

# COLORADO WATER

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

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## HOW EFFICIENTLY IS WATER USED IN COLORADO?

Neil S. Grigg

A highly controversial water issue in Colorado and the West is whether we use water efficiently. This is clearly seen in the debate over agricultural versus urban water uses. A good example of this debate was seen by many viewers of the Channel 6 presentation on February 15 of the Nebraska ETV water program. To some, agriculture was seen as a low-value use of water; they believe that all we need to do to provide urban and industrial water for the state is to divert irrigation water. Others point out that the value of agriculture is more than direct income from crops.

The call to use water more efficiently comes up periodically in legislation. One of the obstacles to progress is a differing perception of what constitutes "water use efficiency" and how to achieve it. There is a lot of confusion about the term, as well as the related terms "conservation" and "water salvage."

According to Dr. Marvin Jensen, Director of CSU's Colorado Institute for Irrigation Management, water use efficiency has a meaning to professionals in irrigation, but it is often misused. Those who call for increasing agricultural water use efficiency in Colorado are generally seeking to introduce water-saving measures to raise the ratio of water used in crops to the total water diverted. However, irrigation water not used by crops returns to the hydrologic system either as surface or subsurface drainage, and such water-saving measures do not increase the total amount of water available to everyone in a basin.

The term "water use efficiency" is not used often in urban applications because calculating

a ratio of water used to water diverted is complicated by difference in uses; rather the term "water conservation" is widely used to express the goal of using water wisely or "efficiently." Also, utilities measure "unaccounted-for-water" as a rough measure of water lost to sales, and observe the ratio of water returned as wastewater to the original raw water diverted. In that sense, without lawn watering, say in winter, this ratio is quite high, perhaps on the order of 90%, leading some to claim that water conservation in urban areas is not needed since most water returns to the stream anyway. Water conservation in urban areas has two general goals: to reduce consumptive uses by lawns through Xeriscape-type measures, and to cut back on in-house uses to reduce the need for storage reservoirs, treatment plants and pipelines.

The river basin is the most complex unit in which to measure water use efficiency. The basic problem is that in Colorado an over-diversion by one water right owner is not necessarily a waste of water because the water not consumptively used will reappear downstream either as surface return flow, or later as groundwater water recharge to the stream or aquifer system. Such an overdiversion will, however, reduce the amount of water remaining for instream flows. In that sense, it is the same as the city situation: water not consumed reappears in the stream. Irrigation system improvements such as canal lining and trickle irrigation may reduce the amount of diverted water required to irrigate a given farm, but in Colorado's water law system the farmer is not allowed to use the water saved so he has no incentive to reduce the amount of water diverted unless it reduces his operating costs.



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Knowledge about the techniques and impacts of conservation and water salvage is extensive. In the area of urban water conservation, CWRRI has published a number of reports about techniques and Colorado case studies. Bruvold recently reviewed numerous reports and compiled them into a "model" of conservation management (Bruvold, 1988). The American Water Works Association presented a handbook on conservation (American Water Works Association, 1984). Both of these publications list the usual methods: supply enhancement techniques such as metering, leak detection, pressure reduction, and watershed management; and demand measures such as pricing, building code restrictions, water use restrictions and public education.

In the area of agricultural water use knowledge is also extensive. The Council for Agricultural Science and Technology (1988) presented a comprehensive educational booklet on the subject in 1988. They state that discussions about agricultural water conservation are often hopelessly confused by lack of agreement on the nature and benefits of conservation; that water savings almost inevitably occur as a result of price increases for water; and that public policies that seek to increase agricultural water conservation on a basinwide basis will be difficult to implement due to complexity of water rights and management systems.

CWRRI made an investigation of the impacts of improving efficiency of irrigation systems in the lower part of the South Platte Basin (Morel-Seytoux, and others 1979). Based on a computer modeling exercise, the study concluded that introducing water-saving devices on farms would not reduce the amount of water leaving the state and provide more for Colorado water right owners, either senior or junior. The study concluded that better use of ground and surface waters together, in a "management scheme", is the only way to increase total utilization of basin water within Colorado.

In Colorado the concepts of water use efficiency, conservation, and water salvage must be considered within the context of overall water resources planning and management. Since in Colorado the terms "planning" and "management" as they relate to water arouse strong passions, the state needs a better understanding of what they are and what their benefits can be. This requires research, data, collaboration among water users and public education programs.

#### References

American Water Works Association, Before the Well Runs Dry: A handbook for designing a local conservation plan, Denver, 1984

Bruvold, William H., Municipal Water Conservation, California Water Resources Center, Riverside, September, 1988

Council for Agricultural Science and Technology, Effective Use of Water in Irrigated Agriculture, Report 113, Ames, Iowa, 1988

Morel-Seytoux, H.J., T. Illangasekare, M.W. Bittinger and Norman A. Evans, The Impacts of Improving Efficiency of Irrigation Systems on Water Availability in the Lower South Platte River Basin, CWRRI Information Series 33, Ft. Collins 1979.

#### REQUEST FOR WATER RESEARCH PROPOSALS

CLOSING DATE: March 17, 1989

Preproposals are invited for the Colorado Water Resources Research Institute FY 1989-90 water research program. The program supports research to help solve important Colorado water problems such as the following list which has been identified by the Institute's Research Planning Advisory Committee:

Conjunctive management of surface and groundwater

Economic value of nonconsumptive water uses

Economics of alternative strategies for fishery enhancement

Fate of metals in Colorado streams

Technology for new uses of the satellite stream monitoring system

Improvement in drought forecasts

Improvement in runoff forecasts: flood late season

Preservation of wetlands: economic costs and benefits

Improvement in urban storm runoff control measures

Biological effects of metals on aquatic organisms

Streamflow criteria for flow-based discharge permits

Reclamation of polluted groundwater

Evaluation of impacts of water exports on basin-of-origin

Technology for efficient groundwater recharge

In addition, research is needed to improve: Colorado water law, policies and institutions; water management and decision making; water-use efficiency; water quality and the protection of the environment, instream flows and agriculture. Preproposals on these general topics are welcome.

#### Project Duration

Awards will be made for one year beginning September 1, 1989.

#### Funds Available

For 1988-89 CWRRI awarded eight projects with direct costs in the range of \$20,000 each. This year we expect to award about the same number of projects subject to the availability of state and federal funds.

#### Indirect Costs/Cost Sharing

Indirect costs must be provided as a cost sharing contribution by the performing institution. In 1989-90 federal requirements for cost sharing go to 2:1. Depending on state funds made available by the General Assembly CWRRI may have to ask investigators for



additional cost sharing beyond indirect costs. Matching university researchers with participants from state and local government to provide in-kind matching can meet this need, and CWRRI can suggest possibilities to potential investigators who would like to explore this possibility.

#### Review Procedure

Preproposals will be evaluated by the Technical Advisory Committee (faculty of CU, CSM and CSU) and by the Research Program Advisory Committee (practitioners). Authors of preproposals judged to have a strong chance of final award will be invited to prepare full proposals. Criteria of selection include relevance of research product to priority Colorado water problems, scientific merit, and performance record of principal investigator.

