



# COLORADO WATER

Colorado Water Resources Research Institute

Colorado State University

Fort Collins, Colorado 80523

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February 1988

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## RESEARCH ADVISORY COMMITTEE REORGANIZED

One of the most important elements of the Institute's water research program is knowledge of high-priority water problems. For this purpose the first-hand experience of water managers and professional practitioners who make up the Research Planning Advisory Committee is invaluable. The RPAC identifies those problems which cannot be solved without new scientific knowledge or better technology.

The newly reorganized RPAC met in January to suggest priority problems facing industry, recreation/wildlife, state government, agriculture and municipal/urban water users. New research will be based upon those problems. Members of the RPAC are:

Industry--Neil Jaquet, Adolph Coors Co.; Richard O. Austermann, Amax, Inc.; Michael J. Everard, Public Service Co.; and Kenneth R. Wright, Wright Water Engineers, Inc..

Recreation/Wildlife--Robert Weaver, Resource Associates, Inc.; Edgar J. Prenzlou, Division of Wildlife; Marcia

Hughes, Hughes, Duncan and Dingess, and Ron G. Holliday, Division of Parks and Recreation.

State Government--Duane Woodard, Attorney General; Jeris A. Danielson, Division of Water Resources; J. William McDonald, Colorado Water Conservation Board; Uli Kappus, Water and Power Resources Development Authority; and Paul Ferraro, Division of Water Quality Control.

Agriculture--Larry D. Simpson, Northern Colorado Water Conservancy District; Barry B. Nelson, Rio Grande Canal Co.; Bart Woodward, Groundwater Appropriators of the South Platte, Inc.; and John Fetcher, Upper Yampa Water Conservancy District.

Municipal/Urban--Robert W. Fischer, Denver Water Department; John D. Hendrick, Nolte and Associates; Rodney F. Kuharich, Colorado Springs Water Department; Leonard Rice, Leonard Rice Consulting Engineers; and L. Scott Tucker, Urban Drainage and Flood Control District.

## RESEARCH IN PROGRESS

Research projects in the Institute's state-supported FY1987/1988 water research program cover six high-priority Colorado water problems: impacts of water quality regulation on water rights; the role of water in economic development; economic impacts in transfer of water from agriculture to urban use; recharge technology for Denver Basin groundwater; groundwater quality protection and technology to improve surface-groundwater

conjunctive management.

Additional research supported by contracts with federal, state or local agencies include: improved low-flow criteria for discharge permits; water salvage in the Closed Basin (San Luis Valley); improved technology for measurement of specific yield in Denver Basin aquifers; computer system for management of a metropolitan combined sewer-

wastewater system; and a comparative analysis of legal and administrative processes used for water transfers in six western states.

The following are summaries of the current state-supported projects.

#### **Water Rights Implications of Water Quality Regulation in Colorado**

Water quality regulation contains legal requirements which tend to conflict with or constrain the administration of the personal property rights of water right owners. The Federal Clean Water Act sets forth national goals related to water quality and establishes specific requirements to achieve those goals. The major provisions are section 402 (discharge permits), section 208 (areawide plans), and section 404 (dredge or fill permits). In 1981 the Colorado General Assembly amended the Colorado Water Quality Control Act to make clear that water quality regulation should not "supersede, abrogate, or impair rights to divert water and apply water to beneficial uses." At the same time, the legislation explicitly recognized that some conflicts were inevitable; for example, when a treatment technique causes consumptive use of water. The impacts of the administration of water quality control regulations upon water rights is therefore of great concern in Colorado.

This research will examine areas in which conflicts, or potential conflicts, have arisen to determine how the interests in national and state water quality objectives have been coordinated with property interests in water rights. The research will examine the existing legal and institutional procedures, analyze case studies in which conflicts between water quality and water development and use have arisen and propose solutions helping to promote resolution of these conflicts.

Principal Investigator:  
Lawrence J. MacDonnell  
University of Colorado

#### **The Economic Role of Water in Colorado**

Many Colorado citizens are greatly concerned that public water policies not discourage economic development. Economic activity including production income and employment depends upon availability, reliability and cost of water. It is therefore critical, in both public and private sectors, that the interrelationships among economic activity and public water policy be known. Methodology and data are needed for projecting statewide economic impacts of prospective changes in water availability and management policies.

