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COLORADO WATER

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

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COLORADO STATE UNIVERSITY

September 1989

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WATER ISSUES FORUM MEETING SCHEDULED NOVEMBER 7, Page 3.

CALL FOR PAPERS: COLORADO GROUNDWATER ENGINEERING AND MANAGEMENT CONFERENCE, Page 4.

A copy of **Drought Planning: A Complete Plan**, a paper given by Peter Macy of Brown and Caldwell at the Colorado Water Engineering and Management Conference, is provided as an attachment.

WATER ISSUES FORUM

The Water Issues Forum presents a mid-day workshop on

DROUGHT AND WATER SHORTAGES

The panel of Speakers will include:

Representative Matthew Jones, Colorado House
Hal Simpson, Colorado Division of Water Resources
Nolan Doesken, Colorado Climate Center

Panel Discussion will follow

Date: November 7, 1989

Time: 12:00 Noon - 2:30 p.m.

**Place: Wyatt's Cafeteria Lakeside Shopping Center -- On 44th Ave.
 between Sheridan and Harlan.**

**All interested citizens are invited to attend. Proceed
 through cafeteria line for meal service, then to designated
 meeting room.**

Presented by

**Cooperative Extension and
 Colorado Water Resources Research Institute**

This is the only WATER FORUM Meeting scheduled for the Fall.

GROUNDWATER ENGINEERING AND MANAGEMENT CONFERENCE
 FEBRUARY 28 - MARCH 1, 1990
 DENVER MARRIOTT SOUTHEAST
 DENVER, COLORADO

CALL FOR PAPERS

Conference Objective

The purpose of the Groundwater Engineering and Management Conference is to evaluate technical and management methods necessary to solve groundwater problems. The Conference will feature contributed papers, invited papers and discussion related to groundwater issues.

Who Should Attend

The Conference will be of interest to engineers, attorneys, hydrologists, geologists, well drillers, government officials, water managers, water users, utility contractors, researchers and citizens with a general interest in groundwater.

Conference Topics

- Groundwater Management Techniques
- Determination of Aquifer Characteristics
- Aquifer Restoration Techniques
- Groundwater Quality Monitoring
- Hydrogeology
- Modeling and Computer Applications
- Legal and Institutional Factors and Role of Governments
- Groundwater Recharge and Conjunctive Use
- Management of Nontributary Aquifers
- Protection of Aquifers from Contamination
- Groundwater Classification Systems
- Well Technology
- High Plains Issues

Co-Sponsors Sought

There is current co-sponsorship by the Colorado Ground-Water Association and the Departments of Civil Engineering and Agricultural and Chemical Engineering at Colorado State University (CSU). Other organizations wishing to co-sponsor, please contact: Janet Lee Montera, Civil Engineering Department, Colorado State University, Fort Collins, CO 80523 (303-491-7425).

To Submit a Paper for Consideration

Send a 200-word abstract by November 1, 1989 to:

Dr. Neil S. Grigg

Department of Civil Engineering

Colorado State University

Fort Collins, CO 80523

Telephone: (303) 491-5247 or 6308

WHAT SHOULD WE DO TO IMPROVE WATER MANAGEMENT IN COLORADO?

Editorial by Neil S. Grigg

What would you do if you were Colorado's Water czar? Dick MacRavey, Executive Director of the Colorado Water Congress, invited several to speak on this topic at the CWC August meeting. This is a summary of my contribution.

Last year I reviewed a number of water policy statements and compiled a general list of needs such as: reduce transactions costs in water marketing, encourage cooperation, deal with new federal roles in decisionmaking, provide better financing, improve water management, groundwater use, exchanges, drought preparation, integrate quantity and quality, provide Front Range water supplies, protect agriculture, provide instream flows, improve water use efficiency, and protect compact entitlements. But it's a long way from compiling this list to the reality of moving toward improvements, so we have to be realistic.

I think that the highest priority is to provide a balanced and adequate water supply, for all needs in all regions, to develop and implement a state water supply strategy to meet these needs. It would be a state water plan, in a manner of speaking.

Now, how would this be done? First we need an agreed-upon goal at the state level: develop a state water supply strategy that meets all needs to the maximum extent possible, guarantees regions a future, enables maximum economic development and provides environmental enhancement; all this being done while protecting individual water rights and compact entitlements. Specifics would be:

- Organize regional water management in the state. Regions would be: Denver metro area (regional raw water), Northern Colorado, Southern Colorado, West Slope (maybe in basins), and San Luis Valley.
- Develop cooperative, market-based pooled approaches to water management.
- End the "use it or lose it" problem and provide ways to really encourage water use efficiency.
- Take an activist approach to citizen education about water resources.

These measures are not simple, and they will require effective policy analysis. The following studies would be needed:

- A policy study to find options for ending the "use it or lose it" problem.
- A water management study to show what could be done with inter-regional cooperation, including the possibilities for

exchange and sharing of water, the enhancement of instream flows and improved conjunctive use.

- An economic study, to show how the state can get the most return, including environmental returns, from its water.
- An environmental study, to show where changes are needed to enhance the environment, with prioritization.
- An improved data base and GIS.

To move ahead on this I would organize a joint executive-legislative study commission. It would need one year for the organizational aspects and two years for the studies, with recommendations at the end of year three, or sooner. It would require effective staffing, so a budget would be needed. To make this work it would have to involve the state's water managers to provide ideas and review staff studies. The chairpersons would have to be committed and rely heavily on a skilled and experienced staff.

What would this do for the State? In the ideal case, regions would be guaranteed economic futures; thus there would be an end to the area-of-origin conflict. There would be an end to controversies like Two Forks, since consensus would be greatly enhanced and effective planning would be in place. The intrusion of the federal government into Colorado water matters would be greatly reduced, and Colorado would be seen as a leading state in the matter of state water policy, not a state that spends \$40 million on a water supply study only to have the federal government come in and make the decision. Urban water use would become more efficient and expensive. Pricing would be used to manage demand. Agricultural water use would become more efficient and market-oriented. Leased water and opportunity water would become more common, and opportunities to lease water to cities would increase. Drought protection would increase. Public trust arguments would end. Cost of decisionmaking would go down. There would be enhanced public support and more respect for water management in the state.

Frankly, there might be less increase in the cost of water rights, less litigation and reduced activity in the water courts, and a reduced need for state agency administration. There would be more need for regional and inter-regional management and administration. The data base and GIS would be an important central agency function.

Obviously, these are ideals, not easy to achieve, but worthwhile to pursue. I personally believe we can move in this direction. Interstate compacts will need continued attention; this is going to be more important in the future, especially in the Platte and Colorado basins. Other water problems, such as water quality and flood control, will continue to need attention also, but do not seem to be the highest priority.

SOUTH DAKOTA TAKES LEADERSHIP IN ORGANIZING WATER CENTER

In a previous newsletter (January, 1989) we announced that South Dakota State University is organizing a Northern Great Plains Water Resources Research Center. Now, the organizational efforts are about to bear fruit, and they offer promise for the economic development and preservation of the agricultural stability in that region.

Governor George Mickelson, in a letter of May 23, 1989, stated that an important goal of his administration was to guarantee that South Dakotans have continued access to adequate quality water supplies for today and the future, and to that end water resource development became a very high priority of his administration. To advance toward that goal, he asked South Dakota State University to develop a program for the NGPWRR, and he pledged to start up funds to get the Center going.

In response to Governor Mickelson's initiative, South Dakota State University has completed a white paper that describes the concept of the research center and the focus on northern plains water management and development. From all appearances, we can look toward this center for a high level of activity in water resources research. Persons interested in obtaining a copy of the white paper can contact Dr. Alan R. Bender, Acting Director, Water Resources Research Institute, South Dakota State University, Brookings, South Dakota

REQUEST FOR WATER RESEARCH PROPOSALS

Proposals are invited by the U.S. Geological Survey under Section 105, P.L. 98-242, The Water Research Act of 1984, for research on water problems of national concern. Cost sharing is required at \$1 non-federal: \$1 federal. Specific research interests for FY1990 include: Groundwater Quality; Water Quality Management; Institutional Changes in Water Resource Management; and Climate Variability and the Hydrologic Cycle. Announcement 7609 is available from the Colorado Water Resources Research Institute (491-6308) and the Office of Sponsored Research at Colorado State University. The closing date is November 21, 1989. There is \$1.8 million in federal funds available. Colorado was awarded 2 projects in FY 1986, one project in FY 1987, 2 projects in FY1988, and 2 projects in 1989.

Matching is required (\$1 non-federal: \$1 federal). Applicant must contribute the matching requirement from in-kind and cash sources. The Colorado Water Resources Research Institute is requesting a state appropriation which includes some state matching funds for this program. However, funds for this program were not appropriated by the Colorado Legislation last year. CWRRRI recommends that indirect costs be contributed by home universities for this program. Investigators can consult with Neil Grigg at CWRRRI for suggestions about proposal preparation of sources of additional funds.

JUDGE BURGER BACK ON BENCH

Some readers of COLORADO WATER know that Judge Alewyn P. Burger spent six months at Colorado State University hosted by the Department of Civil Engineering

and the Colorado Water Resources Research Institute to study water law. Judge Burger, a retired Justice of the South Africa Supreme Court, is a registered engineer and quite an expert on irrigation and water law. During his time at CSU he engaged in a deep study of water management and water law and conducted numerous interviews. A number of Colorado water lawyers got to know Judge Burger personally.

We just learned that when Judge Burger returned to South Africa he found that they were extremely short of judges and was persuaded to accept an acting appointment for as long as he would like. He does report, however, that he hopes to return to his work in the field of water law soon. Friends of Judge Burger desiring to contact him can do so in care of the Supreme Court, South Africa, 8001.

\$90 MILLION BUDGET PROPOSED FOR 35 COLORADO WATER PROJECTS

On July 25 the Senate Appropriations Committee earmarked 90 million in federal funds for 35 Colorado water projects: 41 million for the Dolores project; 5.9 million for Animas-La Plata; 7.75 million to regulate water flowing into the Rio Grande at Alamosa; 2.44 million for Stagecoach dam construction on the Yampa River near Steamboat Springs; 4.5 million for a water treatment plant at Leadville; and 13.9 million for salinity control projects. The balance of funds is for flood control and dam safety, project studies, and repair and construction. The committee designated \$30,000 for a study on the use of glacial aquifers as storage reservoirs.

Animas-La Plata - Southern Colorado farmers would not be seeking drought disaster aid if this project were in place. Part of an Indian treaty passed by Congress and signed by President Reagan in 1988, it assures Southern Ute Indians and Ute Mountain Utes water for irrigation farming, industry, and a regular supply of drinking water. The Denver Post reported in July that large areas of the two reservations, hard-hit by drought, now have water trucked in by tankers. Water expert Sam Maynes warns that failure to provide initial money for the Animas-La Plata or the money to finish the project by the year 2000 could endanger the treaty. The project would nearly double the area's irrigated land. Maynes is general counsel for the South Water Conservancy District and for the Southern Ute Indian Tribe.

Dolores - This project, in Montezuma and Dolores counties, will provide hydroelectric power and about 8,700 acre-feet of water to the Ute Mountain Utes.

