wildlife in central Nebraska with the needs of water users for the next three years. Those water users include farmers along the South Platte River, the Denver Water Board, and communities from Douglas County to Fort Collins. Concern has grown in recent years about the flows in the Platte River, which starts in Colorado, and their impact on wildlife.

The U.S. Fish and Wildlife Service, charged with enforcing the Endangered Species Act (ESA), believes that increasing the flows by releasing more water from dams will protect wildlife. The cooperative agreement would send an additional 130,000 acre feet of Platte River water into central Nebraska. It would also lead to a federal-state recovery program for species listed as endangered or threatened, including the least tern, whooping crane, piping plover, and the pallid sturgeon. The proposed management program will cost about \$75 million over 15 years. Colorado and Nebraska will pay \$15 million each, Wyoming will contribute \$7.5 million, and the federal government will pay the remaining \$37.5 million.

According to the Colorado Department of Natural Resources, the agreement will save 800 water permit holders "millions of dollars" in potential legal fees. Gov. Roy Romer (Colorado) sent a letter to U.S. Department of the Interior Secretary Bruce Babbitt giving his preliminary support for the agreement. The U.S. Department of the Interior hopes to finalize the agreement by the

end of June. Among the pact's provisions are (1) a comprehensive, basin-wide analysis of water conservation and increased water supplies, (2) immediate funding for improving wildlife habitat, (3) simplification of the ESA review process for water-related activities, and (4) steps to develop legal and institutional protections to ensure that existing flows and new water projects will reach critical habitat.

Fort Collins Coloradoan, 5/23/97, 5/24/97 and *Denver Post*, 5/23/97 (Associated Press)

Smallmouth Bass Could Help Restore Brown Trout

According to biologists, the slowly increasing numbers of smallmouth bass in the Flaming Gorge Reservoir may be the key to restoring the reservoir's former world-class brown trout fishery. Smallmouth bass can be found throughout the Wyoming side of the reservoir, which straddles the Wyoming-Utah state line south of Green River. The species' prevalence has prompted many former trout anglers to begin seeking out bass, and it could make the smallmouth bass population an important food source for brown trout, the Wyoming Game and Fish Department said. In 1995, the agency began a three-year program to relocate nearly 50,000 brown trout trapped from the reservoir near the Wyoming-Utah border to the northern end of the gorge. The health of the reservoir's brown trout population peaked in the late 1970s and early 1980s. But the reservoir, created when the Flaming Gorge Dam was built on the Green River in 1962, has aged, making it less able to support brown trout.

Denver Post, 5/24/97 (Associated Press)



ENVIRONMENT

Acid Snow Threatens Wilderness Area Wildlife

According to a new study by the U.S. Geological Survey, there is conclusive evidence that acid rain and snow pollution from power plants in Hayden and Craig is killing wildlife in northwest Colorado's Mount Zirkel Wilderness Area. The USGS study found that sulfur dioxide emitted by the power plants is creating acid snow, which is killing the salamanders, trout, frogs, and zooplankton that provide the primary food sources for wildlife in the wilderness areas. According to authors of the study, the acid-faden snow melts and collects in ponds where the amphibians breed and lay eggs. The acidity can kill between 40 and 100 percent of the eggs, and those that do survive mature more slowly and have trouble catching food.

Last October, the Sierra Club filed a lawsuit claiming that a coal-fired Craig power plant has polluted air and threatened wildlife in the Yampa Valley and Mount Zirkel Wilderness Area. After the



Sierra Club won an earlier suit over air pollution violations near Steamboat Springs, Public Service Company (PSC) and other owners of a Hayden plant were fined \$2 million and agreed to spend \$130 million fitting the antiquated plant with state-of-the-art pollution controls. According to PSC's project manager, these controls should reduce emissions by 85 percent. But according to a USGS scientist, nobody knows whether this 85 percent number is enough to reduce the amount of acid snow.

Denver Post, 4/10/97 and *Fort Collins Coloradoan*, 4/11/97 (Associated Press)

De-Icing Chemicals Threaten Creek Near DIA

When Denver International Airport opened two years ago, its system of recycling de-icing fluids was hailed as a model of environmental progress. But in the past six to eight months, at least two spills of propylene glycol have flowed from the airport into Third Creek. About 100 gallons of de-icer was spilled into the creek last March, along with 3000 gallons of water, when someone failed to open a valve in the glycol recycling system. According to a CSU hydrologist, propylene glycol isn't poisonous itself, but it does kill creatures living underwater by depleting the oxygen they need for life. Apparently, the fluid drips off airplanes as they taxi along the runway. DIA plans to build a new system that will catch the runoff and send it to retention ponds, where it will join the recycling system. The \$1.5 million upgrade has already been budgeted into the airport's plans, and work on the project should be completed by October. Meanwhile, the airport is building dirt berms to prevent the fluid from reaching Third Creek.