#### Eligibility

Open to regular, full-time faculty of the University of Colorado, Colorado School of Mines and Colorado State University. Preproposal format can be obtained from CWRRI; Office of Sponsored Programs, Colorado State University; Office of Contracts and Grants, University of Colorado; and Office of Research Services-Proposals, Colorado School of Mines.

#### WATER SUPPLY OUTLOOK

After a dry summer and fall, with above normal temperatures, water supply conditions have fared well. Several major winter storms have brought enough moisture to the state to bring snowpack and precipitation levels to the slightly below normal mark. Water stored in the state's major reservoirs continues to be above average, even after a fairly dry water year in 1988. Assuming that near normal weather conditions prevail during the remainder of the winter season, water supplies should be adequate for most locations in Colorado.

Source: USDA, Soil Conservation Service

#### NATURAL EVOLUTION MAY DECREASE SALT AND SEDIMENT IN COLORADO RIVER

The Colorado River is becoming clearer due to a natural decrease in sediments and salts delivered to the river, say investigators. Stanley Schumm, Professor of Earth Resources at Colorado State, and U.S. Geological Survey researchers Allen Gillis and Richard Hereford surveyed 55 years of records from water monitoring stations maintained along the river by the USGS. Schumm said the Colorado is recovering naturally from a period of human development that caused land erosion and the pouring of sediment from its tributaries into the river. With increased vegetation, new flood plains and increased sediment storage, the Colorado River is clearing through a process of natural evolution. This process could save taxpayers millions of dollars in water treatment costs and greatly prolong the life of reservoirs like Lake Mead and Lake Powell, Schumm said.

Source: The Coloradoan, January 17, 1989

#### SCHOLARSHIPS AVAILABLE FOR GROUNDWATER STUDIES

Students interested in groundwater resources should contact the American Ground Water Trust. The nonprofit organization awards scholarships of up to \$2,000 for undergraduate studies relating to groundwater. Applications must be submitted by April 1 for the 1989-1990 academic year. Forms can be obtained by sending a self-addressed, stamped envelope to the American Ground Water Trust, Scholarship Program, 6375 Riverside Dr., Dublin, OH 43017.

#### CONSORTIUM FORMED TO ASSESS EFFECTS OF YELLOWSTONE FIRE

Colorado State University will join ten other western universities and four federal agencies in a consortium formed to assess the effects of last summer's fire in Yellowstone National Park. Jay Hughes, Dean of the College of Forestry and Natural Resources at Colorado State, is a member of the consortium's coordinating committee. It will promote communication among scientists who will investigate such topics as vegetation, wildlife biology, geology, hydrology and watersheds, fire science and socioeconomic questions.

Ram Page, March 1989

#### WHAT IS COLORADO'S DAILY WATER CONSUMPTION?

The U.S. Geological Survey estimates that an average 20,800 million gallons per day (mgpd) of water were used in Colorado during 1985. Of this quantity about 60 percent (12,400 mgpd) was used for irrigation and 35 percent (7,390 mgpd) was used for power generation. The remaining 5 percent was used for commercial, domestic, industrial, livestock, mining and other uses. Most water was used in Montrose (3,260 mgpd), Mesa (1,940 mgpd), and Gunnison (1,520 mgpd) Counties. The predominant water uses in these counties were hydroelectric power and irrigation. Among hydrologic subregions in Colorado, most water was used in the Gunnison (5,630 mgpd) and South Platte (4,350 mgpd) subregions; hydroelectric power water use was predominant in the Gunnison while irrigation water use was predominant in the South Platte.

Microfiche and paper copies of the report, "Estimated use of water in Colorado, 1985," by David W. Litke and Cynthia L. Appel, USGS Water Resources Investigations Report 88-4101, may be obtained from the U.S. Geological Survey, Books and Open-file Reports, Federal Center, Box 25425, Denver, CO 80225-0425. Microfiche: \$4.00; paper copy: \$25.50.

#### SURGE IRRIGATION GUIDE AVAILABLE

The Surge Irrigation Guide, a 9-page bulletin on how to apply surge irrigation, is now available. Obtain from:

Bulletin Room  
171 Aylesworth Hall  
Colorado State University  
Fort Collins, CO 80523

Price: \$3.75. Ask for Bulletin No. 543.



## COLORADO WATER ENGINEERING AND MANAGEMENT CONFERENCE

Colorado State University  
Program

By the time you read this newsletter the conference will have ended, but for your information interest program topics and names of speakers are listed below. Abstracts of papers presented at conference will be included in future issues of COLORADO WATER.

Monday, February 27, 1989

### Session 1: Water Policy Issues

Water and Colorado's Economy--S. L. Gray  
The Increasing Importance of Water Transfers and the Need for Institutional Change--C. W. Howe  
Metro Water Supply Issues--William H. Miller  
Colorado Environmental Issues--Dan Luecke

Luncheon Speaker: Cooperation as a Method to Solve State Water Problems--Marshall Kaplan

### Session 2: State Water Issues

State Water Policy Issues--J. William McDonald  
Evaluating Water Use Efficiency--Marvin Jensen  
Water Management Issues in Colorado--Jeris Danielson  
CWRPD Authority Financing Responsibilities--Uli Kappus

### Session 3A: Urban Water Supply Management

How Water Professionals Look at Conservation-A Preliminary Report--Loretta Lohman  
Factors Affecting Residential Water Demand in Colorado--Laurie L. Walters and Robert A. Young  
Water Supply Development for the Upper Cherry Creek Basin: Providing a Basis for Decisionmaking--  
Ralph L. Kerr and Frank Jaeger

### Session 3B: Stormwater and Flood Control

Challenges in Initiating a Stormwater Management Program--William P. Ruzzo and D. Earl Jones  
Financing Stormwater Systems--Roger E. Krempel  
Where is Urban Stormwater Management Today--Jonathan E. Jones and D. Earl Jones, Jr.  
Flood Frequency Analysis for Colorado Foothills--J.D. Salas and X. Guo

### Session 3C: Water Quality Regulation and Control

Antidegradation--A New Level of Water Quality Control--Jerry W. Raisch  
A New Approach to NPDES Permitting--Cynthia L. Paulson  
South Adams County Water and Sanitation District's Response to Groundwater Contamination--Larry  
L. Ford and Randall J. Krueger  
Denver South Platte Water Quality and Wastewater Management Study--Russell N. Clayshulte

Tuesday, February 28, 1989

### Session 4A: Water Planning and Management

Salinity Impacts and the Complexity of Water Resource Management--Loretta C. Lohman  
Drought Planning: A Complete Plan: "Experiences from the U.S."--Peter M. Macy  
Economics of Optioning Agricultural Water Rights for Urban Water Supplies During Drought--Arl  
Michelsen and Robert A. Young  
Increasing Beneficial Use of South Platte Water: Hydrologic and Economic Costs of Changing  
Irrigation and Farming Practices--Jim Booker and Robert A. Young

### Session 4B: Water Rights Engineering/Management

Myths in Water Rights Engineering--Ralph L. Toren  
Evaluation of South Platte River Call Data--Brent E. Spronk and Dick Wolfe



Actual versus Potential Water Consumption by Native and Lawn Grasses at High Altitudes--Edwin D. James and Norman C. Carlson  
 Water Rights and Reservoir Management Software--Gail Lucas