This project will develop an up-to-date Colorado state input-output economic model with which short-term forecasts of regional and/or state output, employment, income and water resource requirements can be estimated given projected changes in final consumption. To the extent possible this model will be disaggregated to the individual county level.

Principal Investigators:  
S. Lee Gray and J. R. McKean  
Colorado State University

#### **Incentives for Improving Irrigation Efficiency Phase III**

Irrigation water accounts for more than 90 percent of the total annual volume of water withdrawn from supplies in Colorado. Demands for urban water supply, dramatically increasing, have led to pressures for transfer of water from irrigation use to urban use. Two broad options are available: (1) outright purchase of water or agricultural lands to obtain the water; and (2) purchase of water derived from more "efficient" utilization in irrigation. The second option has the advantage of lower direct and indirect economic benefits foregone--agricultural production could continue at a reduced level and its indirect income and employment effects would not be fully

lost. This issue is of great concern to policymakers in Colorado.

This project will develop a combined hydrologic and economic model with which simulation studies will be made to assess the impacts of alternative proposed policies for transfer of water from irrigation to urban uses. The analyses will be performed under both normal water supply and drought supply scenarios.

Principal Investigators:  
Robert A. Young and  
H. J. Morel-Seytoux  
Colorado State University

#### **Injection Recharge in the Denver Groundwater Basin: Operational Alternatives**

Municipal water demands in the Denver-Metropolitan region are being met, in part, by pumping from deep bedrock aquifers known as the Denver Basin. As a result water levels and aquifer pressures have declined in parts of the basin. The future of that water supply is limited. Water allocation policies, recharge technologies and aquifer management policies are needed to guide the most effective use of that water supply. The economic stakes are very high, because this is the concentrated metropolitan region of the state where water has an extremely high value.

This project will focus on schemes for recharging the Arapahoe Aquifer in the south-suburban portion of the Denver metropolitan area. The suburban water districts are heavily dependent on the bedrock aquifers, and the area remains a major growth location. This study will produce definitive assessments of possible operational alternatives in managing injection recharge and well withdrawals.

Principal Investigator:  
A. Keith Turner  
Colorado School of Mines

#### **Groundwater Faunas as Indicators of Water Quality**

Water quality problems in the South Platte River Basin now have wide public recognition--and most urgent is cleanup of groundwater contamination from Lowry Landfill and the Rocky Mountain Arsenal. But there are other problems, including nitrates, organics and high total dissolved solids in alluvial aquifers, heavy metals, ammonia and random spills; pollution due to urban stormwater runoff; and problems of trace organics, pesticides and other carcinogenic substances. The prevalence of Giardia lamblia cysts from contributing mountain streams is also a problem.

Since aquatic organisms are widely used as indicators of surface water quality, there is every reason to think they also have great potential as indicators of groundwater quality in alluvial river-aquifer systems. This project will ascertain the distribution, structure and composition of groundwater faunas in the South Platte Basin River System, identify the hydrologic-geologic conditions suitable for their development, and compare habitat sites based on abundance, composition and community structure. With this information it should be possible to use specific groundwater animals and community parameters in an integrative method to monitor and assess groundwater quality degradation.

Principal Investigator:  
James V. Ward  
Colorado State University

#### **SAMSON Documentation and Testing**

The basin hydrologic daily simulation model SAMSON, under development for the past three years, has been adapted for the South Platte Basin and was calibrated last year to historic river flows at the five mainstem gaging stations. A users' manual with general documentation also was produced. This

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project supports the preparation of documentation in detail (over 1,000 pages) for each of more than 140 subprograms constituting the model. In addition, SAMSON is being operated for a small test case which will "exercise" all subprograms to verify that they are working correctly.

With completion of this work the model will be ready for applications. Two staff engineers from the State Engineer's office are currently being trained in its operation. The model will not be released, however, until Institute staff break it in on specific studies. It is expected that several improvements will result from this experience and make SAMSON easier to operate. Its adaptation to new high-capacity PCs is also possible (the Cyber 205 supercomputer is now used).

Principal Investigator:  
Jorge Restrepo  
Colorado State University

#### CWRRI RATES HIGH IN EVALUATION

*Getting high marks on performance  
makes anyone feel good,  
and so it is with CWRRI...*

The Institute was formally evaluated by an external team last April. Dr. Philip Austin, President of Colorado State University, was notified that "The Institute's success in development and coordination of a high-quality water-resources research program relevant to the needs of the State stem directly from its Director's skills, the vast academic resources of the State's universities and its independent status as a State agency."