Denver Post, 4/22/97, 4/25/97

Rocky Mountain National Park to be Included in Amphibian Study

The federal government plans to turn 12 national parks, including Rocky Mountain, into outdoor labs to find out what's ailing amphibians. Freakish frogs with extra legs, missing limbs, and misplaced eyes have been turning up in unusually high numbers during the past year in scattered states from Vermont to California. No one knows what is causing the deformities, but one theory is that increased levels of radiation reaching the Earth are affecting the frogs. By the end of July, The Environmental Protection Agency (EPA) will install \$1.5 million worth of special radiation monitoring equipment at a dozen national parks, including Rocky Mountain, Glacier, Great Smoky Mountains, Olympic, Sequoia, Everglades, and Big Bend. EPA biologists emphasize that the \$5 million project, which they will conduct jointly with the National Park Service, is designed to provide the government with broad information about radiation and its effect on all plants and animals within the parks, not just frogs. But frog experts point out that amphibians can serve as an early alarm system for humans.

Fort Collins Coloradoan, 5/4/97

Cleanup Restarts at Summitville Mine Superfund Site

The EPA has announced plans to begin treating water at the Summitville Mine Superfund site following a winter shutdown. An EPA spokesperson said the shutdown saved an estimated \$2 million. In addition to water treatment plant operations, the agency will complete construction on the cap on the heap leach pad, where the company that ran the mine heaped crushed rock and dripped a cyanide solution over it to leach out microscopic gold bits. Since 1992, the EPA has spent more than \$120 million cleaning up the site, abandoned by Summitville Consolidated Mining Company. The Canadian company closed after declaring bankruptcy.

Denver Post, 5/5/97

U.S. Senator Seeks \$50 Million to Speed Rocky Flats Cleanup

U.S. Senator Wayne Allard asked Senate Republican leaders for an additional \$50 million to accelerate cleanup of the Rocky Flats nuclear weapons plant to save money and to hasten removal of nuclear waste. The freshman senator from Colorado said the extra money would help assure that hazardous plutonium wastes are taken from the Jefferson County site within 10 years. The U.S. Department of Energy has already requested \$642.1 million to continue its cleanup work at Rocky Flats next year. Most of that is for stabilizing plutonium wastes and decommissioning buildings. Rocky Flats must compete with other sites in the nation's nuclear weapons complex for extra discretionary money. Expending more on cleanup there would likely mean diverting dollars from other cleanup projects in other states, a plan that may not meet with favor from lawmakers from those states who have a say on how energy dollars are doled out. Rocky Flats is among the "big five" sites in the country considered to be the largest, dirtiest, and most difficult to clean up.

Denver Post, 4/24/97, 5/7/97

Fish Purchased to Counter Whirling-Disease Losses

The Colorado Division of Wildlife (CDOW) has bought 105,000 fish from private hatcheries and obtained 1.2 million subcatchable trout from federal facilities in an attempt to compensate for whirling disease losses. However, it won't fill the gap in many western Colorado lakes and rivers, according to a state hatchery manager. Dozens of popular waters in western Colorado will receive far fewer fish than were stocked before the disease infected 10 of 15 Colorado state hatcheries. Anglers in southeastern Colorado, though, will find stocking up from recent years. The CDOW plans to stock substantial numbers of subcatchable trout throughout the state, including the San Luis Valley and higher elevations along the Arkansas River drainage.

Denver Post, 5/16/97 and *Pueblo Chieftain*, 5/16/97 (Associated Press)



Water from Burst Pipeline Reaches Superfund Site

Water from a burst pipeline reached a Superfund site polluted with lead, arsenic and cadmium, but did not spread pollutants outside the area. The 66-inch pipeline, which delivers water from Gross Reservoir to Denver International Airport, burst late Friday afternoon, 5/23, flooding furniture stores, several homes, and a church basement in the nearby Globeville neighborhood. An estimated 25 million gallons of water spread to the Asarco Globeville Superfund reclamation site. According to the site manager, the water was diverted and did not reach the operational area. Water samples were taken for testing. The water department issued a statement saying it would investigate the accident to determine whether it was responsible for damage suffered by businesses and residents and would pay for all such reasonable damages.

Pueblo Chieftain, 5/25/97 (Associated Press)



LEGISLATION

Water Resources Management Bill Introduced in Texas

A comprehensive legislative package that addresses many aspects of water resources development and management has been introduced and is moving quickly through the Texas State Senate. SB 1 was introduced by Natural Resources Committee Chairperson J.E. (Buster) Brown, with strong support from Governor George W. Bush's administration. The bill number is an indication of its priority. It also has bipartisan support. At a March 11 hearing in Austin, Western States Water Council staff provided invited testimony and answered committee members' questions on comparable laws, programs, and policies in other western states. SB 1 reflects a long series of suggested legislative changes developed by the Texas Water Commission and Texas Water Development Board. It calls on the Board to adopt a state water plan that provides for the orderly development, management, and conservation of Texas waters. SB 1 addresses many issues, including drought preparation and response, water use permits, water marketing and use transfers, and water conservation.

