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# COLORADO WATER

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

## WATER ITEMS AND ISSUES . . .

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### NOW AVAILABLE

*CWRRI 25-Year Report: The Colorado Water Resources Research Institute: 25 Years of Research, Training and Scientific Publications. Available from: Colorado Water Resources Research Institute, 410 University Services Center, Colorado State University, Fort Collins, CO 80523. Phone: 303/491-6308.*

*Drought Water Management, by Neil S. Grigg and Evan C. Vlachos. Proceedings of a National Workshop held in Washington, D.C. Nov. 1-2, 1988. Contact: Verdia Johnson, Civil Engr. Dept., Weber Bldg., Colorado State University, Fort Collins, CO 80523. Phone: 303/491-5247.*

**MAKE YOUR RESERVATION NOW -- Luncheon Meeting, Friday, June 1, Water Resources Issues Affecting Ski Area Snowmaking.** Sponsored by the Colorado Section of AWRA. Details on Page 8.

## RECREATION - THE CROWN JEWEL IN COLORADO'S ECONOMY

Editorial by Neil S. Grigg

Recreation is a critical Colorado industry, maybe the most important industry in the State. Much of it - fishing, skiing, sailing and kayaking - is water-dependent. All of it requires the clean, natural environments for which Colorado is famous.

I maintain that studies of recreation benefits understate the value to the State of providing high-quality conditions for water-based recreation. Colorado has a natural advantage in attracting visitors for recreation, and I foresee that with the right approach to developing and maintaining our recreation environment, Colorado can be appreciated even more for its one-of-a-kind character, much as Switzerland is. With the right promotion, and if transportation facilities are wisely planned, recreation will become the jewel in the crown of Colorado's economy.

To take advantage of this opportunity Colorado must work together to resolve natural resources and infrastructure issues. In resolving them the State must not only take enlightened actions; it must be recognized for taking them.

Frankly, disputes over water, transportation policy, waste management and air quality haven't helped Colorado's environmental image in the last few years. Still, progress has been made. In the case of water policy, it is imperative to give recreational interests a seat at the table to play in the water game in Colorado.

How to do this? The starting point would be an assessment of needed changes in water policy to provide better conditions for recreation. This would be followed with determinations of what to do, who would do it, and how to pay for it.

### ENTHUSIASTIC RESPONSE MAKES GROUNDWATER CONFERENCE A SUCCESS

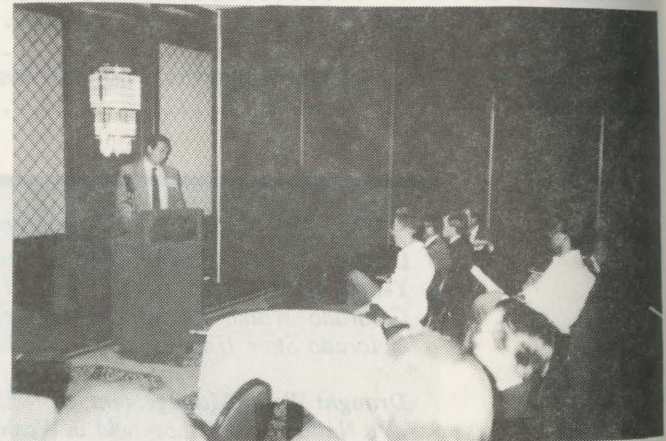
Groundwater issues and ideas took center stage at the February 28-March 1 Colorado Groundwater Engineering and Management Conference. Organized by the Colorado Water Resources Research Institute (CWRRRI) and the Office of the State Engineer, the successful conference attracted more than 200 people to the Marriot in Denver, Colorado. The focus of the conference was on the technical and management methods necessary to solve groundwater problems in Colorado and the West. "The conference helped the people of Colorado understand and assess what we know about groundwater ... and where we need to go," said Dr. Neil Grigg, Director of CWRRRI.

Participants were able to attend workshops on a number of the more than 45 professional papers presented on these topics.



*Neil S. Grigg, CWRRRI Director*

The two-day program was divided into eleven major topic areas: federal and state issues; groundwater quality remediation; applications of models; groundwater quality assessment; groundwater models refinements; artificial recharge; groundwater contamination; aquifer management; well construction; data management, mapping; and aquifer characterization.



*Hal Simpson, Deputy State Engineer*

Plenary session speakers highlighted their concerns about groundwater issues:

- \* Marian Mlay, Head of EPA's Groundwater Office, said that groundwater is one of the "most complex policy issues" of state government;
- \* Jeris Danielson, Colorado State Engineer, re-emphasized the emerging importance of water quality and the lack of data available;
- \* Tom Eggert, Arapahoe County Commissioner, expressed his views about the need for some state presence in water planning;
- \* and Daniel Luecke, Director of the Rocky Mountain Region of the Environmental Defense Fund concluded that "it is time to begin thinking of groundwater as a resource that can be used in a managed, sustained and careful way."

The conference had a very positive response. Phil Burke, President of the Colorado Groundwater Association summed it up with: "The attendance was overwhelming, the speakers and the topics exceptional, and the organization superb."

Conference proceedings are available from Verdia Johnson, Civil Engineering Department, Weber Bldg., Colorado State University, Fort Collins, CO 80523, Phone 303/491-5247.

### **WILDERNESS WATER RIGHTS March Meeting in Retrospect**

The AWRA Colorado Section meeting on March 29 was co-sponsored by the Colorado Water Resources Research Institute, representing a continuation of the Colorado Water Issues Public Forum series. Speaking on the subject of wilderness water rights were Lori Potter of the Sierra Club Legal Defense Fund and Gregg Hobbs of the law firm Davis, Graham, and Stubbs. The program was moderated by Chips Barry, Executive Director of the Colorado Department of Natural Resources.

Gregg Hobbs provided a history of the current litigation involving wilderness water rights in Colorado. Lori Potter discussed the issue of wilderness water rights within the broader context of emerging concern for protection of wilderness areas and of legislative trends in this direction. In response to questions from Chips Barry, both speakers discussed the importance and significance of wilderness water rights. Predictably, their views on the need for reserved water rights for wilderness areas and on the original intent of the law creating wilderness areas were considerably different. Judging from the 54 people registered, the program was on target in terms of public and professional interest.

### **DENVER BASIN AQUIFER RECHARGE DEMONSTRATION PROJECT UPDATE**

In 1988, the Denver Water Board, Willows Water District, Parker Water and Sanitation District and the Colorado State Engineer's Office signed an intergovernmental agreement to investigate the technical feasibility of injecting potable water into the Arapahoe aquifer for storage. This research project is a unique attempt to artificially recharge a deep, consolidated bedrock aquifer. The five-year Denver Basin Aquifer recharge demonstration project, which is being co-managed by Denver and Willows, recently began its second injection season. Pursuant to the terms of the agreement, Parker has shared in funding, up to 500 acre feet/year of potable water is provided by Denver, while use of an Arapahoe well for injection is provided by Willows.

Based on distribution system constraints, water for injection is available from approximately October 1 through April 30 of each year. However, due to equipment problems and delays in retrofitting the well, the first injection season (1988-1989) ran for only seven weeks, injecting 41 AF of the 500 AF available. Injection cycles ranged from one to two weeks duration at an average injection rate of 216 gpm. After each injection cycle, the well was briefly pumped to clean the well and aquifer face. Sand production during the pump-out cycles eventually led to equipment problems that resulted in the early termination of the injection season after

five injection cycles. Sufficient data is not available to quantify the relation between sand production and injection rates and/or injection cycle length. Sand production in this well predates the injection project. Baseline pre-injection sand data under a compromise "on-off" operating schedule are not available for this well.

On average less than three (3) percent of the water injected was removed in the pump-out cycles, so that 97 percent of the injected water remains in the aquifer. Higher than expected build-up of heads during injection and decrease in transmissivities measured during pump cycles may be due, in part, to the cooler temperature and higher viscosity of the injection and pump-out water as compared to the ambient temperature of the aquifer water.

The 1989-90 injection season began December 4, 1989. Three injection runs of 6, 2, and 4 days duration at average rates of 146, 129, and 115 gpm have been completed and 7.4 AF of water have been injected. Unexpectedly, rapid head build-ups during injection forced early termination after 2 and 4 days for the second and third injection runs, respectively. Continued high sand production during the first one to two hours of the pump-out cycles remains a problem. Injection through this well ceased on February 23, so that the well could resume service as a water supply well in Willows' system for an extended period of time in order to monitor the long-range performance of the well. The data from the second injection season have not been completely evaluated and, therefore, no further conclusions regarding the study results are available at this time.

Water quality difference between the injected water and the bedrock water do not appear to be a problem at this time, based on water quality analyses made throughout each injection season. While unduplicated analytical results indicate significant concentrations of both iron and manganese in the pumped water, further data collection is necessary to evaluate whether these data are meaningful as a trend.

### **WATER SUPPLY OUTLOOK**

*by Sheldon Boone, State Conservationist*

Much of Colorado continues to face below normal water supplies for the summer of 1990. The most critical area is the southwestern portion of the state, where water supply projections call for only about 25-35 percent of average supplies in many basins. Where reservoir storage is non-existent, or in short supply, water users should make plans for applying all practical water conservation measures. Crop production will depend on adequate spring and summer rainfall throughout much of the state this year.

The South Platte River Basin saw the largest increase in snowpack in the State. Snow measurements indicate a 24 percent increase in snowpack to 104 percent of average and 124 percent of last year. Reservoir storage is near average at 101 percent of average and 99 percent of last year. Precipitation is over 300 percent of average for March and near 150 percent of average for the water year. Forecasts range from a low of 83 percent of average for Bear Creek near Morrison to a high of 125 percent of average on the Cache la Poudre River at the canyon mouth. Water users can expect near average water supplies throughout the summer.

## DROUGHT UPDATE

**The United States - 1989.** The last six months of 1989 saw the persistence of severe to extreme long-term drought over a fourth of the contiguous United States (Figure 1), while severe to extreme long-term wetness continued over an eighth of the nation. Wet areas were limited to the southeast, northeast, and Ohio Valley. Average rainfall across the nation was above the median for August and September, but most areas shifted to a dry regime during October and November. Conditions were especially severe in the southwest, with November 1989 ranking as the second driest and 18th warmest November on record (the record begins in 1895). November 1989 was the 13th driest November for the west and the 19th driest for the nation overall. The Southwest experienced the fourth driest January-November on record.

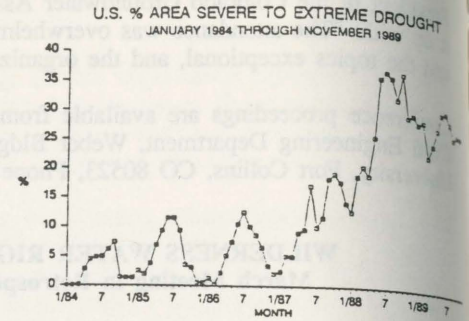


Figure 1.

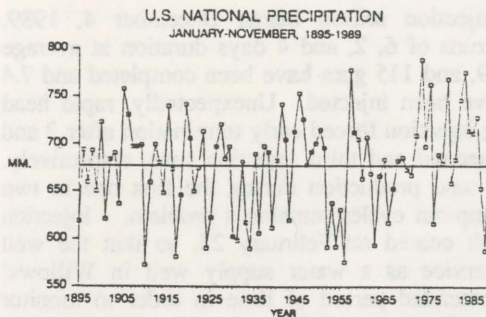


Figure 2.

National precipitation rankings for January through November stand in sharp contrast to the unusual wetness of the first half of the decade (Figure 2). The areal percent of the contiguous United States experiencing severe or extreme long-term drought reached 23 percent in May 1988. The national drought of 1988-89 has been at or above this level for the last 19 months. Only two other droughts have afflicted this much of the nation for this long: the drought of the 1950s reached 23 percent of the country in September 1953 and lasted 43 months, and in the 1930s the drought area reached 23 percent in October 1933 and lasted 21 months (Figure 3). Although the maximum extent of the 1988-89 drought was not as great as the droughts of the 1930s and 1950s, its duration is comparable to the greatest drought episode of the 1930s.

Source : Richard R. Heim, Jr., National Climate Data Center, Federal Bldg., Asheville NC 28801.

**Colorado River, Rio Grande, and Arkansas River Basins--**Across the Colorado River Basin, streamflows are expected to be much below average with few exceptions. Seasonal precipitation totals are much below average for the entire basin. Snowpack averages are: Upper Colorado mainstem 85 percent; Flaming Gorge 75 percent; Yampa 95 percent; Animas 44 percent; and the San Juan headwaters 55 percent. In the Lower Colorado River Basin most stations are reporting no snow at all. March streamflows were below to well below average basinwide. Ten major Upper Colorado River Basin Reservoirs hold 5.37 MAF (121 percent of average and 69 percent of capacity). Storage in Lake Powell is 17.92 percent of capacity. The Salt River Project system holds 1.01MAF or 50 percent of capacity.

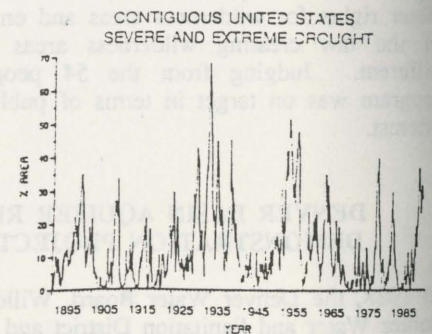


Figure 3.

In the Rio Grande River Basin, runoff is projected at only 20-55 percent, with the exception of streams west of the Sangre de Cristo Mountains at 65-85 percent. March precipitation in the Central Valley area of New Mexico was as low as 40 percent. Basinwide precipitation for the water year totals 50-75 percent, with some small exceptions. Basinwide snowpack averages are 54 percent in Colorado, only about half that of last year, and 59 percent in New Mexico (or 123 percent of last year). Reservoir storage is generally above normal and should provide sufficient water.