Source: Denver Post 7/26/89

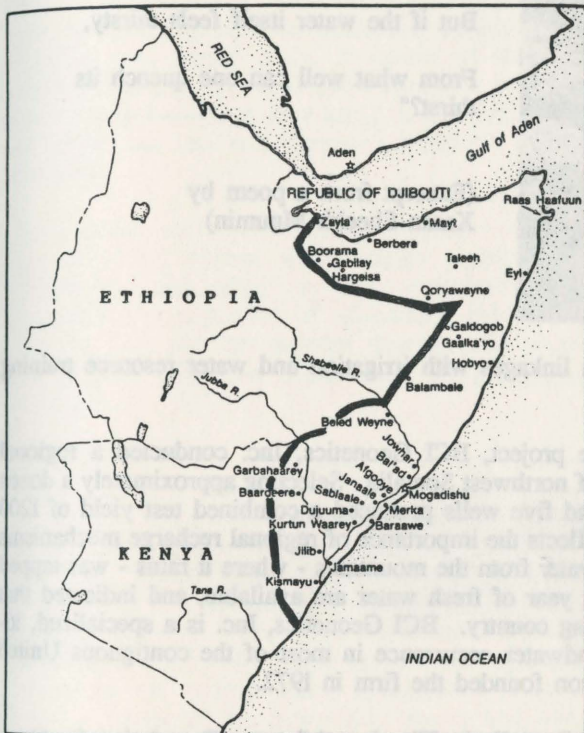
WATER FACTS

Approximately 40 trillion gallons (tgd) of water per day pass over the United States in the atmosphere. Ten percent condenses and precipitates; 2.8 tgd of precipitation returns to the atmosphere through evapotranspiration; 150 trillion gallons are stored in large (50 acre-ft. or more) reservoirs; 30 billion gallons are stored in aquifers within 2,500 feet of the surface; and the remaining 1.4 tgd make up the renewable water supply of the U.S. which flows into the nation's lakes, rivers, and the oceans. Average annual precipitation is nearly 30 inches.

Source: U.S.G.S./U.S. Water Resources Council

COLORADO STATE RECEIVES \$8.9 MILLION CONTRACT FOR SOMALIA IRRIGATION PROJECT

A USAID contract awarded to Colorado State University will provide \$8.9 million for a five-year technical assistance program in Somalia. The project, under the direction of the Colorado Institute for Irrigation Management, will assist Somalis in increasing irrigated agricultural production in southern Somalia's Shebelle River Basin. Marvin E. Jensen, CIIM director and head of the Somalia project, said the contract makes Colorado State one of the top recipients of USAID money. Project staff will include nine full-time employees to oversee the project and additional short-term employees with expertise ranging from irrigation canals to water-borne human diseases, Jensen said.



Somalia, on the horn of Africa, is a large and culturally diverse country that can be divided into three regions: the north, where pastoral nomads herd camels, goats and sheep; the agricultural area between the Shebelle and Juba rivers, and the coastal area that has served for centuries as a principal center for internal and international trade. The three regions are culturally united through the country's religion, Islam.

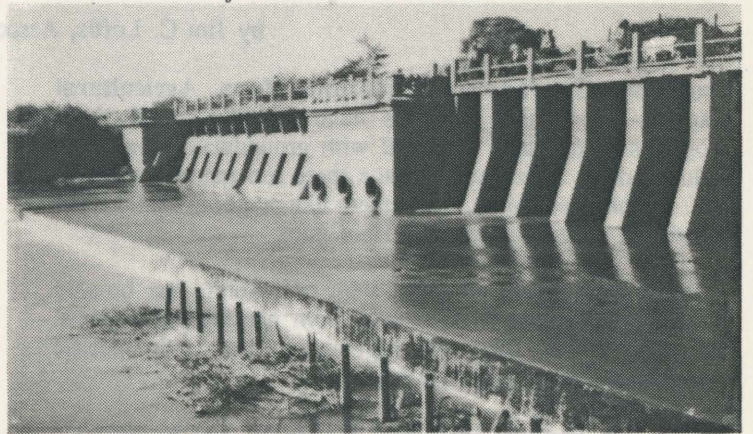
One of the worst droughts in its history gripped Somalia in 1973-74, resulting in a widespread loss of livestock and the near starvation of a large segment of the population. Political unrest also brought a massive influx of refugees, burdening an already strained economy. But after five years of recurring droughts, 1981 brought a rainy season replenishing the water supply and rangelands.

In contrast to Somalia's hot and arid north, the southern area is a well-watered region where once a year, sometimes twice, the Shebelle and Juba Rivers overflow and enrich the adjacent plains, creating excellent conditions for a mixed pastoral/agricultural economy.

The main thrust of the Shebelle Water Management Project (SWMP) is to provide technical assistance to Somalia's Ministry of Agriculture for rehabilitation and reconstruction of the aging Shebelle control and distribution system, and to help develop effective, equitable water administration. Colorado State University, in collaboration with Louis Berger International, will assist in the design of rehabilitation works and development of a basin-wide water control and allocation program and CSU will provide the institutional support to the Somalis.

The program of the technical assistance team will include:

- developing a draft national water law
- training Somalis in river basin management, irrigation water allocation and distribution, system operation and maintenance, and recovery of water delivery costs
- providing baseline agronomic, economic and social data (Irrigated Agriculture Research component)
- establishing an effective communications system between water users and Somalia's Directorate of Irrigation and Land Use
- developing a River Basin Database and Management Information System and training Somalis to use the system and models.



Genale Barrage: Downstream view during dry season (February 1987) Photo by: Marcel Bitoun



Somalis have a rich oral tradition and are very skilled in the use of oral poetry, one of their principal cultural achievements. Poetry is the principal medium of mass communication, the vehicle of politics, and permeates every aspect of Somali life.

"Wherever one looks, the life of this world depends on water

But if the water itself feels thirsty,

From what well can one quench its thirst?"

(Excerpt from a poem by Xasan Sheekh Muumin)

Judson M. Harper, Acting President, said Colorado State also will establish linkages with irrigation and water resource training institutes in Somalia.

From 1985 to 1987, as part of a U.S. AID-sponsored refugee self-reliance project, BCI Geonetics, Inc. conducted a regional groundwater exploration program in 14,000 square miles of the desert region of northwest Somalia. Selecting approximately a dozen favorable sites, drilling in consolidated rock began. Testing at two areas and five wells produced a combined test yield of 1200 gallons per minute. This very high yield in a desert, according to the firm, reflects the importance of regional recharge mechanisms and geologic structure to groundwater movement and storage. In this case, water from the mountains - where it rains - was tapped in the desert. The initial tests proved that many thousands of acre-feet per year of fresh water are available, and indicated that these conditions may persist over an enormous region of this arid, developing country. BCI Geonetics, Inc. is a specialized, 16-year old firm of exploration scientists that have mapped geology and groundwater occurrence in most of the contiguous United States, Europe, Africa and the Middle East. Oceanographer Robert A. Bisson founded the firm in 1972.

Sources: *Somalia: Nation in Search of a State*, Westview Press, Inc., 1987; *Somalia in Word and Image*, Foundation for Cross Cultural Understanding, 1986; "Water and Wastewater International," April 1989.

FROM COOPERATIVE EXTENSION

by Jim C. Loftis, Associate Director, CWRRI

Protecting Colorado's Groundwater from Agricultural Impacts- A number of folks have recently asked about programs in our state that deal with groundwater quality as influenced by agriculture. Since there are many players in this complicated game, it seemed like a good idea to put together a written summary. Here goes.

At present there are no laws, state or federal, that broadly protect groundwater in Colorado from agricultural impacts. However, a few laws and regulations deal with specific practices affecting water quality.

FIFRA (the Federal Insecticide, Fungicide, and Rodenticide Act) indirectly protects ground and surface water quality by mandating proper application rates and handling procedures for pesticides (including herbicides). It is anticipated that FIFRA will soon be more directly connected to groundwater quality protection by requiring that all pesticides that pose a

potential threat to groundwater--as a result of their leaching characteristics--be applied by certified applicators only. Later, further steps could be taken. For example, pesticides that could likely cause groundwater problems might be restricted to use in only those areas where states could show that groundwater was not vulnerable to pollution.

Colorado has adopted a Chemigation Act which is designed to protect groundwater from accidental siphoning of chemicals back down a well due to pump failure, etc. The act requires the use of approved antisiphoning equipment and periodic inspection. It does not, however, have any provisions for protection of groundwater from leaching of pesticides past the root zone as a result of irrigation.

Colorado has adopted Basic Standards for Groundwater to provide a basis for protecting specified beneficial uses of groundwaters on a localized basis. Under the Basic

Standards, ground water in a "specified area" could be classified by the state Water Quality Control Commission as one of the following:

- Domestic Use - Quality
- Agricultural Use - Quality
- Surface Water Quality Protection
- Potentially Usable Quality
- Limited Use and Quality

Classification of a given "specified area" would be based on current and potential uses as well as background quality.

Once classified, groundwater would be subject to standards: both chemical concentration limits and narrative descriptions. Activities that would cause violations of those standards would presumably be prohibited. However, at this point the state is only beginning to attempt to classify groundwaters, and there are no enforcement provisions to the Basic Standards.

A few states, such as California, Nebraska and Iowa, that have identified serious water quality problems related to agriculture have taken a more aggressive stance on management or regulation of agricultural chemical use. For example, Nebraska has targeted districts with severe nitrate problems for intensive management of nitrogen fertilizer applications.

The Clean Water Act as amended in 1987 addresses nonpoint sources of pollution, including agriculture, much more directly than did previous versions of the Act. Section 319 of the Act requires states to develop nonpoint sources assessment reports and management plans. Colorado has prepared both documents, and was one of the first states to complete the task. Both of these documents include mining and urban runoff in addition to agricultural impacts, and both concentrate on surface water as opposed to groundwater. Future versions of the assessment report and management plan are expected to address groundwater more directly as the data base for groundwater quality within the state improves. The lead agency for preparation of the assessment report and management plan is the Water Quality Control Division of the Colorado Department of Health. Many other state and federal agencies are cooperating in the preparation of these reports and the implementation of their provisions. Notably the U.S. Environmental Protection Agency is charged with approving state nonpoint source management plans for compliance with Section 319 and Federal funding.

Although no federal money has yet been appropriated under Section 319 for implementation of management plans, states have been given the option to divert part of the federal funds for construction grants (of municipal treatment facilities) toward nonpoint source management. Colorado has elected to do this to a substantial extent. Several pilot projects are in place, and more are planned for the next two years. These projects involve applied research, demonstration, and technology transfer and are supported with both federal funds awarded by the state and matching funds from local organizations.

One of the projects, carried on by the Northern Colorado Conservancy District, is applied research and demonstration of water and fertilizer management practices to reduce nitrate

contamination of groundwater. The Soil Conservation Service and Cooperative Extension are cooperating in the project.

The Soil Conservation Service and Cooperative Extension at both national and state levels have identified water quality as an issue of the highest priority, and both are cooperating in an effort to improve farmer practices that affect water quality. SCS offices are updating their technical guides to include water quality in conservation planning, and Extension is addressing water quality more directly in its educational programs, specifically those dealing with irrigation management, fertilizer management, pest management, and nutrition and health.

There is a need for an improved groundwater quality data base in Colorado. There are enough data to indicate that we have "spotty" problems with nitrate concentrations, but existing data are not well organized. There are very few data on pesticide concentrations in groundwaters of the state. In response to this need, several state and federal agencies are attempting to coordinate their present and future monitoring activities to produce a useful data base. At this time several organizations, including Central Colorado Water Conservancy District, North Front Range Water Quality Association and the Colorado Department of Health, are planning to collect water quality information, and the Colorado division of Water Resources is monitoring water levels in several hundred wells. The Colorado Water Resources Research Institute has funded a small project to evaluate (under Colorado conditions) the applicability of existing methods for rating groundwater vulnerability to pesticide pollution.

