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COLORADO WATER

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

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November 1990

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COLORADO WATER ENGINEERING AND MANAGEMENT CONFERENCE
FEBRUARY 27-28, 1991
ABSTRACT SUBMITTAL

THERE ARE A FEW SLOTS LEFT FOR ABSTRACTS IN THE PROGRAM PLANNED FOR THIS CONFERENCE. CALL WITH INTENT OR SUBMIT ABSTRACT(S) TO:
JANET LEE MONTERA, CIVIL ENGINEERING DEPARTMENT
COLORADO STATE UNIVERSITY, FORT COLLINS, CO 80523
TELEPHONE: (303)491-7425 OR FAX: (303)491-7727.
DEADLINE: NOVEMBER 15, 1990

CALIFORNIA'S WATER ISSUES



Editorial
by
Neil S. Grigg

Even if we don't always admit it, California is hard to ignore - a trend setter. Now we can watch how they deal with water problems caused by growth, environmental rules and drought. Two sources of information interested me in this: I participated on a drought panel with the beleaguered Santa Barbara team and read the current issue of *Western Water* which is about California's water issues.

A recent poll showed that Californians rate water supply second, behind drugs, as a critical statewide issue of concern. In spite of this, they are unwilling to sacrifice environmental goals to facilitate water supply. Santa Barbara found this also to be true, as the state would not waive environmental permit requirements for emergency water supplies. And Santa Barbara, now facing 40 percent water shortfalls, is planning for 70 percent shortfalls. Does this mean more strict conservation? Is it a signal for Colorado?

Finding water supplies will indeed be a problem for the 35 million Californians expected by the year 2000. Both candidates for governor have water platforms. Diane Feinstein believes in a statewide water plan that is supportable in the north and south, more efficient water use, a policy consensus, environmental benefits, and area of origin protection. Pete Wilson supports building more buckets, win-win solutions, the environmental ethic, conservation, and other water management strategies.

Agricultural water use efficiency in California is an issue, as it is in Colorado, but the stigma of taking agricultural land out of production seems less in California than in Colorado. Maybe it just seems that way from a distant perspective. Marc Reisner's *Cadillac Desert* and other writings have pointed out the large quantities of water going to relatively low-valued crops, an issue that also faces Colorado. We need research on this question.

Recent water transfers in California, as we learned from a new research report from the Natural Resources Law Center, have only involved transferring water as a commodity, not transferring permanent rights to the water. Few of these transfers required state authorization; most involved transfers between water users. Transactions, mostly for periods of one year or less, involved quantities ranging from a few acre-feet to over 100,000 acre-feet. Why are the situations in California and Colorado so different? We need research on this, too.

The Bay-Delta region receives much of the stress of California water management. This ecologically sensitive region is the confluence of two major river systems: the

water-rich Sacramento River and the San Joaquin River, which drain the Central valley and its agricultural industry. In a 1986 ruling the State Water Resources Control Board was required to balance beneficial uses of Bay and Delta waters, and this could lead to modifying existing water rights.

Coloradans watch the development of environmental issues in California. One issue has been California's approach to the Public Trust Doctrine, marked by the case which restricted the right of the Los Angeles Department of Water and Power to divert water from Mono Lake Tributaries. This November, we have the opportunity to see how they vote on the Environmental Protection Act of 1990 ("Big Green") which would adopt federal water quality standards for toxic pollutants in coastal waters and thereby affect water rights.

California doesn't have a "state water plan" and there is no statewide approach to managing groundwater, which is reported to be overdrafted by 2 MAF per year. Still, a compilation of all water matters in the state provides a useful view of how things may develop elsewhere in the West, particularly in Colorado. We can learn a lot from California trends as we consider new water policies.

IMPROVING AGRICULTURAL WATER CONSERVATION

Participants at the conference *Colorado Water: The Next 100 Years* discussed the future of Front Range water and how to provide incentives for better agricultural water conservation in Colorado. Although municipalities have incentives to conserve water, farmers don't, said Neil Grigg, CWRRI Director. Ward Fischer, Fort Collins attorney and water expert, said that under Colorado water law, if a farmer reduces the amount of water he needs through conservation, he cannot sell his excess water rights; and if those water rights are not being used, someone else can apply to take them. Better cooperation between cities and agricultural interests could be encouraged with the flexible transfer of water rights back and forth from agricultural to municipal uses, said Grigg.

Another speaker, William Buckles, compared the current U.S. culture and those of ancient societies, such as the Anasazi Indians. These cultures died out when they overused their natural resources.

Chris Meyer, attorney for the National Wildlife Federation, said Colorado is the only western state that does not consider public values, such as concerns from environmentalists, when assigning water rights.

The meeting took place September 8 at the Holiday Inn in Fort Collins, and was one of seven planned for each Water Division in the State. It was sponsored by the Colorado Endowment for the Humanities and Front Range Community College, Westminster. The next meeting is scheduled for November 10 in Steamboat Springs. Contact Barbara Preskorn, Front Range Community College, (303)466-8811 for additional information.

COLORADO WATER: LIQUID GOLD - STATE FAIR EXHIBIT A BIG SUCCESS

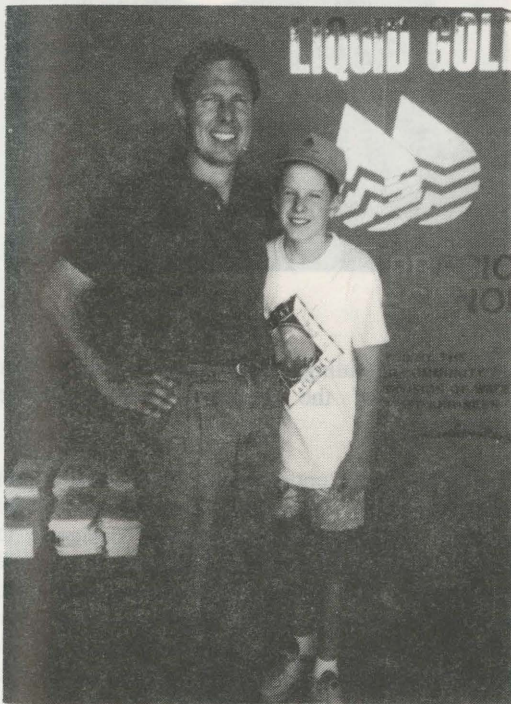
Colorado's water organizations joined together and delivered a real treat to this year's State Fair participants: a high-quality water education display that provided a rare insight into the many different aspects of Colorado's water resources. Describing the exhibit, Channel 4 news anchor Bill Stuart said it was one of the Fair's most popular (and coolest) features. The Industry-Technology building was one of the few air-conditioned buildings on the fairgrounds.

The State Engineer's Office, through the direction of John Kaliszewski, coordinated the efforts of more than 40 organizations that participated in planning and developing the water exhibit.

The exhibit's primary goal was to advance public awareness about the importance of Water to Colorado. It was divided into three basic sections: WATER: Where does it come from? WATER: How is it managed? WATER: How is it used? Exhibits covered the topics of the hydrologic cycle, Colorado's hydrologic system, interstate compacts and water rights administration, historical perspective of water



State Fair Industry-Technology Building, Site of the Exhibit



John Kaliszewski and son Chris

development in Colorado, groundwater, salinity, drought impacts, floods, wetlands habitat, water resources planning, instream flow program, Colorado water-use statistics, fishing, East Slope/West Slope challenges, water quality, hydropower, municipal water use, industrial water use, agricultural water use, water-based recreation, and xeriscape.

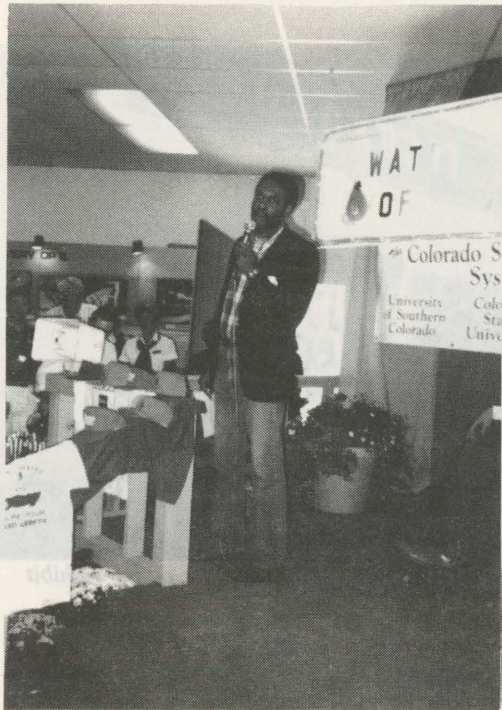
The exhibit was designed to entertain as well as educate the public. A very popular feature was the Water Wheel of Fortune, where contestants won prizes for correctly answering water-related questions.



The Water Wheel of Fortune

Colorado State University, through the President's office, CWRRI, the Agricultural Experiment Station, the College of Engineering, and several academic departments, took an active role in preparing for the State Fair. The Engineering Research Center, with Fred Smith's coordination, prepared

and delivered a Parshall flume display that showed the principles of operation of the flume, the worldwide standard irrigation water flow measurement device invented at CSU in 1922. Smith, Associate Dean of the College of

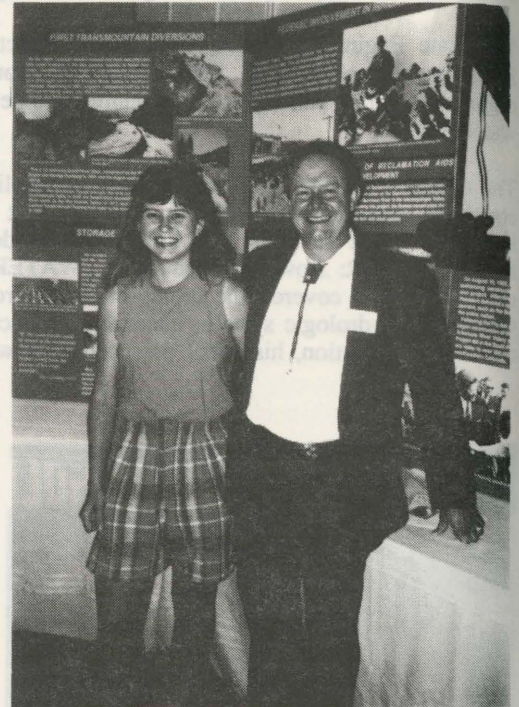


Engineering, also assisted with the groundwater display. Nolan Doesken of the Colorado Climate Center prepared several displays related to drought and climate.

As a follow-up to the Colorado water exhibit, a survey was taken about public water knowledge and education needs. Results of this survey will be given at the 1991 Colorado Water Engineering and Management Conference in a presentation entitled "Assessing the Public's Knowledge and Perceptions of Colorado Water: What Steps Should the Water Community Take in Response."

Left: President Albert C. Yates of Colorado State University

Right: Larry Simpson, Manager, Northern Colorado Water Conservancy District, and daughter, B.J.



ECONOMISTS CAN CONTRIBUTE IN ENVIRONMENTAL ARENA

Major thrusts emerging in the area of environmental concerns may persuade more economists to "...begin to explore more creatively whether long-range benefits of environmental controls can be better justified in economic terms." Dr. A. George Gols, economist with Arthur D. Little, an international management and technology consulting firm, made these observations in a recent presentation to the National Social Science Association Conference. Until now, he said, the economics profession has been rather relaxed in coming to grips with environmental matters. "There is an urgent need for better methods of pricing irreplaceable natural resources--clean water, air, and soil, as well as wilderness," said Gols.

Source: Water Engineering and Management, Sept. 1990

DNR AND OFFICE OF ENERGY CONSERVATION LAUNCH NEW PROGRAM

The Department of Natural Resources has received a two-year grant from the Colorado Office of Energy Conservation to establish a program that addresses water conservation and its relationship with energy conservation in Colorado. Until this grant was established, no agency performed this role on a statewide basis.

Kim Hout has been hired to coordinate the new program. Her responsibilities will include developing a clearinghouse and disseminating water/energy information; assisting local governments with water conservation programs; providing technical expertise and policy assistance on water conser-

vation issues; and providing staff support on water conservation initiatives of the executive and legislative branches.

A familiar name in the water conservation field, Hout is past chair of both Xeriscape Colorado and Metro Water Conservation, Inc., a nonprofit organization designed to facilitate and share water conservation activities throughout the metro Denver area. She brings 6-1/2 years of municipal water conservation experience to the new post from her previous position with the City of Aurora's Department of Utilities. Hout also worked in the areas of public information and represented the department on a variety of statewide water and water conservation issues. She can be reached at 866-3311.