#### Session 4C: Environmental Management

The Environmental Protection Agency's Wetlands Protection Program--Gene R. Reetz  
 Wetlands Evaluation--J. Ernest Flack and Eugene V. Humbles, Jr.  
 Blue River Reclamation Project--Joseph C. Roesser, Jr.  
 Rock Creek/Muddy Creek - Case History of NEPA Compliance for a Colorado Dam Project--Peter F. Lagasse and David E. Merritt

#### Session 5A: Computer-Based Water Planning

Computer-Aided Planning for Multiple-Purpose Reservoir Operations Policies--Lynn E. Johnson  
 Description and Demonstration of a River-Basin Water-Management Model - Water Supply Aspects--Gregory A. Nelson, Doug Cain and Alan W. Burns  
 Value and Role of Computer Models for River Basin Management--H. J. Morel-Seytoux, Jorge L. Restrepo and Cinzia and Miracapillo

#### Session 5B: Water Transfers/Exchanges and Basin Administration

The Characteristics of Water Transfers in Colorado: A Preliminary Report--Chuck Howe and Larry MacDonnell  
 Maximizing the Use of Existing Water Supplies - The Colorado Springs Arkansas River Exchange Plan--Phillip H. Tollefson and Lloyd J. Gronning  
 Role of Water Rights Valuation in River Basin Management--Leo M. Eisel  
 River Administration on the Pine River, La Plata County CO--Kenneth A. Beegles

#### Session 5C: Management of Non-Point Sources

Non-Point Source Pollution Control: Review of Efforts of the State of Colorado--Greg Parsons and Paul Sorensen  
 Water Quality Protection and Implementation of the State's Mining Policy--J. David Holm, Bob Shuckle and Pat Nelson  
 Colorado River Salinity Control Program: A Model for Water Conservation Efforts--Stephen K. Chick

Luncheon Speaker: Water Management in Egypt: CSU Programs--Daniel K. Sunada

#### Session 6A: Project Planning and Management

Guidelines for Water Project Planning--William E. Green  
 Administrative Frameworks for Regional Water Service: Selected Case Studies--Edward F. Harvey  
 Recent Evaluations of Potential Colorado Pumped Storage Projects--Blaine Dwyer  
 The Breaching of Green Lakes No. 2--Douglas M. Yadon, James G. Kuiken and Steven Miller

#### Session 6B: River, Ditch and Canal Management

South Platte River Degradation North of Denver--Ben Urbonas, Kenneth R. Wright and Ronald L. Rossmiller  
 Determination of Transit Losses for Transmountain-Water Return Flows in Fountain Creek, East Central Colorado--Gerhard Kuhn  
 Surging Out of Concrete Ditches--John S. Brenner and Richard C. Bartholomay  
 Irrigation Management With Gypsum Blocks--Wes Robbins

#### Session 6C: Monitoring and Data Management

Discovery of Toxicants in Colorado and Montana Streams Using "Biomonitoring" Techniques--Del Wayne R. Nimmo, Max H. Dodson, Joseph C. Greene, Robert McConnell and Mark A. Kerr  
 A Software Package for Analyzing Water Quality Data on Microcomputers--Jim C. Loftis  
 Groundwater Animals of Alluvial River Systems: A Potential Management Tool--J. V. Ward and J. A. Stanford



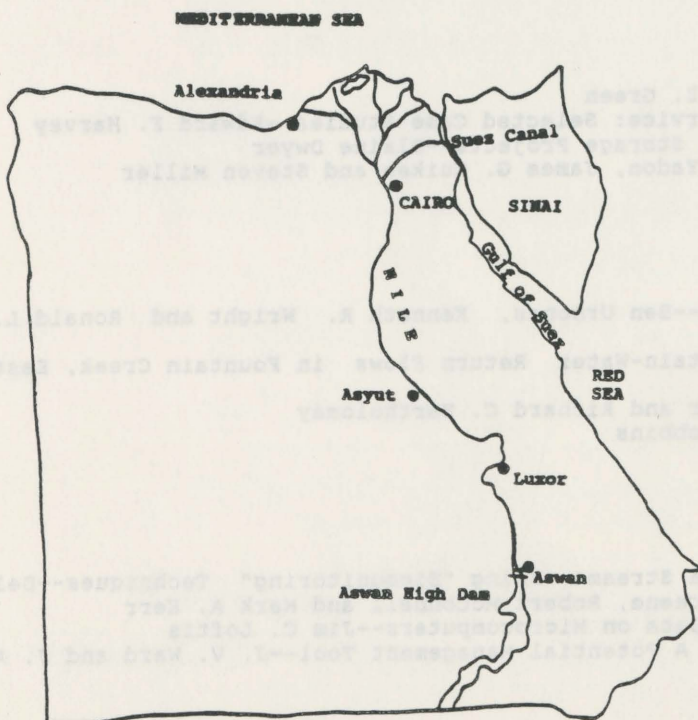
**COLORADO STATE UNIVERSITY CHOSEN TO HELP DEVELOP  
EGYPT'S WATER RESEARCH CENTERS**

A \$25 million grant awarded to Colorado State University in December, 1988 will provide funds to help Egypt increase agricultural production, reduce its food production gap, and improve the social and economic welfare of its people.

Egypt's Ministry of Public Works and Water Resources established a Water Research Center (WRC) Project in 1975 to centralize its water research efforts and provide recommendations to control, use and develop its water resources. Under WRC administration are eleven water research institutes that will focus on specialized aspects of water resources research. Colorado State University will assist in developing the capabilities of the eleven institutes by helping to define research needs, providing technical assistance, and developing a water management policy. Dr. Everett V. Richardson, the project technical advisor and Civil Engineering Professor at Colorado State University, has devoted the past eleven years to improving irrigated agriculture in Egypt. He will be assisted by Dr. Daniel K. Sunada, campus coordinator and training specialist, who has been an engineering consultant to Egypt during the last eleven years.

The program will focus on training Egyptian personnel, providing technical assistance and procuring research equipment. U.S. specialists will work with staff from Egyptian universities and other institutions to provide a variety of in-country training. The program will include short courses, seminars, workshops, and on-the-job daily interaction with technical assistance staff at the eleven research institutes located throughout Egypt.

Without the Nile River, much of eastern Egypt would be unclaimed desert. The river rises in Lake Victoria and, swollen by summer rains, flows north through Sudan and Egypt emptying into the Mediterranean Sea at Alexandria. Overflowing eight to twelve miles on either side in its downward course, for centuries it has enriched



Egypt's delta area near Cairo with thick alluvial deposits. With dams built since the beginning of the 20th century Egypt has reclaimed more than seven million acres of land from the desert. The delta has three major crop-producing areas: a vegetable-producing area serving the Cairo market; a major cotton and rice producing region; and an upstream area producing beans, cotton, sugarcane, and other crops.

In western Egypt's desert are five large oases that receive water from porous sandstone beds where water rises through natural fissures. Here olive trees, date palms, and coffee trees grow together with cotton and an assortment of other crops: wheat; corn; barley; millet; lentils; beans; rice; sugarcane and fruits. About 60 percent of the farms are one acre or less and the remainder one to five acres, but the rich soil makes the small holdings highly productive.

To increase the efficiency and effectiveness of water use in Egypt, each of the following research institutes will be provided technical assistance in its specialized aspect of water research.