The evaluation criteria included research quality, research relevance, statewide research coordination, information transfer, training, accreditation, physical resources, interdisciplinary relationships, administrative relationships and host institution's commitment. The evaluation is required to qualify the Institute for continued federal cost-sharing funds under the Water Research Act (P.L. 98-242).

Members of the review team were: Dr. Madge O. Ertel, U.S. Geological Survey, Reston, Virginia (Team Leader); Dr. James P. Heaney, Director, Water Research Center, University of Florida; Dr. Louis F. Weschler, Dean, College of Architecture and Environmental Design, Arizona State University; Dr. Harold D. Simpson, Deputy State Engineer, Denver; and Mr. Kenneth R. Wright, Wright Water Engineers, Inc., Denver.

#### INSTITUTE AUTHORIZATION EXTENDED

The Colorado General Assembly extended the Institute's authorization as a state agency for ten additional years during its 1987 session. Representative Scott McInnis and Senator Tilman Bishop sponsored the legislation, and excellent testimony favoring the extension was presented by Jack Odor, Kevin Pratt and Ben Urbonas. Each described practical applications of Institute water research. Jack Odor is Manager of the Groundwater Appropriators of the South Platte, Inc.; Ben Urbonas represented the Urban Drainage and Flood Control District; and Kevin Pratt (Fairfield and Woods) is President of the Friends of the Institute Assoc.

## HENRY P. CAULFIELD, JR. REFLECTS ON WATER RESEARCH LEGISLATION

Professor Henry P. Caulfield, Jr. retired from the Department of Political Science in July, 1986 after 17 years at Colorado State University, but he remains actively involved in water policy issues at the state, regional and national levels. In May Professor Caulfield spoke to the National Association of Water Institute Directors on the topic, **Purpose, Accomplishments and Challenges of the Water Resources Research Act**. He was involved in drafting the original Water Resources Research Act of 1964 while serving on the staff of the Secretary of the Interior. He noted that the first Act was supported by the National Association of State Universities and Land Grant Colleges with Dr. William E. Morgan, then President of Colorado State University, playing a leading role in testimony and other supportive activities.

Having followed the Act's administration, reauthorizations, and appropriation history, Professor Caulfield's remarks reflected his views on the forthcoming reauthorization of the Water Resources Research Act of 1984. He focused on four principal topics: (1) the importance of achieving consensus within

the water research community on a reauthorization proposal; (2) a brief historical analysis of the principal legislative issues involved in the original and subsequent water resources research legislation and some institutional problems; (3) the principal issues in reauthorization of the Act; and (4) political decision-making processes involved in all Congressional legislation, including water research reauthorization.

Professor Caulfield recently served on an advisory Institute Program Planning Group sponsored by the U.S. Geological Survey to recommend changes in policies by which the USGS administers the State Water Institutes Program under the Act.

Professor Caulfield, Emeritus Professor of Political Science at Colorado State University, is former Executive Director of the Federal Water Resources Council and former Director of the Resources Program Staff in the Office of the Secretary, U.S. Department of the Interior. He received the Distinguished Service Award from the Department of the Interior in 1966.

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### NEW LOOK FOR Project AWARE

Water information is in big demand these days--because Colorado has more water issues and problems than it has water. Water managers are ever alert for scientific advances and new technologies that will help solve their problems. The Institute tries to meet this demand as one of its established, statutory purposes. This newsletter is one way of meeting that duty. Another is **Project AWARE**, a list of water research proposals from the three state research universities--CU, CSM and CSU. Distributed periodically by the Institute to Colorado water managers, it alerts them to potential new water research. If a proposal

is of special interest the investigator can be contacted, and in many cases the research plan can be oriented to the water manager's specific needs.

**Project AWARE** will now have a new look which should make it even more useful to water managers. It will list new water-related research projects. If a project is particularly relevant to a water manager's problem, he can contact the investigator. With this flow of information the net result should be water research that is even more relevant to Colorado water problems.

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**COLORADO WATER CONGRESS  
OFFERS SPECIAL MEMBERSHIPS  
FOR FULL-TIME STUDENTS, RETIREES**

The Colorado Water Congress has created a special associate membership, at the low cost of \$10, for full-time students and any individual who is retired. This membership includes participation in both summer and winter annual meeting of the Congress, a periodic newsletter, and an annual directory and almanac containing names and addresses of member organizations (state, federal, and local). This is an excellent way for students to get in touch with current water resource issues and activities in Colorado at a very reasonable cost. For additional information contact the Colorado Water Congress, 1390 Logan St., Suite 312, Denver, CO 80203. (303)837-0812.