7TH ANNUAL WSWC SYMPOSIUM HIGHLIGHTS WATER TRANSFERS ISSUES

The 7th Annual Western States Water Council Symposium, **Western Water Management and Use and Interregional Water Transfers**, was held on October 10-12 in Scottsdale, Arizona. Arizona Governor Bruce Babbitt gave the keynote speech and addressed some of the issues surrounding water

transfers. Other special guest speakers included: Professor Frank Gregg of the University of Arizona (and former head of the New England River Basins Commission and Bureau of Land Management); Gary Weatherford, an attorney (and author on water issues); Leo Eisel, a consulting engineer (Wright Water Engineers of Denver) and former Director of the U.S. Water Resources Council; and Dr. N. W. Snyder, with the Ralph M. Parsons Company. Gregg and Weatherford both discussed the arbitrary nature of artificial political boundaries and natural watersheds in addressing regional water management issues. Eisel emphasized the continuing need for a strong state role in water resources planning and management. Snyder outlined a North American continental water transfer plan and its potential benefits. The Parsons Company and others are seeking private funds to conduct a new feasibility study of such a proposal.

Participants and speakers were divided into groups which met separately to identify and rank western water management problems, as well as potential solutions and future actions. The results of this strategic planning exercise will be summarized and distributed to participants, WSWC members and others upon request.

Source: Western States Water, Oct. 15, 1990

THIRD ANNUAL WATER POLICY RETREAT HELD IN SEPTEMBER

Legislative proposals concerning urban water efficiency, water supply alternatives, agricultural water transfers, and lawn irrigation efficiency subsidies were the topics of discussion at the third annual Water Policy Retreat held September 28 in Keystone, Colorado.

The first proposal considered, a draft urban water efficiency bill prepared by Bruce Driver, would require cities over a particular size (approximately 100,000) to develop conservation plans. Driver is a water and energy lawyer and consultant, and represents the High Country Citizens' Alliance in its Gunnison Basin litigation.

A draft water supply alternatives act, prepared by Driver and Chris Meyer of the National Wildlife Federation, was second on the agenda. The bill is seen as an alternative to the "basin of origin protection bills," and would require anyone seeking to import water from another river basin or from another water conservancy or conservation district to explore fully a detailed set of alternatives and demonstrate to the water court that it needs the trans-basin diversion.

Larry MacDonnell of the Natural Resources Law Center reported on agricultural water transfers research. While no bill has yet been drafted, some attending the retreat felt that ag transfers must be a major focus of attention because that is where the new water will come from in the next decade.

Senator Robert Pastore, of Monte Vista, reported on legislation he plans to sponsor which would authorize subsidies to persons installing more efficient lawn irrigation equipment and requiring growing municipalities to fund those additional subsidies.

A total of 61 people attended the retreat, including representatives from local and national conservation groups; the ski industry; ranching and academic communities; federal, state, county, municipal and special district government; the press; and other concerned citizens. The conference was sponsored by 20 organizations, including the Northwest Colorado Council of Governments, Colorado Trout Unlimited, and the Keystone Institute, who contributed to support the retreat. David Getches of the University of Colorado's School of Law served as discussion leader.

For further information about the retreat, contact Christopher Meyer, National Wildlife Federation, at (303)492-6552.

TEXAS PREPARES DRAFT WATER PLAN

The Texas Water Development Board has prepared a 50-year planning document, "Water for Texas: Today and Tomorrow," for the management and development of Texas surface and groundwater resources through the year 2040. It contains statewide projections of water demands, water supplies, and needed facilities. The 50-year projections are broken down by river basins and by eight designated planning regions. The document considers statewide water concerns including alternative water supplies, water supply source protection, regionalization and financing, as well as planning, public education and research. Board members and staff are evaluating reactions to the proposed plan from comments received at public meetings held in 13 Texas cities, including Amarillo and Lubbock. In addition, written comments were accepted by the Board until September 14. With this feedback, the draft water plan will be revised, presented to Board members at a hearing in Austin, and submitted to the Texas Legislature for approval in early 1991.

LAU LEAVES HWRRRC AFTER NEARLY 20 YEARS

Dr. L. Stephen Lau resigned from his position as the director of the University of Hawaii Water Resource Research Center after 19 years. Under Lau's directorship, the Center has expanded its research capabilities and has become one of the nation's leading water research institutes. Lau will continue his research and scholarly pursuits at the Center in Manoa and return to the faculty of the University's Department of Civil Engineering.

MASSEY NOMINATED AS DIRECTOR OF NSF

Walter E. Massey, vice president of the University of Chicago for Research and of the Argonne National Laboratory, has been nominated by President Bush for the directorship of the National Science Foundation (NSF). Massey has an extensive background in teaching, research and administration. His research in physics has centered on the many-body theories of quantum liquids and solids. Outside of research, Massey has been active on many advisory boards for scientific, cultural, and civic affairs. NSF is an independent federal agency intended to strengthen national scientific and engineering research and improve science and engineering education at all levels. The agency annually awards 12,000 to 14,000 grants for research in all fields of science, mathematics, and engineering. Massey's nomination is awaiting approval by Congress.

WATER PRICING POLICY TASK FORCE MEETS IN DENVER

The Water Pricing Policy Task Force of the American Society of Civil Engineers met in Denver September 14. The Task Force was formed by the Water Resources Planning and Management Division to provide suggestions to the National Water Policy Committee about pricing issues. The Committee plans two sessions for the 1991 WRPMD Conference in New Orleans and has also organized five study groups to analyze specific issues. They are: General Principles of Water Pricing Policy - coordinated by Duane Rosa; Federal Government Water Pricing Policy - coordinated by Ron North; Public and Private Utility Water Service Pricing - coordinated by Robert Clark; Agricultural Water Pricing - coordinated by Martin Roach; and Water Transfers - coordinated by Doug James.

The Committee plans to hold open meetings during its technical sessions in New Orleans for anyone desiring to participate in discussions about water pricing issues.

Attendees at the September 14 meeting were Clive Walker, Soil Conservation Service; Joseph Lord, Joseph Lord and Associates; Duane Rosa, West Texas State University; David Merritt, Colorado River Water Conservation District; Gregg Ten Eyck, Leonard Rice Consulting Engineers; Dan Luecke, Environmental Defense Fund; Dick Males, R.M.M. & Associates, Inc.; Jim Abbott, H.D.R. InfraStructure, Inc. and Past President of WPCF; Doug James, Utah State University; Neil Grigg, Colorado State University; Robert Clark, Environmental Protection Agency; Ray Willms, Bureau of Reclamation; Martin Roche, Turlock Irrigation District; and Ronald North, University of Georgia.

Anyone that has information for this committee may contact Neil Grigg at Colorado Water Resources Research Institute, Colorado State University, 410 University Services Building, Fort Collins, CO, 80523. Or call, (303) 491-6308.

PRESIDENT SIGNS REAUTHORIZATION

President Bush signed H.R. 1101, the bill to extend the authorization of the Water Resources Research Act of 1984, into law on September 28, 1990. The measure became Public Law 101-397. The reauthorization maintains the current match of \$2 state/\$1 federal for the State Water Institute Program. It retains the same funding level for state water institutes--\$10 million annually or \$150,000. It also authorizes:

- * a \$10 million annual matching grant program (\$1 state/\$1 federal) for research concerning any aspect of a water resource-related problem deemed to be in the national interest.
- * a \$5 million annual competitive matching grant program (\$1 state/\$1 federal) for additional research or synthesis of the results of research by institutes which focuses on water problems and issues of a regional or interstate nature.



From left to right - First Row: C. Walker, J. Lord, D. Rosa, D. Merritt, G. Ten Eyck, D. Luecke, D. Males. Second Row: J. Abbott, D. James, N. Grigg, R. Clark, R. Willms, M. Roche, and R. North.

- * a \$6 million annual competitive program for technology development concerning any aspect of water resources including water-related technology deemed to be of state, regional, or national importance by the Secretary of the Interior.

The reauthorization also includes a provision that authorizes the Secretary of the Interior, in consultation with the Secretary of Agriculture, to enter into contracts or cooperative agreements with national laboratories, including the Los Alamos National Laboratory, in order to carry out water resources research development and demonstration projects including the effects of potential climate changes on surface and groundwater quality and quantity and the elimination of contamination of groundwater aquifers. Ten million dollars is authorized for this section.

USBR TO EVALUATE EFFECTS OF PLATTE RIVER OPERATIONS ON ENDANGERED SPECIES

The Bureau of Reclamation will begin a five-year program to investigate, describe, and evaluate the operation of Reclamation facilities in the Platte River Basin to ensure compliance with Section 7(a)(1) and (2) of the Endangered Species Act (ESA). The North Platte River Projects office has been designated the lead office. The Fish and Wildlife Service is cooperating in the study effort. Informational meetings will be held in November to discuss the Plan of Study and receive comments. USBR will also distribute information and provide opportunities for input throughout the entire evaluation process. Questions or comments concerning the Plan of Study should be directed to Del Holz, Division of Planning and Special Projects, in the North Platte River Projects office. His telephone number is (307)261-5693.

RESEARCH NEWS

REPORT ON WATER TRANSFERS IN THE COLORADO RIVER BASIN NOW AVAILABLE

Water transfers are increasingly viewed as an important reallocation option to keep pace with increasing and changing water demands. A two-volume report on a major study of water transfer experience in six western states is now available from the Natural Resources Law Center (NRLC), University of Colorado. Supported in part by a U.S. Geological Survey grant under the Water Resources Research Act, researchers from Arizona, California, Colorado, New Mexico, Utah, and Wyoming examined laws and institutions governing water transfers in their states. They also made a detailed study of the water transfers that went through state review between 1975 and 1984.

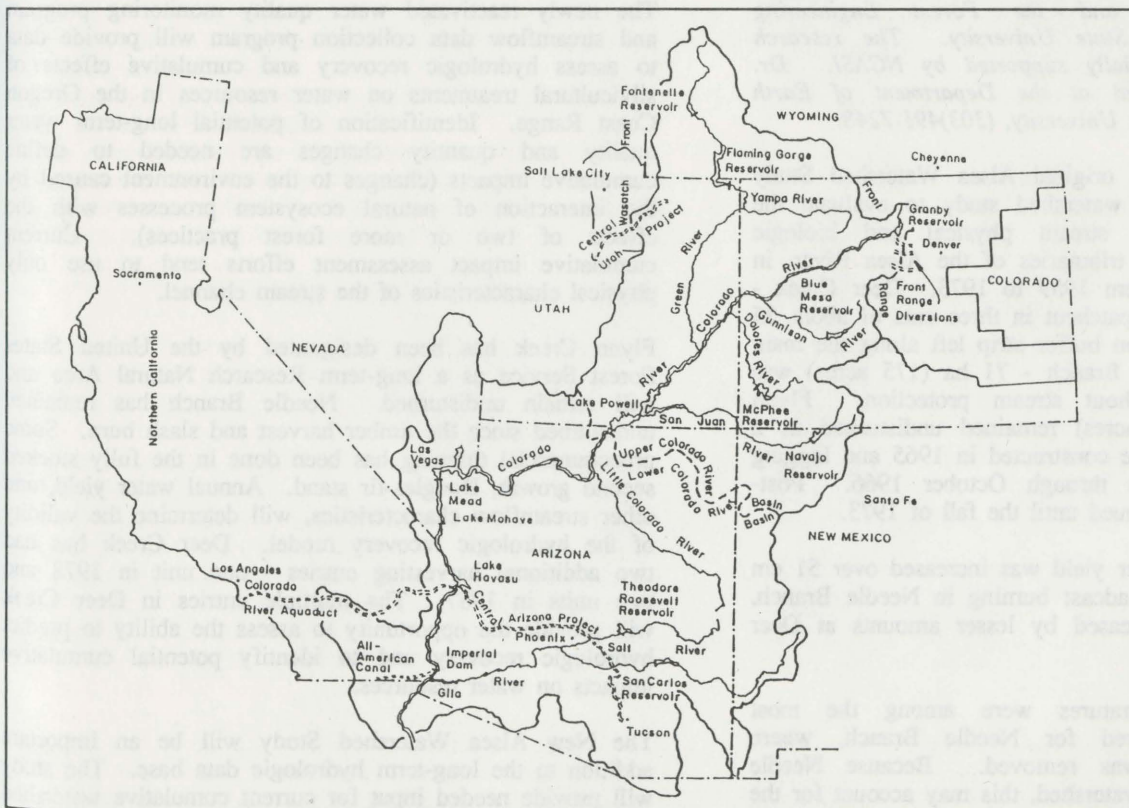
The report discusses the issues of concern in determining the role that water transfers will play in meeting the West's changing water needs. The first volume provides a general summary of the findings from the study, including economic, demographic, and water use comparisons. There is a comparative analysis of the level and types of transfers in the six study states, and general recommendations are offered for facilitating water transfers. Volume two contains the detailed findings from the individual state studies. It includes analyses of the laws and procedures governing water transfer in the six states and the transfer activity in each state during the study period.