Finally, the water quality picture is constantly changing, influenced by political and budget pressures at all levels of government. One thing is certain, though; the topic will remain on center stage for some time.

Tips on drinking water safety - Cooperative Extension staff writers Katherine Timm and Kate Caldwell offer the following guidelines to homeowners who are installing treatment systems in their homes (Colorado State Magazine, August-October, 1989):

- Never have water tested by the same outfit trying to sell you a treatment system. Cooperative Extension agents in your county can provide a list of water testing companies in your area.

- Test water annually for coliform bacteria, nitrate, acidity, and total dissolved solids. Test every three years for sulfate, chloride iron, manganese, lead and hardness.

- Test more frequently if you are on a well near an area of intensive agricultural use, mining or gas drilling operation, dump, landfill, dry cleaning operation, or buried fuel-storage tanks.

- Be cautious, rely on testing, and if in doubt drink bottled water or install a filtration system in your home.

For campers and backpackers, Timm and Caldwell point out that the Giardia parasite can be killed when water is heated

to 131 degrees or when one iodine tablet is added to each quart of water, provided the water temperature holds at 59 degrees for at least 30 minutes.

WATER SUPPLY NEWS ALONG THE FRONT RANGE

- **Denver** - After more than a week of temperatures exceeding 100 degrees in late June and early July, the Denver Water Board topped its water-use record with 553 million gallons on Thursday, July 6. This surpassed the record of 535 million gallons set the previous day. David Walker, Deputy Director of the Colorado Water Conservation Board, said the hot, dry weather drained reservoirs so fast that cities should think about conserving water now to avoid a real crisis next year. Other Denver-area water officials urged residents to conserve water. Most reservoirs have a one or two-year supply of water and began this year nearly full, but water demands could empty some reservoirs by autumn. Ken Mitchell of the Denver Water Board said Dillon Reservoir will be substantially lowered this fall and winter. The Denver Water Board will draw from Cheesman Reservoir until September and then begin on Dillon.

Relying upon groundwater from the Denver aquifer to sustain Metro area growth is only a temporary solution according to David Little, district groundwater specialist. A study with the U.S. Geological Survey tried to project the future of area aquifers should the metro area rely more heavily on groundwater. Study results showed that, even under ideal circumstances, the Denver aquifer would be depleted in 60 years. The other three area aquifers would reach that point much sooner, according to the USGS. Keeping the aquifer alive will require taking surface water, processing it at a treatment plant, then putting it back in the ground, Little said.

If Denver spent about \$6.7 million to upgrade its sprinklers, many of them several decades old, 20 percent of the water it now uses on parks (600 million gallons) could be saved yearly. A proposed \$230 million city bond issue would include the money to fix the sprinklers, but the Parks Department wants the Denver Water Board to pay some of the cost. It could then sell the conserved water at much higher rates than it charges the city. Board spokesman Ed Ruetz says discussions are underway. The city's sprinklers now operate on automatic timers, and workers would have to adjust 1,000 devices to turn them off when it rains. With a centralized timing center, all the timers could be readjusted by computer from one location.

- **Colorado-Big Thompson** - The Colorado-Big Thompson system used to have enough water to handle three years of consecutive drought, but growth along the Front Range has reduced this to just two years. Testifying before a legislative committee that is studying the effects of drought in Colorado, Larry Simpson said local water storage areas were about 40 percent of normal for the time of year. The CBT was at 80 percent of normal, he said, but with no letup in the drought local water storage would be exhausted by the end of summer, leaving only the CBT for next summer. Simpson is manager of the Northern Colorado Water Conservancy District.

- **Fort Collins** - Customers of the Fort Collins water utility used 61.7 million gallons of water on July 5, a record. The city's water treatment capacity is rated at 64 million gallons per day. Assuming a population of 90,000, the per-capita use on July 5 was 686 gallons.

- **Englewood** - The City of Englewood invoked mandatory water restrictions in July, when city employees went door-to-door telling residents to curtail watering their lawns to once every three days or be cited with a fine of \$300. City utilities director Mike Woika said the water supply was adequate, but the treatment plant couldn't produce enough water to satisfy the demand.

- **Aurora** - A new central computer soon will control about 40 percent of the city's sprinkler system, cutting water consumption by an estimated 12 percent. The system now regulates irrigation in 15 parks and soon will be on line in 15 more. Ron Downing, Manager of Parks, said with the new system they can shut down in a matter of about one-two minutes, in contrast to the 8-12 man hours it used to take to manually shut off all the sprinkler systems in the city. Downing said Israel's water commissioner toured the system in late July to check out the technology, possibly for use in his country.

- **Loveland** - The City of Loveland conducted an ongoing public information effort to inform residents about a possible water rate increase to fund water storage and the purchase of additional raw water. A brochure, mailed to all Loveland water customers, discussed the city's current raw water storage capacity and explained the need to secure more raw water storage for the city's future. On August 15 the City Council gave preliminary approval to an ordinance that will increase water revenues which will accumulate in a raw water fund until enough is available to begin the expansion of Green Ridge Glade reservoir in 1998 from its present 600 acre-feet to 3,500 acre-feet. Money will also be available to purchase 1,645 units of CBT water to protect future populations in a 100-year drought.

- **Berthoud** - To obtain a year-round water source, the town of Berthoud will go to water court this fall. The town seeks to change the point of diversion for West Slope water, delivered by the Handy Ditch Company of Berthoud, to Carter Lake, thus providing for year-round use. Anna Lenahan, town administrator, says Berthoud's only present water source for winter is Berthoud Lake. If something happens at that lake, she said, we have no water. Currently if Berthoud doesn't use the water other ditch companies do without paying for it. Several ditch companies are named in the suit. Berthoud is also asking the Handy Ditch Company to give the town additional storage rights to two reservoirs that Handy owns, giving the town year-round storage.

- **Platteville** - A clean, safe water supply is needed and wanted, but the town must decide if the price of almost \$3 million is worth paying - and if it can be paid at all. Platteville residents have known for a couple of years that domestic water supplies contain high levels of nitrates. Tom Norton and Steve Butherus of Norton, Underwood and Lamb Engineering Associates presented seven methods to clean up the town's water or find other sources at a town board meeting in August. All but two of the seven suggested

projects require installing water meters to reduce water use. Norton estimated that a household in town would pay nearly \$85 with a metered system each month instead of the present \$20. Four of the water projects involve using Sandhill Lake; other options are to purchase water shares from Central Weld or to treat already existing well water using the reverse osmosis system. The board was advised, in any case, to construct a facility to store water for fire safety.

- **Lafayette** - Water use in Lafayette also soared to all-time highs, and at a time when the city could least afford it. A booster pump at the city's Marshall water plant broke down at the same time Lafayette's 4 million-gallon water tank was out of commission for repainting. Public Works Director Tim Paranto said the demand was met entirely from Lafayette's two water plants. "In fact," he said, "we ended up not producing as much water as was being demanded on the system. To make up for the excess demand we were having to take water out of storage to make up the difference." The city is proposing a \$2.1 million expansion of its Baseline Road water treatment plant, which is expected to provide an additional 2 million gallons of water per day. Pending City Council approval, construction of the plant will commence in 1990.

Sources: Coloradoan 7/16/89, Reporter Herald 8/16/89, Denver Post 7/3/89, 7/8/89, 8/17/89, Times Call 7/16/89, 8/17/89

STATEWIDE EMERGENCY DECLARED IN JULY

The prognosis was gloomy in July. Governor Romer announced a statewide emergency because of drought conditions and ordered the State Climatologist at CSU to produce a drought severity index for the State. Jim Carrier, Denver Post Rocky Mountain Ranger, said the drought was shaping up as the worst in Colorado history. In places the usual runoff was so low that ranchers got no water at all. Headgates on the La Plata River that lead to ranches were shut off, because the river disappeared before reaching the New Mexico line. Brice Lee of Hesperus said he had only 15 to 20 percent of his normal hay crop. It had rained two-tenths of an inch since Easter. Colorado River runoff was the second lowest on record. Agricultural users in Weld County were given pro-rated amounts of water. The McPhee Reservoir on the Dolores River had plenty of water, said general manager John Porter; but at Dove Creek, not yet on the Dolores System, ranchers began to sell cattle and feed hay. The livestock sale barn in Cortez, which normally sells 200 cows a week in midsummer, was selling 600 to 800 cows a week. Many of the cattle came from the Navajo Indian Reservation to the south in Arizona and New Mexico. Bob McLavey, acting Deputy Agriculture Commissioner, described the condition of the southwest and northwest corners of the state as "extremely severe."

Using the Palmer Drought Severity Index, Colorado had a report of minus 4 in the San Luis Valley, which is severe drought. As of July 22, 14 Colorado counties had sought disaster declarations for federal assistance for crops. David Schaubert, Extension Specialist in Pueblo County, said ranchers in Las Animas reported three inches of precipitation

while the normal average for the area is 15 inches. This, he said, has been the situation for the past two years. Pueblo Reservoir was going down six inches a day and all the water was spoken for, according to Tommy Thomson of the Southeastern Colorado Water Conservancy District. "We are already at the stage where this will have an impact on next year, and the area must have above normal precipitation to even reach average conditions," said Schaubert. He described flying over the John Martin Reservoir and said seeing it from the air visually confirmed the severity of Southern Colorado's situation.

Schaubert said the Drought Hotline, operated by Colorado's Cooperative Extension, stands ready to help producers with farm and ranch management questions related to the drought. The hotline, a clearinghouse for drought information, was started originally to help Western Colorado and the San Luis Valley, but it is available to provide assistance upon request. If your questions cannot be answered, you will be referred to the agency that can help. The Hotline has received calls from Nebraska, Wyoming and other neighboring states as well as from within Colorado. The Drought Hotline number is 1-800-447-4635.

Darrell Hanaven, Executive Director of the Colorado Wheat Administrative Commission, said southeast Colorado suffered most from the drought. This year's Colorado wheat crop totaled 58.8 million bushels, down from 74.5 million bushels in 1988, which was considered a bad year.

Tom McKee, State Climatologist, said many farmers lost their wheat crop completely, but those who were able to plant another crop soon got help from the spring rains. McKee said the problem in Colorado this year has been timing as much as the amount of precipitation that fell.

The Western Slope had received less than half its normal precipitation on July 23, according to Larry Tunnell, Hydrologist for the National Weather Service. Yellowjacket, in southwest Colorado, was the driest spot in the state, without rain for 100 days. Gypsum, and other towns which depend on junior water rights, were searching for water to borrow or lease. Ranchers in the Crow Valley Grazing Association, on the west end of the Pawnee National Grass Lands, moved 25 percent of their cattle, a little more than 1,000 cows and calves, off the land July 17 because of drought. And predictions were that the extreme heat would cut cattle conception rates by 20-35 percent.

Bill Hornby, Senior Editor of the Denver Post, noted in a July 11 editorial that the Boise Interagency Fire Center counted more than one million acres of mountains and plains scorched by wildfires this season, up from 762,000 at the same time last year before the Yellowstone Park fires.

The Loveland Reporter Herald said "...this summer should serve as a strong reminder that we are always at the mercy of nature's whims...Residents of the Front Range won't likely know what kind of danger they are in until next summer."