In the Arkansas River Basin, runoff is predicted at 58-73 percent of average on the mainstem, and 69-78 percent for the tributaries. Precipitation since October is 79 percent, and snowpack improved to 76 percent. Reservoir storage is 116 percent of average, but below normal 1990 water supplies are expected.

Source: Western States Water, April 13, 1990

## CORPS OF ENGINEERS INITIATES NATIONAL DROUGHT STUDY

The Corps of Engineers is conducting the National Water Management During Drought Study in response to the drought of 1988. The study's first-year objective is to determine what changes, if any, should be made in the nation's strategy for managing water during drought. The Corps would like to work closely with other federal and nonfederal agencies and organizations so that the conclusions they reach will reflect the views of the entire water resources community. If you would like more information about the study, or if you feel that you can contribute to its conclusions, please call or write the study manager, Bill Werick, Institute for Water Resources, Policy Studies Division, Casey Bldg., Ft. Belvoir, VA 22060-5586; (202) 355-3055.

## THOUGHTS ON MEMORANDA OF AGREEMENT TO IMPLEMENT SENATE BILL 181

by Loretta C. Lohman

State Senator Tom Norton, in an article in Colorado Water Rights, Winter 1990, emphasizes that Senate Bill 181, which was passed in the 1989 legislative session and signed into law on June 8, 1989, "is the result of a renewed effort to integrate water quantity and water quality." The legislation, according to Senator Norton, focuses on protecting the quality of water for the full range of beneficial uses. The Act calls for an integrative mechanism which will: "provide a procedure for coordination between state agencies which have responsibilities to implement water quality protection of state waters" so that actions taken to protect water quality do not cause 'material injury' to a water rights holder." Unfortunately no additional funding or staff is provided for coordination activities.

Even so, as Senator Norton indicates, S.B. 181 is an opportunity to institute an era of cooperation in the field of water quality. This is a timely effort because activity on the Federal level will be growing more aggressive in the next few years. For example, it is expected that the 1990 Farm Bill will contain provisions for protection of groundwater from agri-chemicals. The Farm Bill is also likely to expand Nonpoint Source Pollution control efforts into the agricultural arena, perhaps by expanding the applicable purposes of the Conservation Reserve Program and recognizing the cleansing effects of natural and artificial wetlands. These last two items also are already important factors in the sections of the Internal Revenue Code that affects farmers. Better cooperation among appropriate and quality agencies intra-state would strengthen their abilities to react to and deal with forthcoming regulations.

The agencies named in S.B. 181, in addition to the Colorado Water Quality Control Commission and Division, are the Mined Land Reclamation Division, the State Engineer, the Oil and Gas Conservation Commission, and the "agency responsible for the Federal RCRA." In addition, the Bill requires that "the Commission and Division shall consult with the State Engineer and the Water Conservation Board . . . before making any decision or adopting any rule or policy which has the potential to cause material injury to water rights." However, the determination of material injury is left completely to the water court.

The requirement upon the Water Quality Control Commission and Division [WQCC/D] to consult with the State Engineer and the Water Conservation Board whenever material injury may occur seems to be one cause of confusion about implementing S.B. 181. This and other conflicts among the agencies named in the Bill resulted in the Governor directing that cooperative efforts get underway in the form of Memoranda of Agreement [MOA]. Early drafts by the Water Quality Control Commission of separate agreements for each agency named have not yet resolved confusion, particularly on the issue of material injury because the law, while reserving determination to the court, seems to presuppose some degree of judgment in requiring consultation procedures among the agencies. Unfortunately, the process of developing the Memoranda of Agreement seems to have bogged down in various administrative details and the issue of material injury. Various groups have asked for additional time to review and react to individual agreements--including

industries affected by the implementing agencies named in the Act. Further, these cooperative duties are new territory to the agencies, thus some degree of uncertainty is understandable.

A modest suggestion here would be that the law, as amended by S.B. 181, be taken at face value. That the MOA do no more than outline a procedure whereby all the agencies with water quality responsibility or having responsibilities or activities that can be affected by water quality issues begin to develop a free and routine habit of consultation and cooperation. While this seems a simple task, tradition has established some adversarial postures between the relevant agencies. That precedent is deeply ingrained and may best be broken by formal recognition of mutual responsibilities and areas of common interest--hence use of the agreement format. As Gregg Hobbs noted in testimony before the Water Quality Control Commission, S.B. 181 does not create new law or new bodies to set water quality standards. The Bill simply restates existing law in that the Water Quality Control Commission sets the standards and the responsible implementing agency enforces them. Hobbs used the example of substitute water supply. His recommendation is that the State Engineer judge the substitute supply on the basis of water quality standards for that body of water being replaced, rather than judging whether the substitute water is suitable for the particular intended water use. This approach could certainly be extended to other agencies and situations.

Perhaps some background on memoranda of agreement would be helpful. Memoranda of Agreement can, by their nature, be confusing documents. They are neither fish nor fowl, but are intended to formalize working arrangements without the need for involved legal discussions and monitoring. In my work with the USDA a few years ago, helping them to implement the Technology Transfer Act of 1986, the requirements for cooperative agreements were one of the most difficult sections of the ACT to address. Some scientists in the Forest Service were using Memoranda of Understanding for anything at all, from working with a University faculty member on an information exchange basis to a major funding agreement with a large lumber company. Most USDA scientists were concerned about getting tied up with procurement regulations when time was of the essence to address an issue. Ultimately, resolution of the confusion about cooperative agreements turned out to be fairly simple. It was to simplify ruthlessly the approach and to separate a cooperative agreement from a contract. The definition of memoranda of agreement and of various types of contracts were detailed in a directive to all personnel--a document separate from the sample agreements themselves. A standard memorandum form was developed that outlined the cooperative responsibilities of each party in three brief sections: the lead agency section; the implementing agency section; and the mutual agreement section. A single page designates representatives and incorporates authorities for the MOA by reference.

This simpler approach seems to be the direction in which some of the participants in the Colorado discussions are moving. For example, on January 3, Bill McDonald called

for a simple procedural document, one that does not "imply" that each WQCC/D action must await response from the affected agency. While McDonald remains concerned about when and where material injury should be defined, he thinks a procedural type of agreement, without categorical exclusions, is the proper approach.

Simplification by standardization would remove the process of developing and implementing these Memoranda of Agreement from the area of internecine politics. Radically simplifying the MOA would also require less involvement by legal advisors. Without insulting that profession, experience in the USDA has shown that involving counsel complicates and lengthens the agreement process. Nothing in S.B. 181 indicates the need for complex legal arrangements, particularly because the Act clearly states that Material Injury shall be determined by the water court.

Because the law does seem to require the Water Quality Control Commission and Division to anticipate what might cause material injury and therefore require consultation with the State Engineer and the Water Conservation Board, the mutual agreement section of an MOA could define the general tenor of material injury or outline areas of potential problems--or, the section on mutual agreement could, instead, establish a committee of the cooperating agencies to develop guidelines that would trigger consultation concerning material injury. There is a variety of mechanisms that could be included as part of a procedural agreement which could

circumvent the difficulty of defining the currently undefinable without placing an agency in the position of making a judicial determination.

A necessarily more complex situation arises when new standards or designations are being set for a body of water or for a particular beneficial use. When there are no established standards it is not unreasonable to use comparable experience as the basis for anticipating injury. This use of precedent could also clarify and simplify the consulting procedure. When no comparable historical example exists to guide either the affected implementing agency or the WQCC/D then the full agency consulting process should be engaged. This is unlikely to be a regular occurrence, and is the most likely event to require a decision of the water court. Probably most State personnel assigned to implement any Memoranda of Agreement that result from the S.B. 181 process will not be trained as lawyers. For this reason alone, it is worthwhile to consider agreements that provide for the exercise of professional judgment and expertise based on experience. Most of the time one of the agencies will be treading familiar ground. A willingness to share experiences would enhance the ability of State agencies to make decisions that complement rather than conflict. This consulting process should result in the development of greater understanding between and among agencies and their designated representatives with respect to their singular and mutual responsibilities.

## COLORADO WATER LEGISLATION

by Loretta C. Lohman

Status of legislation as of April 12, 1990--Most legislation introduced in this session was an outgrowth of the Joint Interim Committee on Water which held hearings throughout the summer and fall of 1989. Sen. Tilman Bishop chaired that committee and senate members have introduced the most legislation this session, and just about the only measures that have passed or are likely to pass. Although much of the legislation introduced in the 1990 Colorado General Assembly has been postponed indefinitely (killed) in committee, measures that have not yet been disposed of in this session include:

S.B. 7, introduced by Sen. Bishop to establish a water resources legislation review committee with three members from each House of the Legislature, three members appointed by the Governor, and the State Engineer and Director of the Water Conservation Board. This Bill has passed the Senate and is now in the House Appropriations Committee;

S.B. 13, introduced by Sen. Harold McCormick, would establish methods for fulfilling the due diligence requirement in establishing conditional water rights. This Bill has passed both Houses;

S.B. 35, introduced by Sen. Bishop, will create a Colorado Greenway Trails System to link various bodies of water with cities and towns. The Bill has passed the Senate with wide support;

S.B. 126, introduced by Sen. Norton, offers control of agriculture chemicals in groundwater. It is now in the House Appropriations Committee;

S.B. 158, introduced by Sen. Bishop, would create a Water Resources Commission and water Resources Division within the Department of Natural Resources (DNR). The State Engineer, District Engineers, and various other departments of DNR would be guided by the new commission. A second section of the Bill would prohibit any Colorado state officials to interstate compact or commission organizations acting without explicit instructions from the Water Resources Commission. The Bill has been sent from the Senate Agriculture Committee to the Senate Appropriations Committee.

S.B. 165, introduced by Sen. Mike Bird, delays for one year transfer of general fund moneys to the Water Conservation Board construction fund, to fish and wildlife reserve accounts in that fund, and to the Water Resources and Power Development Authority. The Bill was signed by the Governor on April 3rd;

S.J.R. 8, by Sen. Dave Wattenberg supporting wastewater treatment projects was signed by the Governor on March 26.

S.J.R. 12, introduced by Sen. Norton, resolved that any additional wilderness areas shall have no reserved water rights. It was adopted by both houses on April 10th.

Measures that have died in Senate Committees include:

S.B. 144, introduced by Sen. Dennis Gallagher, would have made the Directors of Water Conservancy Districts subject to open election;

S.J.R. 5, introduced by Sen. Tom Norton concerning activities of the Water Conservation Board, and S.J.R. 7, introduced by Sen. Jim Brandon concerning coordination of water resources, have received no action since being assigned to the Senate Agricultural Committee;

S.J.R. 20, introduced by Sen. Jana Mendez, resolved that the State of Colorado would ask Congress to create wilderness areas at or near the headwaters of water supply streams, and that any new areas have reserved water rights quantified under state law and protecting existing water rights.

Water legislation originating in the House of Representatives included:

H.B. 1014, introduced by Representative Scott McInnis, is a basin-of-origin bill aimed at protecting the source area of trans-basin water diversions. It has received late bill status in the hope that various interested parties (primarily members of the Colorado Water Congress) can reach a compromise. If such compromise is attained the Bill is likely to move rapidly through the legislative process;

H.B. 1094, introduced by Rep. John Irwin, mandates use of water meters for municipal water suppliers. It has passed both Houses;

H.B. 1109, introduced by Rep. John Irwin, mandates use of water meters for municipal water supplies. The bill was signed by the Governor on April 6th.

H.B. 1130, introduced by Rep. Masson, discontinues some fees charges by the State Engineer for dam and reservoir inspection and revises upward other fees charged for review of plans and specifications, and for reviews of erosion dams and livestock tanks. It has passed both Houses.

Measures that have died in House Committees include:

H.B. 1092, introduced by Rep. Matt Jones, would have required water conservation practices on state landscapes;

H.B. 1210, introduced by Rep. Dan Prinster, would have provided compensation and mitigation for the basin of origin when water rights are sought for trans-basin diversions and diversions outside the boundaries of Water Conservancy District and Water Conservation Districts;

H.B. 1220, introduced by Rep. Jim Pierson, would have made it a policy of the State to use water efficiently.

### SOUTH PARK, COLORADO

*By Joseph Pollara, Student Intern*

In March 1990, a report was completed for the Denver Water Department entitled "Evapotranspiration and Agronomic Responses in Formerly Irrigated Mountain Meadows." The study, carried out in South Park, Colorado, was a cooperative effort by W.W. Wheeler & Associates, Inc., Cimmaron Engineering, Inc., Colorado State University and the University of Wyoming. Gene Siemer of Colorado State's Mountain Meadow Research Center participated in the study, which provides reliable information on historical consumptive use of water on previously irrigated land. The relevance of this evaluation lies within the structure of the prior

appropriation doctrine that governs the distribution of Colorado's waters.

Water rights established long ago, mostly by irrigators, are a valuable commodity since they have a senior priority to use a certain quantity of water. These are senior water rights and are always satisfied first over other "junior" water rights in times of shortages. Rising demand for water by cities experiencing population expansion coupled with the lack of other viable sources of supply make purchasing senior water rights an attractive alternative.

To transfer the right, the diversion point is altered and only that amount of water which was historically consumed can be used for the new right. This last stipulation arises from another axiom of the prior appropriation doctrine that no downstream right can be subject to injury based on the actions of another upstream right. For example, a farmer historically diverts 100 acre-feet of water for irrigation on the land, but crops only consume 25 acre-feet of water through evapotranspiration. The other 75 acre-feet are returned to the stream by runoff and groundwater recharge for other downstream users to ultimately put to use. If, however, a water transfer takes place, then only 25 acre-feet of the total 100 acre-feet from the original right may be diverted for other uses downstream since the remaining 75 acre-feet were not historically consumed.