Lawrence J. MacDonnell, NRLC Director, was the principal investigator and leader of the six-state project. Co-investigators were: Gary C. Woodard, University of Arizona; Brian E. Gray, Hastings College of The Law (CA); F. Lee Brown, University of New Mexico; J. Paul Riley, Utah State University; and Victor Hasfurther, University of Wyoming. The CWRRI administered the project. The two volumes are available from the Natural Resources Law Center, University of Colorado at Boulder, Campus Box 401, Boulder, CO 80309-0401, (303)492-1286. "Transfers of Water Use in Colorado," a chapter from Volume II, can be purchased separately.

(See pages 20-21 of this newsletter for presentations by Lawrence J. MacDonnell and Charles W. Howe at the 1989 Water Engineering and Management Conference).

INTERSTATE TEAM EXPLORES SEVERE DROUGHT STRATEGIES FOR COLORADO RIVER BASIN

Researchers from the seven Colorado River Basin states will continue a study of how to deal with potential drought severity in the Southwestern U.S. with \$175,000 provided by the Geological Survey. Investigators are currently completing the first phase of the study, which was funded by the U.S. Man and Biosphere Program. In the second phase, project investigators will define the basin's existing institutional-economic-engineering system, structure drought scenarios in



Total Project Study Area

light of occurrences during the past 500 years, assess their impacts, and evaluate alternative management strategies for minimizing the losses when such droughts occur. Currently no such system-wide contingency plan exists.

Participants from Colorado include David Getches of the School of Law, University of Colorado; and Ben Harding of WBLA Hydrosphere located in Boulder.

Two interstate advisory committees will be organized - one for technical subjects and the other for institutional issues.

RAINFALL IN AFRICA AFFECTS U.S. HURRICANES

There may be a correlation between rainfall in Western Africa and the frequency of strong hurricanes that hit the eastern coast of the United States, according to an analysis by William Gray of Colorado State University. Gray, Professor of Atmospheric Science and an expert on tropical cyclones, reported on his studies in the September 14 issue of *Science*. His studies show that when rain in the western Sahel region of Africa is plentiful, more strong hurricanes develop in the Atlantic and strike the United States. Such was the case from 1947-1969 when 13 hurricanes with winds of more than 110 miles an hour hit the east coast. From 1970-1987, with drought in the Sahel, only one storm with peak winds of more than 110 miles an hour struck the East Coast. Gray and his colleagues believe that shifts in rainfall patterns are related to long-term, periodic changes in the circulation of ocean currents that are part of broader movements in the global climate system. The studies indicate that a relatively calm period is ending and that a more violent hurricane period is about to begin.

THE NEW ALSEA WATERSHED STUDY: HYDROLOGIC RECOVERY AND CUMULATIVE EFFECTS ASSESSMENT by John D. Stednick

Dr. John Stednick was on sabbatical August 1989-August 1990 with the National Council for Air and Stream Improvement (NCASI) and the Forest Engineering Department at Oregon State University. The research described below is partially supported by NCASI. Dr. Stednick can be reached at the Department of Earth Resources, Colorado State University, (303)491-7248.

INTRODUCTION: The original Alsea Watershed Study was the first long-term watershed study to evaluate the effects of logging on stream physical and biologic properties. Three small tributaries of the Alsea River, in Oregon, were studied from 1959 to 1973. Deer Creek - 304 ha (750 acres) was patchcut in three cuts of about 25 ha each, with a vegetation buffer strip left along the main stream channel. Needle Branch - 71 ha (175 acres) was completely clearcut without stream protection. Flynn Creek - 203 ha (500 acres) remained undisturbed as a control area. Roads were constructed in 1965 and logging took place from March through October 1966. Post-logging monitoring continued until the fall of 1973.

RESULTS: Annual water yield was increased over 51 cm by clear cutting and broadcast burning in Needle Branch. Annual water yield increased by lesser amounts at Deer Creek.

Elevated stream temperatures were among the most dramatic effects observed for Needle Branch, where streamside vegetation was removed. Because Needle Branch is such a small watershed, this may account for the temperature increases being among the largest ever observed. By 1973, temperatures had returned to pre-logging values. No temperature changes were observed on

the patchcut watershed, where riparian shade remained intact.

Suspended sediment concentrations were variable in time and space. Suspended sediment concentration significantly increased over expected values during the first winter after slash burning on Needle Branch. Sediment yields declined to near-normal levels four years later. Increases were also observed on the patchcut watershed, but the source was attributed to periodic road-fill failures which persisted for one year.

These and other findings from the Alsea study were used to help develop state forest practice regulations in Oregon and much of the nation. For example, most regulations require the use of buffer strips along streams to protect stream banks, to provide shade, and to keep slash out of streams.

THE NEW ALSEA STUDY: Increased water yields resulting from timber harvesting are variable by site, vegetation type, and stocking. Increased annual water yields decrease over time as vegetation reestablishes until the site is fully stocked. For 13 years of post-treatment record, at the H.J. Andrews, the increased annual water yield decreased in a linear fashion. A predictive equation using time after harvest was developed to determine hydrologic recovery. The equation predicts that Needle Branch will return to pretreatment levels of annual water yield in 1991.

The newly reactivated water quality monitoring program and streamflow data collection program will provide data to assess hydrologic recovery and cumulative effects of silvicultural treatments on water resources in the Oregon Coast Range. Identification of potential long-term water quality and quantity changes are needed to define cumulative impacts (changes to the environment caused by the interaction of natural ecosystem processes with the effects of two or more forest practices). Current cumulative impact assessment efforts tend to use only physical characteristics of the stream channel.

Flynn Creek has been designated by the United States Forest Service as a long-term Research Natural Area and will remain undisturbed. Needle Branch has remained undisturbed since the timber harvest and slash burn. Some precommercial thinning has been done in the fully stocked second growth, Douglas-fir stand. Annual water yield, and other streamflow characteristics, will determine the validity of the hydrologic recovery model. Deer Creek has had two additional harvesting entries - one unit in 1978 and two units in 1987. The multiple entries in Deer Creek will provide the opportunity to assess the ability to predict hydrologic recovery and to identify potential cumulative impacts on water resources.

The New Alsea Watershed Study will be an important addition to the long-term hydrologic data base. The study will provide needed input for current cumulative watershed effects models.

Source: HYDATA, July 1990

COLORADO WATER RESEARCH AWARDS

A summary of water research awards and projects recently initiated is given below for those who would like to contact investigators to receive information.

Colorado State University, Fort Collins, CO 80523

Effects of Vegetation on Radon Transport Processes in Soil, Thomas B. Borak, Radiation Biology
 Radioecological & Ecotoxicological Investigations at Rocky Flats, Floyd W. Whicker, Radiation Biology
 Ecology of Coyotes and Badgers on the Rocky Mountain Arsenal, William F. Andelt, Coop. Fish & Wildlife Research
 Prediction of Soil Moisture, Gary A. Peterson, Agronomy
 Water Control and Measurement in Irrigation Systems, Ramchand Oad, Agricultural and Chemical Engineering
 Land Condition/Trend Analysis on U.S. Army Lands, Robert B. Shaw, Range Science
 Improved Estimates of Economic Damages From Residential Use of Mineralized Water, Carole J. Makela, Design, Merchandise and Consumer Science
 Evaluation of Revegetation Techniques in Grand Teton National Park, Edward F. Redente, Range Science
 Evaluation of Riprap Sizing in the ARS - Type Low Drop Structure, Steven R. Abt, Civil Engineering
 Pollution Prevention Partnership SOLVENT Project, Harry W. Edwards, Mechanical Engineering
 Colorado Pesticide Use Survey, Bert L. Bohmont, Plant Pathology & Weed Sciences
 The Role of Clouds in CO₂ - Induced Climate Change, David A. Randall, Atmospheric Science
 A Stochastic Formulation of Radiative Transfer in Clouds, Graeme L. Stephens, Atmospheric Science
 Quality Assurance Support for the National Atmospheric Deposition Program, David S. Bigelow, Natural Resource Ecology Lab
 Isotopic Compositions, Paraheliotropism & Productivity of Dry Beans Under Water Limitation, Mark A. Brick, Agronomy
 Fish Habitat Structural Diversity Indices & the Reconstruction of Lake Basins at RMA, Eric P. Bergersen, Coop. Fish & Wildlife Research
 Obtain Baseline Data on Vegetation and Date Analysis for the Grasslands, Harold Goetz, Range Science
 Contaminant Issues on National Wildlife Refuges in the San Luis Valley & Relationships, David R. Anderson, Coop. Fish & Wildlife Research
 The Impact of Lake Michigan Upon Summer Regional Oxidant Precursor Concentrations, Walter A. Lyons, CIRA Admin Unit
 Fate & Effects of Sediment Contaminants, William H. Clements, Fishery & Wildlife Biology
 Developing & Testing a Model in One Pilot State for Implementing the Agricultural Chemicals in Groundwater Strategy, Sandra K. Davis, Political Science

University of Colorado, Boulder, Colorado

Simulation Modeling of the Hiris Using Aviris, Alexander Goetz, Cooperative Inst. for Research in Environmental Sciences
 High-Resolution Holocene Climatic Reconstructions From the Eastern Canadian Arctic, Kerstin Williams, Institute of Arctic and Alpine Research
 Climatology of the Arctic Planetary Boundary Layer and Temperature Inversion, Jonathan Kahl, Cooperative Institute for Research in Environmental Sciences
 Non-Methane Hydrocarbon Emissions from Plants, Ray R. Fall, Chemistry & Biochemistry
 Determinization of Precipitation Via Remote Sensing, Wesley Berg, Aerospace Engineering
 CE&A-Advanced Decision Support for Water and Envir. Systems, John Humphries, Civil, Envir. & Architectural Engineering
 Chemically Assisted In-Situ Recovery of Oil Shale, Fred W. Ramirez, Chemical Engineering

1991 SHORT COURSE PROGRAM INTERNATIONAL INSTITUTE FOR CIVIL ENGINEERING DEPARTMENT OF CIVIL ENGINEERING COLORADO STATE UNIVERSITY

The International Institute for Civil Engineering (IICE) comprises a series of short courses offered each year for continuing professional education and academic credit at Colorado State University. IICE was developed to meet the need for current, high-quality instruction on advanced topics in the field of civil engineering. The IICE 1991 Program includes courses in: Geographic Information Systems (GIS); Computer Pipe Networks; Water Treatment; Waste Disposal, Slow Sand Filtration; Damage and Risk Assessment; Irrigation Management; Forecasting and Control; Water Storage; Expansive Soils; Air Pollution and Wind-Tunnel Modeling; Hydrometry; Wind Loads and Damage Mitigation; Wind/Solar Water Pumping; Design of Dams; and Water and Systems Analysis.

For information and a brochure contact: Janet Lee Montera, Manager, Conference Section, Civil Engineering Department, Colorado State University, Fort Collins, CO 80523. Phone: 303/491-7425 or FAX: 303/491-7727.

FROM COOPERATIVE EXTENSION

by Jim C. Loftis, Associate CWRRI Director
and Paul D. Ayers, Israel Broner and Lloyd Walker, Extension Agricultural Engineers

Senate Bill 126--Colorado Groundwater Protection Act

The following information will be circulated to various agricultural groups over the next six months. The Colorado General Assembly recently passed Senate Bill 126 to create an agricultural chemical management strategy which will protect groundwater. The three agencies given a key role in developing this plan are the Colorado Department of Agriculture, the Colorado Department of Health, and Colorado State University Cooperative Extension. These agencies recognize that this plan can best be developed and implemented only with the active participation of the public.

The development of this strategy comes at the same time the Environmental Protection Agency is urging states to produce a state plan for pesticide and fertilizer management for the protection of groundwater. Colorado has agreed to serve as a pilot state to develop such a plan. Colorado State University received a grant which pays a CSU team to assist in the process of developing this plan. The role of the CSU team is to strengthen the process by informing interested parties about the planning and by bringing interested individuals and organizations together to discuss and contribute to the plan.

Objectives as stated in Senate Bill 126 include the following elements. First, Cooperative Extension and the Colorado Department of Agriculture will draw up the best management practices for the use of agricultural chemicals. Second, Cooperative Extension will provide training in the application of these best management practices. Third, there will be regulations for bulk storage facilities and mixing and loading areas where at least 55,000 pounds of finished product are handled each year. The draft regulations will be subject to the regular public comment process. Fourth, while it is intended that educational processes and storage and mixing regulations will prevent groundwater contamination from occurring, the program will also include acceptable responses to contamination of groundwater and situations that are likely to result in contamination of groundwater.

Fifth, the Water Quality Control Division of the Colorado Department of Health will analyze existing groundwater monitoring data and conduct monitoring programs to determine the quality of groundwater in the state. Sixth, health advisory levels for pesticides will be adopted by the Water Quality Control Commission.