Western States Water, 4/4/97

Land Swap Proposal Could Help Greeley Solve Water Problems

Senator Wayne Allard (R-Colorado) and his GOP House Colleague, Representative Bob Schaffer, have introduced legislation aimed at ending disputes between a federal agency and water users in Greeley. The bill would authorize a land swap that would give the U.S. Forest Service 708 acres of land in northern Colorado that is currently owned by the City of Greeley and the Front Range Water and Storage Company. In exchange, Greeley would gain title to 1,179 acres of Forest Service land containing several high mountain water storage reservoirs. According to Allard, the proposed legislation is a "win-win agreement for both sides."

Fort Collins Coloradoan, 4/24/97

San Luis Valley Water Bill Killed in Senate State Affairs Committee

A Colorado Senate panel voted 6-3 on 4/28/97 to kill legislation intended to stall Baca Ranch owner Gary Boyce's plan to market San Luis Valley water to the Front Range. Boyce, president of Stockman's Water Company, may now proceed with his plan to file for the water rights to approximately 50 new wells without interference from HB 1214, Rep. Lewis Entz (R-Hooper) and Sen. Gigi Dennis (R-Pueblo West). The Entz-Dennis bill lost in the Senate State Affairs Committee, even though it passed the Colorado House by a 42-23 vote and the Senate Agriculture Committee by a 5-1 vote. Voting to kill HB 1214 were Senators MaryAnn Tebedo and Ray Powers, both R-Colorado Springs; Charles Duke, R-Monument; Jim Congrove, R-Arvida; Mike Coffman, R-Aurora; and Frank Weddig, D-Aurora.

The failed bill was a major topic of conversation at the San Luis Valley Lincoln Day dinner held last month in Alamosa. Sen. Dennis told the crowd that she believes the issue was handled improperly and sent to the wrong committee in the Senate. She noted that Stockman's Water and its plan to pipe San Luis Valley water to the Front Range had the support of nine lobbyists, including five former legislators. Rep. Entz called the failure of his water bill a "sad situation."

Pueblo Chieftain, 4/29/97, 5/5/97

Denver Water Board Fighting Scenic Designation for South Platte River

The Denver Water Board is stepping up its efforts to avoid having 48 miles of the South Platte River designated as a National Wild and Scenic River by the U.S. Forest Service. The wild and scenic designation is aimed at protecting the popular rafting and angling river and its banks from dams and most development. The water board opposes the designation because it could give the federal government the right to control river flows, regardless of the needs of 42 water suppliers. The Forest Service recommended in early April that the 48-mile stretch of the South Platte from Eleven Mile Canyon Reservoir to the confluence of the North Fork of the South Platte be designated wild and scenic. The Denver Water Board wants a plan that that will protect the river while still allowing the board to retain control over river flows. The Forest Service has left the door open to alternative ways of protecting the river, according to a planning officer for the agency.

Grand Junction Daily Sentinel, 5/21/97 and Fort Collins Coloradoan, 5/22/97 (Associated Press)



WATER ALLOCATION

Estes Park Relinquishes Fall River Water Rights in Exchange for Electricity

The town of Estes Park will receive electricity from Rocky Mountain National Park in exchange for abandoning its plans to divert water from Fall River to power a hydroelectric plant. The



agreement is the result of months of debate over the future use of Fall River. For decades, a small dam on Fall River diverted water to run the power plant that provided Estes Park with electricity to offset peak usage in the summer. However, the dam and the power plant were destroyed in the 1982 Lawn Lake flood. When the town announced its plans to rebuild the power plant, a dispute over the use of the river began among the town, park officials, and environmental groups. The recent complex agreement is being hailed by park and town officials as a "win-win situation." Estes Park will get 500,000 annual kilowatt-hours of electricity from the park for the next 27 years. The power will be delivered by the Platte River Power Authority, of which Estes Park is a member.

Fort Collins Coloradoan, 5/1/97



WATER PROJECTS

Engineers Seek Ways to Make Cherry Creek Dam Stronger

If a catastrophic storm struck the Denver area, the Cherry Creek Dam could fail, and millions of gallons of water would rush toward the downtown area, threatening an estimated 138,000 people and causing \$3 billion in damage. The earthen dam would contain only 68 percent of the floodwaters; the rest could flow over the top of the dam and erode it, causing it to fail. The chances of that kind of storm occurring are minimal, but the U.S. Army Corps of Engineers are spending \$1 million to study options that might make the dam safer. The options being considered include raising the height of the 140-foot dam, widening an existing spillway, building a new spillway, hardening the dam crest to prevent erosion, and building a new dam upstream to contain the flood waters there. The corps began its three-year feasibility study last October, and public meetings will be held to discuss the options.

Denver Post, 4/22/97

Flaming Gorge Water to Flood Green River

A flood on the scale of the one staged on the Colorado River through the Grand Canyon last year is planned for the Green River below Flaming Gorge Dam. Federal water managers plan to open the floodgate at Flaming Gorge on Wednesday, 6/4/97, making room in the reservoir for high runoff from Wyoming's Wind River Mountains. Scientists concerned about Green River ecology were ecstatic about this "hydrological emergency."