Sources: Denver Post 7/7/89, 7/8/89, 7/11/89, 7/22/89, 7/23/89, 7/24/89, 7/30/89, 8/10/89; Rocky Mountain News, 7/9/89

BUSH SIGNS FARM AID PACKAGE

President Bush signed a disaster aid package that will provide \$897 million to help farmers hit by bad weather. This is the third time in the past four years that Congress and the President have approved disaster aid. Colorado's winter wheat harvest is estimated at 56.7 bushels, the smallest since 1977. Wheat loss was attributed primarily to freeze damage and the spring drought. Peach growers on the Western slope lost their entire \$3.5 million crop last February due to bitter cold. Apricots, plums and sweet cherries also were damaged badly. Producers who purchased federal crop insurance will be reimbursed in cash for up to 65 percent of the portion of their loss that exceeds 35 percent of their historical average production. Bob McLavey, acting Colorado Deputy Commissioner of Agriculture, said his concern is that producers not have false hopes, and questions whether \$897 million will be enough.

Source: Denver Post, August 15, 1989

CURRENT STATUS OF COLORADO DROUGHT CONDITIONS

by Nolan J. Doesken, Assistant State Climatologist, Colorado Climate Center, Department of Atmospheric Science, Colorado State University

The Water Availability Task Force for Colorado met jointly with the Review and Reporting Task Force in Golden, Colorado on August 16, 1989 to review the current drought conditions and to assess impacts to date and impacts that may still lie ahead as a result of this year's hot and dry weather. These and several other impact task forces have been formally activated by Governor Romer to help the State monitor drought conditions and respond appropriately. The following is a brief synopsis of the meeting.

Rains, clouds, cooler daytime temperatures and higher humidities, associated with the typical monsoon weather pattern over the Southwest during this time of the year, began in late July and have continued into mid-August. Some areas have received very heavy rains during this period, but rainfall has been spotty in other areas, both east and west of the mountains. In general, this damp weather, common for this time of year, has reduced immediate drought problems. Forest fire danger has greatly diminished, range conditions have improved and irrigation water demand has been reduced. By no means does this suggest the drought is over. Streamflow continues to be well below average on many rivers and streams. Soil moisture also continues to be short in many areas. Irrigation reservoirs have been drawn down considerably. Total surface water supplies going into this fall and winter are likely to be less than they have been in Colorado for a number of years.

The impacts from this year's drought have been most obvious in the agricultural sector. Wheat harvest appears to be the poorest in Colorado in more than a decade. Other agricultural sectors have also been seriously affected. Livestock producers have been walking a tightrope as grazing conditions have been marginal and hay crops have been reduced in several parts of the State. Final economic impact

on Colorado ranchers may not be known for some time. Forest fire problems have also been significant this year. Fortunately, conditions have returned to normal, at least for the time being. Some impacts have been noted this year on municipal water supplies and recreational resources. For the most part, reservoir storage has been adequate to meet this year's water demands. Fish and wildlife populations have not been greatly affected by drought this year, but negative impacts may be delayed until next year. There appears to have been no statewide adverse affect on tourism this year. Total statewide economic impacts have not yet been assessed.

Overall, the Task Forces feel that Colorado has fared quite well this year. However, should this coming winter bring a continuation of below-average precipitation water supplies next year could be much lower, and more widespread impacts could occur in 1990. Snowpack accumulation will be monitored with keen interest during the approaching winter months.

POUDRE RIVER PROPOSAL APPROVED

The Larimer County Planning Commission has approved a proposal to make an 18.5-mile reach of the Cache la Poudre River a National Recreation Area. The plan now goes to the Larimer County commissioners and the Fort Collins City Council, and in October to the Secretary of the Department of Agriculture. The proposal will then go before Congress for designation. Upper reaches of the Poudre were designated Wild and Scenic by federal legislation about three years ago.

Source: Reporter-Herald, 8/17/89

SINKHOLE APPEARS AT HORSETOOTH RESERVOIR

A sinkhole about 30 feet deep and about 20 feet wide appeared during the weekend of August 19-20 at the southern edge of Horsetooth Reservoir. Officials from the Northern Colorado Water Conservancy District and the Bureau of Reclamation have not determined what created the hole. The sinkhole apparently does not threaten the structure of the reservoir or Spring Canyon Dam, which is about 1-1/2 miles northeast. Officials found water 20 feet deep inside the hole, although the area around it is dry. Horsetooth currently is at 47 percent of its capacity, or 72,000 acre feet. Brian Werner, spokesman for the Northern Colorado Water Conservancy District, said the district will bring in a Denver geologist to help explain the sinkhole. "We're sure it's not a meteor," Werner said. "We haven't seen any aliens coming out, and we haven't seen sunlight at the bottom."

Eric Erslev, Associate Professor of Earth Resources at Colorado State, said there are some layers of gypsum in the south end of Horsetooth. Gypsum, used in plaster board, is dissolved by water, Erslev said. When gypsum layers dissolve, a void within the layers is formed. When the void fills, the surface area collapses, creating a sinkhole.

Source: Coloradoan, 8/17/89

SENATE AG BILL INCLUDES RESEARCH FUNDS FOR COLORADO

The Senate's agriculture spending bill, approved July 27, includes \$8.7 million to complete a national seed laboratory at Colorado State University, \$8.7 million for research to combat the Russian wheat aphid, and \$8.7 million for a wildlife research center in Denver. The Russian wheat aphid has destroyed more than \$50 million in Colorado crops.

Source: Rocky Mountain News, 7/28/89

SENATE BILL MARKS \$550 MILLION FOR ENVIRONMENTAL CLEANUP

The Senate approved a spending bill on July 27 directing the DOE to use \$550 million of its 1990 budget to clean up contamination at 16 nuclear weapons plants, including Rocky Flats. The bill does not specify how much will be spent at each plant. The DOE, however, rates groundwater contamination at Rocky Flats as the most serious potential public health hazard at any of its plants nationwide.

Source: Rocky Mountain News, 7/28/89

COLORADO COMMUNITIES WRESTLE WITH WATER QUALITY/WASTE DISPOSAL PROBLEMS

- **Globeville** - The Asarco Globeville plant is one of a dozen Colorado polluted sites targeted for cleanup under the federal Superfund hazardous waste law. A study released July 26 by the Colorado Health Department says groundwater, air, soil, garden vegetables and drainage ditch sediments near the plant are contaminated by varying levels of lead, arsenic, cadmium and zinc. The 103-year old plant is located in a neighborhood of about 3,700 people in north-central Denver. Since 1926 the plant has smelted cadmium, a metal used in rechargeable batteries. In 1982 Colorado Health Department officials found cadmium at 60 times the federal drinking water safety standard in a drainage ditch between the plant and a 290-resident housing project. As a result of state action initiated in 1983, Asarco build a \$750,000 plant to treat its wastewater and built a fence shielding nearby homeowners from an industrial drainage ditch. Asarco also agreed to pay \$600,000 as compensation for the State's past and expected future health actions at the smelter. A state cleanup plan and public hearings are planned to find the best way to rid the area of contamination.

- **Adams County** - In early August EPA and the State Health Department approved an emergency raw sewage dump into the South Platte River by the Metropolitan Denver Sewage Disposal District. The dumping was approved by the State Health Department to allow for repair of a pump station near Thornton. Adams County residents, opposed to the dumping, hired an independent wastewater firm to seek alternative solutions. The State Health Department, after withdrawing its approval for the dumping, also ordered a study of alternatives.

Adams County commissioners approved a landfill for asbestos and non-toxic materials by a 2-1 vote on August 14

despite threatened legal action from approximately two dozen county residents. Ranchers and farmers complain that the landfill will destroy their property values and pollute their groundwater. The State Health Department, which mandated safety precautions for the landfill, approved the permit.

Because state tests showed excessive levels of the chemical trichloroethylene (TCE) in its water supply, drinking water in southwest Adams County will be retested. The Colorado Health Department, South Adams County Water and Sanitation District and the U.S. Army conducted the initial tests on August 24. Larry Ford, manager of the Water and Sanitation District, said he believes the earlier tests were wrong and that the county's water supply is safe. Results of the new test should be available the last week of August. South Adams County water currently runs through a \$1-million temporary plant installed three years ago by the Army. A permanent treatment system is scheduled to begin operation in October.

Shell Oil Company has agreed to buy five Adams County homes across from the Rocky Mountain Arsenal's northern border. Compounds from the plant, which produced pesticides in the 1960s, have polluted groundwater at the adjacent homes, contaminated drinking water and infected livestock. EPA advised residents last December not to eat any dairy, poultry or garden products from their ranches. A Shell spokeswoman at the company's Houston headquarters said the properties will not be resold, but will become part of the long-term pollution cleanup effort at the arsenal.

- **Brighton** - Groundwater contamination by leaks from underground storage tanks at the Sundstrand Aviation Plant in Westminster will be pumped to the surface, carbon-treated and then flushed down the sewers, Sundstrand officials announced on August 24. Groundwater contamination was discovered under an 80-acre tract near the plant over a year ago. Written permission was obtained to use the Crestview Water and Sanitation sewage system, and the water will end up at Denver's Metropolitan Sewage Disposal District where it will be treated again before disposal.

Sources: Rocky Mountain News 7/27/89, 8/6/89, 8/11/89, 8/16/89, 8/17/89 8/22/89; Denver Post 7/27/89, 8/15/89, 8/25/89

METHANE POLLUTION IN BORDER WELLS TO BE INVESTIGATED

Methane pollution of approximately three dozen domestic water wells along the New Mexico-Colorado border has prompted a joint effort by agencies, industry and private citizens to find the source of the problem. New Mexico's Oil Conservation Division will lead the investigation, which involves eight government agencies, five gas production companies, grassroots environmental groups, real estate agents, a national gas research group and landowners. OCD is the agency responsible for implementing New Mexico's groundwater protection rules in the gas industry. New Mexico OCD officials said they are including Colorado in their study and paying for water testing in contaminated Colorado wells because the contamination problem could affect New Mexico's future. If the pollution is found to be man-caused, the committee will suggest regulatory changes.

The contamination was detected during a "water fair" conducted in Cedar Hill by the New Mexico Environmental Improvement Division. Domestic wells in southern La Plata County and northern San Juan County, New Mexico were tested. The area is the site of thousands of gas wells, a dozen gas-production wastewater injection wells and a wastewater evaporation pit.

Source: Coloradoan 8/3/89

OIL SHALE MAY BE ON AGAIN

Western Slope oil shale backers hope that renewed federal interest will lead to construction of an oil shale research and development facility on the Piceance Basin, halfway between Rifle and Meeker. The House and Senate have approved initial funding that could lead to the facility's construction. The Senate version of the bill provides \$3.5 million for engineering, site design and other start-up costs if private industry, state and local governments contribute 60 percent of the cost to build and run the facility. The House version provides only \$500,000, but both call for a ten-year commitment to the program which could cost up to \$200 million. A House-Senate conference committee must reconcile the two versions of the funding proposal. The funding effort is supported by Colorado Senators Wirth and Armstrong and Representative Ben Nighthorse Campbell. Senators Simpson of Wyoming and Garn of Utah also support the effort.

Occidental Oil Shale, Inc., based in Steamboat Springs, would manage the facility. The firm wants to test its in situ process, burning shale rock underground and then pumping the liquified shale to the surface for further processing. There are an estimated 700 billion barrels of recoverable shale oil in Colorado's northwest corner and parts of Wyoming and Utah. But a big concern is where the industry will get the amounts of water the process needs, and how the water will be treated.