**Water Distribution and Irrigation Systems Research Institute**--design, analyze and evaluate irrigation systems; enhance farmer acceptance of improved irrigation systems; evaluate benefit-cost of different irrigation technologies; and assist with crop water use to determine optimal irrigation practices.

**Aquatic Weed Control and Channel Maintenance Research Institute**--improve maintenance and monitoring techniques; advise on physiological response of fish to water pollution, salinity and ectoparasites; advise on lining materials and installation techniques; and advise on herbicide use for minimal costs and environmental effects.

**Drainage Research Institute**--evaluate crop yields and drainage problems, installation and maintenance procedures; develop simulation models for irrigation and drainage; evaluate water and water-balance budgets for different areas of the Nile Valley; establish a monitoring program to evaluate crop-productivity changes that result from improved drainage practices and evaluate interrelationships of irrigation, water use, salinity, fertilizers and pesticides.

**Groundwater Research Institute**--analyze water quality and identify sources of groundwater pollution; assess the environmental impact of groundwater development in the delta and desert areas; develop cost-benefit analyses of groundwater in desert areas; and evaluate management techniques.

**Water Resource Development Research Institute**--provide help in data collection and analyses in arid lands including rainfall and runoff and amount of water available; and develop and use computer models to evaluate groundwater flow.

**High Aswan Dam Side Effects Research Institute**--analyze and forecast sediment transport and evaluate sediment removal or deposition in Lake Nasser and the Nile River.



Hydraulics and Sediment Research Institute--evaluate scour sedimentation in model studies of large structures which may be constructed on the Nile River or in major canals; develop model studies of coastal protection structures; and assist in design and analysis of locks and other river and canal facilities.

Survey Research Institute--assist in computer applications of digital mapping, automated cartography and aerial surveying.

Mechanical and Electrical Research Institute--test large and field-sized irrigation and drainage pumps and provide assistance in assessment and selection of large discharge, low-head hydropower turbines.

Coastal Protection Research Institute--assist in the analysis and prediction of shoreline degradation and its effects, in the selection and use of materials for shoreline protection, and identification of needed instrumentation to monitor the performance of coastal facilities.

Soil Mechanics and Foundations Research Institute--assist in establishing criteria standards for concrete quality-control and the selection of building materials.

USAID's development and technical assistance program in Egypt is described as a model for U.S. aid in the 1990s in a January 6, 1989 Wall Street Journal article. It is compared to America's post World War II Marshall Plan that revived the economies of Western Europe. The article describes successes in the areas of agricultural support, local development, education, health and family planning. Egypt, says the article, is a major demonstration of what can be accomplished when enough foreign aid is spent on the right projects in one country.

#### GROUNDWATER RESEARCH DESCRIBED FOR COMMISSION

At the November 18 meeting of the Colorado Groundwater Commission, Institute Director Neil Grigg outlined ongoing groundwater-related research activities at the Institute and Colorado State University. The Institute's 1988-89 program includes the following five groundwater research projects:

Efficient Estimation of Water Supply Augmentation Needs in Real Time Allocation Operations--H. J. Morel-Seytoux, Colorado State University

Surface and Groundwater Pollution Potential from Herbicide Use in Colorado Agriculture--Jim Loftis, Colorado State University

Biological Denitrification of Polluted Groundwater--JoAnne Silverstein, University of Colorado

Enhanced Microbial Reclamation of Groundwater Polluted with Toxic Organic Chemicals--Steven K. Schmidt, University of Colorado

Improved Methods for Modeling Conjunctive Management of Surface and Groundwater--Eileen Poeter, Colorado School of Mines

He also described other research that groundwater specialists have underway at Colorado State University. In three separate projects David McWhorter, Agricultural and Chemical Engineering Department, is investigating chlorinated solvents in groundwater, acid production from abandoned

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mine pumps, and hydraulic properties and water flow in spent oil shale. He is also analyzing samples from the Denver Basin Aquifers to determine if the groundwater supply can support the anticipated development of Colorado's Front Range. This project was authorized by the Colorado Legislature and is funded through the Colorado Water Conservation Board. Another project concerns the development of a new laboratory method for measuring two-phase hydraulic properties of porous media.

Jim Warner, Civil Engineering Department, has two projects in progress related to the Rocky Mountain Arsenal: developing an operational management model of the Arsenal's north boundary system and off-post remedial modeling. In a third project, Warner is investigating gasoline spill remediation from leaky tanks.

#### ENGINEERING NEWS RECORD RECOGNIZES CONTRIBUTION OF COLORADANS

Two Coloradans were cited among "those who made marks in 1988" in the January 5 issue of Engineering News Record. Levent Ozdemir, Colorado School of Mines, was recognized for research that produced a 6.5 ft.-diameter tunnel boring machine that drives at a speed of 123 ft. per hour through medium-strength rock (about 6 times the normal rate in such material). The design of the machine's cutter head is based on extensive computer modeling of force distribution; a computer precisely controls thrust, rotation and steering. Jeffrey C. Allen was named for supervising the construction of a sizable dam on the Yampa River south of Steamboat Springs in only 37 days. Allen is project manager for ASI RCC Inc., Buena Vista, Colorado. The contractor's crew worked two ten-hour shifts seven days a week to squeeze 45,000 cu. yds. of concrete into the canyon, resulting in a structure 150 ft. high and 375 ft. long.

Another who "made a mark in 1988" established a causal link between the nation's dwindling investment in infrastructure projects and its sagging growth in productivity. A study by David A. Aschauer, senior economist at the Federal Reserve Bank of Chicago, bolstered the construction industry's argument that vital public works improvements must have higher financing priority.

#### STUDENT INTERNS AT WATER INSTITUTE

Three student interns are undertaking projects this semester at CWRI related to water research and technology transfer. The trial program seeks to increase interest among students in Colorado water issues as well as to carry out projects.

The three CSU students are: Linda Li, Joe Pollara and David Thaumert. Linda is a junior Civil Engineering student. She has experience working with her father's engineering firm in California and Taiwan. Joe recently finished his B.S. degree in Chemical Engineering, and seeks a M.S. in agricultural engineering, with possible plans to attend law school at CU and major in resource issues. David is a senior in agricultural engineering and has a side interest in publishing. His father is a well-known water engineer in Northern Colorado.



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The main project of the interns is to compile data that may be used to publish a Colorado water atlas or data book that could be used by water engineers and managers. The need for and the data that would go into such a publication is being studied this semester. Also, the interns are preparing a compilation of water use and yield data for the state (state water balance) and a background document on Colorado State's contributions to water management in the state. Agencies or persons with ideas or suggestions about these projects are encouraged to contact CWRPI.

#### USGS REPORTS PROGRESS IN PILOT PROGRAM, OUTLINES CONCEPTS FOR NATIONAL WATER QUALITY ASSESSMENT PROGRAM

Water quality has emerged as one of the Nation's most serious environmental problems, and estimated expenditures for water pollution abatement and control through the year 2000 may be as high as \$600 billion, according to the U.S. Geological Survey.