Ashley National Forest officials, however, were less enthused about the release, claiming that \$2 million worth of trails, boating and fishing facilities were at risk. Snowpack is high in the Wind River Range, the principal headwaters of the Green River, and an unplanned spill when the snow melts in July could damage the dam's spillways and destroy facilities on the river. To reduce the risk of a summer spill, hydrologists recommended drawing the reservoir down by about 50,000 acre feet. Scientists generally accept that high flows for a short period do more good ecologically than a lower flow for a longer period. Biologists expect the artificial flood to also improve backwaters, which are prime "nursery habitat" for minnows. Improving fish habitat would be a

big bonus for the river, which is home to four endangered species of native fish.

Fort Collins Coloradoan, 5/29/97 (Associated Press)



WATER QUALITY

CoPIRG Says Wastewater Facility Violated Water Act

According to a report published by the Colorado Public Interest Research Group (CoPIRG), the Boxelder Sanitation District violated the Clean Water Act during a 15-month study period. Water leaving the plant had mercury levels of 0.6 micrograms per liter in December, 1995, according to Larimer County Health Department records. That exceeds the 0.023 micrograms per liter allowed by the state health department and the U.S. Environmental Protection Agency. But a Boxelder pretreatment coordinator said there could have been problems with the mercury measurements. Mercury levels are difficult to test because levels allowed by state and federal officials are below those that can be accurately detected by lab equipment. The Boxelder Sanitation District's "natural treatment system," which has been in place since 1967, relies on bacteria and wetlands rather than chemicals and concrete to treat water from about 1,300 industries, businesses, and households before dumping it into Boxelder Creek and, eventually, the Poudre River. Water flowing out of the system, located west of Interstate 25 and several miles south of East Prospect Road, is required to meet the same federal and state water-quality standards as water coming out of conventional treatment facilities. CoPIRG's most recent report indicated that 10 percent of Colorado's major industrial facilities violated the Clean Water Act during their study, which ended in mid-1996.

Fort Collins Coloradoan, 4/5/97, 4/14/97

Extra Caution Needed to Avoid Diseases from Water

A recent Environmental Protection Agency study found that 40 percent of America's lakes and estuaries are polluted to such a degree that they are unsafe for swimming or fishing. Drinking such water is not even a consideration. Even when pure by ecological standards, "backcountry" still is generally unsafe to drink. In a Colorado State University study, more than 10,000 U.S. streams were sampled, and every stream showed the presence of *Giardia lamblia*, a noxious protozoan.

A newer and more troublesome bug called *Cryptosporidium* has been found in 77 percent of the rivers and 75 percent of the lakes in the western United States. The best water treatment devices combine filtering systems, which screen out larger pathogens, with purifiers, which chemically destroy smaller bacteria and viruses. To adequately protect against both protozoan and bacterial organisms, filter-only devices must have an absolute pore size of 0.2 microns or smaller. The best purifiers are "EPA approved," which means tests confirm they can remove 99.9 percent of all toxins present.

Fort Collins Coloradoan, 4/23/97





WETLANDS

Telski Ends EPA Wetlands Case

Seven years of conflict between the Telluride Ski and Golf Company (Telski) and the Environmental Protection Agency (EPA) ended on April 28, 1997, in Denver when the U.S. District Court signed a final consent decree to approve the wetlands settlement presented between the two parties. The consent is the result of hundreds of hours of meetings between the EPA, Telski, and the Justice Department. A judge ruled in favor of the settlement concerning alleged wetlands violations by Telski around the Mountain Village development property that occurred between 1983 and the present. According to the settlement, Telski must restore approximately 16 acres of wetlands within Mountain Village, pay \$1.1 million in fines to the EPA, and maintain all restored and created wetlands in the Mountain Village, the Silver Mountain Landslide, and the San Miguel watershed areas. Based on the final consent decree, approximately 11 acres of wetlands will be restored through fill removal and restoration, and roughly two acres of wetlands will undergo hydrologic restoration. The EPA has estimated that the restoration work will cost approximately \$2.7 million. Telski has estimated the total fiscal loss for fines, restoration costs of labor and resources, attorneys and scientific studies to be more than \$4 million. Telski plans to start the restoration efforts immediately.

Telluride Times-Journal, 5/1/97



MISCELLANEOUS

Cometlike Objects May Explain How Oceans Formed

Earth is bathed by a steady "cosmic rain" of previously undetected objects from outer space that pour vast quantities of water into the atmosphere, according to startling new evidence released on 5/28/97. The objects, 20 to 40 ton snowballs the size of two-bedroom houses, streak into the atmosphere by the thousands each day.