**INSTITUTE TESTS CHEMIGATION VALVES**

New state legislation is designed to protect groundwater from accidental pollution with chemicals used in chemigation. The 1987 Act (35:11:101-106 CRS) calls for permits and regulations to be issued by the Colorado Department of Agriculture. Among the proposed regulations is a certification of check valves by laboratory tests. The Institute has agreed to perform the tests and certify valves according to performance criteria to be specified in the regulations. One production line valve of each model will be tested. Testing will be supervised by Dr. James Ruff, Civil Engineering Department Colorado State University. A fee to cover costs will be charged to suppliers.

**RECENTLY COMPLETED RESEARCH**

**Monitoring Strategies for  
Groundwater Quality Management**

The stochastic behavior of groundwater quality variables was investigated to improve the technology for detecting quality changes. Recommendations are given for implementing a regulatory groundwater monitoring program in a statistically sound manner for point-source facilities (such as waste disposal ponds).

The primary objective in groundwater quality monitoring is to detect adverse changes in quality. For a point (localized) source the pairing of observations in upgradient and downgradient wells and analysis of resulting differences is an improved approach. Techniques are given for analyzing quality shifts along with their implied water quality impacts.

The project completion report includes the following topics:

- \* the legal and administrative requirements for groundwater quality monitoring;

- \* the current state of monitoring activities;
- \* statistical characteristics of groundwater quality random variables; and
- \* statistical methods for analyzing groundwater quality data.

Principal Investigators:

Thomas G. Sanders

Jim C. Loftis

Robert C. Ward

Colorado State University

**Potential Groundwater Impacts  
From Chemigation**

Chemigation is the practice of applying fertilizers/pesticides through a center-pivot sprinkler irrigation system. Its use is increasing, because it has several economic and environmental advantages. However, regulating agencies have expressed concern about groundwater contamination that may result where the

water supply is a pumped well. If the irrigation pump fails during the chemigation cycle, the fertilizer/pesticide in the irrigation pipeline may back-flow down the well and contaminate the groundwater supply.

The fate of chemicals introduced into the groundwater system by back-flow into a well was investigated using a computer simulation model. The model was developed to simulate the effect of various breakdown scenarios, aquifer properties, pumping rates, quantities of back-flow, and different chemical characteristics of the contaminants. Both conservative and nonconservative chemicals were modeled. The chemigation system layout simulated for this case consisted of typical quarter-section center-pivot system with a 1,000-gallon chemical supply tank.

In the conservative chemicals case, back-flow of nitrate fertilizer was simulated in the model. Nitrate removal from the aquifer after the irrigation pump was restarted was investigated. One and one-half days of pumping were required to lower the nitrate concentrations in the aquifer to original levels. A delay of one week in restarting the pump after breakdown increased slightly the pumping time required to remove the nitrate from the aquifer.

In the nonconservative case, a chemically reactive pesticide was simulated that would be adsorbed on the minerals of the aquifer. The adsorption of the pesticide greatly retarded the movement of the contaminant in the groundwater away from the irrigation well. For a strongly adsorbed contaminant, its movement away from the irrigation well was limited to only a few feet. However, desorption occurs slowly after the pump is restarted. The pumping time required to recover most of the contaminant in some cases may be more than 20 days. Aquifer physical properties did not in general have a significant effect on the pumping time needed for restoration. In all cases studied it was possible to restore the contaminant concentration in

the aquifer to safe levels by restarting the irrigation well.

Principal Investigator:  
James W. Warner  
Colorado State University

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### **The Effect of Conservation Programs on the Quality of Urban Lawns**

Growing populations and a limited water supply have made water conservation a necessary part of municipal supply programs for most Front Range Colorado cities. This research was conducted to determine if intensity of conservation programs has an effect on the quality of urban lawns. Three levels of intensity (which include water price) were identified: aggressive; moderate; and passive.

Lawn quality was measured on a random sample of 209 lawns in seven northern Colorado cities: Greeley; Fort Collins; Broomfield; Longmont; Boulder; Aurora; and Lafayette. Color reference cards were used to determine lawn quality by the relative greenness of the lawn. Data were collected for each city during the summer seasons of 1985 and 1986.