During the winter meetings, further details of this Bill will be explained and input received. Cooperative Extension will be hiring a Water Quality Specialist to develop educational programs. It is planned that this person will be available to attend winter meetings and explain the program. Sandra Davis of the CSU Political Science Department will be directing the EPA grant for pilot studies. Davis will also contact these groups to receive their input on this pilot study. Please keep this opportunity for a presentation at a winter meeting in mind as you prepare such meeting programs. Contact Lloyd Walker if you have any questions.

The Extension Agricultural Engineering Program A Different Structure for 1990-91

Due to the sabbatical leaves of Vince Murphy, Jim Loftis and Paul Ayers, the Extension Agricultural Engineering program will be restructured during their absence. Following is a synopsis of the activities of these faculty members while on their sabbatical, and how their current programs will be handled during the next year.

Vince Murphy, who has served as Department Head for the Department of Agricultural and Chemical Engineering since September 1983, will spend the next year on sabbatical at Los Alamos National Laboratory (LANL). While at LANL, Murphy will be working with a research group that has isolated strains of microorganisms that are capable of degrading hazardous wastes such as trinitrotoluene (TNT) and nitroglycerin. These compounds are common soil contaminants at military bases that must be removed in order to prevent groundwater contamination. Murphy hopes that through his cooperation with LANL scientists it will be possible to design a pilot scale bioreactor to demonstrate the feasibility of using microorganisms to carry out the removal process. If successful, the same sort of approach could be used to clean up sites that have been contaminated with agricultural chemicals. While Murphy is on sabbatical, the Department will be in the capable hands of Professor Terry Lenz.

Paul Ayers will be on a 9-month sabbatical at the University of Queensland at Gatton, Australia, beginning August 27, 1990. He will be working with Dr. Jeff Tullberg at the Farm Mechanization Centre where Tullberg is investigating controlled traffic principles in "broad acre" (dryland) farming. Controlled traffic is a concept of maintaining permanent tractor traffic lanes in the field to reduce widespread soil compaction, increase tractor efficiency and timeliness. These principles may be applicable to Colorado farmers. He also plans to work with the scientists at the Pesticide Application Centre to explore methods of improving pesticide application accuracy. During his absence, his workload will be distributed as follows: Soil Compaction - Bob Croissant; Farm Safety - Herb Lightsey; Tractor Energy Conservation and Conservation Tillage Equipment - Carrol Hamon; Sprayer Calibration and Underground Storage Tanks - Lloyd Walker.

Jim Loftis will also be on a 9-month sabbatical at the Water Quality Centre in Hamilton, New Zealand, beginning August 19, 1990. While at the Centre he will be working with the scientists on research projects dealing with the interpretation of monitoring data using statistical models.

During Loftis' absence, water quality programs and problems will be handled by Lloyd Walker. Deanna Durnford, a faculty member in the Department of Agricultural and Chemical Engineering, will be available to assist with issues related to groundwater. Robert Ward will fill in for Loftis at the Colorado Water Resources Research Institute.

UNIVERSITY NEWS

WATERSHED SCIENTIST JOINS CSU

Lee H. MacDonald, of Seattle, Washington, is a new faculty member of the Department of Earth Resources at Colorado State. He brings to CSU a diversity of research talents and interests, ranging from the effects of forest harvest and cloud-seeding in the Sierra Nevada to natural resources development in the Sahel and agro-forestry in the African humid tropics. MacDonald was formerly Research Coordinator at the Center for Streamside Studies, University of Washington, Seattle, where he was responsible for developing water quality monitoring guidelines for forested areas in the Pacific Northwest and Alaska, under an EPA-sponsored project. His experience includes research and consulting on wetland delineation and restoration, soil moisture modeling, sediment transport, surface water-groundwater interactions, shallow groundwater monitoring, and flood-frequency determinations. As a consultant and program officer for the United Nations University in Tokyo, MacDonald assisted in the formulation and execution of interdisciplinary research projects in western China, Nepal, and developing countries.

DECADE OF SERVICE RECOGNIZED

Robert Aukerman, Colorado State University Professor of Recreation Resources, was honored by the Fort Collins City Council and the city's Department of Parks and Recreation for serving 10 years on the Parks and Recreation Board. He was presented a plaque at a televised presentation and reception. Aukerman recently co-authored an article for the *Journal of Forestry*, entitled, "Water Treatment to Inactive Giardiasis."

LIEBROCK NAMED SE AREA EXTENSION DIRECTOR

Frank Liebrock is Colorado State University's new Southeast Area Research and Extension director. He oversees Cooperative Extension programs for Baca, Bent, Cheyenne, Crowley, Kiowa, Otero, and Prowers counties, as well as the Arkansas Valley, Plainsman, and Southeastern Colorado research centers. He most recently began graduate studies in water resources and worked in agricultural engineering at Colorado State.

HERMAN KOLOSEUS RETIRES

Herman Koloseus has announced his retirement after serving as a professor of civil engineering since 1962. Dr. Koloseus came to Colorado State from the U.S. Geological Survey where he conducted research on open channel flow and model-prototype evaporation relationships. He holds a bachelor's in civil engineering from Rensselaer Polytechnic Institute, a master's from Colorado State, and a doctorate from the University of Iowa in hydraulics. His primary field of research has been in fluid mechanics and hydraulics, and he has numerous authored publications.

Source: Engineering Network, Sept. 1990

VUJICA YEVJEVICH COMPLETES 30 YEARS WITH COLORADO STATE

Dr. Vujica Yevjevich completed 30 years of association with Colorado State University on September 12, 1990.

Yevjevich joined the civil engineering faculty in 1960 and was instrumental in developing the department's graduate research program in hydrology and water resources. Since then, the Civil Engineering Hydrology Program has become known as one of the most advanced graduate research programs in hydrology and water resources in the United States. It has also received international acclaim. Between 1964 and 1980, Yevjevich established the well-known Hydrology Papers series with 100 papers published until his retirement from Colorado State in 1980. The series is in demand by researchers worldwide, and continues under the name Water Resources Papers.

Yevjevich retired for a second time from George Washington University in 1987. Since then he has returned to Colorado and has continued his association and professional activities in the civil engineering department.

His research specialties include unsteady free surface flow, statistical and stochastic hydrology in general, storage theory and applications, flood prediction and control, and drought analysis and prediction.

The National Science Foundation has supported his research for more than 25 years, augmented by institutional support from the University and Civil Engineering Department. That combined support has enabled Yevjevich to write 11 books, five proceedings, and 156 engineering and scientific papers. In 1988, he received the International Hydrology Prize awarded by the International Association of Hydrological Sciences through the American Geophysical Union's Section of Hydrology. It recognizes Yevjevich's outstanding contributions to hydrological engineering and hydrology sciences.

Source: Engineering Network, Sept. 1990

MORGAN LIBRARY RECEIVES ADDITIONAL MAPS

The CSU Library has received a gift of 2,600 maps from the Department of Recreation Resources and Landscape Architecture. Dr. Glenn Haas, Department Chairman, and Dr. Howard Alden were instrumental in having these maps transferred to the library. These historic topographic maps provide valuable information to users wishing to know such things as where roads and stream beds were located in the past. For more information on these and other maps in the Morgan Library, call the Documents Department: (303)491-1882.

LETTERS TO THE EDITOR

Neil Grigg, Editor:

Reliable and relevant water quality data indicate that South Platte River quality is changing. Of major concern is the pH. The pH is the common logarithm of the reciprocal of the hydrogen ion concentration of a solution. Since 1949 the pH trend for the South Platte River has been going up. Presently the pH is very alkaline in the range of 8 to 8.3.

Over 19,000 acres are irrigated out of the South Platte in Sedgwick County. Over time, the pH of the soil is going to come into equilibrium with the water. We believe there is a great need for extensive soil and water studies along the South Platte, before soil alkalinity reaches a point whereby crop production is substantially reduced. Crop production in the river valley may well change the economic structure of the communities, if soil pH balances with the water at 8 to 8.3. High soil pH could require a shift in crop production to a salt-tolerant crop.

In Sedgwick County there is a need today for individuals to study water quality, irrigation management, and soil chemistry, as well as how the three are related. The South Platte River needs intensive study, just as the Colorado River is presently being studied.

The Soil Conservation Service and/or the Cooperative Extension Service need to fund full-time positions in hydrology and soils, so studies may be done in Sedgwick as well as Logan and Morgan Counties. The economics of irrigated farming along the South Platte River are at stake. Your cooperation and leadership are needed to help fund the necessary District Board, if we may assist your efforts.

Joe Shank, Jr.
Sedgwick County SCD
Julesburg

Neil Grigg, Editor:

Colorado's water planning vacuum is jeopardizing the state's competitive future in the arid West.

All Western states, except Colorado, are using noncoercive state water planning processes to supplement their traditional water laws. These planning efforts are resolving major water

conflicts by involving all water user groups -- including environmental, recreational, and public interests. Meanwhile, Colorado is wasting its energy, money, water, and credibility on endless turf battles between conflicting water interests.

As a result of this planning disparity, Colorado's water future is being determined by the Feds and downriver states. The outlook is grim. Our sister states are receiving federal cooperation and funds for well-planned water conservation alternatives that can effectively use Colorado's entitled surplus flows. Colorado is defaulting on its competitive water position, because of its growing preoccupation with internal conflicts.

Seventy percent of our nation's water lawyers are needed in Colorado's unplanned water system. Recent surveys show Coloradoans are paying for the resulting water development gridlock with, by far, the highest water tap fees in the nation. This inefficiency is especially galling, considering Colorado's high topography generates much of the water for the West.

Colorado water traditionalists have historically blocked every Colorado attempt at state water planning. Its leaders do not trust an organized consensus-building process that includes environment, recreation, and public input. They argue that Colorado already has a state water plan embodied in its original prior appropriation doctrine and water laws. The other Western states have similar doctrines and laws, but they also have learned from hard experience that organized water planning is necessary in this age of environmental enlightenment. In fact, most private and public enterprise in the American system uses consolidated planning to give decisionmakers a better perspective on important issues. Noncoercive water planning is a better way than the monopolistic inefficiency created by endless permitting bills and court actions.

Water planning is surely one of the most important, long overdue, legislative needs in Colorado's history. All Colorado citizens should insist on water planning legislation in 1991 to protect the state's future environmental and economic values.

Dave Miller
Palmer Lake

STRAIGHT TALK

by Keith Propst, President
Colorado Farm Bureau

Private property rights are one of the foundations on which this country was created. Do you feel secure that your land and water rights are protected by law? The facts are that those private property rights are being attacked and downgraded every day by those who believe public interest

is supreme and that it justifies the taking of your property rights. I heard that line expressed this summer at the Water Conference in Gunnison. Some people there would take your water for year-round white water rafting, minimum stream flows for fishing, and creation of wild and scenic

rivers and of wilderness areas with a federally granted water right. The head of the Denver Water Board suggested that irrigated farmland be zoned into good and poor classifications. Owners of marginal land could sell their water rights while those possessing good land could not. In other words, with the stroke of a pen, a group of bureaucrats could make wealthy people out of some, but more important, they could destroy the property rights of hundreds. I prefer the market to determine the price rather than this kind of rip-off.

But the issue that is right up front is "wetlands." What brought this to the forefront was President Bush's pronouncement that there would be no net loss of wetlands in the country. It sounded good on the campaign trail, and now it has become national policy. The trouble is, no one in the government has any idea how this is supposed to work. There are at least four major government agencies involved. They are the EPA, Army Corps of Engineers, the Fish and Wildlife Service, and the Soil Conservation Service. What makes matters worse, these agencies cannot even agree on a common definition of what a wetland is. In other words, you could be in compliance with one agency and then lo and behold, the strong arm of the government could come down on you because one of the other agencies said you were out of compliance.

What does all of this mean to farmers and ranchers? Let me give you a couple of examples. If you are a dryland farmer in eastern Colorado and you happen to farm through a pothole that was too wet to farm last year, you could lose all your farm program payments. If you farm near a city or in a mountain valley on land that has development potential, you may not be able to sell it for anything other than agriculture. If it has wetlands on the property, you have an exemption if that land has been farmed continuously the last several years, but the exemption goes out the window if you change its use.

How do you know if you have land that is considered a "wetland?" Well, SCS was given the job of classifying all farmland. Of course, they do not have the personnel to go to the country and look. They are doing it with aerial photos. The trouble is, the system is not foolproof. I think their attitude is that anything that looks like a dark spot on the map is considered a wetland until proven otherwise. So it is in your best interest to look at the map and if you

question their determination, demand an onsite inspection by a technician in your presence.

Well, even the government cannot figure out how to make this all work, so they scheduled six meetings around the country for public input. Guess what? If you were dissatisfied, you could have traveled right up to Bismarck, North Dakota. Even then you might not have heard, because most of the time was taken up by panelists chosen by the government, with very little time for an open mike. I believe people in every state ought to have the right to testify without having to travel several hundred miles to do so.