The giant snowballs disintegrate harmlessly 600 to 15,000 miles up and deposit large clouds of water vapor that eventually falls on Earth's surface as rain, according to a University of Iowa research team that has, for the first time, captured images of these objects. If the team's interpretation of the evidence is correct, it could force scientists to revise long-held beliefs about how Earth and the solar system evolved, how the building blocks of life first arose, how the oceans formed, and whether fluxes in the cosmic rain could have caused the Ice Ages and mass extinction of living species. Scientists might also be compelled to study the impact of this alien precipitation on Earth's climate, the "greenhouse" effect, and the hole in the ozone layer over Antarctica. The discovery suggests that the volume of water on Earth is increasing. It also has implications for the evolution of other planets, such as Mars, that should be getting bathed in the same extraterrestrial drizzle.

Fort Collins Coloradoan, 5/29/97

El Nino May Bring Weather Changes

Satellites have picked up a shift in the trade winds and detected humps of warm water moving across the Pacific Ocean at the equator, signs that another weather-disrupting El Nino may be brewing. If so, heavy rains and drought could result around the world next winter. An El Nino occurs when westward-blowing tradewinds weaken, allowing a mass of warm water normally situated off Australia to drive eastward to western South America. Because water expands as it heats up, warmer seas mean higher seas. A radar instrument aboard the U.S.-French TOPEX-Poseidon satellite detected two humps 6 to 8 inches high in the equatorial Pacific, according to NASA. In addition, a NASA radar instrument aboard a Japanese satellite discerned that trade winds in the western Pacific reversed to the east in December and February, another sign of a possible El Nino. Although their cause remains unclear, El Ninos alter the strength and direction of jet stream winds and disturb weather.

Denver Post, 5/30/97 (Associated Press)

CALLS FOR PAPERS

GAMBLING WITH GROUNDWATER
 Physical, Chemical, and Biological Aspects of Aquifer-Stream Relations
 Las Vegas, NV
 September 27 - October 2, 1998
 International Association of Hydrogeologists XXVIII Congress &
 Annual Meeting of the American Institute of Hydrogeology

For information and abstract form contact: IAH/AIH Conference Las Vegas — Conference Headquarters, Attn: Helen Klose, 2499 Rice St., Suite 135, St. Paul, MN 55113-3724, Phone 612/484-8169, FAX 612/484-8357, e-mail AIHydro@aol.com. (Deadline was not announced).



GROW WITH THE FLOW: Growth and Water in the South Platte Basin
The 8th Annual South Platte Basin Forum
October 29-30, 1997, Raintree Plaza Conference Center
Longmont, Colorado

The '90s have been a time of rapid and relentless growth in the South Platte Basin. Growing pains have come in the form of limited space and resources. Water usage and availability top the list of these concerns. To ease the growing pains and provide a framework for the future, the different views must be investigated, discussed and integrated. The 8th Annual South Platte Forum will examine these different perspectives to gain insight on forming a cooperative relationship between growth and water interests. The forum will be structured by the following subtitles:

“Show me the Money”	“Land of Plenty”
“Of Minnows, Mice and Men”	“Death of a Culture”
“Dam(n) the Water: Full Growth Ahead”	“Land of Depletion”
“Visions of the Future”	

Colorado is standing at the edge of future water planning. Plan to contribute to the dialogue on growth's effects in the South Platte basin by sharing your unique perspective. You are invited to submit a one-page abstract to the organizing committee for a planned poster presentation. The posters will be displayed during the one and one-half day conference during breaks and an informal cocktail hour on Wednesday night. Poster abstracts are due August 1, 1997. To submit abstracts or request information about the conference, call or write:

Jennifer Mauch
 Colorado Water Resources Research Institute
 410 University Services Building, Colorado State University
 Fort Collins, CO 80523-2018
 Phone: 970/491-2657 FAX: 970/491-2293

GEOLOGICAL SOCIETY OF AMERICA -- 1997 Annual Conference
Theme Session: *Role of Natural Organic Matter in Solute Fate and Transport*
October 20-23, 1997, Salt Lake City, Utah

Abstracts are due July 8, 1997. Electronic abstract submission is available on the Geological Society of America home page: <http://www.geosociety.org>. Obtain abstract forms from Nancy Carlson, Abstracts Coordinator at (303)447-2020 x161, or E-mail n Carlson@geosociety.org. Conveners: William P. Johnson (Geology and Geophysics, University of Utah) and Paul Westerhoff (Civil and Environmental Engineering, Arizona State Univ.)

ROCKY MOUNTAIN HYDROLOGIC RESEARCH CENTER
52ND ANNUAL MEETING
ENVIRONMENTAL HYDRAULICS OF MOUNTAIN AND
PLAINS WATERSHEDS AND RIVERS
September 5-6, 1997 at the YMCA Camp of the Rockies

Submit one-page abstract by July 10, 1997 to: Robert T. Milhous, Midcontinent Ecological Research Center, Biological Resources Division, U.S. Geological Survey, 4512 McMurry Avenue, Fort Collins, CO 80525-3400, Phone 970/226-9233, FAX 970/226-9230, E-Mail robert_milhous@nbs.gov

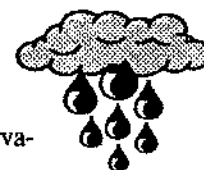
CONFERENCE ON TAILINGS AND MINE WASTE '98
January 26-29, 1998
Colorado State University, Fort Collins, CO

Issues of mining, milling, environmental geotechnics, mining engineering, tailings management, geohydrology, geochemistry and other related topics will be covered in focused sessions.