To provide an evaluation of the diverse water quality conditions that occur in the U.S., the Department of the Interior in 1986 began pilot, four-year water quality assessment projects in seven key river and groundwater basins across the country. The three study areas selected for groundwater studies were the Western Nevada Basin extending into eastern California; the Garber-Wellington aquifer in central Oklahoma; and the Delmarva peninsula covering parts of Delaware, eastern Maryland and eastern Virginia. Surface-water pilot project areas were the Upper Illinois River Basin, the Kentucky River Basin, the Kansas River Basin and the Yakima River Basin in Washington.

Progress made in the pilot program is contained in a report released by the U.S. Geological Survey in December which also outlines concepts for a National Water Quality Assessment Program. The proposed program would focus primarily on a regional scale and emphasize changes and trends over a period of years. It would not preempt the need for detailed studies that focus on local issues, but would provide data on a national scale that examines trends in the national surface and groundwater picture.

At its conclusion in 1990 a committee of the National Academy of Sciences will evaluate the pilot program and make a decision about moving to full-scale implementation.

Copies of the report, "Concepts for a National Water-Quality Assessment Program" by Robert M. Hirsch, William M. Alley and William G. Wilber, released as USGS Circular 1021, are available free upon request from the Books and Open-File Section, U.S. Geological Survey, Box 25425 Federal Center, Bldg. 810, Denver, CO 80225.

#### MAN-MADE MARSH CLEANS MINE WASTE

A researcher from the Colorado School of Mines is utilizing a constructed wetland to experiment with a process that can clean up wastewater from abandoned metals mines at just a fraction of the normal costs. Chemistry Professor Tom Wildeman built a small concrete structure and filled it with organic material and plants such as cattails to create a miniature swamp. Water from an old gold mine near Idaho Springs,

located some 30 miles west, is funneled into the downsized wetland and it comes out clean.

Some coal mines in the East have been using wetlands for cleanups, but until now it was always a "black box" situation, Wildeman said. Now, he has been able to pinpoint the processes at work. Aerobic and anaerobic bacteria are reducing the oxidized metals from sulfates to sulfides and then depositing the metals into the soil. Most metal ores exist as sulfides, so the bacteria are in essence creating a new mineral deposit.

Heavy metals can be removed from water through complex physical and chemical processes involving large consumption of electricity, and thus high costs. But with abandoned mines scattered throughout the Colorado Mineral Belt, leaking pollution and threatening the state's fisheries, the cleanup cost may prove staggering. Wildeman will next figure out how much wetland is needed to treat a given quantity of water.

Source: U.S. Water News, January 1989

Wildeman was principal investigator of an Institute project in 1981 that resulted in a publication titled, *A Water Handbook for Metal Mining Operations* (Institute Completion Report No. 113).

#### HYDROLOGIC CONDITIONS EVALUATED AT PINYON CANYON MANEUVER SITE

Existing hydrologic conditions at the U.S. Army Pinon Canyon Maneuver Site, prior to the commencement of military maneuvers, are documented in a new U.S. Geological Survey report. The report includes a description of groundwater and surface-water resources of the area. The study includes a description of the Dakota-Purgatoire aquifer.

Streamflow was measured at a network of 11 streamflow-gaging stations including the Purgatoire River, Chacuaco Creek, and streams draining the maneuver site. Groundwater samples were collected from 24 wells in the area. Analysis of the samples indicates that groundwater and surface water in the area has large concentrations of dissolved solids. Sediment yields were measured at a network of 29 small watersheds, 22 of which were located on the maneuver site.

The USGS report was prepared in cooperation with the U.S. Department of the Army, Fort Carson Military Reservation. Its title is "Hydrology of the U.S. Army Pinon Canyon Maneuver Site, Las Animas County, Colorado," by Paul von Guerard, P.O. Abbott and R.C. Nickless, and it is published as Water-Resources Investigations Report 87-4227.

Microfiche and black and white paper copies of the report may be obtained from the U.S. Geological Survey, Books and Open-File Reports Federal Center, Box 25425, Denver, CO 80225-0425.

#### 300-YEAR WATER GUARANTEE LAW UPHELD

The Colorado Court of Appeals has upheld an El Paso County Development Code requiring developers of the Plains area east of Colorado Springs to show they can provide water to a proposed subdivision before the subdivision is



approved. Five developers had challenged the subdivision regulation adopted in November, 1986 by the El Paso County Board of Commissioners.

Dennis Bode, water resources and planning manager for Fort Collins, said local developers in Fort Collins are required to supply raw water in varying amounts depending on the density and lot sizes in the development. Bode said he believed the El Paso County case hinged on groundwater supplies from underground aquifers, while Fort Collins depends on streamflow supplies that are considered perpetual.

Source: Denver Post, Coloradoan and news services

#### PROPOSED FEDERAL BUDGET LIMITS WATER PROJECT FUNDS

Former President Reagan's proposed budget includes no money to begin building Animas-La Plata but provides \$3.7 million for preconstruction activities, thus pushing the start of construction to the mid-1990s. The Reagan budget includes \$41 million for continued construction of the Dolores water project, up \$26 million from last year. By contrast, the Central Arizona Project would receive \$218 million and the Central Utah project \$135 million.

The Interior proposal also would cut millions of dollars from payments for mineral and timber production on federal lands by deducting more than \$145 million in federal fire-fighting costs before royalties are shared with states and counties.

Source: Denver Post, January 10, 1989

#### FOREST SERVICE NAMES SIX COLORADO RIVERS FOR WILD AND SCENIC STATUS

Congress is expected to consider legislation for additional river protection measures in this year's session, perhaps including Colorado, and the U.S. Forest Service has named six Colorado rivers that have the "outstandingly remarkable" features needed to qualify for wild and scenic status. They are: a 57-mile stretch of the Conejos River; 20 miles of the Encampment; 29 miles of the Elk; 32 miles of the Piedra; 54 miles of the Los Pinos and 105 miles of the Dolores. The Forest Service said it will also further study 23 miles of the South Platte, 14 miles of the North St. Vrain, 40 miles of the Crystal and 38 miles of the White River's south fork for possible recommendation. The designated area of the South Platte isn't believed to be threatened by the proposed Two Forks Dam.

At its 1989 annual meeting on January 30, 1989 the Colorado Water Congress voted to forward its 1988 Resolution urging Congress to amend the Wild and Scenic Rivers Act:

- (a) to require concurrence of the legislature in the State in which the segment of said river to receive designation as wild and scenic is located; and
- (b) to clarify that said Wild and Scenic Rivers Act was not intended to interfere with present or future beneficial use of waters available pursuant to the law of the State in which said river segment is located.

#### FEDERAL STUDY SAYS PROTECTION OF DENVER BASIN AQUIFERS IS TOP PRIORITY

The Advisory Committee of Environmental Strategies for Metro Denver ranks protection of Denver's bedrock aquifers as one of the Metro area's top five environmental concerns. Committee members--local community leaders and technical experts--conducted an 18-month assessment of Denver's environment. In its report it lists the following recommendations and needs related to groundwater:

- \* Development of a statewide groundwater contamination prevention program.
- \* More data collection on current and potential groundwater use and contamination.
- \* More consideration by local governments to impacts of land use and building permit decisions on groundwater quality.
- \* Development of a statewide program to regulate underground storage tanks and cleanup of leaking tanks.

The study was sponsored by the U.S. Environmental Protection Agency.