Quantifying the amount of historic consumption by formerly irrigated meadows was administered by analyzing data collected from lysimeters, neutron probes, weather stations, observation wells and plant investigations. This information, available in this report, will make future transfers more equitable for everyone involved.

### COLORADO CITIZENS' WATER LAW HANDBOOK

*by George Vranesh, P.E., E.M., L.L.B.*

*Edited by Kathleen Cain*

This handbook addresses the intricacies of Colorado Water Law. It was specifically prepared for participants of the Colorado Endowment for the Humanities Project, **Colorado Water: The Next 100 Years**. However, the author, George Vranesh designed the handbook to also be used for preparation of the public to participate in community and state decisions regarding water. Those already involved can use the handbook as a further reference.

The handbook begins with the very basics of water law. It defines the terms, conversions, and explains the general legal environment. As it becomes more detailed, the book describes exact procedures for dealing with a variety of water law problems. It addresses all these issues in a simple, non-technical way. The section on the Engineering Fundamentals of Water Law ties the role of a water engineer into water law. Vranesh explains what a water engineer is required to prove in litigation.

In summary, the handbook is a non-technical, straight forward approach to the basics of water law. For additional information about the publication and the Endowment for the Humanities Project, contact: Barbara Preskorn, Humanities Department, Front Range Community College, 3645 W. 112th Avenue, Westminster, CO 80030.

## WORKSHOP LOOKS AT HYDROLOGIC ASPECTS OF DAM SAFETY

A workshop was held at CSU on November 16, 1989, to assess current methods for using Probable Maximum Precipitation (PMP) Estimates and snowmelt data for estimating spillway design floods. The workshop was held at the request of the State Engineer. In 1988 a revised Hydrometeorological Report (HMR) 55A was published and distributed, which provides PMP estimates for the United States between the Continental Divide and the 103rd Meridian (approximately 100 miles east of the Foothills). But some suggest that possible variations in snowmelt or precipitation due to elevation should also be considered when developing PMP estimates for Colorado and other mountain states.



Dam Safety Workshop, Nov. 16, 1989

Summarizing the workshop, CWRRI Director Neil Grigg said that, as expected, there was controversy about the adequacy of HMR 55A as a guide for developing site-specific PMP estimates in the Colorado Mountains. Because of insufficient data, additional research is needed to verify or refute HMR 55A at elevations above about 7500 feet in Colorado, and a desired ultimate product would be a manual of practice, based on the input of several disciplines, that provides advice on site-specific PMF determination for locations where either rainfall or snowmelt may be controlling. Specific conclusions of the workshop are presented in CWRRI Information Series No. 62 (see **NEW INSTITUTE PUBLICATIONS**).

Twenty-five individuals attended the workshop, including representatives of the Colorado, Wyoming and New Mexico State Engineer offices; consulting meteorologists and engineers; the State Climatologist; faculty of CSU and CU; representatives of USGS and USBR; and the Director of the Rocky Mountain Forest and Range Experiment Station.

## DROUGHT SEMINAR AND WORKSHOP SCHEDULED IN DENVER

A drought seminar and workshop, **Drought Management and Planning: Today and Tomorrow**, will be held in Denver on May 30-June 1, 1990 to begin the process of networking public agencies and private organizations with drought-related responsibilities at the state, regional and national scale. The program will be two and one-half days

in length, and will include invited papers to be presented in plenary sessions and discussion groups that address specific drought issues and prepare recommendations. Discussion groups will be organized on topics such as monitoring, impact assessment, planning and response, and intergovernmental coordination. Conclusions and recommendations of the discussion groups will be presented. A summary report of the meeting will be distributed, and a proceedings published. The meeting will be held at the Holiday Inn-Downtown Denver, 1450 Glenarm Place, Denver (303)573-1450. This meeting is an integral part of the recently initiated Corps of Engineers National Water Management During Drought Study. Sponsors are: International Drought Information Center, University of Nebraska; National Climate Program Office/NOAA; U.S. Army Corps of Engineers; and USDA. For more information contact Deborah Wood at the International Drought Information Center (402)472-6705.

## Luncheon Meeting Planned WATER FOR SNOWMAKING IN SKI AREAS

Be sure to make a reservation for the luncheon meeting on Friday, June 1, planned by the Colorado Section of AWRA. The topic will be **Water Resources Issues Affecting Ski Area Snowmaking**. Invited speakers and topics include:

Leo Eisel of Wright Water Engineers presenting a summary of a snow-water budget study that involved six Colorado ski areas;

Greg Roush of Leonard Rice Consulting Engineers presenting the Loveland Ski Area's experience in developing a water augmentation plan for snowmaking;

Dan Merriman of Colorado Water Conservation Board presenting instream flow issues affecting ski area water use;

Scott Fifer of ENARTECH presenting water rights and instream flow issues faced by Summit County ski areas.

The program will be held from Noon to 3:00 p.m. at the Village Resort at Breckenridge. Luncheon fee is \$12 for AWRA members and \$14 for non-members. A luncheon deli buffet is included. Mail your registration form and check no later than May 29 to: Ski Area Snowmaking, AWRA-Colorado Section, P.O. Box 9881, Denver, CO 80209. For further information contact Kate Berry at 320-4400 or Bill Fullerton at 453-6394.

## ASDSO WESTERN REGIONAL MEETING SCHEDULED FOR MAY 15-16

The Wyoming State Engineer's Office invites you to attend the 1990 Association of State Dam Safety Officials (ASDSO) Western Regional Meeting May 14-16 in Jackson, Wyoming. The meeting will start Monday morning, May 14 and continue through Tuesday afternoon, May 15. On Wednesday morning, May 16th, there will be a tour of the recently rehabilitated Jackson Lake Dam. Followed by a technical seminar starting the afternoon of May 16th and continuing through the 17th. Registration is \$75.00, including a luncheon on Tuesday. The meetings will be held at the Snow King Resort, 400 East Snow King Ave., Jackson, WY 83001. Optional activities planned for



participants and spouses include a scenic float trip down the Snake River on Sunday, May 13, and for spouses a guided tour of Yellowstone Park on May 15. For information on the conference contact David Benner or Russell Dahlgren, Wyoming State Engineer's Office at 307/777-7354. For information about the technical seminar call 606/257-5140.

### SYMPOSIUM ON POTENTIAL, LIMITATIONS OF WATER CONSERVATION HELD IN FEBRUARY

More than 100 persons attended a symposium on **Water Conservation: Potential and Limitations**, held in Denver on February 9. Topics discussed at the symposium included:

- Water Use Efficiency - *Neil S. Grigg, Director, CWRI*
- Augmenting Municipal Supplies Through Agricultural Water Conservation - *David Engels, Director of Public Utilities, Casper Board of Public Utilities*
- Alternative Rate Structures for Water Demand Reduction - *John Gallagher, Black and Veatch Engineers*
- Revegetation Requirements for Water Transfers from Irrigated Farms - *Ernest Flack, Professor, CU and Paul Flack, Hydrologist, City of Aurora*
- The Trials and Tribulations of Public-Sector Xeriscaping - *Joe Temple, Colorado Dept. of Highways*
- Water Conservation Reality - *Jonas Minton, Water Conservation Office Chief, California Dept. of Water Resources*
- Water Reuse - *William Fischer, Attorney, Fischer, Brown, Huddleson, Gunn*
- Residential Water Efficiency Analyses and Strategies - *Jim Dyer, Water Program Director, Rocky Mountain Institute*
- The Conservation Mirage - *Craig Sommers, President, ERO Resources Corp.*
- Water and Energy Conservation by Improving Irrigation Practices in Colorado - *Israel Broner, Asst. Prof. and Extension Irrigation Specialist, CSU*

A panel discussion led by Jim Loftis, CWRI Associate Director, followed. Panel members were Ralph Curtis, General Manager, Rio Grande Water Conservancy District; David Harrison, Colorado Water Conservation Board; Tom Griswold, Director, Aurora Utilities Department; and Dan Luecke, Senior Scientist, Environmental Defense Fund. Chips Barry, Executive Director of the Colorado Department of Natural Resources, gave the symposium's keynote address

and State Senator Sally Hopper presented the luncheon address. The symposium was sponsored by the Colorado Section of the American Water Resources Association (AWRA) and Metro Water Conservation Inc. (MWCI).

### FLOOD LAUNCHED URBAN DRAINAGE MANUAL

DRCOG will observe its 35th anniversary in March and, to lead up to that event, DRCOG Notes has been carrying some historical information about the agency, its activities and its legacy. This article describes DRCOG's award-winning urban storm drainage manual. The extraordinarily heavy rains that inundated the Denver region in June of 1965 caused a heavy toll in the resulting flood waters that rampaged through the metro area. And while the damage was most extensive in the Lower South Platte Valley, the havoc created by widespread local flooding captured the attention of the region's planning agency. Very quickly a flood study committee had formed, and was later reformed into the Storm Drainage Advisory Committee. Much of the committee's work focused on the funding and implementation of efforts that would help reduce the drastic effects of heavy rains.

With funding from a grant awarded by the Department of Housing and Urban Development, DRCOG contracted with Wright-McLaughlin Engineers of Denver to develop an urban storm drainage criteria manual. Completed in 1969, the manual received the Grand Award of the Consulting Engineers Council of Colorado and the National Outstanding Publications Award from the Consulting Engineers Council of the United States. It has since developed a worldwide reputation as a basis for urban storm drainage practices. Since the formation of the Urban Drainage and Flood Control District (also a result of the Storm Drainage Advisory Committee's work), the manual has been maintained and updated by UD&FCD so that, 20 years later, it remains an important tool in urban development. What's more, that manual is a tangible example of DRCOG's success at developing regional solutions and then setting up the instruments to carry out the solutions. It could be said that in this particular case, DRCOG helped write the book on planning that leads to implementation.

Source: DRCOG Notes, February 1990

## UNIVERSITY WATER NEWS SUMMARY

### PREDICTING MOUNTAIN SNOWFALL IN COLORADO

Researchers at Colorado State's Department of Atmospheric Science are excited about their progress on a project that deals with predicting mountain snowfall in Colorado. The project involves evaluating the performance of a fast-running numerical model of orographic precipitation. It uses standard soundings from the National Weather Service, available every 12 hours, and then predicts snowfall over a 10 km grid covering western Colorado. Predictions over a 26-year period were compared with observations at snowcourse sites and with runoff measurements from stream gaging stations with quite favorable results, said the researchers. Accurate

prediction of winter precipitation amount, timing and distribution in mountainous regions is of vital importance for avalanche prediction, highway maintenance, water supply forecasting and recreation. The researchers believe that these results have the potential to improve the accuracy, timeliness, and cost of snow accumulation predictions; to provide earlier and more accurate guidance for runoff amounts; and perhaps to even prove useful as an index of climate changes.

The SNOWPACK model is currently being used in a "real time" mode to predict daily, weekly, and monthly accumulated precipitation in the Colorado mountains from current soundings. The results are being compared with the 26-year average values for the same time of year. Project

investigators are Lewis O. Grant, Professor of Atmospheric Science, David C. Rogers, Research Associate, and Mark D. Branson, Graduate Research Assistant.

### WATER QUALITY RESEARCH AT COLORADO STATE

Jim Loftis reported on CSU's water quality research at the Colorado Water Congress's Annual Meeting in January. A summary of the projects he identified follows.

#### Agricultural Impacts on Ground Water Quality:

Chemical Transport Models--Nutrients, Pesticides.

*Investigators: Butters, Agronomy; Loftis/Durnford, Agricultural and Chemical Engineering (ACE); Decoursey, Smith, ARS.*

Nutrients--Nitrate Use Model. *Investigators: Soltanpour/Follett, Agronomy.*

Pesticide Breakdown--Microbial Decomposition. *Investigators: Doxtader, Agronomy; Reardon, ACE.*

Soil Chemistry. *Investigator: Lindsay, Agronomy.*

Irrigation - Management Affects Leaching. *Investigators: Broner/Podmore, ACE; Duke/Heermann/Kruse/Bausch/Buchleiter, ARS.*

Screening Tools for Predicting Groundwater Pollution. *Investigators: Durnford/Loftis/Knutson, ACE.*

Ag Chemical Pollution from Horticultural Crops. *Investigators: Ells/Goldsberry, Horticulture.*

#### Hazardous Waste Impacts on Ground Water Quality:

DNAPLs--Sinkers: Solvents such as TCE. *Investigator: McWhorter, ACE.*

LNAPLs--Floaters: Jet Fuel, Gasoline. *Investigators: Durnford, ACE; Warner, Civil Engineering (CE).*

Rocky Mountain Arsenal--Modeling Groundwater Flow. *Investigator: Warner, CE.*

Rocky Flats--Technical Assistance for Cleanup. *College of Engineering.*

Last Chance Hazardous Waste Landfill--Community Support. *Investigator: Richard, Environmental Health.*

#### Water and Waste Treatment:

Effect of Return Flows on Stream Quality, Thornton Purchase of Agricultural Water Rights, Effect of Water Quality on Water Rights.

Leachates from Landfills. *Investigators: Sanders/Hendricks, CE.*

Biological Treatment of Pesticides. *Investigators: Reardon, ACE; Doxtader, Agronomy.*

#### Natural Water Systems:

Groundwater Animals in Alluvial Systems. *Investigator: Ward, Biology.*

Relating Geology to Water Quality. *Investigator: Stednick, Earth Resources.*

Effect of Water Transfers on Flora, Fauna, and Aesthetics of National Parks. *Investigator: Sanders, CE.*

#### Water Quality Monitoring

Water Quality Network Design. *Investigators: Ward/Sanders/Loftis, ACE and CE.*

Water Quality Information Systems. *Investigator: Ward, ACE.*

Water Quality Statistics, Trend Analysis. *Investigator: Loftis, ACE.*

### ALUMNI ASSOCIATION HONORS JERIS DANIELSON

Jeris A. Danielson will be an honor award recipient at the annual award luncheon of the Colorado State Alumni Association on May 11. Danielson earned his B.S., Masters and Ph.D in Civil Engineering from Colorado State. He is State Engineer of Colorado and Director of the Colorado Division of Water Resources, a past president of the Association of Dam Safety Officials, and a special adviser to NASA. Danielson was awarded the Public Service Award by the CSU Department of Civil Engineering.