Again, I believe farmers are willing to do their part, and I believe they have done so. Think of all the stock and irrigation dams built by people on the land. Think of the wetlands and pot holes that have been created by irrigation. As I write, wild geese are flying over head. They would not even be here if farmers had not bonded their land to build Prewitt Reservoir. Farmers should not have to sacrifice their net worth to be a part of the wetlands effort. It is true that in the South and Midwest, land was drained and put under the plow. But good old Uncle Sam - or Brother Bureaucrat - who is coming down on them now, was right there with the checkbook and with cost-sharing programs encouraged them to do so.

What can be done? We believe we must have a fair hearing with one hearing in every state. There must be a common definition that citizens can depend on. The officials in Washington say there is one, but that is not what we find out in the country. Wetlands should be defined by law, not rules, in such a way that they can readily be identified by the average citizen. Prior converted cropland should not be considered wetlands when it changes use and should be exempt from wetland regulation. Wetlands should be classified as to their relative value to the environment. Mitigation for wetland use, as well as penalties for wetland destruction, should bear some reasonable relationship to the environmental value of the wetland.

Now is the time to make your voice heard on this issue. Use your tools we know will work. Write letters, make phone calls, talk to candidates. Let us bring reason to the issue. Let us protect our property rights while we can. If we let this matter slide, the bureaucrats will have the rules bonded in cement, and more of our rights will be gone.

Colorado Farm Bureau News, September 1990

COLORADO WATER SUPPLY

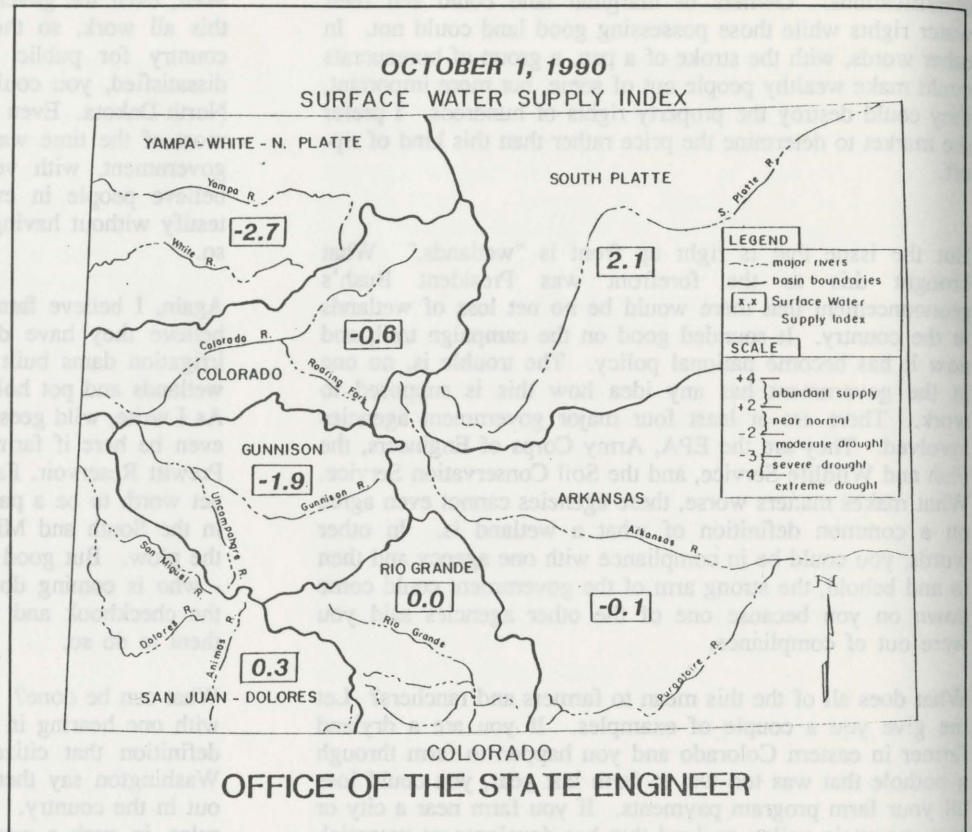
"Northern Hemisphere snow-cover during 1988 and 1989 was at its lowest extent since the advent of reliable satellite snow-cover monitoring in 1972, running some 8 to 10 percent below" average--so says a report by researchers David Robinson of Rutgers University and Kenneth Dewey of the University of Nebraska. The report was published in the Journal of the American Geophysical Union. But in Colorado the '80s were snowier than normal. Nolan Doesken, Assistant State Climatologist at Colorado State

University, said a six or seven-year period in the middle of the '80s was the snowiest period since the 1920s.

Although 1989 was a dry year with snowpack below normal, Colorado began early Fall, 1990 with precipitation significantly above normal during September. More moisture in the ground increases the potential runoff from this winter's snow, said Doesken. And that runoff provides 6.5 billion gallons of water to 12 states.

CONDITIONS UPDATE FROM THE STATE ENGINEER'S OFFICE

Statewide precipitation was significantly above normal for the month of September. Precipitation averaged 168% of normal with a high of 264% of normal in the Rio Grande Basin and a low of 110% of normal in the Yampa/White Basin. These precipitation amounts are in contrast to the August conditions when statewide precipitation was 84% of normal. As is common in Colorado, precipitation varied considerably. Substantial rainfall was recorded at Wolf Creek Pass, Durango, and Saguache with 6.3 inches, 5.1 inches, and 2.9 inches respectively. Abnormally dry conditions were experienced at Rabbit Ears Pass and Cedaredge with 1.1 inches and 0.7 inches of precipitation for the month respectively. Cumulative precipitation for the 1990 Water Year (October 1989 through September 1990) was 25% above normal for the central South Platte Basin area and 25% below normal for the extreme northwest and west-central sectors of the state. In other areas of the state cumulative precipitation was near normal.



Although reservoir storage has been drawn down considerably in the last 12 months, statewide it still remains normal to above normal when compared to historic reservoir storage levels. Storage levels are below normal in the Rio Grande, Gunnison, and Colorado basins. Relative storage remains highest in the Arkansas Basin. The consumption of reservoir carry-over storage this year will impact conditions next year if the 1991 runoff is below normal and as a result storage cannot be replaced. The greatest impacts would be on recreational uses of water. Streamflow at key index gaging stations approached 20-year lows in the Arkansas, Gunnison and Yampa/White Basins. Even with significant above normal precipitation for the month, streamflow remained low in these basins due to low soil moisture levels. Soil moisture deficiency remains at high levels in the West-central and northwest sectors of the state.

South Platte Basin

The SWSI value of +2.1 remains unchanged from the previous month and indicates that current conditions are above normal. This is the highest value recorded in the state. Precipitation was 134% of normal for the month of September. The use of water for irrigation dropped significantly going into October. The major diversions of water are now going into storage structures. Some groundwater recharge projects are beginning to divert water also. Cumulative flow at the key gaging station, South Platte River near Kersey, was 25% below normal for the water year, but was above the minimum flow recorded in 1964.

Streamflow at this station for the month of September was approximately 65% above normal. Dillon Reservoir is currently storing about 250,000 acre-feet of usable water. Soil moisture is classified as being above normal.

Arkansas Basin

The SWSI value of -0.1 indicates that the current conditions are near normal. Precipitation for the month of September was 200% of normal. Cumulative flow at the key index gaging station, Arkansas River near Portland, was 35% below average for the water year. This is above the record low flow recorded in 1977, but only due to reservoir releases from Twin Lakes Reservoir. Flow at this station for the month of September was approximately 60% below normal. Usable storage in Pueblo Reservoir was approximately 60,000 acre-feet on October 1, 1990. About 80% of this is project water. Usable storage in John Martin Reservoir is down to approximately 20,000 acre-feet.

Rio Grande Basin

The SWSI value of 0.0 indicates that the current conditions are normal. Precipitation measured 264% of normal for the month of September. Saguache recorded 2.9 inches of rain. Streamflow conditions on the Rio Grande and its tributaries in the San Luis Valley were below normal in August. Cumulative flow at the key gaging station, Rio Grande near Del Norte, was approximately 25% below normal for the water year, but above the minimum flow recorded in 1977. Flow at this station was approximately 25% below normal

for the month of September. Usable storage water in Rio Grande Reservoir has been totally diminished. Usable storage in Platoro Reservoir is less than 40% of the historic average for this time of year.

Gunnison Basin

The SWSI value of -1.9 indicates that the current conditions place the basin in a moderate drought stage. Drought conditions exist in the southern section of the Grand Mesa and in the upper reaches of the Uncompaghre drainage. Water District 40 reports that reservoir storage is only 14% of capacity as compared to the seasonal historic level of 40%. Although Blue Mesa Reservoir is storing approximately 100% of normal, reservoir storage throughout the rest of the basin has been significantly diminished. The groundwater table has been lowered resulting in diminished flow of natural springs. Cumulative flow at the key gaging station, Uncompaghre River near Ridgway, was approximately 35% below normal for the water year but above the minimum flow recorded in 1977. Flow at the station was approximately 40% below normal for the month of September. Precipitation for the month was 162% of normal. Soil moisture conditions improved significantly in September.

Colorado Basin

The SWSI value of -0.6 indicates that the basin wide supply is slightly below normal. Precipitation for the month of September was 118% of normal. Tributary flow is critically low with conditions being the worst west and south of Glenwood Springs. Three Mile Creek near Glenwood Springs is experiencing an unprecedented no flow condition. At the current release rate, there is only 20-30 days of storage remaining in the West Slope Users Pool. Cumulative flow at the key gaging station, Colorado River near Dotsero, was approximately 35% below normal for the water year and only about 15% above the minimum flow recorded in 1977. Flow at this station for the month of September was near

normal. Granby Reservoir is filling slowly but is relatively low. Dillon Reservoir, Williams Fork Reservoir, and Ruedi Reservoir remain full while other storage facilities in the basin are extremely low. Soil moisture conditions improved during the month of September.

Yampa/White Basin

The SWSI value of -2.7 indicates that the current conditions signify a moderate drought stage. It is the lowest value of any basin in the state. Water supplies in the North Platte, Yampa, Green, and White River basins continue to be below normal. Diversions for irrigation continue due to above normal temperatures. Cumulative flow at the key gaging station, Yampa River at Steamboat, was approximately 45% below normal for the current water year but still above the minimum flow recorded in 1977. Reservoir storage continues to be below normal. Most irrigation storage water has been released. Soil moisture continues to be low but improved during the month of September. Precipitation for the month was 110% of normal.

San Juan/Dolores Basin

The SWSI value of +0.3 indicates that the current conditions are normal. This is a significant improvement from the July value of -2.7. Precipitation for the month of September was 185% of normal with 5.1 inches of rain recorded at Durango. Total precipitation at Durango for the irrigation season was 22.4 inches which is 115% of normal. Reservoir storage for reservoirs on the Pine River, Florida River, and Mancos River is above last year's storage. McPhee Reservoir storage was approximately 240,000 acre-feet on October 1, 1990. Base flows in most streams are only 50% of normal. Cumulative flow at the key gaging station, Animas River at Durango, was approximately 50% of normal for the water year and was only about 20% above the minimum flow recorded in 1977. However, streamflow in the basin on October 1, 1990, was approximately 50% above normal.

WATER NEWS DIGEST

COLORADO-KANSAS CASE BEGINS

Colorado's legal battle with Kansas over the Arkansas River began on September 17 in the Pasadena, California Federal Court. Arthur Littleworth, a Special Master from California, was appointed by the U.S. Supreme Court to hear the case in a neutral venue. Kansas claims Colorado's excess diversions have damaged its ranching and farming and is seeking damages for as much as \$100 million. Kansas Attorney General Robert T. Stephan filed suit against Colorado in December 1985 claiming that Colorado had violated the terms of the Arkansas River Compact. The Supreme Court agreed in March of 1986 to hear the matter. Stephan's lawsuit claims that the proliferation of irrigation wells in Colorado's Arkansas River Basin has dramatically reduced the amount of water flowing into Kansas, and that Colorado has been illegally holding more water than it is entitled to in storage reservoirs.

Sources: Rocky Mountain News 9/18/90, Associated Press

WIRTH PROPOSES INTERIM WILDERNESS LEGISLATION

Senator Tim Wirth on September 19 proposed interim legislation that would place a five-year moratorium on logging, development, mining and off-road vehicle use on 857,400 acres of federal land in Colorado. The bill would not create any new water rights. It includes acreage from three earlier wilderness bills before Congress written by Wirth, Senator William Armstrong, and Representative Ben Nighthorse Campbell.

Source: Denver Post 9/10/90

COE CUTS WETLANDS PROTECTION

The Army Corps of Engineers has removed 60 million acres of cropland from protection as wetlands. The Corps Director of Public Works said that agricultural land that has been

drained and farmed for generations only "minimally" meets the criteria for wetlands.