Source: Denver Post, January 30, 1989

#### WATER CONSERVATION GROUP FOSTERS COORDINATION, COOPERATION

In 1985 Denver area water suppliers and other organizations concerned with the area's water resources formed a non-profit organization known as Metro Water Conservation, Inc. The group's establishment resulted from a recommendation by the Water Conservation Committee of Governor Richard D. Lamm's Metropolitan Water Roundtable. That committee, made up of representatives of the various interest groups, called for a "metro-wide coordinated approach based on a cooperative arrangement among the water utilities."

The organization's goals are to:

- \* identify and recommend ongoing conservation programs which may be implemented more effectively through a shared metro-wide effort;
- \* explore and develop new conservation measures on a shared metro-wide basis;
- \* develop methods for monitoring conservation programs in order to document conservation savings;
- \* develop and implement specific water conservation programs for and on behalf of any member or group of members on a contractual basis;
- \* publicize conservation programs which are effective, citing specific statistics on water savings which can be achieved through such programs; and
- \* foster better communication on water conservation between Metro Water Conservation, Inc. and the general public.



10.

Kim Hout, a water conservation specialist for the City of Aurora, was elected chairman of the group in January. Valeria Smith of Lakewood was named vice chairman, and Bill Miller, manager of the Denver Water Department, secretary-treasurer.

For more information about corporate or individual membership, contact Metro Water Conservation, Inc., 1470 South Havana, Suite 400, Aurora, CO 80012 (303)695-7387.

Source: Metro Water Conservation, Inc.

**THOMAS E. CAHILL NAMED  
EXECUTIVE DIRECTOR OF WYDA**

Thomas E. Cahill has been appointed Executive Director of the Wyoming Water Development Association. George Bartholomew, President of the Association, made the announcement. Cahill is former Executive Director of the Western States Water Council, served as General Counsel of the National Commission on Water Quality, and was Director of Legal and Public Affairs of the Eastern Division of Peabody Coal Company.

**MDWA PRESIDENT RE-ELECTED  
FOR THIRD TERM**

Larry Berkowitz, Littleton City Attorney, has been re-elected to his third one-year term as president of the Metropolitan Denver Water Authority. Julia Robinson, Grant Water and Sanitation District, was re-elected vice president. MDWA was formed in 1985 to provide financing for the proposed Two Forks Dam and Reservoir.

**METROPOLITAN WATER PROVIDERS  
ELECT NEW CHAIRMAN**

Bill Van Schooneveld was elected chairman of the Metro Water Providers at its annual meeting December 1 in Lakewood. Van Schooneveld is the second Providers' chairman in its six-year history. Virgil Hill, chairman of the organization since its inception, will continue to serve on the Providers' Executive Committee. Tom Griswold, Director of Utilities for the City of Aurora, was elected vice chairman. The meeting was attended by nearly 100 metro area municipal and water supply agency officials.

**PESTICIDE CONFERENCE WILL PRESENT  
RESEARCH FROM ACROSS THE NATION**

Researchers from 23 states, District of Columbia and Canada will discuss a variety of current pesticide issues during the Virginia Water Resources Research Center's Pesticides in Terrestrial and Aquatic Environments, May 11-12 in Richmond, Virginia. Topics will include pesticide monitoring in ground and surface waters and terrestrial environments, environmental effects of pesticide use, risk assessment, pesticides in water supplies and wastewater sludge, management techniques for nonpoint source pollution control, pesticide waste disposal, cost-benefit analysis of water quality impacts, case studies of pesticide pollution, and environmental regulations.

The conference will be held at the Hyatt Richmond with special rates for conference participants. Call (804)285-1234. Registration fees are \$120 for pre-registration, \$135 late registration (after April 21). For more information contact the Virginia Water Resources

Research Center, 617 North Main Street, Blacksburg, VA 24060 at (703)961-5624 or (703)231-5703.

**CALLS FOR PAPERS**

Association of State Dam Safety Officials 6th Annual Conference, October 1-5, 1988, Albuquerque, NM. ASDSO invites all persons interested in the safety of dams to submit abstracts of papers to be considered for presentation at the ASDSO Sixth Annual National Conference. Abstracts should be one page, single-spaced, include paper's title and authors' names and their affiliations. Biological sketches must accompany abstracts; resumes. Include full mailing address and telephone number. Deadline: March 15, 1988. Submit abstracts to:

Association of State Dam Safety Officials  
P.O. Box 55270  
Lexington, KY 40555-5270

For information contact: Lori Spragen  
ASDSO Executive Director at (606)257-5140.

International Conference on Metals in Soils, Waters, Plants and Animals, April 30-May 3, 1990, Orlando, FL. Papers are invited on the sources, pathways, behavior, fate and effects of metals and metalloids in soils, waters, plants and animals. Deadline: March 15, 1989. Contact:

Dr. Domy C. Adriano  
International Conference on Metals  
Savannah River Ecology Laboratory  
Drawer E  
Aiken, SC 29802

**1988 AGRICULTURE YEARBOOK,  
IWRA PROCEEDINGS  
NOW AVAILABLE**

Marketing U.S. Agriculture is the title of the newly released 1988 Yearbook of Agriculture. This 336-page hardback examines each link in the agricultural marketing chain and highlights technological and social changes affecting the system. Copies are available for \$9.50 from the Superintendent of Documents, Washington D.C. 20402-9371.

Proceedings from the Vith IWRA World Congress are now available in a four-volume set. Vol. 1 involves training and education, special sessions, and a summary of the conference. Vol. 2 contains papers on hydrology and groundwater, climate and energy. Vol. 3 pertains to agriculture irrigation and drainage, and the environment. Vol. 4 is on water supply and social economic aspects. Price: \$50 per volume, or set of 4 for \$150.

Also available is the Proceedings from the Seminar on Contracting and Construction of Large and Small-Scale Hydraulic Works held in Rome, Italy on September 7-12, 1987.

Order from:

International Water Resources Association  
University of Illinois  
205 North Mathews Street  
Urbana, IL 61801



### COLORADO WATER RESEARCH

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

Arkansas Valley Water Management Project, Frank C. Schweissing, Arkansas Valley Research Center, 27901 Road 21, Rocky Ford, CO 81067

Carbon Isotope Ratio and Production of Dry Beans Under Water-Limiting Environments, Mark A. Brick, Agronomy Department, Colorado State University

Economic Impacts of Alternative Water Allocation Institutions in the Colorado River Basin, Robert A. Young, Agricultural and Resource Economics, Colorado State University

Assessment of the Aquatic Resources of Agate Fossil Beds National Monument, Terry Boyle, National Park Service, Colorado State University

Processes of Community Development and Responses of Ecosystems to Climate Change, John C. Moore, Natural Resource Ecology Laboratory, Colorado State University

Investigation of Sprayer Control System Operations to Improve Pesticide Application, Paul D. Ayers, Agricultural and Chemical Engineering Department, Colorado State University

Hydrologic/Cloud Studies, David A. Randall, Atmospheric Science, Colorado State University

Application of Computer Modeling Techniques for Management of Water Resources, Marshall Flug, National Park Service, Colorado State University

Model for Regional Solute Transport Suited for Calibration and Management, H. J. Morel-Seytoux, Civil Engineering Department, Colorado State University

Seismic Behavior of Tiedback Retaining Walls, Thomas J. Siller, Civil Engineering Department, Colorado State University