### WATER TRANSFERS IS TOPIC OF ANNUAL NRLC CONFERENCE

Moving the West's Water to New Uses: Winners and Losers is the theme for this year's Natural Resources Law Center's annual conference. The meeting will be held June 6-8 at the Law School in Boulder. The conference will consider the changing demands for water in the West and the need to reallocate a portion of the existing uses of water to new uses. For additional information about this program, contact Kathy Taylor, Conference Coordinator, at (303)492-1288.

### CSU PROF EDITS WATER INTERNATIONAL ISSUE ON TRANSBOUNDARY WATER CONFLICTS

A special issue of *Water International*, focusing attention on transboundary water conflicts, is planned for September 1990. Coordinators of the issue will be Evan Vlachos, Associate Director, International School for Water Resources, Colorado State University, and Jerry Delli Priscoli, Senior Policy Analyst with the U.S. Army Corps of Engineers Institute for Water Resources. If you are interested in contributing to this issue contact Professor Vlachos at (303)491-6089 or (303)491-5247. FAX (303)491-6787.

### HEC CONTRACTS WITH CIRA TO DEVELOP PC-BASED DOWNLINK CAPABILITIES

The Corps of Engineers utilizes the GOES satellites to obtain a spectrum for realtime water control purposes. The types of information obtained are: (1) surface information collected

at data collection platforms (DCPs) and relayed to surface stations via GOES, and (2) meteorological data obtained from satellite sensors used to produce weather satellite imagery and severe weather forecasts. The National Weather Service generally provides this data via dedicated phone lines. As an alternative to obtaining this information via phone line, HEC has contracted with the Cooperative Institute for Research in the Atmosphere (CIRA) at Colorado State University to develop a PC-based downlink system. The advantage to this approach over telephone retrieval is that data retrieval will still be possible during emergency situations when phone lines are not available. Also, data retrieval will be more economical.

Source: Advances in Hydrologic Engineering, Jan. 1990

### CADRE IS FINALIST FOR MULTIMILLION-DOLLAR GRANT

The National Science Foundation has selected CSU's Center for Analysis of the Dynamics of Regional Ecosystems (CADRE) as a finalist for a multimillion-dollar grant. CADRE was formed one year ago to merge work done on global climate change by researchers at Colorado State and other institutions. The CADRE proposal was one of 146 submitted to the NSF science and technology center program, and Colorado State is one of 30 institutions in the nation selected as a finalist. NSF ultimately will fund 10 to 15 proposals. CADRE Director Bob Woodmansee said they have requested \$4 million annually for the next five years. CADRE scientists will focus on the ecological consequences of global climate change on arid and semi-arid regions of the United States. An NSF review team visited the Colorado State campus April 17-18 to tour CADRE facilities and interview scientists and students.

### CD-ROM DATA BASES AVAILABLE

CSU's Morgan Library has expanded its CD-ROM databases since 1989 and during 1990 will acquire several more databases including: **Aquatic Sciences and Fisheries Abstracts**, **Hourly Precipitation Data**, and **Cold Regions Research and Engineering Bibliography**. Joan Chambers, Library Director, said use of some data bases was so heavy that sign-up sheets were required. Some of these are:

**NTIS:** Indexes and abstracts reports of U.S. government sponsored research published by the National Technical Information Service from 1980 to the present. It is equivalent to Government Reports Announcements and Index. **Selected Water Resources Abstracts:** Indexes and abstracts monographs, journal articles, reports and other publications on water resources from 1969 to the present.

**CLIMATEDATA:** **Hourly Precipitation** - Hourly precipitation values for more than 5,000 present and historical stations. **Summary of the Day** - National Climatic Data Center's files on daily observations by the state for 100 years: temperature, precipitation, snowfall and evaporation.

**HYDRODATA:** **Colorado Water Rights** - Compilation of conditional and absolute water rights granted under Colorado's prior appropriation system. Legal and administrative information from the State Engineer's

tabulation of water rights. **Daily Values** - Contains resource data from the U.S. Geological Survey's Daily and peak value files for the United State and Canada covering more than 100 years. **Quality of Water** - Data on over 3 million analyses involving 3,000 parameters of surface and groundwater quality from the U.S. Geological Survey's WATSTORE database.

**World Weatherdisc:** A massive meteorological database describing the historic and current climate of the earth.

The Documents Department continually receives additional material on CD-ROM and computer disks. For more information, call the Government Documents Reference Desk at Morgan Library, 491-1882.

### AWRA/UCOWR STUDENT PAPER COMPETITION

Two awards will be given, one sponsored by the Hydrolab Corp. of Austin, Texas, and the other by UCOWR and AWRA. The first award, given by the Hydrolab Corporation, will be for the Best Student Paper Presentation at the Annual AWRA meeting November 4-9, 1990, in Denver, Colorado, with a cash prize of \$250 and one year's membership in AWRA. This award will be presented at the Annual Meeting. Award No. 2 will be given by UCOWR and AWRA to the student who submits the best technical paper, with a cash prize of \$250, one year's membership in AWRA and publication in the *Water Resources Bulletin*. Instructions for submission of paper for Award No. 2: **Subject:** Any water resources topic. **Requirements:** Author must be student or have received a degree during the 1989-90 academic year. **Submission:** Mail 2 copies by June 15, 1990 to:

Student Paper Competition  
American Water Resources Association  
5410 Grosvenor Lane, Suite 220  
Bethesda, MD 20814-2192

\* Cover page (removed during review to ensure anonymity) should contain: Author's name (should appear only on this page), Title of Paper (repeat on first page of text), Institution, Undergraduate or Graduate Division, and (anticipated) date of graduation, and Faculty contact: name, address, and phone number. Paper should comply with "Instructions to Authors," Water Resources Bulletin 18(1):175, February 1982, as regards citations, format, paper size, style, etc. Technical Paper should be approximately 5,000 words. **Criteria:** Scoring will be on a 1(low) to 5(high) basis in each of the three following categories, weighted evenly: 1. **Technical Content** - Degree to which subject matter is correct, analyzed, and sound as well as pertinence to water resources. 2. **Structure and Organization** - Subject development, format, grammar, mechanics, and logic. 3. **Creativity and Originality.**

Each paper will be reviewed without identification of author or institution. Final selections will be made by the Chairman of the AWRA Student Activities Committee, and Editor of the Water Resources Bulletin, and the Chairman of the Education and Public Services Committee of the Universities Council on Water Resources (UCOWR). Write or call RONALD M. NORTH, Institute of Natural Resources, University of Georgia, Athens, GA 30605, (404)542-1555.

## 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.

### COLORADO STATE UNIVERSITY, FORT COLLINS, CO 80523

- The Effects of Base-Level Changes on Fluvial Processes, Sedimentation & Erosion Control, Frank G. Ethridge, Earth Resources
- Ecosystems Processes in Treefall Gaps of a Lowland Tropical Rain Forest, Robert Sanford, Natural Resource Ecology Lab
- Fish Inventories & Evaluations Associated with Sport & Endangered Fish in Northern Colorado, Eric P. Bergersen, Coop. Fish & Wildlife Research
- Radioecological & Ecotoxicological Investigations at Rocky Flats, Floyd W. Whicker, Radiation Biology
- Experimental Study of Aerosol Plume Dynamics, Jack E. Cermak, Civil Engineering
- Evaluation Log - Drop Structures as Habitat Improvement for Trout, Kurt D. Fausch, Fishery & Wildlife Biology
- Ecology of Great Plains Grasslands, Debra P. Coffin, Range Science
- Evaluation of Management Regimes for Dryland Western Turfgrass Cultivars, Anthony J. Koski, Horticulture
- Monitoring the Reduction of Tungsten Hexafluoride Using Insitu Laser Spectroscopy Technology, Carol M. McConica, Agricultural & Chemical Engineering
- Development of Native Western Turfgrass Cultivars, Robin L. Cuany, Agronomy
- Bureau of Reclamation - Saline Water Research, Dennis W. Lamm, Cooperative Extension Services
- Biological Processing and Interactions with Coal, Muhammad N. Karim, Agric. & Chem. Engineering
- Stream Habitat Studies on the Collier Wildlife Area, Eric P. Bergersen, Coop. Fish & Wildlife Research
- Hydrologic/Cloud Studies, David A. Randall, Atmospheric Science
- Enhancement and Documentation of the CORPS - System Computer Program H6209, Albert Molinas, Civil Engineering
- Tropical Atmospheric Dynamics, Wayne H. Schubert, Atmospheric Science
- Geosciences Workshop, Thomas H. Vonderhaar, CIRA
- Current and Forecast Hydrometeorological Conditions, Thomas H. Vonderhaar and Thomas A. Brubaker, Atmospheric Science
- Satellite Remote Sensing, Thomas H. Vonderhaar, CIRA
- Areal Precipitation Estimates Using Satellites, Thomas H. Vonderhaar, Thomas B. McKee, Atmospheric Science
- LES and Mesoscale Model Simulation, William R. Cotton and Roger A. Pielke, Atmospheric Science
- Hydrologic Modeling Model Analysis, Daryl B. Simons and Pierre Julien, Civil Engineering
- Climatic Geomorphology, Stanley Schumm, Earth Resources
- Evaluation of Colorado Squawfish Stocking in Kenney Reservoir, CO, Eric P. Bergersen, Coop. Fish and Wildlife Research
- Predator-Prey Interactions Between Selected Non-Native Fishes of the Colorado River, Robert T. Muth, Fishery and Wildlife Biology
- Ecology of Colorado's Urban Wildlife, Eugene Decker, Fishery and Wildlife Biology
- Larval Fish Laboratory Involvement in Implementing Recovery Actions for Endangered Species, Robert T. Muth, Fishery and Wildlife Biology
- Local Government Severe Weather Information Processing, Thomas H. Vonderhaar, CIRA
- Forecast Product Development for Severe Storm Nowcasting, Thomas H. Vonderhaar, CIRA
- International Satellite Cloud Climatology Sector Processing Center for GOES WEST, 1985, Thomas H. Vonderhaar, CIRA
- Developing and Understanding a Sensor - Topographic Modeling, Thomas Vonderhaar and Thomas Brubaker, Atmospheric Science

### UNIVERSITY OF COLORADO, BOULDER, COLORADO

- Analysis of Ice-Radar Studies of Basal Conditions and Internal Structure in West Antarctic Ice Streams, Robert Jacobel, Institute of Arctic and Alpine Research
- Polar Ocean Surface Fluxes, Roger Barry, Cooperative Institute for Research in Environmental Sciences (CIRES)
- Long-Term Ecological Research in the Colorado Alpine, Nelson T. Caine, Institute of Arctic and Alpine Research

### ABOUT DROUGHT - A BOOKLET FOR THE PUBLIC

The Colorado Division of Disaster Emergency Services (DDES) has produced a booklet called About Drought. Funded by FEMA, it is to be used by states to heighten the level of public awareness about drought. The booklet begins with a brief history, and mentions past federal relief programs. It then defines drought, lists the types of droughts, and explains how to measure their severity. The impact of drought on Agriculture, Forestry, Transportation, and the environment in general are also discussed. The booklet contains a description of the model drought plan

which is now being prepared for use by all state governments. Finally, a list of organizations that are involved in drought relief and numerous suggestions on simple conservation methods round out the brochure. Each state can add localized information to the booklet. The Colorado distribution addition is called Drought in Colorado. It briefly discusses history and current supplies, and provides a summary of the Colorado Drought Response Plan. The booklet is available from DDES, Camp George West, Golden, CO 80401. (303) 273-1771.

## FROM COOPERATIVE EXTENSION

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

**Sprayer Calibration Fundamentals**--Due to the erosion benefit and effectiveness, chemical pesticide application has become a leading method of controlling weeds and insects in U.S. agricultural production. The Food Security Act of 1985 may increase pesticide usage as agricultural producers implement conservation plans designed to reduce soil erosion.

The continued use of pesticides in the agricultural industry has led to concerns of chemical trespassing by groundwater contamination or drift. Inaccurate pesticide application (rates, patterns and droplet size) can lead to movement of pesticides from the target area and/or reduce effectiveness of the pesticide. The lack of accurate field pesticide applications by agricultural producers has been demonstrated in several studies. A recent study in Nebraska revealed that two-thirds of the applicators were improperly applying pesticides (errors greater than 5 percent). A similar study conducted in North Dakota indicated that 60 percent of the sprayers tested had calibration errors greater than 10 percent. Elsewhere, errors of 30 to 100 percent have been reported.

The first step in sprayer calibration is determining the correct nozzle type and size (flow rate). Flat-fan nozzles are used for broadcast spraying of most herbicides and some insecticides. A medium droplet size distribution is obtained. Even flat fan nozzles are used for banding herbicides. Flooding type nozzles, also used for herbicides, produce drift resistant large droplets, and wider nozzle spacing can be used. Cone nozzles produce smaller droplets and are used to apply insecticides that need to penetrate the canopy.

Nozzle size is dependent on the desired application rate, ground speed and nozzle spacing. For each nozzle type and spray angle, the manufacturer will recommend a spray height and nozzle spacing. Typically 80-degree nozzles need a spray height of 18 inches and a 20-inch nozzle spacing, and 110-degree nozzles need a spray height of 12 inches and a 20-inch nozzle spacing. The desired flow rate from the nozzle can be determined from the equation shown:

$$\text{GPM} = \frac{\text{GPA} * \text{MPH} * \text{w}}{5940}$$

5940

where

GPM is the nozzle flow rate in gallons per minute,  
GPA is the desired application rate in gallons per acre,  
MPH is the ground speed of the sprayer in miles per hour, and  
w is the nozzle spacing in inches.