Source: Denver Post, 8/15/89

THE CLEAN WATER ACT

20th anniversary tribute planned - As part of a three-year national tribute to the 20th anniversary of the 1972 Clean Water Act, Congress has designated 1992 as "The Year of Clean Water" and October as "Clean Water Month." The Clean Water Foundation, formed in January by the Association of State and Interstate Water Pollution Control Administrators, will oversee the tribute and sponsor a series of events to increase public awareness beginning later this year and culminating in October 1992. The events will include local cleanup campaigns, water festivals, exhibits, documentaries, public service announcements, conferences, and educational brochures.

Timetable called unworkable - Developing regulations to control toxics has been done in a piecemeal fashion and puts many dischargers in a position of having permit limits to control toxicity from substances they cannot identify, a Senate subcommittee was recently told. Robert Reich, a representative of the Water Pollution Control Federation, said the schedule for enacting amendments to the Clean Water

Act of 1987 has forced states into acting with few numerical standards for toxic pollutants and little technical support from the U.S. Environmental Protection Agency (EPA). He said this "...does not do justice to the priority Congress has placed on this issue."

Source: U.S. Water News, August 1989

CWQCC FORMS BIOMONITORING TASK FORCE

Water quality protection now is regulated under the federal Clean Water Act and the Colorado Water Quality Control Act. Regulations require all municipalities with industrial pretreatment programs to perform biological monitoring of effluent when permits are renewed. The two test organisms used in this process are the fathead minnow and the ceriodaphnia, a small but visible crustacean. Because many toxic substances can kill these organisms, controversy has arisen about what to do if they do not survive and how to identify the toxin(s) responsible. Because of the controversy surrounding the Biomonitoring Program, the Colorado Water Quality Control Commission has formed a 12-member Biomonitoring Task Force (BTF). Members of the BTF are representatives of large and small municipalities, industrial groups, lab consultants, special interest groups, the Colorado Department of Health, the EPA, and CWQCC. Members of the BTF are available to:

- provide technical assistance regarding test protocols;
- review Toxicity Reduction Evaluation procedures and recommend improvements;
- evaluate costs to permittees;
- evaluate the effectiveness of biomonitoring in identifying toxicity problems; and
- provide a communication link between concerned parties and the CWQCC.

Members of the BTF encourage all interested parties to contact them to express concerns and offer recommendations. For a list of BTF members, call Bob Schuckle at 331-4758, or Stephanie Odell at 669-2470, ext. 7719.

Partial Source: RUMBLES, July 1989

CENTER FOR THE NEW WEST ESTABLISHED IN DENVER

Denver is regaining its "can-do" image, says Bill Hornby of the Denver Post, with the establishment of the Center for the New West. The Los Angeles Times, describing the Center as "A Think Tank for the New West," said California - as a resource exploiter of the West - should work with other Western states on environmental protection and cultural development. The Center was initiated by U.S. West with assistance from the Denver Post, Coopers and Lybrand, Goldman Sachs and Co., MCI Telecommunications, Public Service Co. of New Mexico, Rocky Mountain Health Care Corp., Holland & Hart and the Martin Marietta Astronautics Group. Phillip M. Burgess, an executive on loan from U.S. West, is Center President. The Center will sponsor a national conference in Denver January 22-24, 1990, entitled **Beyond Decline: America's Destiny in the New Century.**

DENVER WATER LAWYER RECOMMENDED FOR FEDERAL POST

Interior Secretary Manuel Lujan has recommended John Sayre of the law firm of Davis, Graham & Stubbs to be Assistant Secretary for Water and Science. After background checks are completed, a formal nomination will follow. Sayre was named by Lujan as one among a list of people from the Western states who are slated "to assist...as stewards of our nation's resources." If confirmed by the Senate, Sayre will oversee the U.S. Geological Survey, U.S. Bureau of Reclamation and the Bureau of Mines. Sayre, born in Boulder, graduated cum laude from the University of Colorado in 1943 and from the CU law school in 1948. He was admitted to the Colorado bar in 1948. He has served as a member of the board of directors of the Colorado Water Congress, a director of the Northern Colorado Water Conservancy District, Colorado director and national president of the National Water Resources Association, and a member of the U.S. Committee on irrigation and drainage.

Source: Denver Post 7/19/89, Rocky Mountain News, 7/28/89

PENA ANNOUNCES WATER BOARD APPOINTMENTS

Mayor Federico Pena has reappointed Monte Pascoe to another six years on the Denver Water Board. Pascoe, a corporate lawyer and former Water Board President, is Denver's leading spokesman for the proposed Two Forks Dam.

Romaine Pacheco, a Mile Hi Cablevision vice president, was also appointed to a six-year term on the Board. Pacheco's awareness of local water issues resulted from seven years of work in Congresswoman Pat Schroeder's office. She ran Schroeder's Denver office before joining Mile Hi in 1982. Pacheco, a mother of three, says she will bring to the Board the consumer's perspective. She replaces Beth Hennessey, who asked not to serve another term.

Source: Denver Post 7/29/89

FARBES ELECTED PRESIDENT OF DENVER WATER BOARD

Hubert A. Farbes Jr. was elected to a one-year term as President of the Denver Water Board in August. He succeeds Monte Pascoe, president for the past three years. Farbes is a Denver lawyer and three-year veteran of the Water Board. He is a native of Oklahoma, a graduate of Grinnell College and Yale Law School, and spent four years in Colorado's Division of Natural Resources. Faced with a probable veto of Two Forks by EPA Administrator William Reilly, Farbes said the board will concentrate on speeding up the installation of water meters and promoting conservation during the next year. The Board also elected Malcolm Murray as its first vice president.

Source: Denver Post, 8/2/89

INTERIOR SECRETARY ORDERS ENVIRONMENTAL STUDY OF GLEN CANYON DAM IMPACT

A formal environmental study of the Glen Canyon Dam's impact on the Grand Canyon will be conducted, according to a government spokesman. The study, to assess damage caused by commercial and recreational activities around the dam, was ordered by Interior Secretary Manuel Lujan. Berry Wirth, spokesman for the U.S. Bureau of Reclamation, said USBR has been working on an environmental study for seven years, and the data will be helpful in completing the formal environmental impact study. John McCain (AZ) said the study is the result of "repeated urgings of the Arizona environmental community and the Arizona Congressional delegation."

Source: Denver Post, August 5, 1989

ARMSTRONG TO INTRODUCE HIS OWN WILDERNESS BILL

Colorado Senator William Armstrong says he will introduce his own wilderness bill in September. An earlier proposal by Colorado Senator Tim Wirth would increase wilderness areas by 750,000 acres. Armstrong says his bill will include 580,000 acres. Opponents of Wirth's bill say they're concerned about possible future wilderness additions, and the provision that new wilderness areas should have a right to adequate stream flow that would preserve natural features and sustain fish and wildlife. They fear that the water upstream could not be diverted because it would reduce flows through downstream wilderness areas. Of particular concern are U.S. Bureau of Land Management lands now being studied for possible wilderness designation. Proponents of Wirth's bill say he identified and excluded Colorado's most commercially promising areas from his proposal. Wirth's bill would protect substantial parts of the Sangre de Cristos, the southern part of the Front Range, sections of the Williams Fork Mountains north of Dillon, the Buffalo Peaks area south of Leadville, and a dozen other tracts around the Western Slope, mostly adjacent to existing Wilderness areas.

Source: Denver Post, 7/20/89, 8/3/89, 8/4/89

MCWHINNIE LEAVES METROPOLITAN WATER PROVIDERS

Robert McWhinnie, who ran the Metropolitan Water Providers for five years, has quit to join American Water Development Inc. Robert Tonsing, a Littleton city councilman and public relations executive, will replace McWhinnie. American Water Development Inc. hopes to pump up and sell 200,000 acre-feet of San Luis Valley groundwater and pipe it to Front Range cities, which critics say would dry up San Luis Valley wells. The firm also is developing up to 25,000 acre-feet from other sources including senior water rights in the South Platte River basin and some local wells, according to McWhinnie.

Source: Denver Post 8/25/89

COMPROMISE A POSSIBILITY IN HOMESTAKE II ISSUE

Aurora City Council members, in Vail for their August retreat, invited Eagle County Commissioners and the Vail City Council to dinner to discuss mutual problems. Aurora and Colorado Springs want to remove 22,000 acre-feet of water annually from the Holy Cross Wilderness Area near Vail. Eagle County commissioners last year denied the cities' Homestake II water project a permit, and the issue has been in district court since. Two county commissioners say they hope for a settlement. Commissioner Don Welch said the expensive process of trying to get the Two Forks Dam project approved shows representatives from both the East and West slopes that compromise is needed. Commissioner George Gates said that what is needed is a state water plan where everyone comes out a winner. He said where water is taken out of the stream is the big issue.

Source: Denver Post 8/26/89

PSC PULLS OUT OF CLEAR CREEK PROJECT ALLIANCE

Public Service Company has dropped out of the Clear Creek Water Users Alliance, saying it does not project enough growth in its water needs to justify paying for part of the proposed Clear Creek dam. The alliance, which includes the cities of Arvada and Broomfield, Adolph Coors Co. and several water districts and gravel companies, wants to build a \$400 million dam across the Canyon which would flood part of U.S. 6. The Alliance's plan calls for building a bypass road to Interstate 70 and Colorado 119, but canyon residents are opposed. Virgil Hill, the Alliance's Vice President, said plans for the project will go forward, and that they likely will find other participants. He also said the Alliance plans to work with residents to try to resolve some of the opposition to the project.

Source: Denver Post 8/23/89

NCWCD PROGRAM HELPS FARMERS IMPROVE WATER MANAGEMENT

Northern Colorado farmers can evaluate new irrigation procedures and field instruments at no cost through the Irrigation Management Service (IMS), a program of the Northern Colorado Water Conservancy District. The program helps farmers evaluate their own irrigation practices with seasonal on-farm demonstrations, fact sheets and publications. Farmer participation is normally limited to a few fields for a 1-3 year period, as the program is not intended to compete with commercial irrigation scheduling services.

The program relies primarily upon the root zone water balance method for on-farm irrigation scheduling. Evapotranspiration is a key parameter, with alfalfa as the reference crop. ETR is factored or adjusted using crop coefficients based on plant growth stages to calculate crop water use or evapotranspiration for various other area crops.

The District is completing installation of an automated agricultural weather station network throughout its service areas. The stations are located near Fort Collins, Loveland, Longmont, Greeley, Wiggins, Brush, Sterling, and Crook.

Each station collects air temperature, relative humidity, wind travel and solar radiation data from which ETR is calculated on a daily basis. Precipitation data is also collected at each station. All stations are operated year-round, and data telemetry to the District's VAX computer at its Loveland headquarters is accomplished via the GOES satellite.

Crop water use data is mailed weekly to cooperating individuals and also to area newspapers, County Extension offices and Soil Conservation Service personnel. For further information contact Mark A. Crookston, District IMS Coordinator, at (303)667-2437.