Authors are requested to submit a short one-page abstract by June 13, 1997 (deadline may be extended). To submit an abstract or for information, contact:
 Linda Hinshaw, Department of Civil Engineering, Colorado State University, Fort Collins, CO 80523-1372
 Phone 970/491-6081, FAX 970/491-3584/7727.



WATER SUPPLY



The water supply conditions are good statewide, as reflected in the positive SWSI values and the above average snowpack. Statewide, the snowpack averages 143 percent of normal as reported by the Natural Resources Conservation Service, with the South Platte basin having the highest value at 156 percent of normal and the San Juan/Dolores basin the lowest value at 134 percent of normal. The high snowpack generates high SWSI values.

The SWSI values are higher than last year in all basins except the South Platte. The South Platte SWSI value did not rise because its major input is reservoir storage which is nearly the same as last year. Of special note is the large increase in SWSI from last year in the Rio Grande and San Juan/Dolores basins. These basins were in drought conditions last year, but are expected to receive adequate supplies this year.

The Surface Water Supply Index (SWSI) developed by the State Engineer's Office and the USDA/SCS is used as an indicator of mountain-based water supply conditions in the major river basins of the state. It is based on streamflow, reservoir storage, and precipitation for the summer period (May-October). During the summer period streamflow is the primary component in all basins except the South Platte, where reservoir storage is given the most weight. The following SWSI values were computed for each of the seven basins for May 1, 1997 and reflect conditions during the month of April.

<u>Basin</u>	<u>May 1, 1997 SWSI Value</u>	<u>Change From Previous Month</u>	<u>Change From Previous Year</u>
South Platte	3.2	+0.2	-0.1
Arkansas	3.2	+0.6	+1.3
Rio Grande	2.8	-0.1	+5.0
Gunnison	3.3	-0.3	+2.1
Yampa/White	3.3	+0.1	+1.5
San Juan/Dolores	2.6	-0.3	+4.6

SCALE

-4	-3	-2	-1	0	+1	+2	+3	+4
Severe Drought		Moderate Drought		Near Normal Supply		Above Normal Supply		Abundant Supply

COLORADO WATER CONGRESS CALENDAR OF COMING EVENTS


August 21-22, 1997 — CWC Summer Convention
Sheraton Steamboat Resort, Steamboat Springs, Colorado
For more information contact the CWC office in Denver, CO — 303/837-0812

September 15-16, 1997 — CWC Annual Colorado Water Law Seminar
Colorado Water Congress Conference Room
1390 Logan Street, Suite 312, Denver, CO
For more information contact the CWC office in Denver, CO — 303/837-0812

September, October and November, 1997
CWC Workshops on a variety of subjects
For more information contact the CWC office in Denver, CO — 303/837-0812



MEETINGS



WESTERN WATER LEADERS TO FLOOD COLORADO WATER WORKSHOP JULY 30-AUGUST 1

When new Colorado Water Workshop director Robin Helken announced in April that "Water Partnerships" would be this year's topic for the 22-year-old summer conference on water issues, she had no idea that she would be seeing partnership efforts in action so far ahead of opening day in July.

"I already knew from the topic input sessions I held in February with water leaders statewide that most are interested in exploring partnering as a tool for enhanced management of our limited water supplies," Helken explained. "But after our official announcement, the level of enthusiasm among water interests for this topic was amazing. Suddenly I was receiving calls from water leaders who represent a wide range of viewpoints — from attorneys to rural water-user groups, heads of government water agencies and legislators to ranchers."

"Some of the callers just wanted to tell me that they liked the topic. But most were offering assistance — in developing the program and in helping me find key people to address important issues," said Helken.

As a result, this summer's session, to be held July 30-August 1 on the Western State College campus in Gunnison, has developed into a strong showing of water leaders from throughout Colorado as well as six other western states. California State Senator Jim Costa will deliver the keynote address on Wednesday, July 30th. Senator Costa forged the landmark agreement that signaled a truce in California's decades-old water wars and resulted in Proposition 204, the Safe, Clean, Reliable Water Supply Act approved by voters in 1996.

Colorado Lieutenant Governor Gail Schoettler will open the conference and introduce Senator Costa. Other highlights will include a session on other states' water partnering efforts, with leaders from Arizona, California, Kansas, Nevada, New Mexico and Utah; an address by Colorado Supreme Court Justice Gregory Hobbs, Jr. on the 75-year-old Colorado Compact; some astute observations about water legislation and western water's future by Colorado State Senator Don Ament; and panel discussions on water management, water quality, and environmental issues.

"This year we are beginning an annual series called *Living Legends of Western Water*," Helken reports. "It will give workshop attendees an opportunity to hear from water leaders who have seen many years of change, and who have worked hard to solve the unique problems associated with managing water in the arid West."