An accurate ground speed measurement is essential when applying chemicals. Select the nozzles that will give the desired flow rate within the recommended operating pressure. Spray distribution uniformity is important for broadcast spraying. Uniform spray coverage eliminates weed streaking and crop burning. Concentrations up to four times the recommended amount can result from non-uniform applications. To obtain even coverage, make sure all the nozzles are the same and are equally spaced along the boom. Check each nozzle to make sure the flow rates are correct.

A nozzle tip tester or a measuring cup and stopwatch can be used to determine this. Nozzle wear and plugging can drastically affect nozzle flow rate. The boom height should be adjusted to the recommended height. Spray uniformity can be checked by spraying water on a concrete surface and observing the amount of streaking that occurs when the water dries. Make sure all calibration efforts are conducted using water.

Paul Ayers is available to conduct local sprayer calibration workshops and demonstrations. A portable, self-contained spray table demonstrator has recently been obtained. It consists of three spray nozzles, a patternator (for analyzing spray patterns) and a recirculating pump. Spray pattern, as affected by nozzle spacing and height, can be checked. Also nozzle wear, nozzle types, pressure variation affects, and calibration techniques can be demonstrated. Contact Paul Ayers at 491-6172 for more information.

**Up-and-Coming Issues in Water Quality**--It will come as no surprise to you that I think that water quality will remain a high priority issue for the next five years. I am guessing that we will continue to find spotty areas of high nitrates in Colorado ground water and that we will not find pesticides in ground water at alarming concentrations. There will likely be enough concern to result in some restrictions on chemical use imposed at either the state or federal level. I also think that drinking water quality (especially nitrates) will remain a concern in rural areas for both individual homes and small communities. We will distribute a water quality notebook to all counties this year. In the area of agricultural impacts on ground water quality, the most important role for counties will be to include water quality concerns in existing programming on the management of pests, fertilizers and irrigation water. Our water quality notebook should be a useful resource in this area also.

In the next year or two a ground water quality protection act, such as the current Colorado Senate Bill 126, is likely to become law. In this event, Cooperative Extension will probably be asked to take a leading role in training of agricultural chemical applicators from a water quality perspective. We will hopefully receive the additional resources needed to do this job well. In any case, we will use every opportunity to promote sustainable agricultural practices including integrated pest management, careful selection of pesticides and application methods, and careful management of irrigation water and fertilizers.

We hope to receive water quality program support funding each year from Washington and plan to pass some of these funds along to the counties. This year the focus of the federal funding is training of agricultural chemical users (fertilizers and pesticides), and I would hope that counties would emphasize this topic in their proposals for grants. We should be able to fund on the order of ten proposals in the \$500 range in addition to the five counties selected for the ASCS integrated crop management (ICM) programs, each of which will receive \$1000.

The success of the ICM program in particular as well as the overall national water quality initiative will depend on close cooperation between Cooperative Extension and the Soil Conservation Service. SCS will need our help in developing sound fertilizer recommendations and pest management practices for farmers. In fact, the new SCS standards and

specifications in fertilizer management and pest management are both being written with the assumption that technical assistance will be available from Cooperation Extension. This relationship with SCS represents a great opportunity to see Extension recommendations applied on a wide scale and to have a convenient means of reporting numbers of farmers participating and crop acres affected by the program.

### THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

*Many Coloradoans have forgotten the great floods of 1965. These, and other flood events in the Denver area, led to the creation of the Urban Drainage and Flood Control District, one of America's premier stormwater and flood agencies. The following article describes its progress and current status.*

July 1, 1989 was the 20th birthday of the Urban Drainage and Flood Control district. During that time the District has gradually increased its capabilities, in a carefully planned manner, to a current staff level of 17 employees and 1989 expenditures of \$12,043,200. The December, 1979, issue of Flood Hazard News contains a description of the origin and evolution of the District, for those readers who might be interested in how the District came to be. This article looks at changes which have occurred over the last ten years and also takes a look at some unique and interesting District projects.

All District activities are carried out through one of its five programs: Master Planning, Flood Plain Management, Maintenance, Design and Construction, and South Platte River. Revenues are derived from four property tax mill levies. The District can levy a maximum of 0.1 mill for the general fund which includes office expense and support staff in addition to the Master Planning and Flood Plain Management Programs. The District can also levy maximums of 0.4 mill for each of the Design and Construction and Maintenance Programs; and 0.1 mill for the South Platte River Program (excluding the Boulder County part of the District).

#### Significant Developments of the Last Ten Years

Maintenance Program takes shape. The Maintenance Program was in its infancy in 1979, but has grown to be a vital part of the District's effort. The 1989 maintenance service expenditures were \$4,798,200; and maintenance activities were provided in three categories of effort: routine, restoration and rehabilitation. Routine maintenance consists of mowing, weed control, debris pickup, silt removal, etc. Restoration activities require a higher level of effort and include projects like detention pond mucking, tree thinning, local erosion repair and revegetation. Rehabilitation projects are major construction projects meant to reclaim and rejuvenate existing facilities which are experiencing serious problems. Rehabilitation projects require engineering design and go through a bidding process on a project-by-project basis. Routine and restoration contractors are chosen annually through a selection process which considers unit costs, past experience and past performance.

Newest Program. The newest District program, the South Platte River Program, was authorized by the State Legislature

in 1987. This program is involved in planning, design, construction and maintenance of projects along the South Platte River. The impetus for creating the program was the completion of a master plan for the 40 miles of river from Chatfield Dam to the downstream District boundary. That master plan is now being used to aid in decisions concerning construction and maintenance projects along the river.

Annexation. In 1989 the State Legislature added 408 square miles to the District's area to include newly developing areas in Denver, Adams and Arapahoe Counties around the proposed Denver International Airport, as well as in northern Douglas County. The District now covers an area of 1608 square miles.

New Board Members. At the same time the Legislature added a provision to the District's statute which gives each city with a population over 100,000 a seat on the Board of Directors. The immediate effect of the legislation was to give seats on the Board to Aurora and Lakewood. The Board now totals 17 members.

#### Interesting and Unique Projects

The District has completed many drainage and flood control projects, and a number of them have had interest or value beyond their flood control benefit. Some of those projects are described below.

Boulder Creek Flood Warning. In 1977 the District, Boulder and Boulder County completed an investigation of Flood warning alternatives for Boulder Creek. As a result of that investigation, the sponsors chose to install the ALERT technology (radio reporting rain and stream gages) in the Boulder Creek drainage basin. The District also decided to hire a private meteorological service (PMS) to provide forecasts of flood potential tailored to the District area. Now, the District has completed its 11th year with a PMS, and the ALERT system has been expanded to three additional basins in Boulder County and six basins in Denver and surrounding suburban areas. A total of 49 gauging stations are now in place with 24 more planned for 1990. As a benefit, the Denver Water Board is using the rainfall data collected by the ALERT gages to assist in developing the daily ET (evapotranspiration) ratings for its water conservation program. Similarly, the City of Aurora is using the rainfall data to schedule watering in its parks, and has projected significant savings using the data.

Cherry Creek. In 1977, Denver, Glendale, Arapahoe County and the District completed a master plan for Cherry Creek from the South Platte River to Cherry Creek Dam. Part of the plan called for the rehabilitation of the three-mile reach of the channel between the river and the Denver Country Club, which is contained between two vertical concrete retaining walls. The rehabilitation included construction of a concrete maintenance trail in the walled section and a series of access ramps to the trail. It has become perhaps the most heavily used recreational and commuting trail in the Denver Area, offering three miles of grade-separated trail.

Little Creek/Littleton RR Depression. When the City of Littleton and the Colorado Department of Highways (CDOH) depressed the mainline railroad tracks through the city, the depression had to cross Little Creek, and it also had to have a drainage system. Also, Little Creek had been obliterated

by the development between the railroad corridor and the South Platte River. Littleton, CDOH and the District joined forces to construct a flood control channel for Littles Creek which also was compatible with the depression. An enlarged channel was constructed from the South Platte to the downstream side of the railroad corridor, where a large, stepped drop structure was constructed. A triple box culvert was then constructed over the depression and connected to the top of the drop structure. Finally, a 48" reinforced concrete pipe was constructed under and adjacent to the channel until it could daylight into the channel to provide drainage for the depression. The completed project allows trains to travel through Littleton without tying up traffic as they did in the past, and the channel has taken a number of properties out of the flood plan. It has been an overall success.

Central Platte River/Elitch's. Denver voters recently approved a bond issue of \$14 million to provide infrastructure improvements which will open the Central Platte Valley to new development such as a relocated and expanded Elitch Gardens amusement park. The District and Denver have been developing the preliminary design of the needed flood control improvements. Elitch Gardens is viewed as the "killer amenity" necessary to start development of the Central Platte Valley. Implementation of the preliminary design will provide a number of recreational and wildlife habitat opportunities as well as flood control. It will also improve boater safety at the existing boat chutes at Confluence Park and the Zuni power plant.

1st/2nd/3rd/Irondale Master Plans. Two District master planning projects (First Creek and Irondale Gulch and Second Creek and Third Creek) were begun, fortuitously, at just the right time. The master planning process had just begun when the decision to build the new Denver International Airport in a large portion of the subject drainage basins was made. Because studies were underway, and all the affected local governments were already involved, the drainage master planning for the airport and surrounding areas was handled more easily than it might have been. An earlier start on the master plans would have resulted in plans that no longer reflected the projected development in the basins, and a later start would have had us scrambling to catch up.

THE FUTURE--No one can predict the future, but, based on requests for assistance the District continues to receive, it appears that the future will be both busy and rewarding.

Source: Urban Drainage & Flood Control District

## COLORADANS IN THE NEWS

**Uli Kappus** has left his position as Executive Director of the Colorado Water Resources and Power Development Authority to join the firm of AQUASAN Network, Inc. of Littleton. Dan Law was named Acting Director of CWRPDA.

**Marcia M. Hughes** has announced the opening of her new office, Marcia M. Hughes, P.C., 1350 17th St., Suite 450, Denver, CO 80202. Phone: (303)825-2733; FAX: (303)825-1269. Her practice emphasizes Environmental, Administrative, Municipal Law and Government Negotiations.

Of Counsel: Hayes, Phillips & Maloney, P.C. Marcia is a member of CWRI's Research Planning Advisory Committee.

Governor Romer recently made three appointments to the Ground Water Commission. Reappointed for another four-year term were **George Bush** of Keenesburg and **Ted Schubert** of Ellicot. **John Vasa** of Holyoke was also appointed for a four-year term and will succeed **Bob Mailander**. All of the appointees are agriculturists and will represent their local designated basin while serving on the Commission.

**A. Ivan Johnson**, consultant from Arvada, Colorado, has received the Association of Ground Water Scientists and Engineers' "Special Recognition Award." The Award was presented at the 1989 National Convention of the National Water Well Association held October 31 at the Astrodome in Houston, Texas. The Award plaque stated "For his efforts in promoting the timely exchange of new ideas among the ground-water community."

Source: HYDATA, January 1990

**Dr. Peter E. Black** is President-Elect of the American Water Resources Association. Black, a charter member of AWRA, received the B.S. Degree in Forestry and a Master of Forestry Degree (Forest Influences) from the University of Michigan, and in 1961 the Ph.D in Watershed Management from Colorado State University. He has worked for the Forest Service in the Northwest, at the Coweeta Hydrologic Lab in North Carolina, and taught at Humboldt State College in California and the SUNY College of Environmental Science and Forestry in Syracuse, New York. As a Principal in Impact Consultants for 13 years and as a private consultant, he has provided services to private individuals, firms, government and educational institutions. In 1988 he was selected as an AWRA Fellow and received the 'President's Outstanding Service Award.'

Source: HYDATA, January 1990

**Gregg S. Ten Eyck** has been elected Senior Vice-President of Leonard Rice Consulting Water Engineers, Inc. Ten Eyck holds a B.S. degree in Environmental Engineering from Northwestern University and an M.S. degree in Water Resources from Colorado State University. He currently manages water rights modeling for the Gila River Adjudication in Arizona, and during his eight years with LRCWE has been responsible for major projects in Colorado, Montana and Arizona, according to the firm.

LRCWE also announced that **G. Ross Bethel** and **Jon R. Ford** have joined as principals of the firm. Bethel received his B.S. in Civil Engineering from the University of Wyoming and has an M.S. in Business Administration from the University of Colorado. Ford holds degrees in Geological Engineering and Geophysical Engineering from the Colorado School of Mines.

Brown and Caldwell Consultants have announced the appointment of Vice President **Craig Goehring** as water program director. Goehring replaces **Lyle Hoag**, who recently retired. Goehring holds a B.S. degree in civil engineering from the University of Arizona, where he has completed graduate work for an M.S. in sanitary engineering.

## NEW INSTITUTE PUBLICATIONS

Completion Report No. 145 -- **Impacts of Wastewater Discharge to Fountain Creek on Nitrate Contamination in the Widefield Aquifer.** Price: TBA. The Colorado Springs sewage treatment plant discharges its effluent to Fountain Creek where it accounts for over half of the flow in the creek the majority of the time. Further downstream, Fountain Creek supplies the main source of recharge water to the north-west end of the Widefield aquifer. The City of Colorado Springs and three communities adjacent to the aquifer, Stratmoor Hills, Security, and Widefield, all use water from the Widefield aquifer for municipal supplies. For the past 10 to 15 years, increasing nitrate concentrations have been noted in the Widefield aquifer. Currently the concentrations are approaching and occasionally exceeding the drinking water standard of 10 mg/l as N. The most significant nitrate increases have occurred near the area of recharge from Fountain Creek.