Source: Washington Post 9/30/90

EPA RECOMMENDS EIS FOR CLEAR CREEK QUARRY

Max Dodson, EPA's water management director, has recommended that a permit application for a rock quarry in Clear Creek Canyon be denied. Dodson also suggested that the Corps of Engineers, which is reviewing the project because of its impact on wetlands, require an environmental impact statement. On September 12 the Jefferson County Planning Commission recommended that county commissioners deny the project, saying it would have severe traffic impacts on US 6. The quarry developer's attorney said ways to protect wetlands will be worked out during permit hearings.

Source: Denver Post 9/15/90

BOULDER WILL ASSUME 404 PERMITTING AUTHORITY

The U.S. Environmental Agency is enforcing the nation's wetlands protection law with actions against two Boulder developers who allegedly placed fill materials in a wetland in the Twin Lakes Technological Park without the required Section 404 permits. In the first case, a Boulder firm has agreed to remove fill material it had already placed in a 1.84-acre area, recontour slopes, stabilize adjacent material to keep it from moving into the wetland, and revegetate the area. The other case concerns a company charged with filling several acres of the same wetland and beginning construction without a Section 404 permit from the U.S. Army Corps of Engineers. The City of Boulder is negotiating with federal agencies to establish a program that will delegate Section 404 permitting authority to the city, enabling the local government to control all wetland activities. The city's regulations will be broader than those of Section 404 of the Clean Water Act.

Source: U.S. Water News, Oct. 1990

BROADEN EPA FOCUS, SAYS REPORT

The Environmental Protection Agency should reorder its priorities and commit resources to focus both on risks to human health and the care of natural ecological systems, says a report prepared by the agency's Science Advisory Board. The report grouped problems into high, medium, and low-risk areas. The high-risk group consisted of four problems: global warming, depletion of the ozone layer, extinction of species, and destruction of natural environments such as rain forests. Examples of medium-risk areas included pesticides, acid rain, and surface water pollution. Oil spills, groundwater pollution, and radioactive isotopes pose relatively low risks, said the report. EPA Administrator William Reilly urges a national dialogue involving EPA, Congress, industry, and the public on what areas pose the

greatest risks and where the government's resources should be directed.

Sources: New York Times 10/2/90; Associated Press 9/27/90

FISH DIE IN BIG THOMPSON

The Colorado Division of Wildlife is investigating the deaths of thousands of fish in a mile-long section of the Big Thompson River west of Loveland. The dead fish were mostly trout, but some suckers were included. The investigation was hampered by the amount of time that passed before the dead fish were discovered on October 5.

Source: Coloradoan 10/16/90

WATER QUALITY

Rocky Flats--A five-year, \$110 million plan developed by local, state, and federal officials will help metro municipalities provide protection against water contamination from Rocky Flats. Under the plan, Broomfield will abandon Great Western Reservoir as its water supply. The Department of Energy will spend \$70 million to build a holding pond on Woman Creek above Standley Lake that will contain runoff from a 100-year flood; extend diversions around Standley Lake's north side; build diversions to carry any water from the holding pond north to Great Western Reservoir; and find additional storage space and water to replace Great Western Reservoir. The remaining \$40 million will be used for evaporative systems and other treatments to ensure that no water used in operations or sewage systems at Rocky Flats gets off the plant property. The plan will ensure protection for the drinking water supplies of Northglenn, Broomfield, Thornton, Westminster and Federal Heights. On October 4, Energy Secretary James Watkins committed \$10 million to the plan for 1991.

Source: Denver Post 10/4/90

San Luis--The Costilla County Water Conservancy District wants to meet with Governor Roy Romer regarding a dispute over possible water contamination from a proposed gold mining operation. Battle Mountain Resources has requested 860 acre-feet of water per year for a gold mining operation along Rio Seco Creek, and Water Judge Robert W. Ogburn denied the District's request to obtain information about the company. Water District President Maclovio Martinez wrote Romer that "water quality has not been addressed to the extent that we felt it necessary."

Source: Associated Press, 9/18/90

WATER DEVELOPMENT

Animas-La Plata--Authorized by Congress in 1968, The Animas-La Plata project would irrigate 68,000 acres of farmland and provide drinking water for residents of Durango and the New Mexico cities of Farmington, Aztec, and Bloomfield. In May, however, federal biologists said the project should not be built because it would hurt a small population of endangered Colorado squawfish. The U.S. Fish and Wildlife Service called for a seven-year study of the project to measure its impact.

Now, with the discovery of a 27-inch Colorado squawfish found in Wyoming's Snake River, a federal task force is being organized to search for signs of more squawfish in the river. The task force will include federal, Wyoming and Colorado wildlife officials. The discovery was made by W. L. Minckley, a professor of zoology at Arizona State University. The last squawfish found in Wyoming was taken from the Green River prior to the closing of the Flaming Gorge Dam in 1962, and officials had believed the fish was extinct in Wyoming. The Little Snake River flows into the Yampa, an important habitat for the endangered squawfish.

Sources: Denver Post 8/30/90; Associated Press 8/30/90; 9/4/90

Energy development and water rights were the focus of the First Annual Four Corners American Indian Commission Conference held in September at Ignacio. Representatives of ten Indian tribes and pueblos, the Council of Energy Resource Tribes, the Bureau of Indian Affairs and state officials from Arizona, New Mexico and Colorado participated. It is believed that beneath the Southern Ute Indian Reservation lies 15 billion tons of coal, with more than 400 million tons near the surface which could be strip-mined. Southern Ute leaders say it cannot be properly developed until the Animas-La Plata water project is built. In 1976, the tribe and the Pittsburg & Midway Coal Mining Company reserved more than 50,000 acre-feet of Animas La Plata water for coal development. Coal is already being strip-mined at the La Plata Mine, one of three large surface mines that delivers 12-14 million tons of coal to the Four Corners Power Plant and the San Juan Generating Station annually.

The Ignacio Blanco Gas Field has already produced over 820 billion cubic feet of natural gas for customers as far west as Washington, Oregon, and California. Two years ago, the Rocky Mountain Association of Geologists suggested that "recoverable gas volume of 4 trillion cubic feet" lies within the field. Marvin Cook, tribal energy resource coordinator, said the tribe's energy resources regularly account for 90 to 94 percent of its revenues.

Sources: Denver Post 9/9/90, 9/16/90

NEW U.S. GEOLOGICAL SURVEY REPORTS

National Water Summary 1987. Colorado has ample freshwater and groundwater resources, despite their uneven distribution across the state, according to the Colorado section of the recently published National Water Summary by the U.S. Geological Survey, Department of the Interior. "About 13.5 billion gallons per day (bgd) of freshwater was used in Colorado during 1985. Although water is not evenly distributed across the state, it is nonetheless plentiful enough to meet the state's water needs," said Jerry Pascale, Colorado District Chief of the USGS Water Resources Division office in Lakewood. The report, which is the fifth in a series of annual reports that describe the condition and the characteristics of the nation's water resources, focuses on water supply and use and provides information that can be used at all levels of government and by the general public. It presents for the first time, on a consistently national basis,

WYOMING COMMISSION RECOMMENDS FUNDING OF 17 WATER PROJECTS

The Wyoming Water Development Commission tentatively recommended that 17 water projects throughout the state be funded by the state through loans and grants. The commission plans to approve a final list at its December meeting, which will be forwarded to the 1991 Legislature for funding.

The list includes 12 new projects totaling almost \$2.2 million and five rehabilitation projects at a cost of roughly \$1.4 million. The largest proposed loan is destined for Douglas, which will use the money to improve the city's water intake structure on the North Platte River and replace structures at the city's Box Elder Springs to prevent contamination by surface water.

Also included is a \$575,000 pipeline loan request by the Bridger Valley Joint Powers Board to expand service to more Bridger Valley residents by diverting roughly 318 acre-feet of water annually from Black's Fork to Smith's Fork. The commission also tentatively approved a \$500,000 planning grant to study water efficiency and to conduct a needs analysis on the Wind River basin. Other projects involve improving water distribution systems, rehabilitation of dams, and feasibility studies of canal irrigation structure improvements.

Source: Associated Press 10/17/90

SAUDI ARABIA PROVIDES WATER

According to an article in the October issue of *U.S. Water News*, Saudi Arabia is not only providing American armed forces with financial support, they are also supplying most of the water needed by troops. Saudi companies are using desalinated sea water and tapping into underground water aquifers to supply the required water. Army and Marine units have been taking drilling rigs and reverse osmosis water purification units with them to help ensure water requirements are met. U.S. bottled water suppliers have also been helping with the water demands.

information on water withdrawals by river basin, aquifer and county. It also provides a comprehensive interpretation of the source, use, and disposition of freshwater in the United States for five major categories of use--public supply, domestic and commercial, industrial and mining, thermoelectric power, and agriculture. Selected Colorado water-use facts:

- * Surface water is the source of 83 percent of all withdrawals in the state.
- * Agriculture is the state's primary water use category with 12.5 bgd, followed by domestic and commercial use of about 731 million gallons per day (mgd), industrial and mining with 197 mgd, and thermoelectric with 123 mgd.
- * Only 35.8 percent (4.8) of the water used is actual consumptive use; the remainder is returned to the system.

- * Public-supply systems provide water to 93 percent of the state's population.

The Colorado section of the USGS report contains information about the history of water development, water use by major categories, and water management in the state. Diagrams, graphs, and maps are included that show a water budget, reservoir storage, population trends and distribution, freshwater withdrawals by county and hydrologic unit, and source, use, and disposition of water.

"Traveltime and Reaeration of Selected Streams in the North Platte and Yampa River Basins, Colorado," by Barbara C. Ruddy and Linda J. Britton, published as Water-Resources Investigations 88-4205. Describes traveltime and reaeration characteristics of the Canadian, Michigan, Yampa, Elk, and Williams Fork Rivers and Trout and Fish Creeks.

"Estimating Pumping Time and Ground-Water Withdrawals Using Energy-Consumption Data," by R. Theodore Hurr and David W. Litke, published as U.S. Geological Survey Water-Resources Investigations Report 89-4107. It documents a method for estimating the pumping time and the volume of

water withdrawn at a pumping plant using energy-consumption data. Methods are presented for use with pumps powered by electricity, natural gas, and bulk-supplied fuels such as gasoline, diesel oil, or liquid petroleum gas.

"Summary of Selected Characteristics of Large Reservoirs in the United States and Puerto Rico, 1988," by Barbara C. Ruddy and Kerie J. Hitt. It provides a summary of large reservoirs in the United States and the Commonwealth of Puerto Rico, including data for reservoirs that have normal capacities of at least 5,000 acre-feet or maximum capacities of at least 25,000 acre-feet and that were completed as of January 1, 1988. Reservoir data includes: location, maximum and normal capacities, surface area, drainage area, year completed, and use.

Contact U.S. Geological Survey, Books and Open-File Reports, Federal Center, Box 25425, Denver, CO 80225-0425. Phone: (303)236-7476.

SOUTH PLATTE RIVER RESOURCE MANAGEMENT: FINDING A BALANCE

November 13-14, 1990

Join this endeavor to define the status of biological and hydrological information on the South Platte ecosystem and its tributaries. This two-day workshop will identify information needed to develop an integrated management approach to optimize that vital resource. Sponsored by the Colorado Division of Wildlife, Northern Colorado Water Conservancy District, U.S. Fish and Wildlife Service, Colorado State University, and the Denver Water Department, the meeting will be held at the University Park Holiday Inn, Fort Collins, Colorado. Registration fee is \$35 if received by November 7, 1990. The cost covers workshop materials, proceedings, lunch and coffee breaks. For additional information call Chuck Grand Pre, Colorado Division of Wildlife (303)291-7202.

ANNUAL NCWCD FALL WATER USERS MEETING

The Northern Colorado Water Conservancy District hosts its annual Fall Water Users Meeting on Friday, November 16, at the Raintree Plaza Hotel and Conference Center in Longmont. Interested citizens are invited to attend. The preliminary agenda includes: **Current Issues and Challenges**, Larry Simpson; **Revised Forest Service Plan (Arapahoe, Roosevelt, Pawnee Grasslands)**, Geoff Chandler, USFS; **C-BT Operations Update**, Craig McKee; **Update on State Engineer's Office Activities**, Alan Berryman, Div. I Engr.; **How Much Does the General Public Know About Water Issues?**, John VanSciver, State Engineer's Office; **Colorado River Endangered Squawfish Recovery Program**, Larry Harris, Div. of Wildlife Research Leader. The presentations will be brief to encourage questions and discussion. Registration begins at 8:15 a.m. Lunch will be provided, so reserve a place by November 12 by calling (303)667-2437.