A special guest at this summer's workshop will be Felix L. Sparks. Mr. Sparks' achievements during his long career in law and water could fill several lifetimes. He has held many notable positions, including Colorado Supreme Court Justice, Director of the Colorado Department of Natural Resources, Director of the Colorado Water Conservation Board, and Colorado Commissioner for both the Arkansas River Compact Commission and the Upper Colorado River Compact Commission. "I am pleased and honored that Mr. Sparks has agreed to be the first to share his water wisdom with workshop participants in this series," Helken said.

Most of all, Helken is heartened at the partnership effort she has already seen within Colorado's water community on behalf of the Water Workshop. "Conflict over water in Colorado may be the stuff of legend, but I have to say that if the cooperation and enthusiasm I have seen among 'water folk' as I develop this program is any indication...there is hope for us yet!"

For additional information or a registration brochure on the 1997 Colorado Water Workshop, entitled "Water Partnerships: Can Competing Users Cooperate to Manage a Vital Resource...and Live Happily Ever After?," contact Robin Helken by phone at Arrowhead Ranch, 970/249-3034, FAX 970/240-4884, or e-mail her at arrowhd@rmi.net.



**AWRA/UCOWR ANNUAL SYMPOSIUM
WATER RESOURCES EDUCATION, TRAINING AND PRACTICE:
OPPORTUNITIES FOR THE NEXT CENTURY
June 29-July 3, 1997 — Keystone, Colorado**

The American Water Resources Association (AWRA), in conjunction with the Universities Council on Water Resources (UCOWR), will present a symposium June 29 - July 3 at the Keystone Resort in Summit County, Colorado. The joint symposium, *Crossing the Stream to the 21st Century*, will integrate water resources education and practice with an eye on the future that attempts to answer two fundamental, and yet related, questions:

- Is today's educational system providing the curriculum and experiences needed in water resources for the next century?
- What lessons can we learn from current projects dealing with the complexities of integrated watershed management?

To register, or to purchase copies of the Proceedings after the meeting, write or phone AWRA Headquarters at:

AWRA
950 Herndon Pkwy., Suite 300
Herndon, VA 20170 - 5531 (703) 904-1225/Fax (703) 904-1228

CADILLAC DESERT

WATER AND THE TRANSFORMATION OF NATURE

SERIES SUMMARY

Mulholland's Dream— Evokes the dark intrigues behind the fiction of the film *Chinatown*. **Tuesday, June 24.**

An American Nile — Illustrates how the Colorado River has been asked to do so much — for so many — with so little. **Tuesday, July 1.**

The Mercy of Nature — Traces the fierce political and environmental battles that raged around the transformation of California's Central Valley. **Tuesday, July 8.**

Last Oasis — Travels to present-day India and China, where the American way of big dam-building continues; then to Mexico, the Middle East, and the American West, where conservation may be humanity's "last oasis." **Tuesday, July 15.**

Beginning at 9 pm ET on June 24 1997, public television's *Cadillac Desert* will focus on the history of water in the American West — how it was bought, sold, diverted and managed — and the contemporary legacy of abundance and risk this history. Plan a field trip to a local dam, fishery or watershed. Hold a screening and talk at your local school, church or community center.

Volunteer to work on environmental initiatives in your community.

Visit the Cadillac Desert web site at:
<http://www.cрпи.org/cadillacdesert> or
<http://www.pbs.org/cadillacdesert>

Order a *Cadillac Desert: Discussion and Viewers Guide*. This free guide provides summaries of the episodes and related discussion topics and activities. It also provides helpful ideas for citizens to mediate public dialogue and for teachers to use in the classroom. Contact: Cadillac Desert Outreach Office, 486 Shawmut Ave., Boston, MA 02118. Phone: 617/867-4095 E-mail: cadillac_desert@crpi.org



**1997 SUMMER FIELD TOUR
HIGH ALTITUDE REVEGETATION COMMITTEE
July 24 and 25th, 1997**

For 1997, the committee has lined up three excellent mine visits...one very new, one entering into closure and reclamation, and one that has been closed and reclaimed for a number of years.

- Independence Mining Company's **Cresson Mine** near Cripple Creek, Colorado. Here staff will take you through some of the events leading to construction and operation of Colorado's newest gold heap leach operation. A box lunch will be provided by Cripple Creek & Victor Mining Company.
- Battle Mountain Gold Company's **San Luis Mine** near San Luis, Colorado. This visit will provide an opportunity to see a modern mine and 200-acre tailing facility in the initial stages of final closure and reclamation.
- Homestake Mining Company's **Bulldog Mine** near Creede, Colorado. Bulldog was an underground silver operation that milled sulfide ore from 1967 to 1986. The two tailing disposal impoundments have been reclaimed. The site is considered a "model for reclamation" by the U.S. Forest Service.