To quantify future nitrate increases in the aquifer a predictive modeling effort was conducted using a two-dimensional finite element flow and transport code, and several simulations were run. It was found that, in general, increasing the amount of effluent discharge from Colorado Springs without any nitrogen removal may continue to produce increased concentrations of nitrate in the aquifer. The up-gradient portion of the aquifer near the area of recharge would be most greatly affected. Concentrations of nitrate in the Stratmoor Hills well field, the Pinello well field and the majority of the Security wells could all experience nitrate increases above the drinking water standard.

The most promising action to help prevent future nitrate increases in the Widefield aquifer, and even restore current conditions, would be to reduce the ammonium concentration on the area of recharge. This could be accomplished in one of two ways, either by nitrogen removal at the sewage treatment plant or by diluting the ammonium concentration with some other water supply.

Completion Report No. 154 -- **Acid Mine Drainage: Streambed Sorption of Copper, Cadmium and Zinc.** Price: TBA. The Rocky Mountains are scattered with thousands of abandoned mine workings, many of which discharge acidic waters. These acidic waters, which frequently contain high concentrations of heavy metals, often have adverse effects on the quality and ecology of waters receiving the effluent.

Acid mine drainage (AMD) arises from leaching and subsequent oxidation of sulfide materials. The ferrous iron released by the leaching processes undergoes oxidation, hydrolysis and precipitation as iron oxyhydroxides. These iron precipitates generally have large surface areas and provide a large number of sites for sorption of metals and/or natural organic matter. Sorption processes have been suggested as important controls of trace metal concentrations in natural waters. Few studies, however, have been reported that compare sorption experiments in well-defined media to sorption in natural systems.

St. Kevin Gulch, a sub-alpine Colorado stream heavily contaminated with acid mine drainage, was the site of this investigation attempting to determine the factors that control the transport of copper, cadmium and zinc contaminants.

Monthly samples of stream water and streambed sediments for the period May-October, 1988 provided an extensive chemical and physical characterization of the system. Preliminary sorption studies and dialysis bag experiments in 1988 indicated that iron oxyhydroxides are precipitated with chemical, not biological control, and that such precipitates may be controlling the uptake of trace metals by the sediments. Careful laboratory studies for samples collected in 1989, along with equilibrium computer modeling confirm that iron oxyhydroxides alone can account for the sorption behavior of copper and zinc. Other factors apparently control the sorption behavior of cadmium. These results imply the pH perturbations may be effective in remediation attempts for acid-mine-drainage contaminated streams.

Technical Report No. 56 -- **Multivariate Methods for Detecting Water Quality Trends.** Price: TBA. One of the major goals of long-term, fixed station monitoring for water quality and other environmental variables is the detection of trends. Statistical methods for trend analysis are well developed and fairly routinely applied, and applications of statistical tests for trend have generally been univariate, i.e., have considered only a single water quality variable at a single monitoring location. However, routine monitoring programs typically measure several variables at several locations, and water quality processes are perhaps more logically viewed as multivariate. This report reviews both parametric and nonparametric approaches and compares their performance using synthetic data. A new method, based on a robust estimation and testing approach suggested by Sen and Puri, performed very well for serially independent observations. A modified version of the covariance inversion approach presented by Dietz and Killeen also performed well for serially independent observations. For serially correlated observations, the covariance eigenvalue method suggested by Lettenmaier was the best performer.

Information Series No. 62 -- **Workshop on the Hydrologic Aspects of Dam Safety,** edited by Dr. Neil S. Grigg. Price: TBA. A workshop on the above topic was held November 16, 1989 at Colorado State University.

Its goals were to: 1) look at current methods for using Probable Maximum Precipitation (PMP) estimate and snowmelt data for estimating spillway design floods; and 2) to evaluate these current methods and elicit suggestions about policies and research needed to improve estimates of spillway design floods.

Much of the discussions at the workshop focussed on the adequacy of Hydrometeorological Report 55A (HMR 55A) which develops PMP estimates. Most participants and meteorologists agree that the use of HMR 55A below an elevation of 7,500 ft. is not a problem. The controversy arises where considerable variation of PMP with elevation is expected. Some professionals feel PMP estimates above 7,500 ft. are overly conservative and expensive, while others have confidence in the HMR 55A curves.

All agree that more research is needed to develop site specific estimating and review techniques.

IS 62 includes the summary of the workshop as well as a number of attachments, primarily letters regarding additional suggestions concerning the validity of HMR 55A.



## WATER NEWS DIGEST

### WATER DEVELOPMENT

**Two Forks** - On March 26 Regional EPA Administrator Lee DeHihns announced that EPA will continue the Two Forks veto process. DeHihns' decision was lauded by environmental groups, but project supporters expressed dismay that EPA didn't endorse any alternative long-term water supply plan for the metro area. Marcia Hughes, attorney for the 42 suburban cities and water districts that would pay for 80 percent of Two Forks, said "EPA has to help us find a workable answer." Bill Miller, Manager of the Denver Water Department, said the recommendation came as no surprise. Water officials plan to seek consultation with the decision-maker in Washington. LaJuana Wilcher, EPA Assistant Administrator for Water, has 60 days to affirm, deny or modify DeHihns' decision unless an extension is granted.

The announcement prompted an editorial in the Denver Post saying, "Instead of blindly plunging into paralyzing lawsuits, the Front Range region needs to begin building the kind of metropolitan framework that will help it solve its common problems - including the problem of assuring adequate water supplies." "Only a joint process," said the editorial, "can share surpluses and offset shortages so as to assure the region of having the water it needs in an affordable and environmentally responsible manner."

Upstate, Brian Werner of the Northern Colorado Water Conservancy District said his office expected the Two Forks recommendation and had begun studying ways to protect Northern Colorado's water supply. A study of the water district system, water treatment and future growth in Northern Colorado should be ready by summer, said Werner. A concern of Fort Collins and Greeley officials is recent farmland purchases and rumors of land deals in the area. Werner said he plans to investigate to see who has the water rights on the recent purchases.

Sources: Denver Post 3/27/90, 3/28/90; Coloradoan 3/27/90

**Straight Creek Diversion Project** - The U.S. Water News reports that there is one Colorado water project that is supported by both the Denver Water Department and the Colorado Environmental Caucus. The \$1.8 million Straight Creek project will divert 5,000 acre feet of creek water into Dillon Reservoir. From the reservoir, the water can flow through Roberts Tunnel to the East Slope. The article said that Bob Weaver of the Environmental Caucus confirmed his group's approval of the diversion, which can serve as one of the alternatives to Two Forks. Ken Mitchell, Department Planning Director for the DWD, said that although the Two Forks EIS covered Straight Creek, the Corps of Engineers wants more analysis of the potential effects on endangered fish in the Colorado River Basin and wetlands. Mitchell noted that the diversion might actually improve fish habitat in Straight Creek by cutting down high spring flows which have caused siltation.

U.S. Water News, Feb. 1990

**Northern Colorado** - The City of Thornton has made public the details of its \$500 million, 50-year plan to divert water from Northern Colorado. The plan calls for the conversion of 13,000 acres from irrigated to dryland farms during the next 26 years and transfer of the water to Thornton. The farms will then be offered for sale. In 1986 Thornton bought about 100 farms (21,000 acres) whose irrigation water was supplied by Water Storage and Supply Company to gain control of the company. The city now leases many of those farms to their original owners, but this is the final year of a three-year lease plan. A lengthy court process is expected before any part of the plan is enacted. A hearing on the status of the case in Division I Water Court was scheduled for April 19 in Greeley, but no trial date has been set.

Source: Coloradoan 4/2/90

**Ritchard Reservoir** - The Corps of Engineers has begun work on a major permit to build Ritchard Reservoir near Kremmling. The reservoir would be built on Muddy Creek about seven miles upstream from the confluence with the Colorado River in Grand County. The estimated cost of the 60,000 acre-foot reservoir is \$25 million. Eric Kuhn, Assistant Secretary-Engineer of the Colorado Water Conservancy District, said the CRWCD has been working for five years with all agencies involved, and hopes the mitigation plan that was developed will satisfy everyone on the permits. Kuhn said at least part of the \$10.2 million received in settlement with Front Range water developers will be used to secure financing. The pact would allow Denver to lease up to 30,000 acre-feet per year, but not more than 45,000 acre-feet over any three-year period for at least 25 years. Denver would pay \$3.5 million a year based on 15,000 acre-feet per year. Water not leased to the Denver Metro area would be available to Western Colorado, as well as the entire yield at the end of the 25-year lease, according to the COE.

Source: Associated Press (Denver Post 3/5/90)

**Minimum Flow** - Colorado's minimum flow law allows the Colorado Water Conservation Board to obtain water rights on 7,000 miles of streams and thus ensure flows for fish populations. Water developers say the law could jeopardize plans for at least ten proposed storage projects because they would flood several streams where the state owns water rights guaranteeing minimum flows. The developers are asking CWCB to allow the destruction of its instream water rights without compensation. Environmental groups, including the Colorado Division of Wildlife, argue that it is CWCB's responsibility to protect the water rights. The nine members of the Board, appointed by Governor Romer, are expected to resolve the issue sometime this summer. Keeping an eye on the dispute is the Environmental Protection Agency. "The EPA's involvement could become the key factor," says Environmental Writer Mark Obmascik, "because the same federal agency recently displayed an interest in overruling state water decisions by announcing plans to kill Denver's proposed Two Forks Dam."

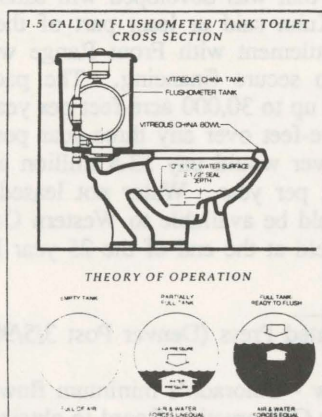
Source: Denver Post 4/10/90

## WATER CONSERVATION

The following letter appeared in a recent edition of **Public Works Pro-Views**, published by the Institutes for Professional Development, American Public Works Association. It is reprinted with permission of the Editor of **Pro-Views** and Lloyd C. Fowler.

**"Print the Success Stories in Using Low-Flush Toilets."** I am quite disturbed by the lead article (2nd Quarter 1989), "Mini-Flush Toilets: Standards Should Come First, Makers Say." It is obvious this article was written by the manufacturers of old-fashioned, poor technology toilets. Of all water uses in American cities, toilets are the greatest wasters of resources. The blame can be placed squarely on American toilet manufacturers. Efficient, effective, low-flush toilets by the millions have been in use in Europe for many decades. To the Americans these are high technology; to Europeans they are standard appliances with a long history of successful operation.

In much of California, the low-flush toilet is the required standard for all new and remodeled construction. Many water agencies are encouraging the replacement of the old fashioned water-wasters by paying part of the cost of replacement. These low-flush toilets of European design have been in use in California for years and have proven to be efficient and effective. There have not been the problems intimated by the article in **Water Resources Pro-Views**.



The simple, intelligent, European gravity flow design has been proven superior over all pressure-assisted designs like the one illustrated in the article. Pressure assisted units (see illustration) invariably fail because of the tricky valve mechanisms and seal problems. The California experience demonstrates that simple valve design with a properly designed bowl will last and be continuously effective. The standard American bowl design will not work with a low-flush toilet. Toilet tank displacement devices have clearly demonstrated that fact. The quote from American Standard's VP stating "toilets cannot rely simply on gravity driven hydraulics" obviously refers to the improper use of the poorly designed American bowl. The quick, high velocity, low volume flush in a properly designed (European style) bowl uses only gravity driven hydraulics to work efficiently.

The problems reported by plumbers and assigned to low-flush toilets have been found to be the usual reluctance to accept something different. When probed in detail, these reported

problems have to a very large degree not been associated with toilets but were caused by garbage disposals, laundry wastes, and the standard sink problems. In some cases the sewer lines and laterals were already blocked at the time of installation, and this resulted in backups.

I think you should print the success stories in using low-flush toilets. Many agencies have found that they not only save water but also eliminate treatment plant overloads. This is another reason to push ahead with low-flush toilets. *Lloyd C. Fowler, P.E., Santa Barbara, California.*

**Metering** - A bill requiring statewide water metering, introduced by Representative John Irwin of Loveland, went to Governor Romer for final approval on March 23. If signed, the law would require developers to install meters on houses built after July 1, 1990. Fort Collins, the only Front Range city of any size that doesn't meter water in residential homes, would have to install meters on about 19,000 existing homes by the year 2009. The city now meters water supplied to commercial businesses and apartment complexes, but houses are charged a flat fee. The Fort Collins City Council established a Water Demand Management Committee to recommend ways to begin a water metering program and how the city should pay for it. The committee will also suggest conservation measures.

Source: Coloradoan 3/24/90

## WATER SUPPLY

**Northern Colorado** - A record-setting 4.84 inches of precipitation in March has brought smiles to area farmers who hope their crops may do better than they have in years. The month was the wettest March since 1872, according to Jim Wirshorn, Weather Services meteorologist. Brian Werner of the Northern Colorado Water Conservancy District said the district's two main storage reservoirs, Horsetooth Reservoir and Carter Lake, are now at 72 percent and 86 percent capacity. As a result of replenished soil moisture, the NCWCD has voted to cut water allotments to its 2,500 users, mainly farmers and municipalities, by 50 percent. Werner said the extra water will be diverted to reservoirs that have been drawn down during the past three years. Lake Granby, the system's largest reservoir, is filled to only 14 percent of its capacity.