HOT TOPICS AT THE FIREHOUSE

A luncheon program series presented by the Natural Resources Law Center and the University of Colorado School of Law. Meetings are held at 12:00 noon at the Old Number One Firehouse, 1326 Tremont Place, Boulder. Box lunches will be provided with one hour of Continuing Legal Education available. Scheduled programs are:

Nov 14--Lujan, Secretary of the Interior vs National Wildlife Federation - The Decision and its Implications

Gene R. Nichol, Jr., Dean, University of Colorado School of Law; William Perry Pendley, President and Chief Legal Officer, Mountain States Legal Foundation; Thomas D. Lustig, Attorney, National Wildlife Federation

Dec. 10--SUPERFUND: Should Strict Liability be Replaced with an Expanded Trust Fund?

Jan Edelstein, National Environmental Trust Fund, Washington, D.C.; Jack McGraw, Environmental Protection Agency, Denver, Colorado

SHORT COURSES

Central Plains Short Course will be held in North Platte, Nebraska, on February 5-7, 1991. It will include workshops on Furrow Irrigation Management, Sprinkler Irrigation, Irrigation Systems, and Irrigation Scheduling. The **Extension-Soil Conservation Service Salinity Control Meeting** will be held in Grand Junction on February 25-28, 1991. For further information contact: Israel Broner, Department of Agricultural and Chemical Engineering, Colorado State University, (303)491-5252.

CALLS FOR PAPERS

Annual Meeting, Western Social Science Association, Resource and Public Land Use Section, April 24-27, 1991, Reno, NV. Topics of special interest: Society and Natural Resources; Human Ecology of Resources and Land Use, Natural Resources Recreation; Natural Resource Negotiation and Decisions; Recreation and Instream Flows; Natural Resource Law and Policy; Public Perceptions of Resource and Land Use. Send proposal for individual presentation to: Nina Burkardt or Jonathan Taylor, Section Coordinators, Resource and Public Land Use, Western Social Science Association, c/o U.S. Fish and Wildlife Service, National Ecology Research Center, 4512 McMurray Ave., Fort Collins, CO 80525-3400; Phone: (303)226-9445. Deadline: Dec. 3, 1990.

Global Warming - A Call for International Coordination- April 8-11, 1991, Chicago, IL. Annual Conference sponsored by SUPCON International and the World Resource Review. Participating agencies include USFS, USDA, NASA, EPA, DOE, EPRI, TVA, and others. Send 200-word abstract to: Global Warming International Conference, 7501 Lemont, Suite 335, Woodridge IL 60517-2661; Phone: (708)910-1551 or (419)372-8207; FAX: (708)910-1561. Deadline: Dec. 1, 1990.

AWRA Conference on Water Management of River Systems, September 8-13, 1991, New Orleans, LA. Submit 3 copies of 200-word abstract to: Harry C. McWreath, USGS, P.O. Box 6976, Fort Worth, TX 76115; (817)334-5551. Deadline: Nov. 15, 1990.

GRADUATE FELLOWSHIPS

Graduate Fellowships in Water Sciences--Michigan State University. Research Components: Systems Modeling and Simulation; Agricultural Water Management; Soil Chemical/Biological Reactions; Groundwater Flow and Chemical Movement; Surface Water Flow and Chemical Movement; Risk Assessment and Economic Analysis; Social and Legal Aspects.

Graduate stipends of \$15,000 per annum will be awarded to Fellows appointed through the USDA National Needs in Water Sciences Training Program. The interdisciplinary nature of the program is designed for Fellows to initiate innovative research emphasizing systems science/computer modeling simulation as it relates to all aspects of the water sciences. Faculty expertise associated with the project includes: hydrology, computer modeling and simulation, soil-water reactions, environmental isotope analysis, biodegradation/bioremediation, biomethylation/bioaccumulation, risk assessment, socioeconomics, and environmental law which provides Fellows with the opportunity for broad and rigorous training in basic research and creative application of computer modeling and simulation of important water related problems.

The program is directed by an interdepartmental committee of faculty in the Department of Agricultural Economics, Agricultural Engineering, Civil and Environmental Engineering, Crop and Soil Sciences, Entomology, Fisheries and Wildlife, Geological Sciences, and Resources Development as well as in the interdepartmental programs in the Institute of Water Research, Center for Remote Sensing, Institute for Environmental Toxicology and the Pesticide Research Center. Fellows must be U.S. citizens or native residents of the District of Columbia, Puerto Rico, Virgin Islands, American Samoa, the Commonwealth of Northern Marianas or the Trust Territory of the Pacific Island.

Program information/applications can be obtained from: Dr. Frank M. D'Itri, Co-Director, Institute of Water Research and Department of Fisheries and Wildlife, 334 Natural Resources, MSU, East Lansing, MI 48824, (517)353-3742.

National Needs Fellowship--Oklahoma State University. The Departments of Agricultural Engineering, Agronomy, and Forestry of Oklahoma State University invite applications for

two Ph.D Fellowships in Water Sciences funded through the USDA National Needs Program. Each fellow will be awarded a graduate stipend of \$25,000 per annum for three years. Fellows will be able to pursue Ph.D degrees in Agricultural Engineering, Environmental Science, or Soil Science.

Current areas of active research include: Hydrology and Hydrologic Modeling, Irrigation and Evapotranspiration, Subsurface Flow and Transport, and Surface Water Quality and Erosion.

Applications are encouraged from U.S. citizens with engineering, soil science, forestry, geology, hydrology, or related degrees. Women and minorities are especially encouraged to apply. To receive full consideration, applicants should submit the following documentation: a letter describing research interests and goals, a complete resume, current official transcripts, and three letters of recommendation.

Applications will be accepted until suitable candidates are chosen. Selection will be made from an overall evaluation that includes academic records, employment history, and area of research expertise.

Persons considering applying are encouraged to contact one of the following faculty: Dr. G. O. Brown, Ag Engineering - groundwater and contaminant transport (405)744-8425. Dr. R. L. Elliott, Professor, Ag Engineering - irrigation and evapotranspiration (405)744-8423. Dr. C. T. Haan, Ag Engineering - hydrologic modeling, GIS, water quality modeling (405)744-8398. Dr. D. L. Nofziger, Agronomy - chemical fate and transport, GIS, decision-support systems (405)744-6417. Dr. J.F. Stone, Agronomy - irrigation, evapotranspiration, water management (405)744-6420. Dr. D. J. Turton, Forestry - streamflow processes, hydrologic modeling, watershed management (405)744-5441. Dr. B.N. Wilson, Ag Engineering - erosion mechanics, hydrologic modeling, transport of surface contaminants (405)744-8422.

Send applications to: Dr. Bruce N. Wilson, Agricultural Engineering Department, Oklahoma State University, Stillwater, OK 74078-0497.

RECENT DEVELOPMENTS IN WATER MARKETING AND WATER TRANSFERS

by Lawrence J. MacDonnell

Presented at the Colorado Water Engineering and Management Conference
February, 1989

Most of the West's renewable water resources are already appropriated and developed. Opportunities for additional development are limited by a number of factors. At the same time, demands for water in the West are undergoing major and lasting changes. Irrigated agriculture, long the dominant user of water in the West, is declining in relative economic importance. New consumptive demands now derive largely from urban growth. There is also a growing demand for "instream" uses of water. These conditions suggest the need for reallocation of a portion of developed water supplies to these new, higher-value demands.

Western Water Rights

Rights to use western water resources exist in a variety of forms. Appropriate water rights may provide either direct flows of water or storage rights. In many cases, rights to use ditch water or water in a reservoir are based on ownership shares. Water may be supplied for use on the basis of a contract. Rights to use water may derive from land ownership as, for example, with groundwater in some states. Reallocation occurs when existing use or right to use is changed or transferred to a new use. The term "water marketing" applies to the lease or sale of any such right. Widespread attention in recent years has been focused on water marketing as a voluntary, incentives-based mechanism for facilitating necessary reallocation of water resources.

Water Marketing

The most common form of water marketing in the West involves the sale and transfer of an appropriate water right or a share in such a water right. Simple change in ownership generally occurs without state supervision. Transfers involving changes in the point of diversion, the place of use, or the type of use typically are subject to review to ensure that no injury to other water users will occur.

Changes of Water Rights

While the specifics vary from state to state, the general elements in changing a water right are largely the same. The holder of the water right must file an application requesting approval of the desired change by some state agency. Notice of the requested change is publicized to inform other potentially affected water rights holders. The applicant bears the burden of demonstrating that no injury will result from the change. Generally the question of injury centers on whether the change would adversely affect stream conditions upon which other rights depend--usually by increasing the quantity of water consumed or by changing the timing of the flow patterns. The formality of the review process largely depends on whether there are any protests.

Terms and conditions may be added to modify the transfer proposal in response to concerns about injury. Changes in appropriative water rights including changes in beneficial use of the water without loss of priority were first allowed by California courts in the 1850s and have occurred with regularity in several western states including Colorado, New Mexico, and Utah. In these states, the procedures for changing water rights and the rules respecting such changes are well established. Accordingly, there is an active market in the sale of appropriative water rights in these states.

Not all states followed this approach, however. Arizona and Wyoming, for example, decided early in this century to tie the right to use the water directly to the land on which it was used. This strict appurtenancy requirement prevented transfers of water rights involving change in the place of use. Although both states now have eliminated this strict appurtenancy rule, there is very little transfer activity involving appropriative water rights in either one.

Water Farms

There has, however, been transfer activity of a different kind in Arizona--the purchase of land outside designated Active Management Areas by cities and developers interested in obtaining rights to the underlying groundwater resource. Under the 1980 Arizona Groundwater Management Act, there are few restrictions on the development and use of groundwater from lands outside of Active Management Areas. Thousands of acres of such "water farms" have been purchased in anticipation of future use of the associated groundwater for urban and commercial development in other locations.

Transfer of Conserved Water

Approximately 80 percent of all withdrawals of the water in the West are for irrigated agriculture. By today's standards, much of this irrigation is highly inefficient. Especially in areas without a strong dependency on historical return flow patterns, there are opportunities to conserve significant amounts of water. Financial incentive to make necessary conservation improvements can be provided by allowing the transfer of conserved water to the use of the entity paying for the improvements. California and Oregon have enacted statutes encouraging such transfers of salvaged or conserved water. The recent agreement between the Imperial Irrigation District and the Metropolitan Water District of Southern California (MWD) provides for expenditures by MWD to fund conservation measures that will make an estimated 100,000 acre-feet of water available for use in the MWD service area. A separate agreement provides for MWD to fund the lining of the All American Canal in return for rights to use the salvaged water.

Transfers of Bureau of Reclamation Water

The Department of the Interior recently announced a policy aimed at encouraging voluntary reallocation of water supplied by Bureau of Reclamation projects. The statement of principles, issued December 16, 1988, recognizes the important federal role in transactions involving Bureau of Reclamation storage and conveyance facilities, water rights, and water supply contracts. It insures active federal participation in any such transaction but conditions approval on a number of factors including adequate consideration of "third-party consequences." An important decision embodied in these principles is that the U.S. Government will not impose any special charges on such transactions.

Concern About Third Party Effects of Transfers

While these developments tend to encourage transfers, other developments are occurring which may tend to limit such transactions. For example, in 1982 California made approval of water transfers subject to findings that the change will not unreasonably affect fish, wildlife, or other instream uses and will not unreasonably affect the overall economy of the area from which the water is being transferred--in addition to the finding that there will be no injury to other water users. New Mexico in 1985 added the requirement that, to change water use from irrigation, it must be shown that the change

is "not contrary to conservation of water within the state and not detrimental to the public welfare of the state...". In February, 1989, the Utah Supreme Court ruled that the State Engineer had to consider whether a proposed change of water right would interfere with public recreation, the natural stream environment, or the public welfare in addition to the usual question of impairment to other water rights. Arizona has been actively considering some kind of area-of-origin protection legislation in response to the purchases of water farms. Change of water right applications in Colorado and Utah have raised issues of effects on water quality.

Conclusion

Voluntary reallocation of water through transfers of existing rights provides an important means of meeting the changing water needs in the West. Possible effects on other water users can be met by limiting transfers so there is no increase in consumptive water use and no adverse change in the timing or quality of flows. States with limited experience in allowing such transfers can look to the procedures already well established in other states for guidance. Concerns about the third party effects associated with transfers are more problematic. These concerns could limit the size of transfers or restrict transfers in certain sensitive locations. Water marketing is not a panacea for western water problems, but it is a set of approaches which represent the direction in which western water policy must go.

THE INCREASING IMPORTANCE OF WATER TRANSFERS AND THE NEED FOR INSTITUTIONAL REFORMS

by Charles W. Howe

Presented at the Colorado Water Engineering and Management Conference
February 1989

The General Desirability of Water Transfers

Flexibility in the allocative pattern of any scarce resource is highly desirable from point of view of economic efficiency. The resource can move from lower-valued uses to emerging higher-valued uses that result from demographic, economic, and public value changes. Naturally it is desirable that this flexibility be accompanied by security of tenure for those holding the resource so that longer-term investments will not be endangered. These two attributes make water markets attractive as vehicles for effecting water transfers (Howe, et al, 1986).