Slow Sand Filter Design Manual, David W. Hendricks, Civil Engineering Department, Colorado State University

General Analysis of Allocation of Flow Increases, H. J. Morel-Seytoux, Civil Engineering Department, Colorado State University

Central Region Fisheries Inventory, Stephen A. Flickinger, Fishery and Wildlife Biology, Colorado State University

Warmwater Fish Culture -- Channel Catfish, Stephen A. Flickinger, Fishery and Wildlife Biology, Colorado State University

The Effect of Base-Level Change on Fluvial Processes, Sedimentation and Erosion Control, Stanley Schumm, Earth Resources Department, Colorado State University

Relation of Stream Flows to Fish Population Abundance, Eric Bergersen, Fishery and Wildlife Biology, Colorado State University

Study of the Physics and Development Theory of Infiltration for Improved Irrigation, Paul D. Ayers, Department of Agricultural and Chemical Engineering, Colorado State University

Indirect Electrolysis Process for Removal of Pollutants from Coal Liquids, Carl Koval and Richard Noble, Chemistry and Biochemistry Department, University of Colorado

Characterization and Mapping of Mine Waste at Leadville, Colorado Using Imaging Spectroscopy, Fred Kruse, Cooperative Institute for Research in Environmental Sciences, University of Colorado

Sediment Flux, Along a Fiord-Shelf Transect, East Greenland, John Andrews, Institute of Arctic and Alpine Research, University of Colorado

Mammoth Lakes Michelson Tiltmeters-Noise Suppression Maintenance and Data Analysis, David Yamaguchi, Institute of Arctic and Alpine Research, University of Colorado

Deduction of Quaternary Bottom Water Paleotemperatures from Epimerization Rate Changes in AMS Dates Foraminifera, Institute of Arctic and Alpine Research, University of Colorado

Investigation of the Validity of Using Equilibrium Geohydrochemical Models to Predict the Transformation and Fate of Redox-Sensitive Elements in Groundwater, Donald Runnells, Geological Sciences



**NEW INSTITUTE PUBLICATIONS**

Technical Report No. 53--Gunnison County Interindustry Spending and Employment Attributed to Fishing at Blue Mesa Reservoir, by John R. McKean, Donn M. Johnson and Richard G. Walsh. Price: \$5.00

This report describes an economic input-output model generated from the USDA IMPLAN system and used to study the role of fishing at Blue Mesa reservoir in the Gunnison County economy. The current contribution of spending by non-resident fishing is estimated to be \$5.25 million in added sales revenue and 170 jobs. A weighted least squares statistical travel cost demand model is estimated using a sample of 200 on-site personal interviews. The demand function is used to measure the effect of changes in expected fish catch and travel cost on visit rate. Schedules of visit rates for different expected fish catch and travel cost are created. The input-output model and statistical demand equation are combined to calculate schedules of local employment and interindustry sales associated with various levels of expected fish catch and travel cost to visit Blue Mesa Reservoir.

Technical Report No. 54--Review of Outdoor Recreation Economic Demand Studies with Nonmarket Benefit Estimates, 1968-1988, by Richard G. Walsh, Donn M. Johnson and John R. McKean. Price: \$6.00

Outdoor recreation is an important economic activity in rural areas throughout the nation. There is increasing evidence that land and water-based recreation resources provide substantial nonmarket benefits that contribute to the well-being of resident and nonresident participants. These benefits are equivalent to the dollar amount that participants would be willing to pay over and above their current expenditures to ensure the continued availability of opportunities to use recreation-resources.

In the last two decades interest in nonmarket valuation of natural resource use for outdoor recreation has grown more widespread and intense. This is particularly due to growing pressure from both inside and outside government for improvement in the criteria on which public-expenditure decisions are made. This report addresses some of the important issues in the past application of nonmarket value analyses from the perspective of future policy analysis, particularly for the 1990 resource planning program of the USDA's Forest Service.

Technical Report No. 55--A Comparison of Long-Run Forecasts of Demand for Fishing, Hunting, and Nonconsumptive Wildlife Recreation Based on the 1980 and 1985 National Surveys, by Richard G. Walsh, Kun H. John and John R. McKean. Price: \$4.00

This study compares two long-range forecasts of participation in fishing, hunting and nonconsumptive wildlife recreation based on the 1980 and 1985 national surveys. A logit model is used to forecast the proportion of the population of the continental United States who are expected to participate in (1) nonconsumptive wildlife recreation trips; (2) fishing for cold-water and warm-water species; and (3) hunting big game, small game and migratory

waterfowl in the years 2000, 2010, 2020, 2030 and 2040.

Wildlife-related activities currently represent one of the most important forms of outdoor recreation in the United States, and national participation surveys are undertaken every five years to provide the data base needed to update the demand.

Completion Report No. 149--The Economic Role of Water in Colorado: An Input-Output Analysis, by S. Lee Gray, John R. McKean and Thomas A. Miller. Price: \$6.00

Continuing concern has been expressed by state and regional planning bodies, researchers and the public over the adequacy of available water supplies to sustain Colorado's growth of population and economic activity. Policy makers require information relating Colorado's economy and water use as input to the decision-making process. The focus of this research is the relationship between economic activity by sector and the direct and indirect water requirements that constitute the focus of this research.

An economic input-output (I/O) model is used to address the indirect effects of sector expansion (or contraction) on water withdrawn and consumed. Current water withdrawn and water consumed by economic sector is estimated in order to calibrate the input-output model for water. The report includes a descriptive analysis of the current interdependence among producing sectors of the Colorado economy as well as sector-by-sector water use, income and employment.

**POSITIONS AVAILABLE**

Specialists in Irrigation Management--The International Irrigation Management Institute is seeking Specialists in Irrigation Management to undertake multidisciplinary research and training activities on irrigation management, in collaboration with irrigation agencies and research organizations in the host countries. IIMI staff also participate in the promotion of research interaction and collaboration among professional staff at the various IIMI field operation locations, and with other international research centers. Currently, IIMI has nine offices in Asia and Africa.

Several position openings will arise in Sri Lanka, Pakistan, and other parts of the IIMI system, particularly in the fields of civil/agricultural engineering, agricultural economics, and rural social sciences. Minimum qualifications include an advanced degree, or equivalent experience in agricultural or civil engineering, agriculture, anthropology, economics, public administration, management, or other fields related to irrigation management; demonstrated experience in a second relevant discipline; at least five years of significant multidisciplinary irrigation management field research in developing countries; excellent oral and written communication skills in English; and willingness to travel extensively.

Salary and benefits are commensurate with internationally recruited positions in other international agricultural research institutes. Qualified applicants are invited to submit a



detailed resume and three letters from professional references no later than 31 March 1989 to: The Director General, International Recruitment (Ref: 1989 ML), International Irrigation Management Institute, Digana Village via Kandy, Sri Lanka.