COLORADO STATE ORGANIZES NATO ADVANCED STUDY INSTITUTE ON STOCHASTIC HYDROLOGY

A NATO Advanced Study Institute (ASI) on Stochastic Hydrology in Water Resources Systems: Simulation and Optimization will be held in Peniscola, Spain September 18-29, 1989. Jose D. Salas, North American co-director of the Institute, organized the program in collaboration with his European counterpart, Professor Juan Marco. Marco, European co-director of the Institute, is with the School of Civil Engineering, Polytechnical University of Valencia, Spain. Salas is a Professor of Civil Engineering and Program Leader of the Hydrology and Water Resources Program at Colorado State.

Specialists in stochastic hydrology and water resource system simulation will gather at the Institute to exchange information and identify potential needed directions in the field of stochastic hydrology. The Institute was organized with the financial support of NATO Scientific Affairs Division, Belgium; the Ministry of Public Works, Spain and the Department of Public Works, Valencia, Spain.

NEW VP FOR INTERNATIONAL COMMISSION ON IRRIGATION AND DRAINAGE (ICID)

Larry D. Stephens of Denver was elected Vice President of the International Commission of Irrigation and Drainage (ICID) during the Commission's 40th International Executive Council Meeting in Ottawa, Canada, June 1989. During a three-year term as Vice President, he and other ICID officers will provide policy and management of the technical and administrative operations of the Commission.

ICID, with headquarters in New Delhi, India, is a non-governmental organization of 75 member nations working together to help meet the World's needs for food and water through improved irrigation agriculture.

Stephens has served as Executive Vice President of the U.S. Committee of Irrigation and Drainage since 1971 and recently completed 30 years of Federal government service, 29 with the Bureau of Reclamation in Denver. He also serves as the Executive Vice President of the American Water Foundation (AWF) and as the Executive Director of the U.S. Committee on Large Dams (USCOLD). The three societies were organized to facilitate the exchange of water resources technology among professionals in the U.S. and internationally, and to develop opportunities for U.S. goods and services to be used overseas.

A Colorado native, Stephens was born in Sterling, attended high school in Fleming, and received a B.S. in Agricultural Engineering from Colorado State University in 1960 and a Master of Business Administration from the University of Colorado in 1967. In addition to USCID, USCOLD and AWF, he is a Member of the International Water Resources Association, the Colorado River Water Users Association, the Council for Engineering and Scientific Society Executives and the Colorado Society of Association Executives.

STUDENT INTERNS AT INSTITUTE COMPLETE SEMESTER PROJECTS

Three student interns worked on CWRI projects during the spring semester, in a trial program to increase student interest in Colorado water issues. One of their projects was to gather data for a Colorado Water Atlas for future publication by CWRI. The Atlas is now completed in draft format, and a working committee will be assembled in the near future to critique the draft, suggest revisions and prepare it for final publication.

The three interns were Linda Li, Joe Pollara and David Thaemert. Linda returns to CSU this fall for her senior year in Civil Engineering. During the summer Linda worked for Arco Pipeline in Independence, Kansas, a firm affiliated with the Atlantic Richfield Oil Company.



David Thaemert



Joe Pollara

David Thaemert received his B.S. degree in Agricultural Engineering in the spring, and begins a M.S. program in the same field at the University of Arizona this fall. David continued his CWRI internship during the summer before leaving for Arizona. He had

the additional assignment of preparing, in draft form, the contributions of Colorado State in the field of water resources development. Joe Pollara, who seeks a M.S. in Agricultural Engineering, worked during the summer for the Denver Water Department. Joe describes his summer working for DWD in the report that follows. (Note: A picture of Linda Li was not available.)

Lysimeter Report, by Joe Pollara

My work in the water rights section of the Denver Water Department began on May 15, 1989. I was assigned to lysimeter studies taking place in Denver and on the Western slope. In Denver, three experimental sites at golf courses are visited weekly for measurements. They are Wellshire, Overland and City Park. On the Western slope, sites are located at the Hall residence, Hi-Country Haus, Pole Creek Golf Course, Corral Creek Ranch, Lawrence Ranch and Dillon DWD headquarters.

Two types of lysimeters are being employed in the study. The first type, a bucket lysimeter, measures actual water consumption by utilizing a water balance based on measuring water applied, deep percolation and weight change. The second type, a square lysimeter, has a continuous water source and measures potential evapotranspiration. Both lysimeter types are used because together they provide data for comparison. During the work week all sites are customarily visited once with the exception of the buckets at Corral Creek Ranch, which are visited twice after irrigation stops.

The data obtained from the field is entered into Symphony spreadsheets for analysis. In the spreadsheets themselves are formulas for calculating soil moisture changes and ultimately water consumption. These consumption values are then used in conjunction with corresponding weather data to generate monthly K-value coefficients by the Blaney-Criddle equation (see Actual v. Potential Water Consumption by Native and Lawn Grasses at High Altitudes paper by Ed James and Norm Carlson). These monthly K-value coefficients provide irrigators an empirically calculated approach to finding the amount of water historically used by their crop. This knowledge is valuable in water right transfer situations since it is imperative that only that amount of water historically used be transferred to avoid injury to other users' rights.

In the future, there are many other avenues to explore in this field. In addition to generating K-values using the Blaney-Criddle method, analysis of the data by the Jensen-Haise and Penman equations also needs to be completed. Furthermore, to exploit the most beneficial application of this study a depletion model should be developed from the data collected in the past two years, this year, and next year. A more immediate advantage of this study can be realized by closer scrutiny of present data. With the information we have now, and will accumulate next season, water conservation through carefully managed irrigation practices will be possible.

CU PROFESSOR NAMED TO WATER SCIENCE AND TECHNOLOGY BOARD

Donald D. Runnells, Professor of Geology at the University of Colorado, has accepted appointment to the Water Science and Technology Board of the National Research Council. The appointment, effective July 1, is for a three-year term. Runnells' professional interests include the geochemistry of natural waters, pollution by mining and milling, disposal of hazardous wastes, and geochemical prospecting. The Water Science and Technology Board serves as an independent advisor to the federal government on scientific and technical questions of national importance.

COLORADO WATER THE NEXT 100 YEARS

Participate in a lively three-hour program, free and open to the public, to entertain thoughts and ideas of how water can be managed most effectively. A special publication, Colorado Citizen's Water Handbook, will provide background information for participants prior to the program. Brief informative talks by scholars and water professionals will precede the public discussion:

- Dr. William Buckles will speak on how various societies, including ancient ones in Colorado, have managed water and how civilizations are born and changed because of water availability.

- Converse with George Vranesh, author of Colorado Water Law, and historian Dan Tyler.

- Hear water professionals speak about timely issues and tell interesting stories regarding the history of regional water development.

- Consider the attitudes and values which will most effectively guide us in responsible decisions.

- Participate in audience discussion that produces a statement about the spirit of future water laws and policies.

This program, a project of the Colorado Endowment for the Humanities and Front Range Community College, will be held in each of Colorado's seven water divisions:

Steamboat Springs	Nov. 11, 1989
Glenwood Springs	Jan. 6, 1990
Montrose	Jan. 13 or Jan 20, 1990
Durango	Feb. 3, 1990
Alamosa	Feb. 17, 1990
Pueblo	Mar. 3, 1990
Greeley	March 17, 1990

Written results from all divisions will be distributed to participants and interested parties. For further information contact: Barbara Preskorn, Project Director, Humanities Dept., Front Range Community College, 3645 W. 112th Ave., Westminster, CO 80030 or call 466-8811, ext. 434.

ALLIANCE TO COSPONSOR CONFERENCE ON GROUNDWATER

The Freshwater Foundation, in cooperation with the National Water Alliance, is currently in the process of planning a jointly sponsored conference on groundwater and agrichemicals. Plans are that the conference, which will be titled "Groundwater and Agrichemicals: Suggested Policy directions for 1990," will be held at the Radisson Hotel in St. Paul, MN on Wednesday, October 25, through Friday, October 27. With Congress due to formulate a new farm bill in 1990, the timing of this conference couldn't be more critical. It is anticipated that recommendations from this meeting, which will include representatives from the environmental and agricultural communities, as well the general public, will contribute meaningfully to policy.

The focus of the conference will be on policy constraints and potential solutions related to agrichemical use and groundwater protection. Related issues such as institutional barriers, economic incentives (and disincentives), funding sources and suggestions for modification of policies to better assure that desired changes do occur have tentatively been identified as agenda items for the fall meeting. NWA members will be provided with additional details on the conference as they become available. Also being considered is the Alliance's involvement in planning a conference on the wetlands that would be held at a later date.

NATIONAL SYMPOSIUM ON WATER QUALITY SCHEDULED FOR NOVEMBER

The Water Resources Division of the U.S. Geological Survey will hold the 2nd National Symposium of Water Quality in Orlando, Florida during the week of November 12, 1989. The Symposium will emphasize the application of earth-science information to major water-quality issues. Geologic, hydrologic, chemical and biological processes and the use of process knowledge will be presented in the context of integrated studies and major issues. In addition, a number of invited representatives will present overviews of prominent water-quality programs in other agencies. The program will consist of 2-1/2 days of presentations following a half-day plenary session of invited speakers. Approximately 150 technical papers will be presented in a series of three concurrent sessions. Also featured will be commercial and educational exhibits, including an elaborate exhibit by the USGS. A unique field trip to the spectacular sinkholes and springs of central Florida is scheduled. For information contact: Vivian Olcott, U.S. Geological survey, R.B. Russell Federal Bldg., 75 Spring St., Suite 772, Atlanta, GA 30303. (404)331-5174; FTS 242-5174.

WATER INDUSTRY TRADE FORUM MEETS AT BEAVER CREEK

Senator James McClure (ID), Representative David Obey (WI) and Priscilla Rabb, Director of the U.S. Trade and Development Program, met with water industry representatives at Beaver Creek, Colorado August 5-6. The Water Industry Trade Forum, sponsored by the Denver-based American Water Foundation, was convened to examine international marketing and competitiveness issues faced by U.S. firms and to develop strategies for solving associated problems.

The American Water Foundation will prepare a report based on the Water Industry Trade Forum discussions to summarize the major issues identified and outline the suggested strategies for addressing trade problems. Single copies maybe obtained free of charge by writing the Foundation at P.O. Box 15577, Denver, CO 80215.

FELLOWSHIPS IN WATER SCIENCE

Colorado State University will award three USDA National Needs Fellowships in Water Science. Each fellowship will support a Ph.D candidate for three years with an annual stipend of \$15,000. Fellows will conduct research on some

aspect of agricultural chemical transport including the following:

- Simulation modeling, with experimental validation, of contaminant transport in the vadose zone. Geostatistical analysis of spatially variable soil transport properties.
- Surface transport of sediment and agricultural chemicals.
- Statistical design of monitoring programs to support management of non-point source pollution.
- Development, verification and validation of management models for agricultural chemicals.

Fellows may be located in any of four academic departments: Agricultural and Chemical Engineering, Agronomy, Civil Engineering, or Earth Resources. Fellows must be U.S. citizens who have completed an M.S. degree and must have an interest in pursuing a career in an agriculturally related field. Programs of study must begin by the Fall of 1990. Applications must be received by February 15, 1990. Additional information and applications may be obtained from:

Dr. Jim C. Loftis

Dept. of Agricultural and Chemical Engineering
Room 100 Engineering South
Colorado State University
Fort Collins, Colorado 80523
(303)491-5252

UCOWR DIRECTORY UPDATED

The UCOWR Expertise Directory, maintained by the Universities Council on Water Resources, is a computerized file of its member faculty coded by area of expertise (keywords). The directory provides a process by which professionals interested in research and consulting opportunities can be contacted. It also helps potential students who want to contact prospective major professors concerning future graduate study. Others may find the directory useful in obtaining expert scientific information.