The statistical tests and other observations suggest that higher conservation intensity (including water price) results in lower lawn quality. The lowest-quality lawns were associated with cities using aggressive conservation intensity. There was little difference in lawn quality between the two lower levels of conservation intensity (moderate and passive). However, lawn quality was acceptable even with a moderate level of conservation intensity and price.

Principal Investigator:  
J. Ernest Flack  
University of Colorado

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### Evapotranspiration of Native Vegetation in the Closed Basin of the San Luis Valley

The Closed Basin project in the San Luis Valley of south-central Colorado is a water salvage project now under construction. Its objective is to pump and salvage water from the unconfined (water table) aquifer which would otherwise be lost through evapotranspiration (ET) from native vegetation. In order to determine the proper pumping rate to lower the water table correctly, an accurate estimate of the ET of these plants must be obtained. The purposes of this research were: (1) to further develop and apply gas analysis technology for measuring ET from native vegetation; (2) to obtain ET measurements on representative plants; (3) to compare these measurements with measurements of ET taken from U.S. Bureau of Reclamation (USBR) lysimeters operating in the same area; and (4) to observe the trends in ET for several different water table depths.

Measurements of ET of native vegetation were carried out using the gas analysis chamber method during several periods of 1985 and 1986. Measurements were made of greasewood (*Sarcobatus vermiculatus* Hook. Torr.), rabbitbrush (*Chrysothamnus nauseosus* Pall. Britt.), and salt grass (*Distichlis stricta* L. Greene). These plants constitute the major indigenous vegetation of the closed basin plant community. Both plants showed reduced ET when the water table was lowered below 4.8 meters. There were no substantial differences in the ET of greasewood and rabbitbrush at sites where the groundwater levels have been constant historically at either 1.25 meters (m) or 4.3 meters.

Measurements on bare soil indicate a decrease in evaporation with an increase in depth to water table. It was also found that evaporation from bare soil contributes significantly to the total ET from areas of shallow water table (1.25m).

A direct comparison of ET for salt grass measured by gas analysis chamber and lysimeters shows that the lysimeters accounted for only 40 percent of the total salt grass ET measured by the chamber. Measurements covered a period of 77 days. ET measurements on other vegetation at the same site showed similar discrepancies, suggesting problems in the lysimeter data.

Principal Investigators:  
Walter C. Bausch  
J. A. Morgan  
USDA/ARS and  
Colorado State University

### Recharge as Augmentation in the South Platte River Basin

This is the first comprehensive documentation of the augmentation/recharge projects currently in operation in the South Platte Basin. These projects are rapidly developing as an essential part of the water management practices in the basin. The purpose of most of the recharge projects is augmentation of surface stream flow to compensate for flow reduction caused by groundwater pumping.

Because these augmentation/recharge projects have been developing so rapidly, little information about them has been available previously. Data were collected during this study on the number, location and total annual recharge for 44 projects. This represents about 75 percent of all recharge projects in Colorado. However, the total annual recharge of about 55,000 acre-feet (1985) is still relatively small. Most of the current operations are being conducted by irrigation companies in cooperation with groundwater-user associations.

Recharge projects to this time have been primarily projects of opportunity, taking advantage of existing canals and seepage from existing reservoirs or natural depressions suitable for ponding. As a consequence, the groundwater return



flow which augments the surface stream flow is not highly efficient. In general, the recharge credit appears to range from 30 to 40 percent of total annual recharge. This could probably be increased substantially through a more optimal site selection. However, the cost and economic benefits in operating recharge sites not now served by existing canals will need to be investigated. Nevertheless, these projects are a critical component in allowing maximum use of the basin's total water supply--groundwater and surface water conjunctively managed.

Principal Investigator:  
James W. Warner  
Colorado State University

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**Wildlife and Fish Use Assessment:  
Long-Run Forecasts of Participation  
in Fishing, Hunting and  
Nonconsumptive Wildlife Recreation**

A logit model is used to estimate the proportion of the population of the United States who participated in (1) non-consumptive wildlife recreation trips; (2) fishing for cold-water and warm-water species; and (3) hunting big game, small game, and migratory birds in 1980. The logit equations are then used to forecast the number of persons who are likely to participate in these activities from 1990 to the year 2040. Indications are that nonconsumptive wildlife recreation will be the fastest-growing activity. The historic growth in fishing is expected to continue, although at somewhat lower levels owing to a slower increase in population. Hunting is forecast to decrease in the long run, consistent with preliminary findings of the 1985 National Survey of Fishing, Hunting, and Wildlife Associated Recreation. Participation is shown to be a function of changes in population; travel cost; the price of substitutes; income, age, residence, and other socio-economic characteristics of individuals; quality of the experience; and availability of resources. The study replicates previous research with respect to specific

indicators of resource quality and availability. It attempts to correct a bias introduced into previous participation functions due to the omission of price and cross-price variables. It presents a tentative empirical test of the effect of variable travel costs or miles traveled on the probability of participation in these activities.