Staff Associate-Water Specialist, Sullivan County, Liberty, NY. Responsible for planning, implementing and evaluating an educational program addressing water quality and quantity of Sullivan County. Serve the Sullivan County Department of Planning and Economic Development to coordinate water resource study programs for the county. Minimum qualifications: Bachelor's degree in natural resource management, environmental engineering or related fields. Course work in water resources, natural resource policy and planning. Three years experience in Cooperative Extension or related field. Background in social sciences and humanities. Knowledge of basic water and environmental principles, plus methods of adult education. Must reside in Sullivan County. Salary: \$28,000, commensurate with qualifications. Send letter of intent and resume by February 23, 1989 to Paul W. Townsend, Cornell Cooperative Extension, Cornell University, 212 Roberts Hall, Ithaca, NY 14853-5901. (607)255-2291.

13.  
Faculty Positions, Utah Water Research Laboratory--Utah State University, Utah Water Research Laboratory, Department of Civil and Environmental Engineering invites applications for two tenure track positions (rank is open) in surface and groundwater hydrology. Responsibilities include continuing development of research programs dealing with theoretical, experimental, and/or computational approaches to the role of surface and or groundwater in areas which may include: basin, regional, and global scale hydrology, hillslope processes, soil-water processes, multiphase fluid flow, passive/reactive transport of tracers and contaminants, use of remote sensing, spatial representation of watershed processes, partial area hydrology, stochastic/numerical analysis, arid zone hydrology, and hydrology for fractured rock systems. The candidate is expected to teach two or three courses from his or her specialty within the graduate and undergraduate programs.

Applicant should submit a complete resume, list of publications, and names and addresses of three references to: Chair, Faculty Search Committee, Utah Water Research Laboratory, Utah State University, Logan, UT 84322-8200.

#### CONFERENCES

- Mar. 5-16 NATIONAL CONFERENCE ON URBAN STREAM CORRIDOR MANAGEMENT AND STORMWATER. University of Colorado at Colorado Springs, CO. Contact: Jon Kusler, Box 2463, Berne, NY 12023. (518)872-1804.
- Mar. 18-19 INTERNATIONAL GEOGRAPHIC INFORMATION SYSTEMS (IGIS) SYMPOSIUM '89: GLOBAL SYSTEMS SCIENCE--AN EFFECTIVE RESPONSE TO HUMAN NEEDS, Baltimore, MD. Contact: AAG, 1710 Sixteenth St. NW, Washington, D.C. 20009-3198, Attn: IGIS Symposium. (202)234-1450.
- Apr. 14-15 CONFERENCE ON WATER AND SANITATION IN DEVELOPING NATIONS, Denver, CO. Contact: Jim Horner, D-3620, P.O. Box 25007, Denver, CO 80225-0007. (303)236-3898.
- Apr. 17-20 CHAPMAN CONFERENCE ON CAUSES AND CONSEQUENCES OF LONG-TERM SEA LEVEL CHANGES, Snowbird, UT. Contact: MMP: Sea Level, American Geophysical Union, 200 Florida Ave. NW, Washington, DC 20009. (202)462-6903.
- Apr. 17-21 HYDROLOGY DAYS, Fort Collins, CO. Contact: Prof. Morel-Seytoux, Hydrology Days, Civil Engr. Dept., Colorado State University, Fort Collins, CO 80523. (303)491-6762.
- Apr. 18-20 57TH ANNUAL WESTERN SNOW CONFERENCE, Ft. Collins, CO. Contact: Jim Marron, Sec., Western Snow Conference, 12810 SW Hart Rd., Beaverton, OR 97005.
- Apr. 21 GLOBAL CLIMATE CHANGE AND NATURAL RESOURCE IMPLICATIONS FOR THE INTERMOUNTAIN WEST SYMPOSIUM, Logan, UT. Contact: Dean's Office, College of Natural Resources, Utah State University, Logan, UT 84322-5200. (801)750-2445.
- May 3-5 WESTERN SURFACE COAL MINING CONFERENCE, Gillette, WY. Contact: Society of Mining Engineers, Box 625002, Littleton, CO 80162. (303)973-9550.
- May 21-25 WATER RESOURCES FOR THE FUTURE; THE MANAGEMENT CHALLENGE, 16th Ann. Spec. Conf. ASCE Water Resources Planning and Management Div., Sacramento, CA. Contact: Darell D. Zimbelman, NCWCD, P.O. Box 679, Loveland, CO 80537.
- May 22-25 PARTNERSHIPS; EFFECTIVE FLOOD HAZARD MANAGEMENT, ASSOCIATION OF STATE FLOODPLAIN MANAGERS 13TH ANNUAL CONFERENCE, Scottsdale, AZ. Contact: Rebecca Hughes, Maryland Water Resources Administration, Tawes State Office Bldg. D-3, Annapolis, MD 21401. (301)974-3825.
- June 7-9 INTERNATIONAL SYMPOSIUM ON DESIGN OF WATER QUALITY INFORMATION SYSTEMS, Ft. Collins, CO. Contact: Robert Ward or Jim Loftis, Agric. & Chem. Engr. Dept., Colorado State University, Ft. Collins, CO 80523. (303)491-5252.
- June 8-9 TOXIC SUBSTANCES IN AGRICULTURAL WATER SUPPLY AND DRAINAGE - AN INTERNATIONAL ENVIRONMENTAL PERSPECTIVE, 2nd Pan-American Regional Conference of ICID, Ottawa, Canada.



14.

Contact: USCID, P.O. Box 15326, Denver, CO 80215. (303)236-6960.

June 26-29

INTERNATIONAL SYMPOSIUM ON DESIGN OF HYDRAULIC STRUCTURES, Fort Collins, CO. Contact: Janet Lee Montera, Civil Engr. Dept., Colorado State University, Fort Collins, CO. (303)491-7425.

June 27-30

SYMPOSIA ON HEADWATERS HYDROLOGY AND INDIAN WATER RIGHTS AND WATER RESOURCES MANAGEMENT, Missoula, Mt. Contact: William W. Woessner, Dept. of Geology, University of Montana, Missoula, MT 59812. (406)243-5698.

July 18-20

1989 NATIONAL WATER CONFERENCE AND LIFE SYMPOSIUM OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS, Newark, DE. Contact: William F. Ritter, Agricultural Engr. Dept., University of Delaware, Newark, DE 19717-1303. (302)451-2468.

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## COLORADO WATER ISSUES PUBLIC FORUM



THIRD TUESDAY of Each Month  
No-Host Noon Luncheon — 11:45 a.m.-1:30 p.m.  
WYATT'S CAFETERIA—Lakeside Shopping Center  
on 44th Ave. between Sheridan & Harlan.

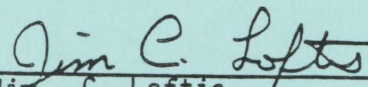
[Exit #270 on I-70 (Harlan St.) opposite Lakeside  
National Bank, then 2 blocks south on Harlan]

All interested citizens are invited to attend and provide input into the discussion generated by our expert presenter. Proceed through cafeteria line for meal service, then to designated meeting room.

Mar. 21 — Jeris Danielson, Colorado State Engineer: "EMERGING ISSUES IN MANAGEMENT OF COLORADO GROUNDWATER"

Apr. 18 Joe Shoemaker, Shoemaker, Wham and Krisor, and Chairman, South Platte River Foundation: "SOUTH PLATTE RIVER GREENWAY"

Please mark your calendar for the 3rd Tuesday of each month through June 1989.

  
\_\_\_\_\_  
Jim C. Loftis  
Extension Specialist  
491-7923