Sources: Coloradoan 4/8/90, 4/14/90

**Southwest Colorado** - Snowpack in southwest Colorado is only 44 percent of normal, according to the Soil Conservation Service's April survey. This puts the area in a condition of extreme drought, scoring a minus 7 on the Palmer Index. Mike Smith of Weather Data Inc., a private weather consulting firm, says he can't remember ever seeing a minus 7. "About 50 percent of the irrigators in the San Juan Basin will feel a severe impact on their water supply," says Chuck Lile of the State Engineer's Office. He said reservoirs in the area are 38 percent of normal and stream flows are running 75 percent below normal. The drought conditions will also impact on the danger of forest fires in the area, where a record \$420,000 was spent fighting fires last summer.

Source: Coloradoan 4/5/90

**Colorado River** - In 1990, for the first time in history, the Colorado River cannot meet its demand. This is the result of widespread drought in the mountain West and unchecked growth in Arizona, Nevada and California, according to Jim Carrier, Denver Post Rocky Mountain Ranger. Colorado River flow into Utah's Lake Powell is forecast to be 45 percent of normal this year, says Carrier, or 3.6 million acre-feet compared with an historic average of 8.1 million acre-feet. Compact requirements call for delivery of 7.5 million acre-feet to Arizona, Nevada and California. The Bureau of Reclamation has 46 million acre-feet stored in Lake Powell and Lake Meade, but releases only what the compact calls for. This year, when California asked for more water, Secretary of the Interior Manual Lujan said no. In prior years neither Arizona nor Nevada used their full share, and California drew off excess water. But with Nevada's growth and construction of the Central Arizona Canal Project, last year the three states used their allotted 7.5 million acre-feet.

Source: Denver Post 4/9/90

### HAZARDOUS WASTE DISPOSAL

Pueblo would be the site of a national center to train experts in the disposal of hazardous wastes under legislation proposed in Congress. The designation is included in a bill pending in the House Subcommittee on Transportation and Hazardous Materials. The Pueblo Chamber of Commerce and city lobbyists have been working to have the Association of American Railroads' Transportation Test Center near Pueblo designated the National Transportation Test Center for Hazardous Materials Response. The center was once used by the Department of Transportation to test freight and passenger rail equipment. The AAR now operates the center, which does testing for government and private companies but has been especially successful in hazardous material training.

Source: Associated Press (Denver Post 2/2/90)

**Last Chance Dump** will soon be the first place in Colorado to legally dispose of hazardous wastes since the Lowry Landfill shut down in 1980. The new landfill will be operated by Chemical and Environmental Conservation Systems International, a subsidiary of Browning-Ferris Industries, on 325 of the 5,700 acres that BFI bought in 1980 near the boundary between Adams and Washington counties. Although disappointed, residents of the counties, who have fought the dump for nearly 10 years, are signing a pact allowing the landfill. Their primary concern was that groundwater might be contaminated by leaking storage cells. During a September hearing state Administrative Law Judge Judith Schulman dismissed all of the residents' challenges except one dealing with the control of heavy rainfall at the landfill. Waste that is accepted will be stored in cells lined with compacted clay and impermeable synthetic liners. Each cell will contain a leak-detection system and a leachate collection and removal system. Eventually, each of the 16 cells will be covered with clay, a synthetic liner, soil and vegetation.

Source: Associated Press (Coloradoan 2/5/90)

### WATER QUALITY

**Adams County** - Residents of South Adams County have urged federal environmental officials to toughen - or

eliminate - a permit allowing Rocky Mountain Arsenal to discharge 20,000 gallons of treated wastewater each day into First Creek. At a March 21 public hearing on the permit application, 75 Adams County homeowners, farmers and politicians expressed their concerns about past permit violations and the fact that the arsenal isn't forced to meet the same tough discharge standards now enforced at the Rocky Flats plant. The arsenal's old discharge permit expired in 1985, but was extended by EPA for the past five years. EPA officials noted that arsenal discharges will account for less than one of every 2,000 gallons in Barr Lake, a farmers' water supply reservoir that receives First Creek water. They also noted that the proposed permit requires the Army to clean its discharges so thoroughly for some chemicals that creek effluent actually would meet many federal drinking water standards. An EPA representative said he doesn't think there is a significant public health risk from the discharge, but EPA pledged to consider residents' comments before reaching a final decision by summer.

In another development between Adams County and the Metro Sewage Disposal District, a cease and desist order was issued on March 9 to halt work on a new sewer line. County officials said Metro Sewage officials reneged on their promise to deal with potential contamination of nearby residents' wells. Robert Hite, manager of the sewage district, said efforts would be made to prevent damage to the wells, but the contractor would be liable if damage were done. The Denver Post reported on March 29 that the district agreed to supply water to several Adams County residents whose shallow wells could be dried up by the construction of the sewer line. County commissioners decided to lift the stop-work order. District officials met with residents and agreed to spend up to \$75,000 to install a water line from the North Washington Water and Sanitation District. It also agreed to provide temporary water service for any residents whose wells dry up while construction is underway.

Sources: Denver Post 3/13, 3/22/90, 3/29/1990

**Colorado Springs** - Environmental Protection Agency scientist Bob Erickson says EPA wants to work with the city and the State Water Quality Control Commission to improve water quality in Fountain Creek at the lowest cost possible. Erickson and Dennis Cafaro, the city's wastewater manager, agree that Fountain Creek's nitrate levels should be lowered to protect the water supply of residents who live downstream of the sewage plant. Cafaro says this will cost \$20 million. But they do not agree on the need to remove ammonia from the stream to protect the fish population at a cost of \$22 million. Cafaro says it doesn't make sense to spend \$22 million to remove ammonia when the fish are surviving. Erickson says his studies show that water temperature and pH factor change downstream, so although the fish survive, the population isn't as big as it could be if ammonia were removed from the creek. EPA recommends a two-year study of Fountain Creek to explore options that would provide good water quality at the least cost. Erickson said this might be followed by 3 to 4 years before ammonia standards are implemented.

Source: Denver Post, 3/15/90

**Denver** - Because of a problem in its chlorination removal system, the Metro Sewage Disposal District discharged about 5 million gallons of partially untreated wastewater into the

South Platte River in late March. David Holm, Director of the State Water Quality Control Division, said he authorized the discharge because the alternative would have been to dump water high in chlorine, which could have prompted a fish kill. Holm said the effluent was fully treated, but "it just missed the final step of chlorination." The wastewater was released during the 40 minutes it took to repair a broken line. Fort Lupton, the only downstream community that uses the river as a water source, increased its chlorination of drinking water with assurances from state health officials that this would disinfect the water properly.

Sources: Denver Post 3/27/90, 3/28/90

**Nunn** - With its well water labeled a potential health hazard due to high nitrate levels, Nunn town officials have been working with the Northern Colorado Water Conservancy District and the Northern Weld Water District to solve the problem. Town Clerk Julie Jensen said the option of purchasing water from the Conservancy District and having the Weld District bring it into Nunn to mix with well water seems to be the best solution so far. Larry Simpson, NCWCD Manager, said this process could eliminate the nitrate problem as well as ensure a stable water supply for the town.

Source: Greeley Tribune 2/9/90

**Greeley** - Weld County voters defeated a proposed ordinance that would require the National Farms hog farm to filter its sewage before spreading it on the ground. National Farms will save about \$20 million in initial sewage-system costs and about \$1 million each year in operating costs. The firm is run by the billionaire Bass brothers of Fort Worth, Texas. Its president, Bill Haw, says the farm is environmentally sound.

Source: Denver Post 3/21/90

**Golden** - Tests by Colorado's Water Quality Control Division of water samples taken from the Adolph Coors Company plant show no hazardous levels of chemicals are being released. Coors had announced that in 1982 trace amounts of an industrial chemical were discovered in the spring water used to brew beer. The company also had announced that well water containing larger amounts of the solvents was discharged into Clear Creek without notification to the State Department of Health. Pat Nelson of the WQCD said only very trace amounts of chemicals used to treat wastewater were discovered in the water now being discharged by Coors.

Source: Denver Post 3/14/90

#### **WHITE HOUSE CONFERENCE ON WATER RESOURCES PROPOSED**

Representatives of the National Water Alliance, which has proposed a White Conference on Water Resources, met early in the year with Administration officials to review the proposal. David Roderick, chairman of the Alliance's Committee on the White House Conference, and NWA President Ron Linton briefed officials on the conference including EPA Administrator William Reilly, Secretary of the Interior Manuel Lujan, Jr, senior officials at USDA and

OMB, and members of the White House staff. Resolutions are pending in both the Senate and House calling for the President to declare the conference (Rep. Henry Nowak, NY, and Sens. Dennis DeConcini of AZ and Dave Durenberger of MN). Topics identified by NWA for the proposed conference include groundwater protection, wetlands, water supply, surface water quality, water resources, financing, water rights/transfers, pollution prevention and water conservation. For more information contact NWA Vice President Kevin McCarty at (202)646-0917, ext. 228.

Source: National Water Alliance Report, Jan. 1990

#### **FEDERAL AGENCIES MUST PAY FINES FOR POLLUTION**

Federal agencies that pollute streams must pay the same fines as private companies that violate environmental laws, a federal judge has ruled. In a case brought by the Sierra Club and Colorado Environmental Coalition, Judge Lewis T. Babcock ruled that the Department of Interior and Bureau of Reclamation were not exempt from the possibility of fines that accompany environmental violations. The environmental groups claim the agencies violated the federal Clean Water Act for 13 years by letting toxic metal pollution from mines seep through an old tunnel known as the Leadville Drain and into the upper Arkansas River.

Source: Rocky Mountain News 1/23/90

#### **WATER QUALITY ASSESSMENT PROGRAM MOVES AHEAD**

With a go-ahead from the National Academy of Sciences and proposed funding of \$18 million for FY1991, the National Water Quality Assessment Program (NAWQA) will soon move from the pilot test phase to full implementation. Interior Secretary Manuel Lujan invited top federal water officials to a meeting in late March to discuss strategies for the first systematic assessment of the Nation's water quality. John Sayre, Interior's Assistant Secretary for Water and Science, said "NAWQA will provide the first systematic assessment of the status, changes and causes of water quality conditions across the United States. Its goals are to provide nationally consistent water quality information, to define long-term water quality trends, and to describe the factors that affect water quality."

In its current pilot phase, NAWQA studies are being conducted in parts of Washington, Maryland, Delaware, Kansas, Nevada, Illinois, Kentucky, Oklahoma, Virginia, Indiana, Wisconsin, Nebraska and California. The expanded program will include about 60 study units based on river basins and aquifer systems that represent a wide range of settings nationwide and account for a large percentage of the nation's water use. Sayre said when the program is fully implemented studies will be conducted in parts of every state.

Source: Department of the Interior, Mar. 16, 1990

#### **LAND DAMAGE INCREASES BECAUSE OF DROUGHT**

The Agriculture Department reports that 4.93 million acres of Great Plains land were wind-damaged during the four-month

period of November 1 through February 1 because of drought. In Colorado, the total of 263,890 acres was up sharply from 154,550 acres during the same period a year earlier. In the seven-month 1988-89 season, a total of 14.3 million acres were damaged by wind in the Great Plains, the most since nearly 16 million acres were damaged in 1954-55, the year the USDA's Soil Conservation Service began keeping records.

Source: Denver Post 3/29/90

### PRESIDENT'S USDA BUDGET INCLUDES RESEARCH, WATER QUALITY DEMO PROJECTS

President Bush's Budget for FY1991 includes USDA support for a major new research program and also establishes water quality demonstration projects in eight states. The research program, a National Research Initiative (NRI), will award research grants in the areas of plant science, animal science, human nutrition, and natural resources. In 1991, as the basis for the NRI, the existing USDA competitive grants program would be doubled to a total of \$100 million, and expanded by \$50 million each year "to the extent that funds are awarded competitively and not earmarked for special interest purposes." The water quality demonstration projects will show new ways to minimize the effects of agricultural nutrients and pesticides on water quality. Secretary of Agriculture Clayton Yeutter said that this is part of USDA's accelerated water quality effort for the '90s. The eight projects are in California, Florida, Maryland, Minnesota, Nebraska North Carolina, Texas and Wisconsin.

Source: Experiment Station Letter 2015, Feb. 16, 1990.

### BUREC FOCUS TAKES NEW DIRECTION

The first groundbreaking ceremony in the High Plains Groundwater Recharge Program took place in York, Nebraska in August 1989. Speaking at the ceremony, Congressman Doug Bereuter of Nebraska said it marked a new emphasis and very big change for the Bureau of Reclamation in at least two important respects. First, it concentrates on groundwater resources rather than surface water supplies; and second, program financing is a joint federal-state venture with almost a third of the money for 21 project sites coming from non-federal sources. The 1990 Appropriations Act, signed by President Bush, contains \$7,232,000 in construction funds for the USBR High Plains States Groundwater Demonstration Program.

The demonstration program, designed to bring groundwater recharge from research to the pilot demonstration phase, is not a traditional USBR project, said Bereuter. He said the time has come for an extended conjunctive approach to water development projects, and the program may prove to be the most significant new effort in water restoration since the original 1902 Reclamation Act. The end product that we are seeking from this program, Bereuter said, is information concerning the feasibility of recharging aquifers in the West.

Another of the 21 study sites is located in northwest Oklahoma, where irrigation and municipal demands have led to recent groundwater declines. In a two-phase project to be

carried out in cooperation with the Oklahoma Water Resources Board, the USBR will seek to increase water supplies available in alluvium and terrace deposits of the North Canadian River. The feasibility of constructing a subsurface concrete dam to capture and hold groundwater in Woodward County will be explored. The first phase involves extensive computer modeling to determine if the dam will be effective. If results of phase one are positive, in the second phase the dam would be constructed below Woodward's existing well field, and monitoring wells would also be drilled to determine the dam's effectiveness in raising the area water table.

For additional information about the High Plains States Groundwater Demonstration Program contact Bruce Glenn, USBR, 236-8367.