Principal Investigator:  
Richard G. Walsh  
Colorado State University

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**Economic Benefits and Costs  
of the Fish Stocking Program  
at Blue Mesa Reservoir, Colorado**

Understanding the value of alternative fishery management practices can help managers improve the economic efficiency of state programs. This report provides new evidence on the value of alternative fish-stocking practices. The contingent valuation methodology was used to investigate the economic value of the cold water fishery at Blue Mesa Reservoir near Gunnison, Colorado. A sample of 200 recreation users was analyzed.

At current catch rates, the annual gross economic value to anglers is \$5.43 million. Of this amount \$2.64 million represents trip expenditures by anglers which impact on state and local economic development. The remaining \$2.79 million is the net value to anglers above what they spend. The net economic value to anglers greatly exceeds the cost of stocking and management, which is reported as \$0.44 million. The analysis uses statistical functions to relate marginal willingness to participate and pay to the number and size of fish caught. The results indicate that anglers place a higher marginal value on the size of fish caught, \$1.25 per additional inch, than the number caught, \$0.95 per additional fish.

Principal Investigator:  
Richard Walsh  
Colorado State University

## JENSEN HEADS COLORADO INSTITUTE FOR IRRIGATION MANAGEMENT

Dr. Marvin E. Jensen was appointed Director of the Colorado Institute of Irrigation Management (CIIM) at Colorado State University effective July 1, 1987. Dr. Jensen recently retired from the Agricultural Research Service, U.S.

Department of Agriculture, after 32 years of research and research management in irrigation and soil and water management. He currently serves as President of the International Commission on Irrigation and Drainage.

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## WATER ISSUES PUBLIC FORUM RESUMES MONTHLY MEETINGS

All interested citizens are invited to attend the Institute's COLORADO WATER ISSUES PUBLIC FORUM meetings in Denver. The monthly luncheon meetings (no-host) feature guest speakers on a variety of key, statewide water issues. Mark your calendar for the 3rd Tuesday of each month through June, 1988.

TIME: 11:45 a.m.-1:30 p.m.

LOCATION: Wyatt's Cafeteria-LAKESIDE SHOPPING CENTER, Sheridan and 44th Avenue. Take I-70 to Exit 270-Harlan St., then 2 blocks south on Harlan to Lakeside Mall.

**March 15** RECENT FEDERAL DEVELOPMENTS IN WATER QUALITY REGULATION--James J. Sherer, Regional Administrator, U.S. Environmental Protection Agency, Region VIII

**April 19** WATER QUALITY HOT SPOTS FOR 1988--Paul Ferraro, Director, Water Quality Control Division, Colorado Department of Health

**May 17** PROTECTING PUBLIC HEALTH AT LAST CHANCE HAZARDOUS WASTE LANDFILL--A SIX-COUNTY JOINT MONITORING PROGRAM, Michael G. Richard, Department of Environmental Health, Colorado State University

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## NEW NATIONAL WATER INFORMATION SYSTEM UNDER DEVELOPMENT

The Water Resources Division (WRD) of the U.S. Geological Survey is developing a National Water Information System (NWIS) that will integrate and replace its existing water data and information systems. Representing the largest redesign, conversion and development effort ever undertaken by WRD, the system will be operated as part of the network of computers linked together through a national telecommunication network known as GEONET.

Integrated in the system, when completed, will be the following water data and information systems of the Division:

National Water Data Storage and Retrieval System (WATSTORE)--The primary system used by the Division for the storage, retrieval and dissemination of its water data

National Water Data Exchange

(NAWDEX)--An interagency program managed by the Division which indexes water data from both federal and non-federal agencies and coordinates a nationwide user-service program for the identification and acquisition of available water data

National Water-Use Information Program (NWUIP)--A national program for gathering site-specific water use information through a network of State Water Use Data Systems and

the aggregation of water-use information in a National Water-Use Data System (NWUDS)

Water Resources Scientific Information Center (WRSIC)--A program for abstracting water-resource publications worldwide and providing a bibliographic user service program.