There is no pre-registration, no registration fee, and everyone is welcome. For additional information contact any of the following:

Jeff Todd, Schafer & Associates, 303/216-1600 or 421-4680 (home)
Larry Brown, L.F. Brown and Assoc., Idaho Springs, CO, 303/674-9813
Gary Thor, HAR Secretary, Colorado State University, Fort Collins, CO, 970/491-7296

CALENDAR

1997

- June 29- July 3 **AWRA/UCOWR ANNUAL SYMPOSIUM, WATER RESOURCES EDUCATION, TRAINING AND PRACTICE: AWRA/UCOWR ANNUAL SYMPOSIUM, WATER RESOURCES EDUCATION, TRAINING AND PRACTICE: OPPORTUNITIES FOR THE NEXT CENTURY**, Keystone, CO. Contact: John Stednick, General Chairperson, Phone 970/491-7248, E-mail jds@cnr.colostate.edu; or Robert Ward, General Chairperson, UCOWR, Phone 970/491-6308.
- July 14-15 **1997 ROCKY MOUNTAIN SYMPOSIUM ON ENVIRONMENTAL ISSUES IN OIL AND GAS OPERATION**, Golden, CO. Contact: Continuing Education, Colorado School of Mines, Phone 303/273-3321; FAX 303/273-3314; E-mail space@mines.edu.
- July 16-19 **BEST MANAGEMENT PRACTICES FOR IRRIGATED AGRICULTURE AND THE ENVIRONMENT**, Fargo, ND. Contact: USCID, 1616 Seventeenth St., Suite 483, Denver, CO 80202, Phone 303/628-5430, FAX 303/628-5431, E-mail stephens@uscid.org, Website: www.uscid.org/~uscid.
- Aug. 5-8 **HYDROPOWER: NEW CHALLENGES, OPPORTUNITIES AND PARTNERSHIPS**, Atlanta, GA. Contact: American Society of Civil Engineers at Direct Line 703/295-6000, Exhibits 703/295-6009, FAX 703/295-6144, Website: www.asce.org.
- Aug. 10-14 **EVAPOTRANSPIRATION AND IRRIGATION SCHEDULING**, San Antonio, TX. Contact: American Society of Agric. Engrs., 2950 Niles Rd., St. Joseph, MI 49085-9569, Phone 616/429-0300, FAX 616/429-3852, E-Mail hq@asae.org.
- Sept. 7-10 **DAM SAFETY '97**, Pittsburgh, PA. Contact: ASDSO, 450 Old East Vine St., 2nd Fl., Lexington, KY 40507, Phone 606/257-5140, FAX 606/323-1958.
- Sept. 17-19 **INTERSTATE WATER MANAGEMENT: NEW TRENDS IN WATER ALLOCATION**, Interstate Council on Water Policy 1997 Annual Meeting, San Diego, CA. Contact: Dennis Letl, California Dept. of Water Resources, 1020 Ninth St., Sacramento, CA, Phone 916/327-1764.



- Sept. 22-24 COLORADO ASSOCIATION OF STORMWATER AND FLOODPLAIN MANAGERS (CASFM), Vail, CO. Contact: Cindy Edwards, Arapahoe County Dept. of Engineering, 5332 S. Prince St., Littleton, CO 80166-0001, Phone 303/795-4640.
- Sept. 24-26 CONNECTIONS '97: GROUND WATER IN THE ROCKY MOUNTAIN REGION, Boise, ID. Contact: Peggy Hammei, Idaho Water Resources Research Institute, Phone 208/885-6429; FAX 208/885-6431; E-mail iwri@uidaho.edu.
- Oct. 12-17 RISK BASED DECISION MAKING IN WATER RESOURCES VIII, Santa Barbara, CA. Contact: Engr. Foundation, 345 E. 47th St., New York, NY 10017, Phone 212/705-7836, FAX 212/705-7441, E-mail engfnd@aol.com, Website: www.engfnd.org.
- Oct. 18-22 WEFTEC '97, Chicago, IL. Contact: Water Environment Federation, Phone 800/666-0206; FAX 703/684-2471; E-mail confinfo@wef.org.
- Oct. 26-29 SYMPOSIUM ON CLIMATE VARIABILITY, CLIMATE CHANGE AND WATER RESOURCE MANAGEMENT, Colorado Springs, CO. Contact: Betty Neal, Hagler Bailly Services, Inc., P.O. Box 3524, Eagle, CO 81631. Website: <http://civil.colorado.edu/climate>.
- Nov. 3-6 EVAPOTRANSPIRATION AND IRRIGATION SCHEDULING, San Antonio, TX. Contact: American Society of Agricultural Engineers, 2950 Niles Rd., St. Joseph, MI 49085-9569, Phone 616/429-0300, FAX 616/429-3852, E-Mail hq@asac.org.
- Nov. 16-19 INTERNATIONAL CONFERENCE ON ADVANCES IN GROUNDWATER HYDROLOGY – A DECADE OF PROGRESS, Tampa, FL. Contact: Andy Smith, So. Fla. Water Mgmt. Dist., 2379 Broad St., Brookville, FL 34609, Phone 352/796-7211, ext 4235.