Sources: Groundwater Recharge Advisory, Jan. 1990; U.S. Water News, February 1990

### NSF CELEBRATES 40TH ANNIVERSARY

In the 1945 report to President Harry S. Truman, Vannevar Bush, then director of the federal Office of Scientific Research and Development, proposed the establishment of a National Research Foundation (*Science - The Endless Frontier*). Five years later, in 1950, President Truman signed into law an Act creating the National Science Foundation. Erich Bloch, NSF Director, sees the Foundation "...as the offspring of the Cold War and a logical extension of the contribution of scientific research during World War II." It was an investment, he says, that established American technological and economic preeminence and strengthened our national security. But with major changes in global politics and international markets, says Bloch, the rationale for supporting science and engineering research and education has been changing. He sees the emerging arena as a global economy that needs new ideas and innovation, with basic research in science and engineering assuming a vital importance.

Patrick M. Olmert, Editor of *NSF Directions*, tells of one such development:

*"One of the memorable images of the 1980s is that of 18-month old Jessica McClure being rescued from a Texas well in October 1987. For more than two days while Jessica was trapped - most of the time only a few feet from rescue - the entire nation was witness to "prime time" coverage of the heroic rescue endeavor. Young Jessica's heroes - the fire, rescue, medical technicians and drilling rig experts, and certainly the many people within her community - are all due much of the credit for saving her life. But there is another story behind the major story; science and technology contributed to the effort too. After many failed attempts at reaching the child, rescuers resorted to an ultra highpressure water jet - capable of eroding the stubborn rock surrounding Jessica with a 40,000-pound per square inch blast. The technology, developed under a 1980 National Science Foundation grant, didn't receive much applause, but it should have. Today's advances in science and technology can be attributed to thousands of men and women throughout the nation who have devoted their lives to science and engineering research and education...."*

## NON-POINT POLLUTION LATEST THREAT TO WATER

by Louis E. Stephenson, Extension Specialist

Non-point source water pollution will be the No. 1 water quality problem in the next 20 years. Engineers have solved the point-source pollution problem and have turned their attention toward non-point-source pollution, said Max Dodson, Water Management Division Director, Environmental Protection Agency in Denver.

Dodson addressed some 180 scientists, engineers, agricultural producers and local, state and federal agency representatives at the Non-Point Water Quality Symposium recently in Colorado Springs. The symposium was sponsored by the Colorado chapter of the Soil and Water Conservation Society, Agricultural Research Service, Colorado State University, Colorado State Soil Conservation Board, Northern Colorado Water Conservancy District, Soil Conservation Service and Water Quality Control Division of the Colorado Department of Health.

Dodson predicted that efforts to reduce or eliminate non-point source water pollution would soon cut across political boundaries and take on an eco-region approach. Although agriculture is the largest contributor to non-point-source water pollution, urban runoff, mining activities, wildlife and recreational activities contribute to the pollution of surface water and underground aquifers, he said.

Currently, efforts to reduce non-point-source water pollution are voluntary. However, if efforts to reduce this type of water pollution are to remain voluntary, local and state agencies must ensure that everyone is involved. Otherwise the federal government will mandate and direct the effort, said Melinda Kassen, senior attorney for the Environmental Defense Fund in Boulder.

Section 319 of the 1987 Water Quality Act establishes monitoring, research, technical assistance and educational guidelines to deal with non-point-source water pollution.

Under the law, the Soil Conservation Service is responsible for technical implementation of non-point-source water pollution mitigation efforts and Cooperative Extension is responsible for educational programs. Colorado State Cooperative Extension is involved in such educational

activities as chemical applicator training, spray equipment calibration demonstrations, pesticide recommendations, chemical transportation workshops, soil and pesticide interaction studies, monitoring programs, alternative pest control, sustainable agriculture and no-till research.

The Integrated Pest Management program is a monitoring and management program that helps producers reduce the amount of chemicals needed to control insect pest. No-till programs are another way for agricultural producers to reduce non-point-source water pollution. No-till farming does not use mechanical tillage to control weeds or prepare a seed bed. Weeds are controlled with herbicides. Crop residues are left on the surface and the seed is planted through the residue.

Gary Peterson, Professor of Agronomy, Colorado College of Agricultural Sciences, explained that no-till farming allows crop residues to remain on the surface of the soil to conserve soil moisture and control water and wind erosion. Long-term herbicide residues or contamination are not a problem if chemicals are used according to labeled directions, he said.

Representatives from more than 40 agencies and groups attending the water quality symposium were told of groundwater monitoring efforts conducted by CSU's Water Resources Research Institute.

Results of efforts by such federal agencies as the Soil Conservation Service, Bureau of Land Management, U.S. Forest Service and Agricultural Research Service to reduce non-point-source water pollution on private and public lands also were reviewed.

Non-point-source water pollution is a diverse problem and many agencies are involved, Dodson told the group. "Overall, we're doing a good job, but we need to tell people what we're doing. If efforts to reduce non-point-source pollution are to remain voluntary, we must concentrate not only on improving our performance but on telling the public about our successes."

### FELLOWSHIPS, SHORT COURSES, CALLS FOR PAPERS POSITIONS AVAILABLE

#### NRLC INVITES APPLICATIONS FOR FELLOWSHIP AWARD

The Natural Resources Law Center of the University of Colorado School of Law invites applications for the position of Burlington Natural Resources Law Fellow for either Fall or Spring semester 1990-1991. The Fellow will spend a semester in residence at the School of Law researching a topic concerned with energy, mineral, or public land law. Candidates may be from business, government, legal practice, or universities. A stipend of \$20,000 is available for the semester, along with additional support for secretarial and research assistance. Candidates should apply by letter, outlining the nature of their research interest and when they wish to come. They should enclose a brief statement of

their qualifications. Address letters to: Lawrence MacDonnell, Natural Resources Law Center, University of Colorado School of Law, Campus Box 401, Boulder, CO 80309-0401.

#### SHORT COURSES

**Groundwater Contaminant Transport Modeling Using the USGS Method of Characteristics Code (MOC)**, May 11, 1990, Colorado School of Mines, Denver, CO. A one-day short course sponsored by the Rocky Mountain Section of the Association of Engineering Geologists. Instructors: Dr. Eileen Poeter and Dr. Ken Kolm. Fee of \$190 includes course instruction, MOC code, User's Manual, and supporting reports and exercises. Prior experience in flow modeling is

preferred. Contact Eileen Poeter, Department of Geology and Geological Engineering, Colorado School of Mines, Golden, CO 80401, (303)273-3829.

**Design of Water Quality Monitoring Networks**, June 11-15, 1990, Colorado State University, Fort Collins, CO. The short course will present detailed procedures for designing a water quality monitoring system and will include ambient conditions, trends, and excursions beyond a limit. Analyzing and redesigning an existing monitoring network will be emphasized citing case studies. The course is directed to persons actively involved with the design, operation and/or management of a water quality monitoring network for both surface and subsurface monitoring. The course directors are Drs. Thomas G. Sanders and Robert C. Ward.

The course fee of \$795 includes tuition, class materials, text, software and users manual, the proceedings of the course, refreshments, some meals, and a family program. Contact: Water Quality Short Course, Office of Conference Services, Rockwell Hall, Colorado State University, Fort Collins, CO 80523. Telephone: (303) 491-6222.

#### CALLS FOR PAPERS

**International Symposium on Hydrology and Water Resources Education and Training: The Challenges to Meet at the Turn of the XXI Century** April 15-19, 1991, Universidad Autonoma de Chihuahua, Chihuahua, Mexico. Papers are sought for an interdisciplinary symposium sponsored by the Universidad Nacional Autonoma de Mexico and the Universidad Autonoma de Chihuahua on educational and training programs in hydrology and water resources.

The symposium seeks to both identify conditions that are critical to the success of educational and training programs and to propose courses of action that will minimize the impacts of these conditions. The symposium will address all topics related to education and training in hydrology and water resources. Subjects of particular interest, however, will be: *the role of education and training in national water plans; education and training as technology transfer channels; research and development as catalysts for the process of education and training; and personal computing in education and training.*

Deadline for one-page abstracts in English is June 1, 1990. Send to: Adolfo Chavez, Facultad de Ingenieria, U.A.Ch., PO Box 1528-C, 31000 Chihuahua, Chihuahua, Mexico. Cosponsors include UCOWR, AWRA, AGU, ASCE and AIH.

**International Seminar on Efficient Water Use**, October 1-5, 1991, Mexico City. The Mexican Institute of Water Technology and the International Water Resources Association request one-page abstracts on efficient water use. Papers will address the scientific, technical social, educational, legal or practical aspects of efficient water use in one of the following topics: *houses, cities and rural areas; industry; energy generation; agriculture and aquaculture; river basin scale.* Within each topic, the authors will emphasize saving devices and techniques, rate structure, consumption regulations, gardening, recreation, leak detection and control, treatment, reutilization, pollution control, measurement, quality needs, irrigation losses, legislation, education and public participation.

Submit one-page abstracts in either English or Spanish, by Nov. 15, 1990, to: International Seminar on Efficient Water Use, Secretariat of the Seminar, Instituto Mexicano de Tecnologia del Agua, Paseo Cuauhnahuac 8532 Col Progreso, Jiutepec, Morelos C.P. 6550, Mexico. Phone (73)19-43-81, Telex (0234900008980.IMTA), FAX (73)19-37-42.

#### POSITIONS AVAILABLE

**Water Rights Specialist-** Arizona's Salt River Project has an opening for a water rights specialist. The position is a professional one, requiring a degree in a resource management field, and at least two years of experience in western water rights or water resources administration. A knowledge of hydrologic systems and Arizona (or western) and federal law and adjudication procedures is needed. Duties include carrying out studies and research on a wide variety of water rights topics. The salary and benefits are highly competitive.

Send resumes to John Keane, Surface Water Resources, Salt River Project, P.O. Box 52025, Phoenix, AZ 85072-2025, Telephone: (602)236-5087.

#### CONFERENCES

- May 18-20 **PLATTE RIVER STRATEGY FOR THE 90s**, Casper Inn Convention Center, Casper, WY. Contact: National Wildlife Federation, Fleming Law Building, Box 401, Boulder, CO 80309, (303)492-6552.
- May 22-23 **PROFITING FROM WATER: BUSINESS AND INVESTMENT OPPORTUNITIES IN DRINKING WATER**, Santa Monica, CA. Contact: Lou Olmos, Water Research Assoc., 12233 W. Olympic Blvd., Suite 152, Los Angeles, CA 90064, 213/207-8277.
- May 29-Jun 9 **AMERICAN WATER FOUNDATION 1990 INTERNATIONAL SEMINAR & WORKSHOP: SYSTEM-WIDE WATER MANAGEMENT**, Denver, CO. Contact: American Water Foundation, P.O. Box 15577, Denver, CO 80215.
- June 4-8 **SOCIETY OF WETLAND SCIENTISTS 11TH ANNUAL MEETING**, Breckenridge, CO. Contact: Dr. Gerry Horack, GS Tech., P.O. Box 9076, Fort Collins, CO 80525, (303)226-9413.
- June 6-8 **MOVING THE WEST'S WATER TO NEW USES; WINNERS AND LOSERS**, Boulder, CO. Contact: Kathy Taylor, Natural Resources Law Center, Campus Box 401, Boulder, CO 80309-0401, (303)492-1288.
- June 5-7 **GREAT PLAINS AGRICULTURAL COUNCIL'S 1990 ANNUAL MEETING**, Tulsa, OK. Contact: Melvin D. Skold, Executive Director, Department of Agricultural and Resource Economics, Colorado State University, Fort Collins, CO 80523, (303) 491-7370.

- June 21-22 INTERNATIONAL SYMPOSIUM ON MAPPING & GEOGRAPHIC INFORMATION SYSTEMS, San Francisco, CA. Contact: A. Ivan Johnson, A. Ivan Johnson, Inc., 7474 Upham Ct., Arvada, CO 80003, 303/425-5610.
- July 9-11 1990 WATERSHED MANAGEMENT SYMPOSIUM, Durango, CO. Contact: Robert Riggins, USACERL, P.O. Box 4005, Champaign, IL 61824-4005.
- July 9-13 NATIONAL CONFERENCE ON IRRIGATION AND DRAINAGE ENGINEERING and WATERSHED MANAGEMENT SYMPOSIUM, Durango, CO. Contact: Robert Riggins, USACERL, P.O. Box 4005, Champaign, IL 61824-4005.
- July 9-20 AMERICAN WATER FOUNDATION 1990 INTERNATIONAL SEMINAR & WORKSHOP: CONSTRUCTION MANAGEMENT PRACTICES FOR WATER RESOURCE FACILITIES, Denver, CO. Contact: American Water Foundation, P.O. Box 15577, Denver, CO 80215.
- July 29-Aug 1 UTAH 45TH ANNUAL SOIL AND WATER CONSERVATION SOCIETY, Salt Lake City, UT. Contact: Tim Kautza, 7515 NE Ankeny Rd., Ankeny, IA 50021-9764, (515)289-2331.
- July 31-Aug 1 UCOWR '90, WATER ISSUES IN AN ENVIRONMENTAL ERA, West Point, NY (Hosted by the U.S. Military Academy). Contact: Margery Robinson, UCOWR Executive Director's Office, 4543 Faner Hall, Southern Illinois University, Carbondale, IL 62901, (618)536-7571.
- Aug. 12-15 CONSERV 90. NATIONAL CONFERENCE AND EXPOSITION FOCUSING ON WATER SUPPLY SOLUTIONS FOR THE 1990s, Phoenix, AZ. Contact: Kathy Butcher or Lisa Ammerman, 6375 Riverside Dr., Dublin, OH 43017, 615/624-6358.
- Oct. 14-18 ASSOCIATION OF STATE DAM SAFETY OFFICIALS 7TH ANNUAL CONFERENCE, New Orleans, LA. Contact: ASDSO, P.O. Box 55270, Lexington, KY, 40555-5270, 606/257-5140.

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