Work on the development of NWIS began in 1983 and it is scheduled for operation in 1990.

### OFF THE PRESS

The following publications are available upon request at prices listed plus postage. Send order and check payable to Colorado State University to:

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

	<u>Price</u>	<u>Postage</u>
	Up to 99¢	\$ .75
	\$1.00-\$4.99	\$1.00
	\$5.00-\$9.99	\$1.50
	\$10.00 and over	\$2.00
CR 140	<b>MONITORING STRATEGIES FOR GROUNDWATER QUALITY MANAGEMENT</b> , by Jim C. Loftis, Robert H. Montgomery, Jane Harris, David Nettles, P. Steven Porter, Robert C. Ward and Thomas G. Sanders.	
	\$5.00	\$5.00
CR 141	<b>POTENTIAL GROUNDWATER IMPACTS FROM CHEMIGATION</b> , by James W. Warner and Kit Nielsen.	
	\$5.00	\$5.00
CR 142	<b>THE EFFECT OF CONSERVATION PROGRAMS ON THE QUALITY OF URBAN LAWNS</b> , by Andrew S. Winje and J. Ernest Flack.	
	\$5.00	\$4.00
CR 143	<b>EVAPOTRANSPIRATION OF NATIVE VEGETATION IN THE CLOSED BASIN OF THE SAN LUIS VALLEY, COLORADO</b> , by F. L. Charles, J. A. Morgan and W. C. Bausch.	
		\$5.00
CR 144	<b>RECHARGE AS AUGMENTATION IN THE SOUTH PLATTE RIVER BASIN</b> , by James W. Warner, Daniel Sunada, and Anne Hartwell.	
		\$5.00
TR 49	<b>ECONOMIC BENEFITS AND COSTS OF THE FISH STOCKING PROGRAM AT BLUE MESA RESERVOIR, COLORADO</b> , by Donn M. Johnson and Richard G. Walsh.	
		\$4.00

TR 50 **WILDLIFE AND FISH USE ASSESSMENT: LONG-RUN FORECASTS OF PARTICIPATION IN FISHING, HUNTING AND NONCONSUMPTIVE WILDLIFE RECREATION**, by Richard G. Walsh, David A. Harpman, Kun H. John, John R. McKean and Lauren LeCroy.

\$5.00

TR 51 **STATUS, ISSUES AND IMPACTS OF COAL SLURRY PIPELINES ON AGRICULTURE AND WATER**, by Ari M. Michelsen and John W. Green.

\$5.00

TR 52 **COUNTY INPUT-OUTPUT MODELS FOR THE STATE OF WYOMING: WITH ANALYSIS OF NEW INDUSTRIES AND NEW CONSTRUCTION IMPACTS**, by John R. McKean.

\$5.00

### CONFERENCES

Mar. 28-31 SAGEEP '88: Symposium on the Application of Geophysics to Engineering and Environmental Problems, Golden, CO. Contact: CB and Assoc., 122 Zang Ct., Lakewood, CO 80228.

Mar. 31-  
Apr. 1 INSTREAM FLOW PROTECTION IN THE WESTERN U.S.: A Practical Symposium, Boulder, CO. Contact: Natural Resources Law Center, School of Law, University of Colorado, Campus Box 401, Boulder, CO 80309-0401.

Apr. 25-29 NATIONAL SYMPOSIUM ON PROTECTION OF WETLANDS FROM AGRICULTURAL IMPACTS, Fort Collins, CO. Sponsored by U.S. Fish and Wildlife Service and National Ecology Research Center. Contact: Henrietta Cullinane, Office of Conference Services, Rockwell Hall, Colorado State University, Fort Collins, CO 80523.

May 17 PROFITING FROM WATER, Santa Monica, CA. Contact: Water Research Associates, Inc., 12233 W. Olympic Blvd., Suite 152, Los Angeles, CA 90064 (213)207-8277.

April 19-22 HYDROLOGY DAYS, Front Range Branch, AGU, Fort Collins, CO. contact: Prof. H. J. Morel-Seytoux, Department of Civil Engineering, Colorado State University, Fort Collins, CO 80523.