The increasing economic and environmental costs of new water supplies reinforce the increasing popularity of water transfers (e.g., Fredrick, 1986; Howe and Easter, 1971). The largest pool of water available for transfer is found in irrigated agriculture, where about 80 percent of consumptive use in the Western United States takes place (USGS, 1988).

The agricultural sector is currently under increasing pressure from international competition and increasing domestic resistance to farm price support programs. The outlook is for a continued fall in real prices for major agricultural commodities on world markets (Young, et al, 1988). Thus

one would expect reallocations from agriculture to emerging non-agricultural uses, especially urban and industrial uses, provided the institutional framework permits such transfers.

The Nature of Agricultural to Non-Agricultural Water Transfers

The economists' models of efficient competitive markets, if applied to water resources, would picture a smooth, relatively low-cost process of moving water from the lowest value applications in agriculture to growing non-agricultural uses. Naturally, no one expects the process to work perfectly since water markets suffer from lack of information, heterogeneity of water itself (by location, seniority, quality, etc.), and possibly high transactions costs.

Some models of the transfer process, especially those of the linear-programming variety, overlook some of the realities of water as a tradeable resource and thus may produce some misleading predictions (e.g., Mann, Sparling and Young, 1987; Howe and Ahrens, 1988).

A study currently underway in Colorado (USGS grant through the Colorado Water Resources Research Institute to

the Natural Resources Law Center, University of Colorado, 1987) has investigated 743 completed transfers for which application was made in the decade 1976-84. These transfers exhibited the following characteristics:

Agriculture to agriculture	146
Agriculture to non-agriculture	531
Non-agriculture to non-agriculture	66
1 cu. ft./sec. or less	330*
Greater than 1 cfs.	216
100 acre-ft. or less	148
Greater than 100 acre-ft.	48

**Under the Colorado system of water administration, water rights and their transfers are often characterized by a flow rate only. Storage rights and some flow rights are volumetrically quantified.*

Secondly, cities frequently accumulate water supplies far in excess of current needs, either in anticipation of future growth or to have "super safe" systems. While some of this excess water may be leased back to the agricultural sector until it is needed, a higher level of risk is introduced for the user, precluding higher valued uses. Since urban water costs are frequently hidden from urban water users (because of inappropriate pricing), urban managers adopt an excessively risk-averse attitude, making the accumulation of raw water supplies excessively large.

Even if water transfers are economically efficient from state or national points of view, there is no guarantee--indeed, little likelihood--that the area or basin-of-origin will gain from the transfer. Most transfers are out of the basin-of-origin, so the benefits to the new user do not accrue to the basin-of-origin. Since many of the basins-of-origin are depressed or declining regions to begin with, the likelihood that the proceeds from the sale of the water will be reinvested in the basin is small. Thus, the phasing out of agriculture will be accompanied by various negative local multiplier effects (forward or backward linkages) that are unlikely to be offset by new activities. Finally, the environmental effects on the basin-of-origin are almost always negative.

Institutional Reforms Needed to Maximize Net Benefits from Transfers

It should be clear from the discussion above that unfettered free-market transfers are unlikely to be economically efficient. What is needed is the protection of or accounting for public values that are not taken into account by buyers

and sellers not, in some states, incorporated in the water law. Since appropriations doctrines everywhere protect other water diverters, what is needed is an expansion of state water laws to recognize and protect the wider set of instream, recreational, and aesthetic values. The states of Idaho, Utah, Wyoming, and New Mexico have incorporated in their water law such criteria as non-degradation of water quality, protection of fish and wildlife, and even (Idaho) impacts on the local economy and on family farming. The "public trust doctrine" that has been invoked in California in the Mono Lake case serves to protect an undefined set of public values--probably not a desirable policy development because of the uncertainty of the criteria being used.

Governance structures for irrigation and conservancy districts that are more representative of the populations affected by water systems would help in the introduction of broader social values in water management. Included among the issues is the need to make district boundaries and allowable water uses flexible. Districts typically distribute project water within specified boundaries that had significance historically but that grow out of date. Failure to allow water to be sold outside historical boundaries can introduce substantial inefficiencies in water allocation. An example is found in the contrasting water prices found in the Northern Colorado Water Conservancy District--about \$1,000 per acre-foot in perpetuity--and prices for comparable non-project water in the northern Denver suburban area--up to \$4,500 per acre-foot. While the Northern District's management feels an obligation to keep Colorado-Big Thompson project water in the District, the farmers who still own most of the water see their water wealth diminished by a factor of 3 or 4, while Denver suburbs pay unnecessarily high prices for water or are backed into supporting unneeded new projects like the Two Forks Dam.

Other small federal and state policy changes could greatly facilitate socially responsible water transfers. Federal projects, originally authorized by Congress for certain water uses only, should be freed up to serve any beneficial purposes able to buy the water and to repay federal cost obligations. States could streamline the administrative or court processes by which transfers are reviewed and approved (or modified) by using standard guidelines (e.g., for computing historical consumptive uses), by keeping better water rights and transfer records (today only a specialist, lawyer, or engineer dare venture a guess about the real nature of a water right), and by providing information of stream flows and storage that will help bring buyers and sellers together.

Water transfers are clearly destined to play an expanding role in the future. No major region of the country need fear water shortage if imaginative transfers are permitted and responsibly administered.

POSITIONS AVAILABLE

Assistant/Associate Professor of Civil (Water Resources) Engineering-The Center for the Management, Utilization and Protection of Water Resources at Tennessee Technological University is an interdisciplinary Research Unit which is

supported by Substantive State resources. The Center addresses the following areas: Allocation and control of public waters; Satisfaction of quantitative and qualitative water needs; Preservation of water quality in resource

development activities. It involves the Colleges of Engineering, Arts & Sciences, Agriculture and the Tennessee Cooperative Fisheries Research Unit.

Position Requirements: Provide water resources expertise to the Center's research, teaching, and public service roles. Develop long-term research programs in the area of water resources. Develop models to simulate water body dynamics of lakes, reservoirs, streams, cooling ponds, and other aquatic systems using multidimensional mathematical and numerical models. Attract external funds for support of a research program in the water resources area. Teach courses at the undergraduate and graduate level in water resources with emphasis on modeling aquatic systems.

Qualifications: Applicants must hold a degree in engineering with an earned doctorate in water resources or related areas; have a record of research publications and external funding; be able to demonstrate an expertise in hazardous waste treatment, chemical and physical fate of conservation and non-conservation parameters of water quality; be able to relate to industry/government and have good interpersonal skills. Preference will be given to persons having or having the ability to obtain a Tennessee professional engineers license within a reasonable period of time.

This position is to be filled at the Assistant or Associate Professor level and is a tenure-track position. The position is available January 15, 1990. Rank and salary will be commensurate with qualifications and experience. Applicants should submit a complete resume with names, addresses, and telephone numbers of three references no later than November 15, 1990, to the following: Dr. V. Dean Adams, Director, Center for the Management, Utilization and Protection of Water Resources, Tennessee Technological University, P.O. Box 5033, Cookeville, TN 38505.

Director, Northwest Colorado Council of Governments Water Quality/Quantity Trust Fund Program, Frisco, Colorado. Reports directly to county and municipal elected officials and works closely with state and federal agencies. Program implemented in conjunction with General Counsel and NWCCOG Water Quality Engineer. Responsible for policy analysis, development and implementation related to state and regional water management issues, and other activities as directed by Trust Fund members. Must have experience working with elected officials. Working knowledge of Colorado water policy and water management issues a plus. Salary open depending on qualifications. Submit resume by Nov. 19, 1990 to NWCCOGWQQTF, P.O. Box 739, Frisco, CO 80443. Phone: (303)668-5445.

MEETINGS

- Nov. 4-9 26TH ANNUAL AWRA CONFERENCE - THE SCIENCE OF WATER RESOURCES: 1990 AND BEYOND, and SYMPOSIA- TRANSFERRING MODELS TO USERS & URBAN HYDROLOGY, Denver, CO. Contact: AWRA, 5410 Grosvenor Lane, Suite 230, Bethesda, MD 20814-2192 (301-493-8600).
- Nov. 5-8 1990 ANNUAL CIVIL ENGINEERING CONVENTION AND EXPOSITION, MEETING THE NEEDS OF SIX BILLION PEOPLE, San Francisco, CA. Contact: American Society of Civil Engineers Conventions, 345 East 47th St., New York, NY 10017.
- Nov. 8-9 PESTICIDES IN THE NEXT DECADE; THE CHALLENGES AHEAD, Richmond, VA. Contact: Diana L. Weigmann, Water Resources Research Center, Virginia Polytechnic Institute and State University, 617 North Main St., Blacksburg, VA 24060-3397 (703)231-5624.
- Nov. 15-16 WATER MARKETING 1990: MOVING FROM THEORY TO PRACTICE, Denver, CO. Contact: Institute for Advanced Legal Studies, University of Denver, 7039 E. 18th Ave., Denver, CO 80220.
- Nov. 16 ENVIRONMENTAL LAW SERIES, EXPERT WITNESS COURSE, Fort Collins, CO.*
- Nov. 28-Dec. 1 MIDWEST FLOOD PROOFING CONFERENCE AND EXPOSITION, Schaumburg, IL. Contact: Assn. of State Floodplain Managers, P.O. Box 2051, Madison, WI 53701.
- Dec. 3-6 ADVANCED TECHNOLOGY ASSESSMENT, GEOGRAPHIC INFORMATION SYSTEMS, Fort Collins, CO.*
- Dec. 3-7 INSTREAM FLOW, DESIGNING AND CONDUCTING STUDIES USING IFIM, Fort Collins, CO.*
- Dec. 10-14 INSTREAM FLOW, PROBLEM SOLVING WITH THE INSTREAM FLOW INCREMENTAL METHODOLOGY, Fort Collins, CO.*

*Contact: National Ecology Research Center Courses, Office of Conference Services, Rockwell Hall, Colorado State University, Fort Collins, CO 80523; Phone (303)491-7767.

The position is to be filled at the Assistant or Associate Professor level and is a tenure-track position. The position is available January 15, 1990. Rank and salary will be commensurate with qualifications and experience. Applicants should submit a complete resume with names, addresses, and telephone numbers of three references no later than November 15, 1989, to the following: Dr. V. Don Adams, Director, Center for the Management, Utilization and Protection of Water Resources, Tennessee Technological University, P.O. Box 5033, Cookeville, TN 38502.

development activities. It involves the College of Engineering, Arts & Sciences, Agriculture and the Tennessee Cooperative Fisheries Research Unit.

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Foreign Residencies: Provide water resources expertise to the Center's research, teaching and public service roles. Develop long-term research programs in the area of water resources. Develop models to simulate water body dynamics of lakes, reservoirs, streams, cooling ponds, and other aquatic systems using multidimensional mathematical and numerical models. Assist external units for support of a research program in the water resources... and graduate... on modeling aquatic... Applications... in water... have a record of research... to demonstrate... physical... and physical... to obtain a Tennessee professional engineer license within a reasonable period of time.

MEETINGS

1990 ANNUAL AWRA CONFERENCE - THE SCIENCE OF WATER RESOURCES: 1990 AND BEYOND and SYMPOSIUM: TRANSPORTING MODELS TO URBAN & URBAN HYDROLOGY, Denver, CO. Contact: AWA, 2410 University Lane, Suite 120, Bethesda, MD 20814-2102 (301) 462-8600

1990 ANNUAL CIVIL ENGINEERING CONVENTION AND EXPOSITION: MEETING THE NEEDS OF SIX BILLION PEOPLE, San Francisco, CA. Contact: American Society of Civil Engineers, 1801 L Street, N.W., Washington, D.C. 20036

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WATER MARKETING 1989: MOVING FROM THEORY TO PRACTICE, Denver, CO. Contact: Barbara J. Advanced Legal Studies, University of Denver, 1985 E. 14th Ave., Denver, CO 80202

ENVIRONMENTAL LAW SERIES: EXPERT WITNESS COURSE, Fort Collins, CO. *
MIDWEST FLOOD PROOFING CONFERENCE AND EXPOSITION, Schaumburg, IL. Contact: Ann of State Floodplain Manager, P.O. Box 2021, Madison, WI 53701

ADVANCED WATER RESOURCES SYSTEMS, Fort Collins, CO. *

INSTREAM FLOOD PROOFING, Fort Collins, CO. *

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*Contact: National Biology Research Center, Office of Conference Services, Keeswell Hall, Colorado State University, Fort Collins, CO 80523; Phone (970) 785-7161

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