A revised edition of the directory was issued this year, providing greater specificity in the areas of expertise. For information about the directory contact Duane D. Baumann, UCOWR Executive Director, 4543 Faner Hall, Southern Illinois University, Carbondale, IL 62901-4526. (618)536-7571.

NEW INSTITUTE PUBLICATIONS

Completion Report No. 151--**Water Quality and Water Rights in Colorado**, by Lawrence J. MacDonnell. Price: TBA

Water quality and water use are intimately related. The quality of water affects its usability. In turn, water use affects water quality. Colorado water law long has recognized this relationship. In a series of cases culminating in *Wilmore v. Chain O'Mines*, Colorado courts established the rule that one's use of water may not pollute that water to the injury of another's use.

Water quality protection now is regulated under the federal Clean Water Act and the Colorado Water Quality Control Act. The Colorado act contains a number of provisions

aimed at minimizing the effect of water quality regulation on water use pursuant to a water right. Most importantly, Section 104 provides that nothing in the act shall be interpreted so as to supersede, abrogate, or impair water rights or to cause material injury to water rights.

The Colorado Water Quality Control Commission considered the meaning of this provision in establishing policies and procedures for its Section 401 certification process under the federal Clean Water Act and its antidegradation review process. Views expressed before the Commission ranged from, on the one hand, the opinion that any state water quality regulation would impair a water right to, on the other hand, the opinion that a water right is subject to any legitimate water quality regulation that does not prevent its economic use. The Commission has determined that it cannot prohibit a Section 401 certification if, to do so, would violate the intent of Section 104 of the Colorado Water Quality Control Act. However, it deferred more explicit definition of the meaning of Section 104, preferring to leave this to a case-by-case determination.

At the same time, the water courts have been faced with water quality issues in connection with plans for augmentation and exchanges. Under Colorado law, water supplies may be substituted or exchanged subject to the requirement that the replacement water must be of a quality and quantity "so as to meet the requirements for which the water of the senior appropriator has normally been used....". The standard by which adequacy of quality will be established is not yet clear, but it appears that evidence of compliance with point source permit requirements and established water quality standards is not necessarily sufficient. Restrictions on the operation of the substitute supply or exchange have been established in several cases when streamflows go below a specified minimum.

HELICOPTER SQUADS SPY ON WATER CHEATS AS THE DROUGHT CRISIS DEEPENS

England is stereotyped as a country that has cool, damp and foggy weather. Much of the following article, however, that ran under the headline above in the June 25, 1989 edition of the London Sunday Express, might well be describing the 1989 summer conditions in Colorado and other parts of the midwestern and southwestern United States.

Many parts of Britain became official "absolute drought" zones yesterday after another day of sunshine brought water levels very near to crisis point. Even the Royal Family came under scrutiny, with water officials touring islands owned by Prince Charles on the Scilly Isles to ensure a hosepipe ban was being obeyed. With the dry weather likely to continue for several days, more water authorities are certain to impose restrictions this week to preserve stocks. Five authorities have already banned hosepipes. Unprecedented steps, including spy-in-the-sky helicopters, are being brought in to ensure they are enforced. People who flout instructions are being prosecuted.

As fears grow that many parts of the country could experience water shortages as serious as 1976, farmers warned yesterday that poor crop yields will lead to increased

food prices. Potatoes may more than double in price...and vegetables and cereals are likely to rise similarly. Water-starved crops are giving lower returns and lack of grass means animals are having to be fed costly supplements. This could lead to an increase in meat prices later in the year. Cereal crops in East Anglia, known as the grain basket of England, are seriously threatened. Area National Farmers' Union spokesman Mike Hollingsworth warned: "Yields will inevitably be down and there is real concern about the quality of the crop. It is just burning up."

Anglia Water, which is using helicopters to catch people using sprinklers without licences, said yesterday they are to bring their first prosecutions. Aerial observers look out for green lawns and get patrol vans to see if the householder has a licence.

Many parts of the country became "absolute drought" areas under Met Office guidelines yesterday after their 15th consecutive day without rain. A snowplough had to be brought in to spread grit on roads in Derbyshire melting during the heatwave. Firemen were called to cool sweltering fish at Baffin's Pond after a request from Portsmouth City Council's parks department. A spokesman for Hampshire fire brigade said: "It was certainly an unusual job, cooling down a pond. We are told it helped to aerate the water, which was becoming oxygen-starved in the hot weather."

Heatwave Hits Homes. Insurance companies braced themselves for a multi-million pound payout with thousands of homes threatening to crack under the stress of Britain's heatwave. From Swindon to Stirling, soaring temperatures have already caused some foundations to shrink, bringing fears of sinking walls and ceilings and even endangering whole houses. Insurance experts said the last major hot spell, in 1976, cost insurance companies 55 million pounds in domestic subsidence claims alone.

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 data for Paleozoic rocks in the Upper Colorado River Basin, Colorado, Utah, Wyoming, and Arizona, by Arthur L. Geldon, Open-File Report 89-59. Includes yields of springs and flowing wells and values of hydraulic characteristics of aquifers in the 100,000 square-mile area. Microfiche \$4; paper copy \$33.50.

Hydrogeology and simulated effects of groundwater development on an unconfined aquifer in the Closed Basin Division, San Luis Valley, Colorado, by Guy J. Leonard and Kenneth R. Watts, Water Resources Investigations Report 87-4284. Presents the results of a 5-year investigation of the groundwater conditions in the Closed Basin Division.

Stability of nitrate-ion concentrations in simulated deposition samples used for quality-assurance activities by the U.S. Geological Survey, by Timothy C. Willoughby, Randolph B. See, and LeRoy J. Schroder, Water Resources Investigation Report 89-4042. Microfiche \$4; Paper \$3.

Selected hydrologic data for Fountain Creek and Monument Creek basins, east-central Colorado, by Gerhard Kuhn and Roderick F. Ortiz, Open-File Report 88-705. Contains 1,100 water-quality analyses and about 420 measurements of discharge for Fountain and Monument Creeks and numerous tributary streams. The data were obtained during 1986, 1987 and 1988 in conjunction with a study done by the USGS in cooperation with the Pikes Peak Area Council of Governments to determine the effects of wastewater discharges on the two streams. The report also presents traveltime and channel-geometry data for the two creeks. Microfiche \$4; paper copy \$16.50.

Simulation of streamflow in small drainage basins in the southern Yampa River basin, Colorado, by R.S. Parker and J.M. Norris, Water Resources Investigations Report 88-4071. The report uses the U.S. Geological Survey's Precipitation-Runoff Modeling System for nine small drainage basins where snowmelt is the dominant source of streamflow. The nine drainage basins are located in Moffatt and Routt Counties, Colorado.

Hydrogeologic characteristics of the valley-fill aquifer in the Arkansas River valley, Prowers County, Colorado, by Gregory A. Nelson, R. Theodore Hurr, and John E. Moore, was prepared in cooperation with the Colorado Department of Natural Resources, Division of Water Resources, Office of the State Engineer. The report is released as Open-File Report 89-254.

Hydrogeologic characteristics of the valley-fill aquifer in the Arkansas River valley, Crowley and Otero Counties, Colorado, by Gregory A. Nelson, R. Theodore Hurr, and John E. Moore, was prepared in cooperation with the Colorado Department of Natural Resources, Division of Water Resources, Office of the State Engineer. The report is released as Open-File Report 89-255.

Hydrogeologic characteristics of the valley-fill aquifer in the Arkansas River valley, Pueblo County, Colorado, by Gregory A. Nelson, R. Theodore Hurr, and John E. Moore, was prepared in cooperation with the Colorado Department of Natural Resources, Division of Water Resources, Office of the State Engineer. The report is released as Open-File Report 89-256.

POSITIONS AVAILABLE

Chief, Office of External Research, Water Resources Division, U.S. Geological Survey, Reston, VA. Directs and participates in the development of strategies for implementation of provisions of Sections 104 & 105 of Title I of Water Resources Research Act of 1984 relating to operation and funding of state water resources research and technology institutes and grants program. Participates in identification of national research issues. Coordinates acceptance of research proposals under Section 105. Lends technical expertise in setting of national research priorities. Develops and manages a scientifically sound, objective and comprehensive review and evaluation process for Section 105 research proposals to ensure validity of value of research grant program. Directly influences technical achievement through detailed surveillance of scientific activities of external research program. Determines and recommends policy

relating to external research effort. Enunciates and negotiates policy on research activities related to collaborative efforts in technical matters with other federal and non-federal scientific organizations.

Closing Date: October 2, 1989. Contact Telephone Number: (703)648-6131; FTS 959-6131. Address of Personnel Office: Recruitment and Placement Section, Personnel, 12201 Sunrise Valley Dr., MS-215, Reston, VA 22092.

Hydrogeologist - Dept. of Geology, University of Nebraska--Applications and nominations are invited for an additional tenure-track position in hydrogeology. The successful applicant will join four faculty currently involved in a strong program in Groundwater Geology in the Department of Geology, UNL. Permanent funding for the position has been made available through the Nebraska Research Initiative-Water Science. Applicants must possess a Ph.D. in Geology, or closely related subject, and have research experience in field sampling, laboratory analysis, and modeling of contaminant transport in groundwater. A strong quantitative background is essential. The position is mainly research-based, but some graduate level teaching, and the direction and supervision of graduate students, will be expected. Movement of agricultural chemicals in groundwater is of prime concern to Nebraska water quality, and is a major reason for establishing the position. The successful applicant will be expected to devote his/her main research effort to this area of work, and to cooperate with the inter-disciplinary activities of the Water Center at UNL. Rank and salary are negotiable, depending on experience.

Applicants should send a current curriculum vitae, publication list, a description of current and planned research, record of funding, and the names and addresses of three references by October 1 to: Chairman, Geology Search Committee, 214 Bessey Hall, Department of Geology, University of Nebraska-Lincoln, Lincoln, NE 68588-0340, (402) 472-2663.

Three positions are available at the Water and Energy Research Institute, University of Guam:

Assistant or Associate Professor, Water Resources Engineering--This is a faculty position with rank depending upon qualifications. The initial appointment is by means of a three-year contract; subsequent appointments are tenure track, or 1-2-3 year non-tenure track appointments. Responsibilities include developing and conducting research projects in the candidate's areas of expertise. The candidate is expected to teach one or two courses per year in his or specialty within the graduate and undergraduate programs. Applicants must have a Ph.D and academic experience in the area of Hydraulics or Groundwater Hydrology and be either a U.S. citizen or have permanent resident status.

Assistant or Associate Professor, Environmental Toxicology/Chemistry--Job description same as above; applicants must have a Ph.D and academic experience in the area of Environmental Toxicology, Environmental Chemistry, and or Environmental Biology and be either a U.S. citizen or have permanent resident status.

Assistant or Associate Professor, Geo-Science--Job description same as above; applicants must have a Ph.D and

academic experience in the area of Geology, Hydrology or Meteorology and be either a U.S. citizen or have permanent resident status.

Send resume with names of three references to:
Dr. Sh. Khosrowpanah, Acting Director
University of Guam/WERI
Mangilao, Guam 96923 USA

Assistant/Associate Professor - Dept. of Civil Engineering, University of Wyoming--The Dept. of Civil Engineering and the Wyoming Water Research Center at the University of Wyoming have a joint faculty position available at the Assistant/Associate Professor level for an individual with expertise in the area of groundwater contaminant transport modeling and remediation techniques. This is tenure track in the Civil Engineering dept.