May 23-26 SECOND NATIONAL OUTDOOR ACTION CONFERENCE ON AQUIFER RESTORATION, GROUNDWATER MONITORING AND GEOPHYSICAL METHODS, Las Vegas, NV. Contact: Nat'l. Water Well Assoc., Education Foundation, 6375 Riverside Dr., Dublin, OH 43017. (614)761-1711.

May 29-  
June SIXTH IWRA WORLD CONGRESS ON WATER RESOURCES, Ottawa, Canada. Contact: The Secretariat, Sixth IWRA Congress, Univ. of Ottawa, 631 King Edward Ave., Ottawa, Ontario, Canada, K1N 6N5

June 8-10 SUBALPINE WATERSHED PROCESSES AND WATER QUALITY, Crystal Bay, NV. Contact: Watershed Symposium Committee, ATTN: Leo Poppoff, P.O. Box 10529, So. Lake Tahoe, CA 95731.

**Position Announcement:**

**Director - Colorado Water Resources Research Institute (CWRI)  
Half-time**

Description: CWRI, at Colorado State University, is Colorado's statutory agency with the mission of developing, implementing and coordinating water and water-related research programs and transferring the results of research and technology development to potential users. The Director is responsible for liaison between the scientific resources of Colorado's universities, water managers, and public officials, in support of effective problem-solving research and technology transfer. Required qualifications: earned doctorate and demonstrated research record involving water resources research; experience in research management; familiarity with federal and state agencies funding water research; and ability to work with various publics including governmental agencies, water conservancy districts, consulting engineers, water boards, advocacy groups, elected officials, and university faculty. Non-academic professional experience in the water industry and qualifications for an academic appointment at the level of Professor are desirable. Salary will be commensurate with experience and qualifications. Half-time position will become available 1 July 1988.

**Application deadline:** March 11, 1988 (postmark)

**Submit:** Letter of application, CV, and names, addresses and phone numbers of three references to:

Dr. E. V. Richardson, Chair  
Search Committee for Director of CWRI  
Office of Vice President for Research  
Colorado State University  
Fort Collins, Colorado 80523  
Phone: 303/491-7194

**CSU is EEO/AA employer. E.O. Office: 314 Student Serv. Bldg.**

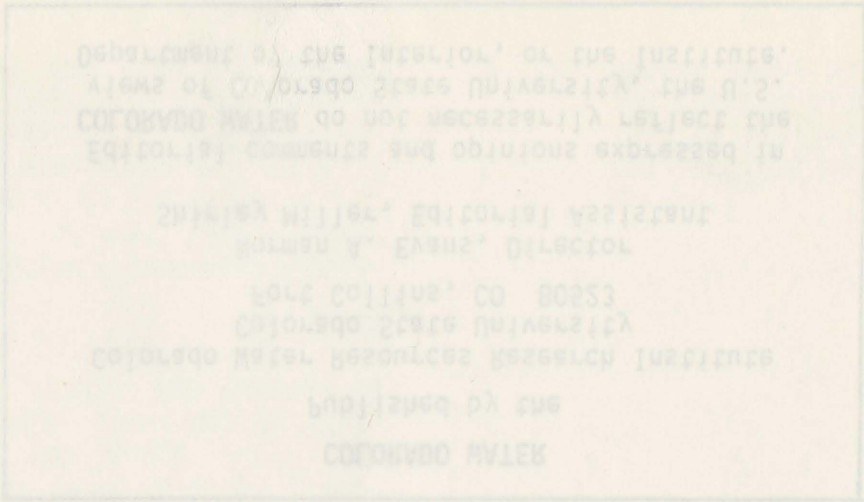
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Colorado State University - Fort Collins - Colorado 80523

Office of Vice President for Research  
Research Committee for Director of CWRRI  
Dr. E. A. Richardson, Chair

Colorado Water Resources Research Institute  
Colorado State University  
Fort Collins, Colorado 80523

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The position is a full-time position with a minimum of a master's degree and a Ph.D. preferred. The position holder will be responsible for the day-to-day management of the Institute and will report to the Director. The position holder will also be responsible for the financial and administrative management of the Institute. The position holder will be expected to develop and maintain a strong working relationship with the Colorado State University and the Colorado Water Resources Research Institute. The position holder will be expected to develop and maintain a strong working relationship with the Colorado State University and the Colorado Water Resources Research Institute. The position holder will be expected to develop and maintain a strong working relationship with the Colorado State University and the Colorado Water Resources Research Institute.

Director - Colorado Water Resources Research Institute (CWRRI)

Position Announcement: