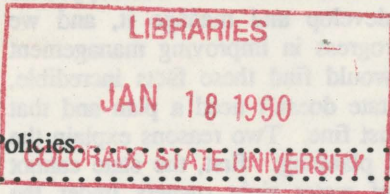


COLORADO WATER

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

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January 1990

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COLORADO'S WATER NEEDS: STRONGER AGENCIES AND NEW POLICIES

Editorial by Neil S. Grigg

Water is Colorado's most valuable natural resource, yet we don't have a plan to develop and manage it, and we haven't made enough progress in improving management and efficiency. Some would find these facts incredible, while others insist the state doesn't need a plan and that water use efficiency is just fine. Two reasons explain the difference in view about planning: first, the state cannot fully plan the actions of water right owners under the Appropriation Doctrine, and second, what we need is more than a plan; we need a better overall process to coordinate water development and to resolve conflicts. The reasons for lack of progress in improving management are more complex and are to be found in constraints caused by water laws and regulations, property right disputes and the thick web of agencies and interest groups that have a say in water matters.

The main problem comes in the need for complex joint actions which require planning and coordination across organizational or regional boundaries, often involving complex networks of interest groups. The thickening of those networks of interest groups and increasing conflicts between them are the new factors that call for a different approach to coordinating water actions. The networks include: cities, districts, environmental groups, farmers, regional interest groups, state and federal agencies, and downstream states, and their interests usually don't coincide.

Existing state arrangements for water planning, coordination and regulation work adequately in many situations, so why is there a need to coordinate water management and to resolve conflicts? This is a hard question to answer, but there is a widespread sense that some improvements are needed in the light of Two Forks and the resulting expense, frustration, and malaise about assuring a metro water supply.

In Colorado's deadlock over finding a philosophy of "planning" for water it has not developed adequate strategies to deal with these problems. I believe that unless we deal with these water issues the consequences will be negative for all except those that profit from continued conflict and lack of coordination, and those consequences will impact both the environmental quality and economic development of the state.

What to do? Let's start with some givens. First, the Appropriation Doctrine will remain; there is no reason to overturn this system that has worked and has become the basis for property rights. Second, the state cannot and should not try to develop a "state water plan" to try to direct the actions of water right holders, but it should develop a flexible plan that shows that we intend to use our compact entitlements by working within our water law system.

My proposal has the general goal of giving the State the capabilities to resolve complex conflicts and to encourage management innovations. It has two parts: to strengthen existing state government agencies and to work through a joint legislative-executive study commission to find answers to the institutional questions needing answers.

We have in place a system of state water agencies with substantial capabilities. We should begin by making them more effective. Two of these, the Colorado Water Conservation Board and the State Engineer's Office, are old and well-established. Their missions and capabilities should be reviewed and strengthened. Although it is not within the DNR, the Colorado Water Resources and Power Development Authority is an effective project planning and financing agency and its role in integrated water planning and management should be affirmed. The State Engineer's Office should be recognized and strengthened as the focal point for management and data innovations to enable the kinds of improvements needed for the 21st Century.

The missing element, even after improving these agencies' missions and capabilities, is the capability to find new joint solutions to problems amidst the complexity caused by the competition between interest groups working within the Appropriation Doctrine and the thick web of agencies and interest groups. What are the needed functions of the missing water planning and management elements? They are joint planning, coordination and conflict management, an integration of the interests of Colorado's diverse water groups. In a recent speech at a DU water conference Governor Romer called these needed elements cooperation and inclusion, along with conservation.

We don't know yet how to provide for these missing elements, or what kind of process or entity to initiate, and we certainly should not create a new government agency to undertake a mission we don't fully understand. That is why I recommend the experimental step of initiating a study commission. Such a commission is essential if we are ever to be able to sort out the many conflicting proposals for water policy reform. Perhaps more than anything else the commission is needed to provide a focal point for leadership and new thinking about the state's water future.

Three general problems need the commission's attention: state-level institutional questions, the metro area's unique problems, and technical water management questions. The principal state-level institutional question is how to make the state's regional water management entities strong and effective enough to adequately provide for the water futures of their regions and to deal with each other in inter-regional transfers and exchanges. The metro area study would examine the feasibility of inter-regional cooperation to meet the needs of the metro area. The water management effort would evaluate proposals for improved water management.

The study commission should work during a defined time period. It should hold hearings, carry out studies and explore policy alternatives. At the end of its life, existing agencies or processes might be strengthened, our water laws might be modified or a new entity or process might be created.

A frequent reaction to any proposal to create a study commission is: "We don't need studies, we need action!" Well, one reason for this reaction is that many study groups are ineffective or biased. This one would have to be fair and objective, cognizant of the many issues involved, able to access the state's institutional memories about water policy, and able to synthesize the many diverse viewpoints into recommendations for improved policies. If it can achieve this tall order it would be able to go beyond a few tactical actions and to propose new policies and programs to implement institutional reforms.

CWRRI REQUESTS PREPROPOSALS

Closing Date: March 1, 1990. Preproposals are invited for the CWRRI FY1990-91 water research program. Priority will be given to research proposals that address Colorado's most critical water problems, such as: improved water management and water use efficiency; Colorado water law, policies and institutions; water quality; protection of the environment, instream flows and agriculture; and stormwater and flooding. Specific topics identified as high priority by CWRRI's Research Planning Advisory Committee are:

- Conjunctive management of surface and groundwater
- Economic value of nonconsumptive water uses
- Economics of alternative strategies for fishery enhancement
- Fate of metals in Colorado streams
- Technology for new uses of the satellite stream monitoring system
- Improvement in drought forecasts
- Improvement in runoff forecasts: flood, late season
- Preservation of wetlands: economic costs and benefits
- Improvement in urban storm runoff control measures
- Biological effects of metals on aquatic organisms
- Streamflow criteria for flow-based discharge permits
- Reclamation of polluted groundwater
- Evaluation of impacts of water exports on basin-of-origin
- Technology for efficient groundwater recharge

Awards will be made for one year beginning September 1, 1990. Awards will depend on CWRRI's receiving an appropriation from the Colorado Legislature. For 1989-90 CWRRI awarded eleven projects with direct costs in the range of \$10,000-20,000 each. Depending on the adequacy of an appropriation from the Colorado Legislature, cost sharing of projects may be required. Indirect costs must be provided as a contribution by the performing institution. Financial arrangements for projects will be negotiated after successful preproposals have been identified.

For preproposal instructions and format, contact CWRRI at 491-6308 or your contracts and grants office.

THE SOUTH PLATTE RIVER: ITS HISTORY AND EVOLUTION

James Michener, in his novel Centennial, says that confusion surrounds the name "Platte." Probably no river in history, he says, has been called by so many different names - at least 31 of Spanish, French or Indian origin - but in each tongue at some point it was called the "flat" river. "Its name reflects its appearance," he says, "yet for a while it was the highway of an empire." The South Platte - "a trickle in the summer when its water was needed, a raging torrent in spring."

Delph Carpenter, author of the Colorado Proceedings of the South Platte River Compact, says of the river: "Early irrigation along the upper reaches of the stream yielded large returns. This supply was diverted by lower ditches and applied to lower lands and, step by step, the process was repeated. As a result, the "disappearing river" no longer exists...It is an indisputable fact that the flow of the main river is more dependable than it was of nature. Irrigation along both the North Platte and the South Platte rivers has operated to store and equalize the flow of the main river, with benefit and without cost to lower users."

The South Platte Basin Water Management Study has attempted to analyze historical data in its effort to interpret and analyze today's water system, in some cases as far back as the 1930s. To provide an understanding of river conditions as they existed prior to irrigation development and how the river evolved as irrigation expanded, the Groundwater Appropriators of the South Platte River Basin, Inc. (GASP) has reprinted the Colorado Proceedings of the South Platte River Compact, originally published in 1925. Carpenter was Colorado's Commissioner for the South Platte Compact.

South Platte Basin Study Report - Members of the Study's Technical Support Subcommittee are summarizing work done by study participants on Step 1 of Phase I of the South Platte River Basin Water Resources Management and Development Plan. The area encompassed is that portion of the mainstem and tributaries downstream of the confluence of the South Platte River and Cherry Creek, extending to the Colorado-Nebraska state line. The final report for Phase I, Step 1 will be available sometime in March, 1990, at actual printing cost, estimated to be \$30. If you are interested in purchasing a report, submit your name, address and the number of reports you want to:

SOUTH PLATTE BASIN STUDY REPORT, c/o South Platte Basin Water Management Committee, P.O. Box 679, Loveland, CO 80539.

For questions or concerns regarding the study, contact Tom Cech, CCWCD, 330-4540; Jack Odor, GASP, 867-5298; Roger Weideman, USBR, 667-4410, or Eric Wilkinson, NCWCD, 667-2437.

Source: South Platte Basin Water Management Committee Newsletter, Nov. 1, 1989.

COLORADO GROUNDWATER ENGINEERING AND MANAGEMENT CONFERENCE

PRELIMINARY PROGRAM

Wednesday, February 28, 1990

8:30 - 10:00 AM Registration and Coffee

10:00 - 10:15 Opening Session: Neil Grigg and Jeris Danielson

10:15 - 12:00 N Session 1 (Plenary): National and State Groundwater Issues

"National Groundwater Agenda":

Marian Malay

"State's Groundwater Agenda":

D. Craig Bell

"Colorado Groundwater Management Issues":

Jeris Danielson

"Groundwater as an Environmental Issue":

Dan Luecke

12:00 - 1:30 PM Luncheon "Colorado's Water Agenda": Governor Roy Romer (Invited)

1:30 - 3:00 Session 2A: Groundwater Quality Remediation 1

"Groundwater Remediation Near the Lincoln Park Superfund Site, Canon City, Colorado": A. Brown and T.C. Smith

"Hydrogeologic Characterization Leading to a No Action Alternative With Monitoring for Groundwater Contamination at Air Force Plant PJKS, Waterton, Colorado": T.M. Murphy, J.R. Hicks, L.A. Korner, T.C. Shangraw and J.K. Yu

"Operational Model of North Boundary Barrier System at the Rocky Mountain Arsenal": J.W. Warner

1:30 - 3:00 Session 2B: Application of Groundwater Models

"The Anticipation of Augmentation Needs for Allocation Operations": H.J. Morel-Seytoux and C-M. Zhang

"HELM: An Integrated Model Applied to the South Platte Stream-Aquifer System": J.F. Booker, R.A. Young, C-M. Zhang and H.J. Morel-Seytoux

"Finite Difference Model Application to a 3-Dimensional Aquifer System in the San Luis Valley: Model Adjustments to Compensate for Dewatered Cells": I.R. McGowan, R.E. Brogden and D.H. Koch

"A Solute Transport Model for Conjunctive Use Studies with Water Quality Considerations": T.H. Illangasekare and J.H. Zou

3:00 - 3:30 Break

3:30 - 5:00 Session 3A: Groundwater Quality Assessment

"Assessment of Relative Vulnerability of Shallow Groundwater Resources in the Greater Denver Area": M. Wireman

"Nitrate Pollution of Shallow Groundwaters in the West": J. Silverstein and N. Cook

"The High Plain's Ogallala Aquifer System vs. the Northern Plain's Spiritwood Aquifer System: Water Quality Comparison": R.F. Meyer

"Complementary Investigative Techniques for Accurate Site Assessment with Low-Level Contaminants": M.E. Byrnes, R.W. Nelson, R.G. La Poe, D.E. Lundquist, W. McNeill and S.E. Hulse

3:30 - 5:00 **Session 3B: Groundwater Model Refinements**

"Simulation of Stream Boundaries in Groundwater Models: An Historical Overview": C. Kraeger-Rovey

"Improved Methods for Modeling of Surface and Groundwater Interactions": J. Schenk, E. Poeter and C. Kraeger-Rovey

"Solution Refinement of a Finite Difference Groundwater Model": D. Zachmann, J.W. Warner and S. Choi

"How Aquifer Heterogeneities Affect Numerical Groundwater Models": M.B. Allen and R.E. Ewing

5:00 - 6:30 PM **Reception**

Thursday, March 1, 1990

8:30 - 9:45 AM **Session 4 (Plenary): Groundwater Issues**

"Comparing Groundwater Quality Protection in the Western States": L. MacDonnell

"Dependability of Groundwater Supplies: County Perspective"

"Role of Bedrock Groundwater in a Municipal Supply": J. Hendrick

9:45 - 10:15 **Break**

10:15 - 12:00 N **Session 5A: Groundwater Quality Remediation 2**

"Aquifer Protection in a Changing Regulatory Environment for Above Ground Storage Tanks": P.C. Sorensen and J.M. Kerr, Jr.

"Soil Venting: An Aquifer Remediation Technique for Volatile Organic Compounds": J.M. Davidson

"Soil Vapor Surveys and Soil Venting as an Aquifer Restoration Technique: A Case History": J.M. Kerr, Jr., B. Steadman and J.A. Adams

10:15 - 12:00 **Session 5B: Test Results from Castle Pines Hole Study**

"Comparison of Specific-Storage and Storage-Coefficient Values Measured by Aquifer-Test, Barometric-Efficiency and Aquifer-Compression Techniques in Deep, Closely Spaced Wells": S.G. Robson and E.R. Banta

"The Concept of Specific Yield and Its Evaluation by Laboratory Measurements": D.B. McWhorter and A.J. Garcia

"Preliminary Results from the Coring of the Denver Basin Aquifers": R.L. Raforth and J.L. Jehn

10:15 - 12:00 **Session 5C: Artificial Recharge**

"Determination of Aquifer Recharge from Pond (or Trench) Operations": H.J. Morel-Seytoux, C. Miracapillo, H. Khadr and C-M. Zhang

"Artificial Recharge: Willows Experience, Willows Water District, Arapahoe Aquifer Recharge Project": J.C.

Halepaska, K.T. Le and B. Lytle

"Recharge: Is it the Answer to Future Storage Needs in Northeastern Colorado": T. Cech

"Status of Bureau of Reclamation Artificial Recharge Demonstration Projects": B. Glenn

12:00 - 1:30 PM Luncheon "National Groundwater Perspective": Congressman Dan Schaefer (Invited)

1:30 - 3:00 Session 6A: Groundwater Contamination Issues

"Contamination of Groundwater by Chlorinated Solvents": D.B. McWhorter

"Investigation of the Movement and Location of Immiscible Organic Fluids in Groundwater Systems": D. Durnford, D. Hansen and J. Billica

"Adsorption/Partitioning/Biodegradation/Bioconcentration - The Impact on Hydrophobic Organic Mobility in Contaminated Aquifers": T.C. Peterson and K.G. Doxtader

1:30 - 3:00 Session 6B: Aquifer Management

"Evaluation of Groundwater for Municipal Supplies Using a PC-Based Spreadsheet Analysis": W.F. Hahn, J. Slattery and D. Little

"The Widefield Aquifer Management Program": G.B. Thompson

"Hidden Costs of Farm-to-City Water Rights Transfers": J.E. Flack

"Hydrologic Impacts of Groundwater Development in the Denver Basin": T. Hatton

1:30 - 3:00 Session 6C: Well Construction and Management

"Optimal Well Field Design for Reducing Phreatophyte Uptake Losses": G.A. Nelson, R.W. Ritz, Jr., S. Sorooshian and H. Bouwer

"Well Treatment Techniques for Restoring Yield and Reducing Sand Pumping": B.E. Kroeker and C.E. Nuzman

"Use of Bentonite in Well Field Management": F. Ogden and J. Ruff

3:00 - 3:30 Break

3:30 - 5:00 Session 7A: Data Management and Mapping

"Geographic Information Systems (GIS) Technology Applied to Hydrologic Mapping": S.B. Urban and D.W. Gallaher

"Use of the Colorado Water Well Data File": W. Burt

"Determining Sampling Frequency in Water Quality Monitoring": M.L. Brogden and M.G. Richard

"Gradient Analysis of the Groundwater Fauna of the South Platte River": J.V. Ward and N.J. Voelz

3:30 - 5:00 Session 7B: Aquifer Characterization

"Aquifer Characterization in the Northern San Juan Basin, Colorado Using Borehole Geophysical Logs": K.G. Witherbee

"Stratigraphic Nomenclature Inconsistencies in Laramide Orogenic Sediments: Denver Basin, Colorado": R.R. Crifasi

"Structure and Outcrop Mapping of the Laramie-Fox Hills Aquifer in Colorado Springs": J.M. Kaufman

LORI LOHMAN TO WORK ON INFORMATION TRANSFER PROJECT FOR INSTITUTE

Lori Lohman, a veteran researcher in the area of water policy, will undertake a special Institute project to assess Colorado water research and information transfer needs. Lori will network with water leaders and managers to pinpoint interests and new water issues that might relate to CWRI research programming. As part of her project responsibilities she will monitor and report on initiatives and new legislation with research or policy implications, provide a roster of technological "gatekeepers" in Colorado water organizations and find out interests, and frame an identification and analysis paper on Colorado water issues.

When opportunities arise, Lori will seek funding for Colorado water research faculty. A permanent water library collection in the Denver area is another of CWRI's interests, and if time permits Lori may do some preliminary groundwork on this collaboration with Marty Reuss, Senior Civil Works Historian with the U.S. Army Corps of Engineers.

The legal, institutional and economic aspects of water supply problems in semiarid regions are Lori's particular focus, and a major area of interest is the use of water conservation, including reuse, to maximize quality water supplies. She recently completed a study of the economic impact of salinity in the Colorado River Basin as it relates to public policy, water reuse and conservation efforts. From 1986-89 Lori was a research social scientist with Chapman Research Group and Milliken Chapman Research Group focusing on economics of water quality and on technology transfer. From 1976-86 she was a research associate with Denver Research Institute, University of Denver, and responsible for all phases of research studies from the initial proposal writing through final reporting requirements. Lori authored or co-authored more than 18 major research reports. A candidate for a Ph.D in History at the University of Denver, she received an M.A. in Social/Political Science from the University of Northern Colorado and a B.A. in Political Science from the University of Denver.

COLORADO WATER SUPPLY OUTLOOK

by Sheldon G. Boone, State Conservationist

Precipitation across Colorado has been well below normal throughout the months of October and November. SNOTEL sites are reporting totals of only 50-85 percent of average for the water year. Many National Weather Service stations at the lower elevations in southern Colorado received no precipitation during the month of November, while near average amounts were recorded in Yampa, White, North Platte, and Colorado basins. These conditions have continued to decrease the soil moisture amounts in southern Colorado, making less water available for runoff next spring.

Snowfall at the higher elevations is well below normal, statewide. The only significant accumulations of the season occurred during the winter storm at the end of November. This storm helped to increase the snowpack in the northern

and central mountains, while completely missing the south-central and southwestern mountains. As of December 1, the statewide snowpack was only 46 percent of normal, and only 48 percent of the last year's readings.

The normal runoff of last summer, along with below normal summer precipitation, created increased demands on the state's reservoirs. Current statewide storage levels are 103% of average. When compared to 1988 storage volumes, this year's December 1 volumes are only 90 percent of last year.

A summary of snowpack, precipitation, and reservoir storage, as a percent of the average, is listed in the table below:

BASIN	SNOWPACK (DEC. 1)	PRECIP. (OCT.-NOV.)	RES. STORAGE (DEC. 1)
Gunnison	47	61	106
Colorado	56	90	82
South Platte	96	58	97
Yampa, White & N. Platte	66	90	
Arkansas	40	57	104
Rio Grande	5	52	96
San Miguel, Dolores, Animas, & San Juan	12	53	122

The first streamflow forecasts for the season will be issued after January 1, 1990.

1989 WATER YEAR WRAP-UP FROM THE COLORADO CLIMATE CENTER

Drought made headlines throughout Colorado in 1989. A very dry fall and early spring across Colorado's eastern plains proved disastrous for dryland agriculture. Good rains fell on the plains in late May and June and again in August and September. These rains, while very beneficial, came too late to help much of the 1989 winter wheat crop. It ended up being the poorest crop since 1978. Range conditions also deteriorated badly, but summer moisture was sufficient to avert a major ranching disaster. By the end of the summer, moisture conditions in Eastern Colorado were generally average or above, and the immediate drought event had apparently ended.

The mountains and Western Slope also got off to a bad start with an extremely dry October. However, mid-November brought a series of storms which whitened the mountains and got the snowpack and ski conditions off to a good start. December was stingy with its mountain snow, but storms arrived just in time for Christmas, and skiing conditions remained good. With the help of heavy February snows and very cold weather, mountain snowpack remained near or above average at the beginning of March and water supplies for Colorado were looking good. That's

when mother nature turned off the faucet. The months of March through June were extremely dry. In parts of southwest Colorado this was the driest spring on record in 100 years. With the help of unseasonably warm temperatures, snowpack melted prematurely, forests and rangeland dried up and surface water supplies dwindled. Instead of average water supplies, runoff ended up less than 70 percent of average for most Colorado watersheds. Several major forest fires were raging in early July and a crisis was arising for mountain and Western Slope ranchers as Federal land managers considered moving animals off some Federal lands to avoid overgrazing. Fortunately, summer monsoon moisture arrived in Colorado in July and August in sufficient quantity (average to a little above average) to avoid a major crisis. However, with a return of warm and dry weather on the Western Slope in September, concern lingered over potential serious long-term drought.

In addition to the 1989 drought, there were several other noteworthy weather events during the year. The "Alaska Blaster" of February 1-7 brought a potent duo of extreme subzero cold and heavy snow to Colorado. A late-June snowstorm surprised residents of the eastern foothills. Summer lightning killed 4 Coloradans and injured at least 18. As usual, hailstorms pummelled various areas of eastern Colorado doing millions of dollars of damage to crops and property. A record-breaking heatwave of early June sent temperatures over the century mark in northern Colorado and caused record water usage. Near the end of the heatwave, a flash forest fire near Boulder destroyed many homes and buildings. Snow in early September seemed dramatically out of place after the kind of year we just experienced.

At this time, Coloradans look with anticipation toward the next winter and the new snowpack in the mountains. Interest this year will be especially keen since many reservoirs have been drawn down to their lowest level since before the 1980's wet spell. For the State as a whole, multi-year drought is much more threatening than a one-season or one-year drought. Let's hope for the best.

THE WEST'S WATER DILEMMA: PROVIDING FOR MAN AND PROVIDING FOR THE ENVIRONMENT

"In the next 50 years, the use of non-agricultural water will triple. We have to be prepared for that," said State Representative Wayne Allard. Allard, speaking at the annual meeting of the Weld County Farm Bureau on November 19, also addressed the issue of federal reserve and wilderness rights. Any legislation that would include water rights to supersede existing water rights "would have a serious impact on our state," he said. River corridor trails, to be considered in the next session of the State Legislature could also supersede existing water rights, said Allard, if a public trust doctrine is included. U.S. Representative Hank Brown was scheduled to address the meeting but remained in Washington to wrap up the current session of Congress.

Federal reserve water rights are at issue in a trial scheduled to start January 8 in Greeley before Chief District Judge Robert A. Behrman. The U.S. Government has said it needs to keep certain amounts of water in U.S. Forests. Water users have objected, saying this would hinder future water projects and development in Colorado.

Source: Greeley Tribune 11/19/89

In the December 2 edition of the Greeley Tribune, Senator Tim Wirth defended his proposed legislation to designate wilderness areas in Colorado. Wirth said in an interview that preservation of wilderness areas and whether those areas should have water rights are two separate issues. The designation of wilderness land won't affect downstream water rights because the wilderness areas are located in high-mountain headwaters, he said.

In Fort Collins the Water Resources Branch of the National Park Service is gathering data on Colorado's Black Canyon. The canyon was granted a federal reserved water right in 1978 for "the preservation of spectacular gorges and additional features of scenic, scientific and educational interest" (Herbert Hoover, 1933). The Colorado Supreme Court ruled in 1978 that this right included water for timber, recreation, domestic uses, agriculture and irrigation, stock grazing, wildlife management, fire fighting, forest improvement, wilderness preservation, erosion control, scenic and aesthetic values and fish management. But the right was never quantified. Personnel of the NPS Water Resources Branch will determine the nature of studies needed to complete the quantification process. A figure of 300 cfs or less will have little impact on other users, but a larger figure might affect water rights upstream from the Canyon, junior to the 1933 priority date of the Monument.

Source: U.S. Water News, Dec. 1989

Opening the Western Regional Instream Flow Conference at Jackson Hole, Wyoming in October, John Turner said water allocation has grown from being a phenomenon of the West into a problem of national proportion. Turner is Director of the National Fish and Wildlife Service. Linking the protection of fisheries with the preservation of wetlands, Turner said he hopes the policy of "zero net loss" of wetlands will restore current waterfowl numbers, the lowest in the nation's history, to the 100 million birds that existed nationwide in the 1970s.

Source: Special to the Denver Post 10/21/89

The Washington Post reported on December 16 that the U.S. Fish and Wildlife Service's plans to implement President Bush's "no net loss of wetlands" pledge were withdrawn after objections by top Interior Department officials. The oil industry, supported by the Energy Department and other administration officials, said it could hobble oil development on Alaska's North Slope. The plan was withdrawn so that it can be reviewed by top department and White House officials, said the Post.

The Supreme Court has agreed to resolve the federal/state conflict over regulating the environmental impact of hydroelectric power plants. The question is whether the federal government or the state is entitled to the final word on how much water can be diverted from a free-flowing river to serve the needs of a hydroelectric plant. The Federal Energy Regulatory Commission takes the view that it has the authority to establish the water-flow rate. That position was upheld in a decision earlier this year by the U.S. Court of Appeals for the Ninth Circuit in San Francisco. California, supported by a brief signed by 43 other states including Colorado, appealed to the Supreme Court arguing that states must be free to make "important policy judgments concerning allocation of water among competing public and private needs."

Source: New York Times (Denver Post 12/5/89)

Instream Flow Protection in the West, a publication of the CU Natural Resources Law Center at Boulder, provides information on the legal theories, history and politics of instream flow protection efforts throughout the Western United States. The book resulted from a conference held in 1988 that drew over 200 people. Larry MacDonnell, NRLC director, co-edited the book. It is available from the Natural Resources Law Center at the University of Colorado, School of Law, Boulder, CO 80309-0401 (Price \$20).

WATER SUPPLY AND GROWTH ALONG THE FRONT RANGE

- **Colorado Springs** - The city, which owns a substantial portion of Arkansas River water rights, has outlined proposed water supply options that would provide water for double the city's population over the next 50 years. The options, contained in a study prepared by the engineering firm of Black and Veatch, include four water storage proposals for the Arkansas River:

- A new Elephant Rock Reservoir upstream of Buena Vista
- Expansion of Lake Henry and Lake Meredith
- Expansion of Pueblo Reservoir
- Negotiations of contracts with the Bureau of Reclamation, which owns several reservoirs in the Arkansas Basin.

Any proposal that would reduce Arkansas River flows for rafting, however, can be expected to arouse opposition.

- **Aurora** - Pueblo Water Court Judge John Tracey has fined the city and the Resource Investment Group (RIG), a water resource company, \$4,000 for failing to meet provisions of a court order controlling the transfer of 10,000 acre-feet of Arkansas River water to municipal use. Tracey had ruled earlier that the city and RIG were in violation of his 1986 decree because they hadn't completed a plan to revegetate lands dried up by a transfer of agricultural water to municipal water use. The city has agreed to a revegetation program, and Mayor Paul Traver said he is encouraged that "...we have another opportunity to do the project as it's supposed to be done."

Rather than engage in expensive legal battles the City of Aurora and Arapahoe County have agreed to share Gunnison Basin water from whatever projects develop there. Arapahoe County wants to build Union Park Reservoir near Gunnison and take 60,000 acre-feet from it each year. Aurora wants to pipe 70,000 acre-feet of water to the city annually. An agreement signed November 20 stipulates that whichever entity wins the water rights battle will get 70 percent of the water, and the other gets the remaining 30 percent.

- **Denver** - The Colorado Supreme Court ruled on Nov. 13 that Denver must obtain permits from Grand and Eagle counties to build or expand water diversion projects there. Grand and Eagle counties, which adopted permit regulations under Colorado's Land Use Act, require that a permit be obtained by those wishing to build major new water diversion projects. Justice Anthony Volland, in his written decision, said, "The Land Use Act gives Grand and Eagle County the power to regulate, but not to prohibit Denver's operation of extraterritorial waterworks projects." Ed Ruetz, Water Board spokesman, said the Board will review the ruling. Denver officials say the Williams Fork Extension project in Grand County and the Eagle-Colorado Project in Eagle County are needed to meet future water needs between the years 2010-2035. Dick Gustafson, Chairman of the Eagle County Commission, said the decision gives the counties the right of "self-determination" in land-use planning. He added that he hopes the decision will lead to more intergovernment cooperation on water.

Sources: Associated Press-Denver Post 11/15/89; Denver Post 11/8/89; Denver Post 11/21/89; Denver Post 11/14/89 and Rocky Mountain News 11/14/89.

DENVER WATER BOARD VOTES TO REVISE RATE STRUCTURE

The Denver Water Board voted unanimously on Nov. 7 to implement a rate change on March 1 that rewards conservation and penalizes heavy water use. The vote came after a one-year study of water rates, and water officials believe that when combined with other conservation measures (installation of meters and low-flow toilets), the new rates will eventually conserve 9.4 billion gallons a year. The average metro-area home uses 15 gallons per month.

Current Water Rates:

\$0.83 for each 1,000 gallons up to 30,000 gallons
\$0.67 for each 1,000 gallons over 30,000 gallons

Proposed Water Rates:

\$0.71 for each 1,000 gallons up to 30,000 gallons
\$0.89 for each 1,000 gallons over 30,000 gallons

Suburban water users served by Denver will also see rate changes: in 65 areas the rate will increase after 15,000 gallons, in 26 areas the rate will go down in the winter but increase during the summer. The new rates will mean a 6.2 percent increase in monthly water bills for Lakewood customers, according to Virgil Hill, president of the

Consolidated Mutual Water Company, which serves Lakewood users. They now pay an average of \$320 per year. The 26 districts that operate their own distribution systems pay Denver \$1.42 per 1,000 gallons now. Under the new rates they will pay \$1.15 per 1,000 gallons in the winter, but \$1.42 per 1,000 gallons during the summers.

COLORADO WATER QUALITY NEWS

- **Leadville** - A bill authorizing construction of a \$10.5 million treatment plant to remove toxic metals from water flowing into the Arkansas River near Leadville was approved November 1. The Senate Energy and Natural Resources Committee sent the bill, introduced by Senator Tim Wirth, to the Senate for consideration. Congress already has approved \$4.5 million for the Bureau of Reclamation to begin construction of the plant, which will remove lead, cadmium and other heavy metals from the water that drains into the east fork of the Arkansas River from a government-owned drainage tunnel near Leadville. Wirth said the bill must be approved to authorize the expenditure.

Source: Associated Press (Coloradoan 11/2/89).

Leadville residents are concerned about the cleanup process at the California Gulch Superfund site, designed to protect Arkansas River headwaters. A \$2.5 million surge pond, approved by the Environmental Protection Agency after modifications were completed early in November, will serve two purposes: first, it will catch toxic water that flows into California Gulch out of the 4.1-mile Yak Tunnel, which drains the Leadville mining district. Minerals in the water will settle out before it is pumped into the Arkansas River. Second, the pond will contain periodic surges of contaminated water so they will not pollute the river. The plan includes plugging the Yak drainage tunnel, in 1994, with concrete stoppers. Residents are concerned that this will jeopardize their water supply. The next phase of the project, in 1991, will be the installation of a network of monitoring wells to gather data about groundwater movement. The data will be used to determine if contaminated groundwater will migrate toward Evans Gulch, Leadville's water source, after plugs are set in the Yak Tunnel. Don Moffett, Lake County commissioner, said a lot of questions will be answered by putting in the monitoring wells.

Source: Rocky Mountain News 11/8/89

- **Adams County** - On November 17 Adams County's treatment plant, described as one of the most technologically advanced in the nation, began operation. More than 600 people attended a ribbon-cutting ceremony for the facility. Residents had suspected that the water supply was contaminated with by-products of chemical weapons and pesticides manufactured at the Rocky Mountain Arsenal. The Army eventually agreed to pay for most of the new drinking water plant. Scientific tests have since confirmed, however, that toxic plumes coming from Chemical Sales, a private firm, and Scotts Liquid Gold are also sources of the Adams County pollution.

EPA officials said the agency still may force those firms to pay for part of the cost of the new water treatment plant if they can prove the companies are the main sources of the Adams County pollution. The new plant will treat 12 million gallons a day and enable operators to test every day for more than a half-dozen pollutants.

Source: Denver Post 11/17/89.

Adams County officials have called for unity among Colorado congressional representatives over cleaning up contaminated sites around the Rocky Mountain Arsenal. Representative Pat Schroeder's proposal would let the Army proceed with the cleanup, allowing the land to be used as a wildlife habitat. She argues that if the cleanup is delayed much longer, there may not be federal money available to clean it up at all. Senator Tim Wirth, Governor Romer and Adams County officials favor a clean-up process so thorough that schools and homes could be built there. The cost is expected to be at least \$1 billion, and the Army and Shell have agreed to split costs under a formula that calls for U.S. taxpayers to pick up a higher share of the costs as they increase.

Sources: Rocky Mountain News 10/28/89; Denver Post 11/7/89

- **Jefferson County** - An Air Force research facility, located on land owned by Martin Marietta, Inc. has been placed on the EPA's Superfund list of most-polluted areas. The site is uphill from small drinking-water wells at Denver's Kassler Water Treatment Plant which was closed in 1986 when contamination was found on water department grounds. It was polluted by rocket fuel and industrial solvents in the late 1950s and 1960s, which then leaked into groundwater. Inclusion on the list makes the site eligible for money raised primarily through a tax on petrochemicals. The Martin Marietta site is proposed to be dropped from the Superfund list.

Source: Denver Post 11/16/89

1989 POOR SPAWNING YEAR FOR COLORADO SQUAWFISH

Although fishery biologists are not sure what caused a dramatic drop in the number of young produced this year by the Colorado squawfish, some suspect it resulted from a 10,000-gallon oil spill on the Yampa River last Spring. The spill occurred when the squawfish were migrating to their spawning grounds in the Yampa River. Only 70 baby squawfish were found in a stretch of the Green River, fed by the Yampa River, where normally 1,000 young are found. The oil spill is one possible cause; another might be the unusually low water levels in the Yampa River.

Sources: Coloradoan 12/11/89; Associated Press (Rocky Mountain News 11/8/89).

TASK FORCE PROPOSED FOR POUDRE RECREATION AREA PROJECT

A citizen task force may be created by the City of Fort Collins to resolve questions about designating an 18-mile section of the Poudre River as a national recreation area. The task force would look at two key questions: whether legislation can be tailored to resolve concerns over loss of local control and whether a "willing and able federal managing partner" can be found. Kari VanMeter, senior city planner and coordinator of the project, said the most likely partners would be the National Park Service, the U.S. Forest Service, the Bureau of Land Management or the Corps of Engineers.

Source: Coloradoan 11/13/89

GAO TO INVESTIGATE TWO FORKS DECISION

The General Accounting Office, which reports to Congress, has informally agreed to investigate the U.S. Environmental Protection Agency's probable veto of Two Forks Dam. Colorado Senator William Armstrong charged that EPA had disregarded established procedures in deciding to veto a permit needed for the dam.

Source: Denver Post 12/1/89

EPA PROPOSES BAN ON MOST USES OF FUNGICIDES

EPA Administrator William Reilly has proposed a ban on the use of EBDCs (ethylene bisdithiocarbamates), used to protect food crops from mold and mildew and to control fungus. In the U.S. farmers use EBDCs to treat about \$12 billion worth of crops each year. The ban, to take effect within 18 months, would affect 45 of the 55 crops to which it is now applied. Farm experts said consumers should be prepared for an eventual rise in some fruit and vegetable prices. Under the EPA proposal, EBDCs would continue to be used on grapes, wheat, cranberries, onions, sugar beets, sweet corn, peanuts, almonds, asparagus and figs.

Sources: Chicago Tribune (Denver Post 12/10/89); Washington Post (Coloradoan 12/15/89)

COLORADO BLM DIRECTOR NAMED

Bob Moore, Director of the Bureau of Land Management's Denver Service Center, succeeds Neil Morck, who is retiring, as Colorado BLM Director. Moore began his career with BLM in 1955 as a forester in Coos Bay, OR and has been in the Colorado BLM office since 1981 when he became associate state director. He became service center director in 1986.

Source: Denver Post 11/22/89

FEDERAL INSURANCE ADMINISTRATION ISSUES UPDATED GUIDELINES

NFIP Guidelines: In an effort to clarify varying interpretations of the National Flood Insurance Program (NFIP), new guidelines have been issued to create a more uniform understanding of the program and its requirements. The Federal Insurance Administration (FIA), previously part of the Department of Housing and Urban Development (HUD), had not updated its guidelines for implementing NFIP requirements since it became part of the Federal Emergency Management Agency (FEMA) 10 years ago. During those ten years, FIA has been involved in numerous meetings with other federal agencies to resolve questions regarding interpretation. As a result, FIA recently issued new NFIP guidelines to bring about greater uniformity and understanding among federal agencies, lenders, borrowers, and the general public.

In order to provide a well-rounded picture of the Flood Disaster Protection Act of 1973 and its implementation, the guidelines are divided into six sections: 1) an introduction describing the NFIP, 2) a legislative history of the 1973 act and an explanation of the act's requirements, 3) a description of the act as it applies to federal officers, 4) a description of the authority of federal agencies and lenders, 5) the updated guidelines, and 6) a description of the act as it pertains to condominiums. For further information, contact James M. Rose, Jr., Federal Emergency Management Agency, Federal Insurance Administration, 500 C. Street, S.W., Washington, DC 20472, (202) 646-2780.

Source: HYDATA, September 1989.

REPORT COMMENDS NEBRASKA'S NATURAL RESOURCES DIVISIONS

A report prepared for Nebraska's Natural Resources Commission, which analyzed over 600 responses to a questionnaire about the state's Natural Resources Divisions, finds that all divisions in the state "are doing a commendable job of carrying out their assigned responsibilities." The report was prepared in response to legislation adopted by the 1987 Nebraska State Legislature. That legislation directed the Commission to determine if changes should be made in the NRD structure so that the districts could more "equitably and economically manage, conserve, develop and protect the state's natural resources." The Commission concluded that no major changes are necessary. The report's summary conclusions and general recommendations included the following:

- All existing NRD authorities should be maintained.
- NRDs will and should be expected to take on new responsibilities as new resource needs, problems and opportunities arise.
- Many NRDs will need additional revenue sources as new responsibilities are assigned.
- NRDs need to continue to work toward improved relationships with other entities, especially other units of government.

The report also found the current criteria for division boundaries generally appropriate and favored retaining the election-at-large method, especially in those districts with extremely uneven population distribution. The report concluded that use of river basin boundaries as the primary criteria for NRD boundaries was still generally appropriate. It also found that state funding of water quality monitoring costs and additional state funding of cost-share for soil and water conservation practices would benefit all divisions.

Source: Nebraska Resources, Fall 1989

LAJUANA S. WILCHER CONFIRMED AS ASSISTANT ADMINISTRATOR FOR WATER

The Senate on October 20 voted to confirm LaJuana S. Wilcher for the post of Assistant Administrator for the Environmental Protection Agency's Office of Water. President Bush announced his intent to nominate Wilcher for the agency post on September 8.

Possessing a strong background in environmental law, Wilcher previously served at EPA from November 1983 to July 1986 as an assistant to the Deputy Administrator and as a special assistant to the agency's General Counsel.

Her most recent work has been in the private sector, having been a law partner with Bishop, Cook, Purcell and Reynolds in Washington, DC from 1986 to 1989. In this capacity, Wilcher specialized in environmental law and litigation. A 1977 graduate of Western Kentucky University in Bowling Green, Wilcher received a law degree in 1980 from the Salmon P. Chase College of Law at Northern Kentucky University.

Source: National Water Alliance Report, October 1989.

A "SOIL-UTION" TO DREDGE DISPOSAL?

Dredge disposal problems on the River Clyde in Scotland were solved with the building of a "soil factory." Faced with the cost of disposing of the equivalent of about 100,000 dry tons of sediment each year, and with the approaching end of the useful life of the disposal site, the Clyde Port Authority chose to turn port sediment into landscaping soil. The "factory" dries, desalinizes and further ameliorates the dredge material to produce soil for use in land renewal projects in the Glasgow area. To date, the plant has produced more than 50,000 tons of soil. The project not only generates revenue from soil sales, but also saves money through reduced disposal costs.

The PIANC Newsletter, Summer '89, printed in HYDATA, Nov. 1989.

NSF GRANT CREATES RESEARCH FELLOWSHIP AT NIST

A National Science Foundation (NSF) grant awarded to the American Statistical Association (ASA) will support a new research fellowship program at the National Institute of

Standards and Technology (NIST) on the use of statistical techniques for quality control in industry. The fellowship program will encourage collaborative research between engineers and statisticians on problems affecting productivity and quality control in industry in an attempt to bridge gaps between research and the use of statistical quality techniques.

The grant is sponsored by the NSF Division of Mathematical Sciences and the Division of Design and Manufacturing Systems. The first-year grant is for \$105,172 and may be renewed for two years, subject to the success of the program and the availability of funds. Under the program, research fellows will work for periods of up to one year with the NIST Statistical Engineering Division, leading a cross-disciplinary research effort in process-modeling and optimization for quality control. ASA and NIST will establish an advisory board with members from statistical and engineering professional societies to evaluate applicants for the fellowships. Further details of the program may be obtained from the American Statistical Association, 1429 Duke Street, Alexandria, VA 22314-3402.

Source: National Science Foundation

VIESSMAN ELECTED 1990 AWRA PRESIDENT

Dr. Warren Viessman, Jr., P.E. has been elected President of the American Water Resources Association for 1990. Viessman is Professor and Chairman of the Environmental Engineering Sciences Department of the University of Florida in Gainesville, Florida. Prior to his present assignment he was Senior Specialist in Engineering and Public Works of the Congressional Research Service of the U.S. Library of Congress. He also has served as Director of the Nebraska Water Resources Research Institute. Viessman is a member of the American Society of Civil Engineers and is Past President of the Universities Council on Water Resources.

COMPUTERS TO REPLACE METER READERS

The Hartford, Connecticut Water Department is among the first to employ a new generation of technology which allows its computer to use telephone lines to collect meter information remotely. The Hartford Courant says utilities of the 1990s will use telephone lines, power lines, cable television lines and even the airwaves silently to find out how much gas, electricity and water their customers use. Over the next decade, says the article, the system will replace human meter readers and also allow utilities to remotely control equipment.

Source: Coloradoan 11/12/89

FROGS AND TOADS SHOW POPULATION DECLINE

Marked declines of frog, toad and salamander populations have scientists worried. Field biologists are documenting

the decline in a variety of settings including Europe, tropical Central and South America and North America. The U.S. Fish and Wildlife Service's National Ecological Research Center has documented dramatic declines of the boreal toad and the leopard frog in the Rocky Mountains. Researchers have organized a special meeting next year entitled "Declining Amphibian Populations - A Global Phenomenon?"

Source: Denver Post 12/15/89

APPROVED USDA BUDGET INCLUDES \$5.5 MILLION FOR CSU SEED LAB

Congress has approved and sent to President Bush the 1990 USDA budget, which includes \$5.5 million to expand and modernize Colorado State's seed storage lab. The lab holds the nation's base collection of seeds for all major crops grown in the United States. Also included in the budget is \$1.75 million for research on the Russian wheat aphid, \$6.5 million for the Denver Wildlife Research Center, and \$7.1 million for USDA extension service for pest management.

PRESIDENT SIGNS BILL EXPANDING ROCKY MOUNTAIN NATIONAL PARK

President Bush signed a bill on November 29 that will add 515 acres to Rocky Mountain National Park. Included in the 515 acres is land on the Park's eastern boundary that includes Lily Lake and a migratory route for deer and elk. Other portions, now within the Roosevelt National Forest, will be ceded to the park.

NEW TECHNIQUE DEVELOPED TO IMPROVE WELL PRODUCTION

A Colorado State University professor has developed a remedy for mountain homeowners who have underproducing water wells. James Waltz, director of Colorado State's hydrogeology program, says the technique is a low-cost water-well adaptation of an expensive oil field technique known as hydraulic fracturing. Named Flexifrac, the technique uses an inflatable rubber plug that is placed into the well to seal off the lower portion. Workers then pump high-pressure water into the well beneath the plug to create cracks in the surrounding rock. The cracks extend out and interconnect with nearby water-bearing fissures and provide a channel for new water to seep into the well. The technique has been successfully used on more than 600 wells in Boulder, Jefferson, Larimer and Park counties by Waltz and his research partner Ray Boyle.

RIVER ECOLOGISTS GO UNDERGROUND

Recent research on rivers in Colorado and Montana reveals important interactions between the surface water in river channels and their groundwater aquifers. Remarkably diverse and abundant animal communities live in the water-filled spaces between sand and gravel particles beneath the river bed and for some distance under the banks. Animals adapted for life within this underground labyrinth of tiny

interconnected spaces include riverine invertebrates that migrate to and from the aquifer as well as specialized groundwater animals that are blind and lack pigment. Many of these underground species, that include crustaceans, worms, and immature insects, were previously unknown to science.

Work on the South Platte River in Colorado is being conducted by J.V. Ward, Professor of Biology at Colorado State University, supported by a grant from the CWRRI. Animals and water quality samples are collected at various locations along the course of the South Platte by pumping from perforated pipes driven into the groundwater beneath and adjacent to the river channel.

After extensive sampling from a grid of unscreened wells on the floodplain of a western Montana river, Ward and J.A. Stanford, Director of the Flathead Lake Biological Station, concluded that the health of the river is dependent on its being connected to the groundwater aquifer. Working under a National Science Foundation grant, these scientists found that some aquatic insects migrate miles away from the river to complete their growth as part of the subterranean food web. Eventually, however, they return to the river, emerge as flying adults, mate and deposit eggs in the river where they become prey for fish. In addition, significant amounts of dissolved nutrients are transported from the aquifer to the channel during low-flow periods, thereby further enhancing productivity in the river.

The new studies suggest that river ecosystems encompass much more than the actual river channels. Gravel bed rivers, those with broad floodplains of permeable gravel deposits, should exhibit especially strong interactions between surface and underground waters.

If animals and nutrients move between the groundwater and the river, so can pollutants. Pollutants in the river will contaminate the aquifer and pollution of the aquifer will be reflected in the river. These findings suggest that groundwaters and surface waters should not be treated as if they were separate entities in water quality legislation. Groundwater animals may play an important role in cleansing the waters that enter rivers and streams. Aquatic animals have been effectively used as indicators of surface water quality. Studies at Colorado State University are examining the feasibility of using groundwater animals as biomonitors of groundwater quality.

ARI MICHELSEN TAKES POST AT WYOMING WATER CENTER

Ari Michelsen is the new Associate Director of the Wyoming Water Research Center and will also hold an appointment as Associate Professor in the Department of Economics at the University of Wyoming. From 1987 to 1989 Ari was a Senior Associate of the Environment and Resource Group, RCG/Hagler, Bailly, Inc. of Boulder. In 1988 he received a Ph.D from the Department of Agricultural and Resource Economics at Colorado State.

FROM COOPERATIVE EXTENSION

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

SCS and Extension Cooperate to Reduce Pesticide Impacts on Water Quality--You may remember from a previous newsletter that Extension and Soil Conservation Service have signed a national memorandum of understanding on water quality. We are also cooperating with SCS in the development and implementation of water quality action plans for Colorado. In the national MOU, Extension agrees to concentrate on its traditional role of education, and SCS agrees to assume primary responsibility for implementing water quality management strategies via conservation planning with individual farmers. Since both agencies have direct contact with farmers, it is highly desirable that we know what each other is doing, and that we try to provide a consistent message to farmers. Cooperation between the two agencies is working very well at the state level, and our goal should be close cooperation at the county level as well.

One of the areas in which we have agreed to work together in Colorado is pesticide management from a water quality standpoint. SCS is now developing a state standard and specification which will be reviewed by Cooperative Extension and will become a part of the farm conservation plans. The implementation of water quality management practices may eventually become a required component of conservation plans for participation in the Farm Bill price support programs in a manner similar to that of current "sod buster" and "swamp buster" provisions.

The overall theme of the SCS pesticide management standard and specification will be IPM, integrated pest management. The goal will be to reduce the use of chemical pest controls through intensive management including scouting, appropriate tillage practices and biological controls where applicable. Assistance from Cooperative Extension will be essential for implementation of IPM.

When chemical pesticides are called for, selection should consider water quality protection along with toxicity, economics and efficacy. SCS has developed a soil/pesticide interaction rating scheme for comparing alternative pesticides in terms of their surface and ground water pollution potential. The other three factors listed above are not considered in the interaction rating. However, the ratings can provide useful information to farmers who must weigh all of these factors when making a pest management decision.

We (Cooperative Extension) have computerized the soil/pesticide rating scheme using RBase for DOS and will be providing the software to SCS for use in all county field offices in Colorado by early 1990. The same software package, currently call WATPEST, will be available for use by County Extension Offices. We hope to provide a compiled version which will run on any hard disk without the need for RBase itself.

To rate a pesticide using WATPEST, one enters the name of the pesticide (insecticide, herbicide, etc.) and name of the soil (from SCS soil survey) on which it is to be used.

WATPEST then looks up the surface runoff pollution potential and ground water pollution potential of the soil (each potential is 1, 2 or 3 with 1 being the greatest danger of pollution) and then looks up the pollution potential of the pesticide (1, 2, 3 or 4 with 1 being the greatest danger of pollution). Next WATPEST enters a table with these three numbers and finds an overall surface runoff pollution rating (1, 2 or 3) and an overall groundwater pollution rating (1, 2 or 3) for the soil pesticide combination.

The process can be repeated for various pesticides under consideration for a given pest problem in order to evaluate their relative pollution potential. The depth to ground water and proximity to lakes, ponds, or streams would determine whether surface or ground water protection would be most important in a given situation. The WATPEST data base contains about 4000 soil types for Colorado and some 200 pesticides from a national USDA list. Neil Humberg is working on the pesticide list to revise the data base for Colorado. Dale Holden from the State SCS Office is developing county-level soils data bases to improve the speed of soil information retrieval.

The tables of pollution potentials are based on soil properties such as texture, erosion potential, and organic matter content and pesticide properties such as half-life, absorptivity, and solubility. These soil and pesticide characteristics are directly retrievable from the data base.

Disposal of Household Chemicals--"Out of sight, out of mind" is a phrase which accurately describes the attitude which many of us have toward disposal of household chemicals. We typically think nothing of pouring leftover chemicals down the drain or throwing half-empty containers in the trash. We fail to realize, however, that in doing so we are leaving the door open for toxic materials to eventually find their way into our drinking water supplies. Chemicals poured down the drain, of course, will go to a municipal waste treatment plant. Toxic substances may not be effectively removed by treatment and they may interfere with the treatment process, thereby having a negative impact on water quality.

Substances thrown in the trash will be placed in municipal landfills. Even if chemicals are in containers, they will eventually come in contact with percolating waters in the landfill and will ultimately contaminate ground water supplies. This process may take 20, 50 or more than a hundred years. Even so, the knowledge that someday someone might be drinking water contaminated by our old pesticides, cleaners, etc. should give us a reason to take action. What then must we do? There are several simple rules one should follow.

1. Buy only what you need. Don't buy a larger size of a toxic product just because it costs less per ounce. The ultimate costs to the environment due to the "leftovers" may be many times greater than the apparent savings.

2. Use it all up according to manufacturer's directions. Occasionally a neighbor or friend may have a use for chemicals that you no longer need.

3. If you have a choice of methods in dealing with a pest or cleaning problem, choose the one which requires the least use of toxic chemicals. For example, many insect problems can be dealt with using non-chemical control measures or using relatively non-toxic insecticides. Likewise, "elbow grease" and scouring can often be used in place of very harsh cleaning chemicals. By carefully choosing which chemicals you use, you can protect your own health as well as the environment.

4. Remember that all of our water is supplied by nature's hydrologic cycle. Chemicals that you dump on the ground, in a ditch, in a stream or lake, down the drain, or in the trash enter this cycle and may reappear in someone's drinking water.

5. Do not burn toxic materials. Dangerous fumes may be produced.

6. Do use common sense in disposing of chemicals and containers. Always read label directions carefully! Some common materials and satisfactory disposal methods are listed below. When in doubt about what to do with a particular substance, contact your local health department.

TOXIC MATERIAL

Empty containers (pesticides, cleaners, etc.)

target area (i.e., lawn,

Leftover ammonia based cleaners or drain cleaners, bathroom cleaners disinfectants, alcohol-based lotions, perfumes, alcohol, lye-based products such as drain cleaners, Latex paint, windshield washer solution, water-based glue

Oil-based paints, paint remover, thinner, primer, wood-finishing products, rust remover, wood finishing products rust remover, window cleaner, metal polish, furniture polish, floor-care products, metal polish; furniture polish; specific fertilizers, pesticides, solvents, solvent-based glue, gasoline, kerosene, diesel oil, batteries,* fuels, butanes, acids,

DISPOSAL METHOD

Triple rinse and place in trash. For pesticide containers, apply the rinse water to the garden, etc.)

May be poured down drain with plenty of water

Must be completely used or disposed of by licensed hazardous waste contractor. Contact your local landfill or health department for instructions.

motor oils,* other oils; automatic transmission fluid; antifreeze; car wax

*In some areas, recycling programs are available for used motor oil and used auto batteries. A local service station should be able to provide you with this information.

7. Finally, become active in your community by alerting others to the dangers of toxic wastes. Investigate, through your local health department, the possibilities of a community-wide collection day for toxic materials.

Crop Management Expert System--(by Israel Broner)
Expert systems are computer programs that use knowledge derived from human experts to solve problems. Consequently, expert systems mimic the problem-solving processes that a human expert would use. Some scholars claim that by emulating human reasoning in its ability to combine objective and subjective knowledge, expert systems can expand both our capabilities and the availability of specialized expertise. Expert systems are composed of a knowledge base derived from human experts, an inference engine and a user interface. Expert systems differ from traditional computer programs by the knowledge they contain and the way a recommendation is obtained. Expert systems rely on declarative knowledge and experience-based knowledge rather than the number-crunching style of conventional programming. Knowledge-based expert systems are well suited to applications in agriculture because they can be designed to handle the uncertainty and incomplete knowledge associated with weather and crop behavior.

Crop producers addressing production problems look to a variety of sources for information, including the public sector (Cooperative Extension and Experiment Stations) and private-sector organizations such as consulting firms and firms that contract to buy agricultural products. The quality and accessibility of advice is variable and largely dependent upon access to experienced persons and to data bases. The data bases available are usually in printed format, often highly dispersed, of doubtful currency, and require interpretation by an experienced, knowledgeable person. Budget constraints in both the public and private sectors make access to experienced persons increasingly difficult or expensive. Recent advances in experience-based programming technology make it possible to develop widely available, user-friendly expert systems that allow farmers to have easy access to expert advice and information on how to best manage their crops.

A malting barley management expert system is being developed at Colorado State University as a joint project of the Department of Agriculture and Chemical Engineering and the College of Agricultural Sciences. The faculty involved in this project are Charles Basham and Robert Croissant from the College of Agricultural Sciences and Israel Broner from the Department of Agricultural and Chemical Engineering. The students that are doing the research and development are Phil King and Armando Parente from the Department of Agriculture and Chemical Engineering and Carlton "Sam" Comstock from the College

of Agricultural Sciences. This project is funded by the Colorado Institute for Artificial Intelligence (CIAI). CIAI requires cooperation between the research institution and an industry. Our industry partner is Adolph Coors Company, which is a major American brewery as well as one of the leading buyers of malting barley in Colorado. Coors provides barley crop management support through 15 area field agronomists who provide advice to Coors' barley growers. A domain expert is needed for the development of an expert system. In our project the 15 Coors' agronomists served as local domain experts while Robert Croissant served as global domain expert. As Coors' agronomists supplied localized experience-based knowledge, CSU's Crop Specialist, Robert Croissant, supplied the research perspective and resolved conflicts that arose among local experts. Coors' cooperation and help in developing the knowledge base for the expert system was outstanding. Knowledge was extracted using a 28-page questionnaire and interviews. All Coors' agronomists answered the questionnaires and supplied ample information.

The barley management expert system will provide advice in two areas: fertilizer and water management. The amount of nitrogen and phosphorus to apply will be recommended by a fertilizer module. Irrigation recommendations, including when and how much to irrigate, will be given by an irrigation module. Other crop production recommendations may be incorporated in later stages of the program development.

This is the second year that we have received funds from the CIAI to conduct research and develop the barley expert system. A working program will be deployed next spring. Coors' agronomists will be the first to try the program and will supply feedback on its performance. Our goal is to continue in the direction of developing expert systems for crop management and use the barley expert system as a prototype to develop expert systems for other crops.

Annual Meeting-- The Annual Meeting for cooperators of the Energy Conservation for Colorado Agriculture project and persons interested in efficient irrigation methods will be held in Grand Junction on February 21 and 22, 1990. The theme of the meeting will be surge irrigation and water management. Cabling will also be discussed.

Nitrogen and Irrigation Water Management Workshop-- scheduled for January 17-18, 1990, Fort Collins. Free of charge. Our intention is to focus on problems of non-point source pollution and to discuss the relationship between water management, nitrogen management and ground water contamination. We will focus attention on methods and practices to reduce inputs while sustaining high yields. Subjects such as soil and water testing, use of soil probes, soil sensors and water balance for irrigation scheduling will be taught. Computer programs for fertilizer recommendations and irrigation scheduling will be demonstrated. Call 491-6172 to obtain information or pre-register.

1989 in Review--(by Sharon Patterson, Agricultural Engineering News, December 1989). Our program this past

year has moved strongly into the area of water quality -- a major issue that affects everyone. Jim Loftis has taken on this program with a vengeance. He's given a multitude of programs on this subject and served on various water-related committees. He's made so many trips to Denver for meetings that his car just automatically heads toward I-25 when it leaves the Engineering parking lot...He's been so busy this past year that we've decided to overlook the fact that he came to work one morning wearing two different shoes. Paul Ayers continues his fight for a safe environment as well as dealing with soil compaction problems. He has been doing field studies on soil compaction with pinto beans and dryland wheat, and is gearing up for sprayer calibration workshops this coming year. Israel Broner became a U.S. citizen and changed his name (Israeli) back to his family name (Broner). His irrigation program has expanded to more areas in the state, and he's also involved in crop and irrigation modeling programs as well as developing an expert system for barley management. During the summer he leads a two-week tour of irrigation systems throughout Colorado.

NEW INSTITUTE PUBLICATIONS

Technical Report No. 60--Proceedings: Seventh Workshop on On-Site Wastewater Treatment in Colorado, Edited by Robert C. Ward. The Seventh Workshop on On-site Wastewater Treatment in Colorado was held March 28, 1989, on the campus of Colorado State University in Fort Collins, Colorado. On-site wastewater treatment in Colorado has evolved over the years as the science that supports it is being better defined and understood. As more science enters what has traditionally been an empirically based means of treating wastewater, the need to update regulations, design methods, installation procedures and management practices becomes more obvious. This Seventh Workshop was held to review developments in on-site technology and management that may be precipitating changes in past practices as a result of the evolving use of more science in the field.

The first two sessions provided updates on technology and management practices. David Holm, the luncheon speaker, discussed on-site wastewater treatment issues related to state-wide efforts to manage water quality. The afternoon session was devoted to a discussion of current on-site regulations and the need, if any, for change. The Workshop was sponsored by the Cooperative Extension Service and Colorado Water Resources Research Institute and the Colorado Environmental Health Association.

Completion Report No. 152 -- Enhanced Microbial Reclamation of Water Polluted with Toxic Organic Chemicals. Price: TBA. This research was undertaken to develop an inexpensive and easy to operate microbiological system to reclaim water contaminated with toxic organic chemicals. Groundwater pollution is a major environmental and public health problem in Colorado, and solving this problem is of great importance to the quality of life and the future economic growth of the region. Inexpensive methods for removing toxic chemicals from water are

needed to address the large present problem and to prevent future buildup of these compounds.

Significant new information on the enhancement of microbial removal of toxic organic compounds was obtained. Research was aimed at optimizing operating parameters such as microbial species composition, type and concentration of stimulating carbon compounds, effect of cell recycle, and retention time in the reactor. The breakdown of hazardous chemical wastes, such as 2,4-dinitrophenol, was greatly enhanced in treatment systems employing specially selected strains of bacteria. Optimal conditions for the destruction of toxic chemicals by these bacteria were determined in Sequencing Batch Reactors, a type of biological treatment system. Addition of ammonia and glucose to the reactors greatly enhances the destruction of the chemicals tested. This enhancement was attributed to the increased rate of growth of the bacteria, which normally grow very slowly on the toxic chemicals tested. The technology developed as a result of this study has great promise in the future cleanup of contaminate sites in Colorado and elsewhere.

Potential users include industries that create toxic organic wastes and agencies and companies involved in the cleanup of already contaminated sites such as the Broderick Wood Products site in Adams County, Colorado, the Snytex Chemical Inc. site near Lyons, and the Rocky Mountain Arsenal. The technology can also be applied to the removal of contaminating organic compounds from municipal drinking water sources.

Completion Report No 153 -- **Biological Denitrification of Polluted Groundwater.** Price: TBA. Many groundwaters are contaminated with nitrate from fertilizers, domestic wastewater leachates and municipal waste treatment plant effluents that have entered groundwater aquifers. Nitrate is a mobile and very soluble ion, thus it has become a common groundwater pollutant. A recent report of the Colorado Water/Sewer Needs Committee (Colorado Division of Local Governments) categorized the drinking water supplies of Baxter, Brighton, Chambers Subdivision, Fort Lupton, Gilcrest, Hudson, Kim, LaSalle, Milner, Peyton, Platteville, and Southgate as demonstrated health hazards or producing immediate health effects due to high nitrate concentrations. Because the nitrate ion is toxic to infants, drinking water supplies that contain greater than the U.S. primary drinking water standard of 10 mg/L as nitrogen require treatment. Unfortunately, conventional water treatment processes do not remove the nitrate ion.

Nitrate is removed from water readily by denitrification, a bacterial respiration process which converts nitrate to harmless nitrogen gas. Denitrification is carried out by numerous bacterial species found in soil and aquatic environments. Most denitrifying bacteria can respire using either nitrate or oxygen as the terminal electron acceptor. These bacteria require a reduced exogenous carbon for energy production and cell synthesis. Acetic acid was chosen as the carbon source because it is readily available in bulk quantities, not toxic to humans and is less

hazardous to handle and store than alternatives such as methanol.

Biological denitrification of wastewater has been carried out in suspended growth, fluidized bed and biofilm reactors. The fixed biofilm process is a suitable choice for potable water denitrification because it avoids the problems of solids separation and recycle associated with the activated sludge process, and produces less effluent solids than fluidized bed processes. The simplicity of operation associated with fixed biofilm processes is also a significant advantage for small communities that cannot employ large staffs of specially trained operators.

Biological treatment of water is not new to small communities; many operate biological waste treatment facilities. The processes investigated were selected because for normal day-to-day operation they are easy to operate and require minimal operator attention. The introduction of bacteria into a potable water source may meet considerable resistance, yet one of the oldest water treatment methods, slow sand filtration, is now recognized to be primarily a biological process. Biological denitrification appears to the authors to be a most reliable and economical solution to the widespread problem of nitrate-polluted potable water supplies.

COLORADO WATER CONGRESS TO HOLD 32ND ANNUAL CONVENTION

This year's annual convention of the Colorado Water Congress, scheduled for January 25 and 26, features a general session on the subject "Water Issues in the 1990s," and concurrent workshops on various subjects of current interest. Six legislators will address the delegates at the Legislative Breakfast on Friday, January 26. The meeting will be held at the Holiday Inn, Northglenn, I-25 and 120th Avenue. For further information contact the Colorado Water Congress, 1390 Logan Street, Suite 312, Denver, CO 80203. Deadline for advance registration is January 19, 1990.

FOUR STATES IRRIGATION COUNCIL TO MEET IN FORT COLLINS

The 39th annual Conference of the Four States Irrigation Council will be held at the University Park Holiday Inn in Fort Collins on January 8-10, 1990. Attending will be 250 to 300 managers, directors and representatives of nearly 100 irrigation districts from Nebraska, Kansas, Colorado and Wyoming in addition to many federal, state and local government and administrative officials. The meeting agenda features general sessions the mornings of January 9 and 10 on topics including facing new challenges, the Two Forks Project, a USBR update, oil spills, habitat enhancement on water and irrigation projects, managing multiple uses on canal rights-of-way, Fish & Wildlife Service concerns and the water supply outlook for the Four States area. The afternoon of January 9 will feature concurrent workshops on a variety of topics. For further information contact the Northern Colorado Conservancy

District, P.O. Box 679, Loveland, CO 80539, (303)667-2437.

SHORT COURSES AND WORKSHOPS

1990 Central Plains Irrigation Short Course, Feb. 5-6, Wray Elks Club, Wray, Colorado. Sponsored by Cooperative Extension in Kansas, Colorado and Nebraska and hosted by Colorado State University, the course is designed to provide a regional forum for information exchange on irrigation technology, practices and policies in the Central Plains. Included will be state-of-the-art information on sprinkler irrigation technology, irrigation management and non-point source water pollution. The meeting is designed for producer/irrigators and agency personnel. Technology practices and applied research information transfer sessions will be held immediately following the meeting. The registration fee of \$25 includes lunch and dinner on Monday and a copy of the Proceedings of the Central Plains Irrigation Short Course. Send your registration to: Israel Broner, Extension Agricultural Engineer, Dept. of Agricultural and Chemical Engineering, Colorado State University, Fort Collins, CO 80523. Phone: (303)491-6171; FAX: (303)491-6172.

International Short Course on Appropriate Technology for Water Supply and Sanitation in Developing Countries, Jan. 15-19, Colorado State University. The course will present training materials similar to those developed by the World Bank for low-cost water supply and sanitation in developing countries. It is designed to teach the planning, construction, operation, maintenance and management of water supply and sanitation structures and systems in rural areas and in developing countries. Contact: Kate Taylor, Room 203 Weber Bldg., Civil Engr. Dept., Colorado State University, Fort Collins, CO 80523 (303)491-0633.

Nitrogen and Irrigation Water Management Workshop, Jan. 17-18, Colorado State University. Free. (See FROM COOPERATIVE EXTENSION).

AWF schedules workshops--The American Water Foundation (AWF) will sponsor five international seminars and workshops in the United States during 1990. The international training programs are intended for international water resources professionals from foreign governments, international organizations and the private sector, including policy-makers, administrators, project managers and senior engineers. Each training course includes formal presentations and discussions, as well as field tours. The 1990 seminars and workshops are: 1) **System-Wide Water Management** - May 29 - June, 1990; 2) **Construction Management Practices for Water Resources Facilities** - July 9-20, 1990; 3) **Design and Construction of Roller Compacted Concrete Dams** - August 13-24, 1990; 4) **Hydropower - Design, Construction and Equipment Requirements** - September 17-28, 1990; **Dam Safety, Operation and Maintenance** - October 31 - November 16, 1990.

9th High Altitude Revegetation Workshop, Mar. 1-2, Fort Collins, CO. This year's conference will update you on the current regulatory environment, water quality issues and techniques, tailing and mine waste reclamation, microbiological aspects of reclamation, visual and aesthetic planning, and various reclamation projects. This year's workshop will also include poster papers and educational and exhibitor displays. For information contact: Gary L. Thor, HAR Committee Secretary, Dept. of Agronomy, Colorado State University, Ft. Collins, CO 80523, (303)491-7296.

PEST MANAGEMENT SERIES OFFERED BY CONTINUING EDUCATION

Pesticide Management, Management of On-Farm Stored Grain, Management and Control of Turfgrass Pests, and Management and Control of Wood-Destroying Pests - These four correspondence courses are now offered by Colorado State's Division of Continuing Education. The author/instructor for the Series courses is Bert L. Bohmont, Professor in the Department of Plant Pathology and Weed Science and a nationally recognized authority on pest control and pesticides. For more information call Colorado State Continuing Education at (303)491-1995 or toll free at 1-800-525-4950.

CALLS FOR PAPERS

International Water Resources Association, International Seminar on Hydrology and Water Management of the Amazon Basin, to be held August 5-9, 1990 in Manaus, Amazonas, Brazil. Researchers, consultants, planners or others who have studied the hydrology of large tropical rivers such as the Amazon River are invited to submit a one-page, single spaced abstract on or before January 30, 1990. The seminar is sponsored by the International Water Resources Association (IWRA) and the Brazilian Water Resources Association (ABRH) with the support of the United Nations Environmental Programme (UNEP) and the United Nations Educational Scientific and Cultural Organization (UNESCO).

Submit abstracts to: ASSOCIACAO BRASILEIRA DE RECURSOS HIDRICOS, Centro Tecnológico de Hidráulica, Attn: Benedito P.F. Braga, Jr., P.O. Box 11014, 05499 Sao Paulo, SP - Brazil, Fax: (55) (11) 815-4272; Bitnet: Benbraga @ Bruspa. For information contact: INTERNATIONAL WATER RESOURCES ASSOCIATION, University of Illinois, Attn: Glenn E. Stout, 205 N. Mathews Avenue, Urbana, IL 61801, USA FAX: (1) (217) 333-8046, Bitnet: Stout @ Uiucvmd.

January 31, 1990 (abstracts due) - 2nd International Symposium on Gas Transfer at Water Surfaces, September 11-14, 1990. Minneapolis, MN. Contact: Mr. Steven Wilhelms, Chrm., Organizing Committee, U.S. Army Engineer Waterways Experiment station, P.O. Box 631, Vicksburg, MS 39180, 601/634-2475.

National Water Supply Improvement Association Biennial Conference - NWSIA will hold its biennial

conference from August 19-23, 1990 in Orlando, Florida. The subject is "critical Issues for the 1990's - Desalination and Water Reuse". NWSIA solicits abstracts on a broad range of topics that includes advances in water sciences, water reuse, desalination, conservation and related subjects. Please note that the deadline for the submission of abstracts has been extended to January 8, 1990. Send abstracts to: National Water Supply Improvement association, P.O. Box 102, St. Leonard, MD 20685. For information, call O.J. Morin at (407) 423-7275 or Ms. Patricia Malaxos at (813) 877-7275.

NEW USGS REPORTS

Contact Books and Open-File Reports, Federal Center, Box 25425, Denver, CO 80225-0425 for the reports described below. (303)236-7476.

"Hydrologic Effects of Pumpage from the Denver Basin Bedrock Aquifers of Northern El Paso County, Colorado," by Edward R. Banta, published as U.S. Geological Survey Water-Resources Investigation Report 88-4033.

"Indexes of Hydrologic Data from Selected Coal-Mining Areas in Northwestern Colorado," by Neville G. Gaggiani, published as U.S. Geological Survey Open-File Report 88-347.

"Water-Level Changes in the High Plains aquifer underlying parts of South Dakota, Wyoming, Nebraska, Colorado, Kansas, New Mexico, Oklahoma, and Texas--predevelopment through nonirrigation season 1987-88," by William M. Kastner, Donald E. Schild, and Debra S. Spahr, published as Water-Resources Investigation Report 89-4073.

"Sediment-Transport Characteristics and Effects of Sediment Transport on Benthic Invertebrates in the Fountain Creek Drainage Basin Upstream from Widefield, Southeastern Colorado, 1985-88," by Paul von Guerard, published as Water-Resources Investigations Report 89-4161.

"Reconnaissance of Water Quality of Pueblo Reservoir, Colorado--May Through December 1985," by Patrick Edelmann, prepared in cooperation with the Pueblo Board of Water Works, Fountain Valley Authority, Southeastern Colorado Water Conservancy District, Pueblo West Metropolitan District, St. Charles Mesa Water District, and the U.S. Bureau of Reclamation. The report is published as Water-Resources Investigations Report 88-4118.

FELLOWSHIPS

OTA Congressional Fellowship Program, 1990-91. The Office of Technology Assessment (OTA) is seeking outstanding candidates from academia, business and industry, and the public sector for its Congressional Fellowship Program. Up to six Fellows will be selected for a 1-year appointment in Washington, DC, beginning in September 1990. The program provides an opportunity for individuals of proven ability to gain a better understanding of science and technology issues facing Congress and the

ways in which Congress establishes national policy related to these issues. Assessments are conducted in such areas as economic competitiveness, international security, energy, advanced materials, biotechnology, neuroscience, agriculture, advanced medical technologies and services, telecommunications and information technologies, environment, education, and science policy. The program is open to individuals who have demonstrated exceptional ability in such areas as the physical or biological sciences, engineering, law, economics, environmental and social sciences, and public policy. Candidates must have significant experience in technical fields or management or have completed research at the doctoral level. The salary range is from \$28,000 to \$55,000 per year, based on the Fellow's current salary and/or training and experience. In some instances a Fellow may accept a salary supplement from his or her parent organization. Such instances are addressed on a case-by-case basis.

Applicants are required to submit the following: (1) a resume limited to two pages, including education, experience, area(s) of special interest; and a one-page listing of most recent published works; (2) three letters of reference, including telephone numbers, from individuals who know the applicant well enough to write about his or her professional competence (sent directly to the address below); and (3) a statement of up to 1,000 words that either: (a) evaluates an issue with both technical and public policy content and why this is of interest to you, or (b) summarizes the findings of a piece of public policy related to work you have done. Applications/letters of reference must be postmarked by January 31, 1990. Screening and selections will be made by committees appointed by the Director of OTA. Personal interviews of the finalists will be conducted during the week of March 26-30, 1990. Awards will be announced by April 6.

Send applications to: Congressional Fellowships, Personnel Office, Office of Technology Assessment, Congress of the United States, Washington, DC 20510-8025.

National Needs Water Sciences Fellowship, 1990 - 1991. Agricultural Engineering Department at Oklahoma State University invites applications for one Ph.D Fellowship in Water Sciences funded through the USDA National Needs Program. The fellowship will be awarded a graduate stipend of \$15,000 per annum for three years. The Fellow will be able to pursue research in the water science area of his/her choice. Applications are encouraged from U.S. citizens with engineering, hydrology, geology, soil science or related degrees. The Water Science group of the Agricultural Engineering Department has defined four major thrust areas: Erosion and Sedimentation, Ground Water, Hydrology, Irrigation.

Applicants should submit a letter describing research interests and goals; a complete resume; current official transcripts; and three letters of recommendation. Applications will be accepted until a suitable candidate is chosen. Applications should be sent to : Dr. Glenn O. Brown, Agricultural Engineering Department, Oklahoma State University, Stillwater, OK 74078-0497.

POSITIONS AVAILABLE

Associate Director-Water Resources Research Institute of the University of North Carolina. Will have administrative and research responsibilities. Administrative duties will include: (a) oversight of active research projects that have been funded by the Institute, including facilitation of technology transfer associated with the projects; (b) organization and administration of conferences, workshops, and other technology transfer activities; (c) maintenance of liaisons with federal, state, and local water/resource agencies and organizations; and (d) the conduct of special projects. In addition to the administrative duties, the Associate Director will be expected to initiate research proposals that involve faculty members and graduate students in The University of North Carolina.

Preference will be given to candidates who hold a doctorate degree in a relevant field, who have experience in working with faculty members and administrative units of government, and who have demonstrated the ability to initiate cooperative research proposals. Closing date: January 1, 1990. Submit resume to: Dr. David Moreau, Director, Box 7912, North Carolina State University, Raleigh, NC 27695-7912. (919) 737-2815.

Lake Management Extension Specialists (2)-University of Wisconsin-Stevens Point. These positions were created "to provide lake management educational and organizational assistance" to lakeshore property owners and local communities. Assistance is provided through educational materials development on the lake ecosystem, lake problems, community organization options, and physical and institutional technologies to achieve lake protection and restoration. Assistance is also provided by frequent contact with clientele via telephone, correspondence, and local meetings. Program planning and delivery is coordinated within Wisconsin Cooperative Extension Service and in consultation with the Wisconsin Department of Natural Resources.

PhD preferred, MS required, with at least one degree in adult education, environmental science/engineering/law, limnology, natural resources, planning, or sociology. Preference will be given to candidates with (1) training in both natural and social science, and (2) experience in communicating with citizens and local officials. Extensive travel throughout the state and teaching in a wide variety of settings and times (including evenings, weekends, and holidays) will be required. Appointment date: January 1, 1990 or as soon thereafter as possible. Rank and Salary: \$28,000-36,000. MS - Instructional Academic Staff in the College of Natural Resources; Phd - Faculty appointment as Assistant Professor possible in a discipline in the College of natural Resources. Submit the following to Prof. Lowell Klessig; Chair, Search and Screen Committee; College of Natural Resources; Univ. of Wisconsin; Stevens Point, WI 54481: (1) Cover letter indicating interest in position, special skills and experiences, and availability. (2) Resume (3) Transcripts (4) Names of three references and your immediate supervisor in your two most recent positions. (Please indicate if you would like us to refrain

from contacting your current employer until you are a finalist for these positions.) Deadline: Screening will begin November 29, 1989.

Director of Water Center and Professor-University of Nebraska Lincoln, Institute of Agriculture and Natural Resources. Will coordinate and provide administrative leadership for water-related research, extension and teaching activities. Responsibilities include the planning, coordination and review of water-related research and extension programs funded through the Water Center including Public Law 98-242 funds. Will provide primary leadership and management for the University of Nebraska Water Science Research Initiative which is part of a \$20 million State-supported initiative to enhance the research base at the University of Nebraska. Expected to stimulate water-related interests within the University through administration of competitive grant programs, preparation of proposals, coordination of educational programs, conferences and seminar series. Will provide liaison between IANR and other divisions and colleges of the University and with local, state and federal agencies and associations and others interested in water programs. Will coordinate, supervise and evaluate faculty, staff and students associated with the Water Center and participate in annual evaluation and promotion/tenure decisions of faculty employed with Water Science Research Initiative funds. Incumbent will have the opportunity to develop an active research and academic program in a designated priority area of the water science program.

Will carry out those functions and work directly with the appropriate deans for water-related program activities in extension, research and teaching with the Associate Vice Chancellor for Agriculture and Natural Resources serving as primary supervisor. Responsible to the Vice Chancellor for Research and administering activities funded by the Water Science Research Initiative. Academic department and academic assignment will be mutually agreed upon at time of appointment and will be responsible to the appropriate department head for department academic program responsibilities. Tenure for faculty position will be considered.

Requirements: Ph.D degree in applicable discipline. Adequate professional experience in some area of water-related research and education to qualify for rank of Professor in an appropriate academic department is required. Submit letter of application, resume and the names and addresses of three references postmarked by **December 15, 1989** (or until a suitable candidate applies thereafter) to: Dr. T.E. Hartung, Associate Vice Chancellor, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln, Lincoln, NE 68583-0708, (402) 472-2871.

Hydrogeologist-Conservation & Survey Division. The Conservation and Survey Division is a research/service unit responsible for natural resources programs and comprises the State geological, water and soil survey programs. Faculty have access to the following facilities: Water Science Laboratory equipped with GC-MS, AA, IC, and

stable isotope analyses; Geological Department lab equipped with ICP-MS, SEM, and XRF; Chemistry Department lab which functions as the regional Mass Spectrometry Center; and others. Division facilities and support activities include surface and borehole geophysics, auger and rotary drilling rigs, cartography, computing laboratory, editorial, remote sensing and GIS (through the Center for Advance Land Management Information Technologies).

Major Responsibilities: Develop and implement innovative research program in quantitative hydrogeology. Develop and solicit outside support for research. Participate in interdisciplinary activities of the Water Science program at UNL. Opportunities to teach and advise graduate students are available in the departments of geology, agricultural engineering, civil engineering, and agronomy. **Qualifications:** Ph.D in hydrogeology, geology or closely related field. Special consideration will be given to applicants with a background in the following areas: geochemical processes, numerical modeling and development, and/or groundwater quality.

This is a twelve-month tenure-leading faculty position. Salary and rank commensurate with experience and qualifications. A life insurance policy is provided by the University and additional optional insurance is also available. A group health insurance program is provided at minimal cost. The University retirement program is TIAA/CREF. **Closing Date:** January 31, 1990 or until such time that a suitable applicant is found thereafter. Send current curriculum vitae, publication list, a description of current and planned research, record of funding, and the names and addresses of three references to: Darryll Pederson, co-chair, Hydrogeologist Search Committee, Conservation and Survey Division, 113 Nebraska Hall, University of Nebraska-Lincoln, Lincoln, NE 68588-0517. (402) 472-7563.

Graduate Research Assistantships--The Utah Water Research Laboratory, Utah State University, offers research assistantships for outstanding students with backgrounds in Engineering, as well as in the mathematical, Physical, Biological, and Social Sciences, seeking graduate degrees in Civil and Environmental Engineering. Assistantships will be awarded in the following areas:

- Bioengineering and microbiology; Drought and climatic change; Economic and social aspects of water resources planning; Groundwater management and protection; Hazardous wastes; Hydraulic transients, hydraulic structures, and cavitation; Hydrology of hillslopes, mountainous terrain, and landslides; Natural and environmental or hydraulic systems modeling; Remote sensing; Risk assessment; River salinity; Soil-water-waste chemistry/physics; Spatially distributed hydrology; Systems optimization; Water and waste treatment.

Assistantships are awarded on a competitive basis. Initial awards for each year will be made in March. Applicants should send a letter of interest, transcripts, and resume to: Head, Dept. of Civil and Environmental Engineering, Utah State University, Logan, UT 84322-4110, (801) 750-2932.

Senior Hydrologic Scientist-The Water Resources Center of the Desert Research Institute, University of Nevada System, invites applicants and nominations for a Research Professor in hydrogeology/hydrology. Applicants are encouraged from outstanding candidates specializing in one or more of the following or related areas: surficial and fluvial process; geochemistry; unsaturated zone processes; contaminant transport; surface-groundwater interactions; watershed modeling, hydrogeophysics and regional aquifer analysis. Applicants must have appropriate academic qualifications, scholarly distinction, and national and international prominence. The successful applicant will be expected to conduct and build vigorous research programs, publish in refereed journals, and foster mutually beneficial relationships with other DRI Centers, other components of the University System and outside organizations. Opportunities exist to participate in the graduate programs at the University of Nevada, Reno and University of Nevada, Las Vegas.

The search committee will begin its review in April 1990, and continue to accept and review applications and nominations until the position is filled. Send curriculum vitae, transcripts, list of references and a statement of research interests to: Personnel Office, Desert Research Institute, University of Nevada System, P.O. Box 60220, Reno, NV 89506-0220. For additional information, please call Dr. Jack Hess at (702) 798-8882.

Hydrogeologic Scientists-The Water Resources Center, University of Nevada System, seeks applicants for the positions listed below. Successful candidates will be expected to fit into ongoing research projects as well as to develop creative programs of his/her own. The positions are to be filled in the Las Vegas Office. The Institute offers salary commensurate with education and experience and an excellent benefit package.

Senior Hydrogeologist- Ph.D preferred, with emphasis in hydrogeology or a related field. The successful candidate must show demonstrated theoretical and field ability, preferably including publication in peer-reviewed journals. Research interests in the following areas are preferred: regional aquifer analysis and modeling, designing and implementing drilling programs, developing aquifer testing programs and analysis of aquifer test data. Ability to work as part of a team in planning and conducting research is important, as are demonstrated management and communication skills. Opportunities exist to participate in the graduate program at the University of Nevada at Las Vegas.

Hydrogeologist- Ph.D or M.S. is preferred. The successful candidate must show demonstrated theoretical and field ability, preferably including publication in peer-reviewed journals, in one or more of the following areas: analysis of regional groundwater systems; hydrogeochemistry; use of geophysical methods in hydrogeologic investigations; fracture flow and transport; design of aquifer testing programs; and analysis of aquifer test data. The successful applicant must be able to qualify for a Security Clearance.

The closing date for these positions is March 28, 1990, or until a suitable candidate is found, whichever is later. For additional information, please call Dr. Roger Jacobson at (702) 798-8882. Send curriculum vitae, transcripts, list of

references and a statement of research interests to: Personnel Office, Desert Research Institute, P.O. Box 60220, Reno, NV 89506.

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

- Organic C, N, S, and P Formation and Loss From Great Plains Agroecosystems**, Vernon C. Cole, Natural Resources Ecology Lab
Rapid Biological & Chemical Assessment as Cost Effective Techniques for Monitoring Toxicity in Sediment and Water Samples, Clarence Carlson, Fishery & Wildlife Biology
Enhancement and Documentation of the CORPS - System Computer Program H6209, Albert Molinas, Agricultural and Chemical Engineering
Multivariate Tests for Trends in Water Quality, Jim C. Loftis, Agricultural and Chemical Engineering
Simulation of Plant Community Structure Across Resource Gradient from Grassland to Forest, William J. Parton, Natural Resource Ecology Lab
Effects of Range Grasshopper IPM Projects on Fish and Wildlife, Lowell C. McEwen, Fishery & Wildlife Biology
Workshop on Terrestrial & Aquatic Phosphorus Cycles in the Amazon Basin, Vernon C. Cole, Natural Resource Ecology Lab
Numerical Simulation and Analysis of Convective Storms, William R. Cotton, Atmospheric Science
Analyses of Sage Grouse Banding and Recovery Data, Colorado, Robert S. Cook, Dept. of Fishery and Wildlife Biology
Study the Physics and Develop Theory of Infiltration for Improved Irrigation, Paul D. Ayers, Dept. of Agricultural and Chemical Engineering
Western Regional Radon Training Center, James W. Young and Thomas B. Borak, Industrial Sciences Dept.

UNIVERSITY OF COLORADO, BOULDER, COLORADO 80309

- Development and Implementation of ADSS (Advanced Decision Support Systems) For River Operations in the West**, Kenneth Strzepek, Civil, Environmental and Architectural Engineering
Linking of Hydrological Models, Steven Chapra, CE&A-Advanced Decision Support for Water & Environ Systems
Innovation Approaches for Valuing Perceived Environmental Quality, William Schulze, Economics-Center for Economic Analysis
Public Understanding of News About Environmental Risks: An Exploratory Study, Lee Wilkins, Institute of Behavioral Science
Studies of Global Sea Level and Ice Sheet Volume Changes, John Wahr, Cooperative Institute for Research in Environmental Sciences
Collaborative Research: Global Positioning System Geodesy in Iceland, Roger Bilham, Cooperative Institute for Research in Environmental Sciences
Work Plan for Study of Dissolved Gases in Ground Water as a Measure of Oxidation-Reduction Status, Donald Runnells, Geological Sciences
Chemically Assisted In-Situ Recovery of Oil Shale, Fred W. Ramirez, Chemical Engineering
The Policy and Economic Implications of Climate Change: A National Assessment and Regional Case Study, William Riebsame, Institute of Behavioral Science
International River Basin Management in a Changing Climate: A Sensitivity Analysis of Selected Rivers, William Riebsame, Institute of Behavioral Science
Imaging Spectrometry as a Quantitative Geologic Tool, Rattlesnake Hills Area, Natrona County, Wyoming, Alexander Goetz, Cooperative Institute for Research in Environmental Sciences
From the Continental Divide to the Denver Plain: A Meditation on the Boulder Creek Watershed, Michael Crane, Fine Arts
An Influence Diagramming Based Risk Analysis System, James Diekmann, Civil, Environmental and Architectural Engineering
A Clearinghouse on Natural Hazards Research and Applications, William Riebsame, Institute of Behavioral Science
Fracture Mechanics of Concrete Gravity Dam; Part I; Static Loading, Victor Saduma, Civil, Environmental and Architectural Engineering
An Advanced Decision Support System for Surface Water Quality Modelling, Steven Chapra, Civil, Environmental and Architectural Engineering

CONFERENCES

- Feb. 1-3 **INTERNATIONAL SYMPOSIUM ON BOREHOLE GEOPHYSICS FOR PETROLEUM, HYDROGEOLOGY, MINING AND ENGINEERING APPLICATIONS**, Tucson, AZ. Contact: Dept. of Mining and Geological Engr., Univ. of Arizona, Tucson, AZ 85721.
- Feb. 28-Mar. 1 **COLORADO GROUNDWATER ENGINEERING AND MANAGEMENT CONFERENCE**, Denver, CO. Contact: Janet Lee Montera, Mgr., Civil Engr. Conf. Section, Colorado State University, Ft. Collins, CO 80523 (303)491-7425.
- Mar. 12-16 **INTERNATIONAL CONFERENCE ON MINIMIZING RISK IN THE HYDROLOGIC ENVIRONMENT**, Las Vegas, NV. Contact: AIH, 3416 University Ave. SE, Minneapolis, MN 55414, (611/379-1030).

AWRA -- COLORADO SECTION
JANUARY PROGRAM

THE LEGISLATIVE
WATER AGENDA

FRIDAY JANUARY 19, 1990

11:45 Lunch
12:30 Presentation
WYATT'S CAFETERIA - LAKESIDE MALL
5801 West 55th Avenue, Denver

Judy Ann Kriss, the Legislative Liaison for the Colorado Water Resources and Power Development Authority, will summarize the key water issues facing the Colorado legislature this year.

There will be no registration needed for this program. Lunch purchased at your own expense. For more information, call Kate Berry at 320-4400.



AWRA -- COLORADO SECTION
AND
METRO WATER CONSERVATION INC.

present,

WATER CONSERVATION:

POTENTIAL AND
LIMITATIONS

FRIDAY FEBRUARY 9, 1990

8 a.m. to 5 p.m.
Sheraton Hotel
360 Union Boulevard, Lakewood

This one-day symposium will bring together the state's water policy leaders to examine the appropriate roles of water conservation strategies in meeting Colorado's future water needs. The symposium will feature presentations on:

- current conservation programs
- conservation potential from municipal and agricultural irrigation cooperation
- water reuse
- conservation planning problems
- economics of conservation
- legislative initiatives
- conservation efforts in California, Arizona and Wyoming

For information contact:

Kim Hout 695-7387
or Kate Berry 320-4400

- Mar. 21-22 FROZEN SOIL IMPACTS ON AGRICULTURAL, RANGE, AND FOREST LANDS, Spokane, WA. Contact: Conferences and Institutes, Washington State University, 208 Van Doren Hall, Pullman, WA 99163-9986.
- Apr. 1-5 AWRA/CWRA JOINT SYMPOSIUM, INTERNATIONAL ASPECTS OF WATER RESOURCES, Toronto, Canada. Contact: AWRA, 5410 Grosvenor Lane, Suite 220, Bethesda, MD 20814-2192 (301/493-8600).
- Apr. 9-13 AGU TENTH ANNUAL "HYDROLOGY DAYS," Ft. Collins, CO. Contact: Janet Lee Montera, Mgr., Civil Engr. Conf. Section, Colorado State University, Ft. Collins, CO, 80523, (303/491-7425).
- Apr. 17-19 COPING WITH EXTREMES - 58TH ANNUAL WESTERN SNOW CONFERENCE, Sacramento, CA. Contact: Neil Berg, U.S. Forest Service, P.O. Box 245, Berkeley, CA 94701, (415/486-3456).
- Apr. 17-20 17th ANNUAL ASCE WATER RES. PLANNING AND MGMT. DIV. & WATER RES. INFRASTRUCTURE SYM., Fort Worth, TX. Contact: Kyle E. Schilling, Inst. for Water Res., Casey Bldg., Suite 2594, Fort Belvoir, VA 22060, 202/355-2370.
- Apr. 25-28 ASSOCIATION FOR ARID LANDS STUDIES - WESTERN SOCIAL SCIENCE ASSOCIATION ANNUAL MEETING, Portland, OR. Contact: E.R. Gay, Dept. of Economics, BA402, Univ. of Arkansas, Fayetteville, AR 72702, 501/575-6222.
- Apr. 29-May 4 14th INTERNATIONAL CONGRESS ON IRRIGATION & DRAINAGE, Rio de Janeiro, Brazil. Contact: The Secretary, Int'l Commission of Irrigation & Drainage (ICID), 48 Naya Marg, Chankypuri, New Delhi 110 021 (India).

This newsletter was financed in part by the Department of the Interior, U.S. Geological Survey. The contents of this publication do not necessarily reflect the views and policies of the Department of the Interior, nor does mention of trade names or commercial products constitute their endorsement by the United States Government.

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