Requirements - The individual is expected to have a Ph.D degree in environmental engineering, environmental science or a related field that would allow for tenure consideration through the College of Engineering. Interests in groundwater contamination and movement problems, particularly as associated with development, utilization and disposal of fossil energy resources is desired. Knowledge of ground- and surface-water hydrology, saturated and unsaturated zone movement of water and chemical and remediation techniques is also expected. Some demonstrated research and teaching abilities are required.

Responsibilities - The individual would be expected to develop and conduct an independent as well as interdisciplinary research program in groundwater and surface water contamination and movement problems through the Wyoming Water Research Center (an integrated multi-disciplinary research center with faculty appointments in several academic units). Teaching responsibilities would include at least one course per year in groundwater contaminant transport, one graduate level course in groundwater and surface water remediation techniques and an undergraduate level course in the engineering area.

Salary commensurate with qualifications. The position will be available after January 1, 1990. To apply submit a letter of application, curriculum vita, and the names of at least three references on or before November 15, 1989. Send to: Dr. Victor R. Hasfurther, Chairman, Search Committee, Civil Engineering Dept, P.O. Box 3295, University Station, University of Wyoming, Laramie, WY 82071.

CALLS FOR PAPERS

A conference on **Geology, Water Resources, and Climate Changes and Man in the High Plains** will be held at Colorado State University, Fort Collins, CO, October 13-14, 1989. The purpose of the conference is to review the state of research on Tertiary and Quaternary deposits and environments of the Great Plains and Gulf Coast. Topics will include stratigraphy and sedimentology, aquifers, climate changes and impacts. The conference will feature invited and contributed papers. Twenty-five minutes will be allowed for each paper, followed by five minutes of discussion. To submit a paper for consideration send an original and 2 copies of the abstract, no later than Sept. 13, 1989, to: Frank G. Ethridge, Dept. of Earth Resources, Colorado State

University, Fort Collins, CO 80523. (303)491-6195. This meeting will be held in conjunction with SHOWCASE '89, a symposium on Strategic Response to Global Change, cosponsored by the College of Forestry and Natural Resources, Colorado State University and Senator Tim Wirth. The program includes a companion field trip to examine the Tertiary Ogallala and Brule formations and Holocene gully development near the Wyoming border.

The American Institute of Hydrology will hold a conference on **Minimizing Risks to the Hydrologic Environment** March 12-16, 1990 in Las Vegas, Nevada. Sessions will include Hydrogeology of High-Level Waste Depository at Yucca Mountain, Monitoring of Underground Storage Tanks and Hazardous Waste Sites, and Models of Groundwater flow and Solute Transport. Abstracts of 250 words or less must be submitted no later than September 15, 1989 to: M.S. Bedinger, AIH Program Chairman, University of Nevada Las Vegas, Environmental Research Center, 4505 Maryland Parkway, Las Vegas, NV 89154. Please indicate whether the paper is for oral or poster presentation.

The **Urban Non-Point Source Pollution and Stormwater Management Symposium** will be held July 22-25, 1990 at the University of Kentucky, Lexington, KY. Topics include Non-point Source Management, Stormwater Management, Modeling and Monitoring. Submit abstract (250 words or less) by September 30, 1989 to: Association of State Dam Safety Officials, P.O. Box 55270, Lexington, KY 40555-5270. (606)257-8013, (606)257-5140.

26th Annual Conference and Symposium of the American Water Resources Resources "The Science of Water Resources: 1990 and Beyond" (Conference) and **"Transferring Models to Users"** (Symposium), November 4-9, 1990 in Denver, CO. Poster papers and oral papers are invited on Hydrologic Trends, Legal Issues, Water Resources Development, and Emerging Issues. Submit Conference

abstracts to either of the Conference Technical Chairmen: Jim C. Loftis, Agricultural and Chemical Engineering Dept., Engineering South, Colorado State University, Fort Collins, CO 80523 (303)491-7923; ; or Bob Montgomery, Woodward Clyde Consultants, Stanford Pl. 3, Suite 1000, 4582 So. Ulster Parkway, Denver, CO 80237 (303)694-2770. Submit Symposium abstracts to either of the Symposium Technical chairmen: Eric Janes, P.O. Box 25047, Denver Federal Center, Building 50, Denver, CO 80225 (303)236-0170 or Jeffrey Miller, USGS/WRD, MS406, P.O. Box 25046, Denver Federal Center, Denver, CO 80225, (303)236-5931).

Submit three copies no later than November 1, 1989. The abstract cannot exceed 200 words and must include the title of the paper or poster, all authors' names, and their affiliations. The submitting author must include, on a separate page, the FULL MAILING ADDRESSES (including position, student status if any, firm or institution, department, city, state, zip code, and country) and a telephone number for EACH AUTHOR. Please indicate if there is a preference for either poster or oral session consideration.

The 1990 Biennial Conference on **Critical Issues for the 1990s: Desalination and Water Reuse** will be held at Walt Disney World, Orlando, FL on August 19-23, 1990. Papers will be chosen from abstracts submitted on or before December 1, 1989. Abstracts must be limited to approximately 500 words (two pages, double spaced). Tables or figures may be included where appropriate. Abstracts must include the title of paper, authors' names, titles, affiliations, presenter of paper, indication of whether the work has been or will be published elsewhere, and the date of completion of the project being reported. Five copies of each abstract should be submitted to: O.J. Morin, Post, Buckley, Schuh & Jernigan, Inc., 800 Magnolia Ave., Suite 600, Orlando, FL 32803. (407)423-7275 Ext. 330.

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

- CSU/TTU Cooperative Research Program in Wind Engineering, Robert N. Meroney, Civil Engineering
- Contaminant Issues on National Wildlife Refuges in the San Luis Valley, David R. Anderson, Fishery and Wildlife Biology
- Leaching Atrazine and Its Metabolites, Philip Westra, Plant Pathology and Weed Sciences
- Data Analysis & Limnological Inventory for the Colorado Division of Wildlife Central Region, Stephen A. Flickinger, Fishery and Wildlife Biology
- Greenback Cutthroat Trout Investigations, Eric P. Bergersen, Cooperative Fish & Wildlife Unit
- Shebelli Water Management Project, Marvin E. Jensen, Colorado Institute Irrigation Management
- Mississippi River Bed Sediments, Carl F. Nordin, Civil Engineering
- Range Improvement Research for the Central Shortgrass Plains, Harold Goetz, Range Science
- Population Estimation, Gary C. White, Fishery and Wildlife Biology
- Data Use Investigations and Science Support for the Earth Radiation Budget Experiment, Thomas Vonderhaar, CIRA Administrative Unit
- Radioecological and Ecotoxicological Investigations at Rocky Flats, Floyd W. Whicker, Radiology-Radiation Biology
- Analysis of Nesting and Vegetation Data on the Monte Vista National Wildlife Refuge, David R. Anderson, Cooperative Fishery & Wildlife Research Unit

- Coal Solubilization by Penicillium, Muhammad N. Karim, Agricultural and Chemical Engineering
- Drought Control and Water Management in Humid Regions (Budget Increase), Neil S. Grigg, Director, CWRRI
- Bank Erosion Processes in Meander Bends of the Red River Between Index, AK and Shreveport, LA, Colin R. Thorne, Civil Engineering
- Climate and Weather Programs, William E. Marlatt, Earth Resources
- Drought Monitoring, Thomas B. McKee, Atmospheric Science
- International Satellite Cloud Climatology Sector Processing Center for GOES WEST, 1985, Thomas H. Vonderhaar, CIRA Administrative Unit
- A Quantitative Evaluation of Stream Habitat Improvement Using PHABSIM, Kurt D. Fausch, Fishery and Wildlife Biology
- Enhancement and Documentation of WESTEX and SELECT Models, Albert Molinas, Civil Engineering
- Zinc and Cadmium Solubility Controls in Arid-Zone Soils, Willard L. Lindsay, Agronomy

UNIVERSITY OF COLORADO, BOULDER, COLORADO 80309

- Incorporating Public Preferences in the Optimization of Urban Water Supply Reliability: Planning Procedures and Survey Techniques, Charles Howe, Environment and Behavior Program
- A Study of Atmospheric Fronts Over Mountainous Terrain, William Blumen, Astrophysical, Planetary and Atmospheric Sciences
- Delta-D and Deuterium Excess Measurements on the Gispil Deep Core Ice, James White, Geological Sciences
- Icesheet, Sea-level, Climatic Interactions During the Younger Dryas/Cockburn Internal (11-8KA): Evidence Based on a Lake Coring Program, John Andrews, Geography
- Using Multi-Sensor Data to Model Factors Limiting Carbon Balance in Global Grasslands, Carol Wessman, Geological Sciences
- The Effects of Migration on Perceptions of Hazardous Waste, Michael Greenwood, Economics
- Facilitating Voluntary Transfers of Bureau of Reclamation-Supplied Water, Lawrence J. MacDonnell, Natural Resources Law Center
- AMS 14C Dating of Arctic Lake Sediments, Gifford Miller, Institute of Arctic and Alpine Research
- A GIS Extension to the Early Warning System for Boulder Creek Floods, Kenneth Strzepek, Civil, Environmental and Architectural Engineering
- Transport and Fate of Multiphase Subsurface Contamination, Tissa Illangasekare, Civil, Environmental and Architectural Engineering

CONFERENCES

- Sept. 8-9 1989 CLUB 20 FALL MEETING, Grand Junction, CO. Contact: Club 20, P.O. Box 550, Grand Junction, CO 81502, (303)242-3264.
- Sept. 15 FUNDAMENTALS OF STORMWATER MANAGEMENT, Austin TX. Contact: Bruce Ferguson, American Society of Landscape Architects, 2733 Connecticut Ave., Washington, D.C. 20009. (404)542-1816.
- Sept. 17-22 25TH ANNUAL CONFERENCE, AWRA, WATER: LAWS AND MANAGEMENT, and WETLANDS: CONCERNS AND SUCCESSES, Tampa, FL. Contact: L.M. Buddy Blain, Blain and Cone, P.A., 202 Madison St., Tampa, FL 33602. (813)223-3888.
- Sept. 18-22 THE ENVIRONMICS CONFERENCE - WATER: THE ENVIRONMENTAL AND ECONOMIC POLITICS OF THE AMERICAN MOUNTAIN WEST, Park City, UT. Contact: Jennifer Kohler, The Center for Environmental, Economic and Political Policy, 44 Exchange Pl., Salt Lake City, UT 84111. (801)649-3181.
- Sept. 19-21 PRINCIPLES OF SUBSURFACE CONTAMINANT FATE AND TRANSPORT MODELING and MICROBIAL PROCESSES IN THE DEGRADATION OF GROUNDWATER CONTAMINANTS, Salt Lake City, UT. Contact: Nat'l Water Well Assoc., 6375 Riverside Dr., Dublin, OH 43017. (614)761-1711.
- Sept. 22-23 WATER QUALITY AND AVAILABILITY IN THE MIDWEST; CURRENT STATUS AND FUTURE PROSPECTS, Kansas City International Airport, MO. Contact: Division of Continuing Education, University of Kansas, (913)864-4790; FAX (913)864-3952.
- Sept. 24-27 JOINT CONFERENCE, ROCKY MOUNTAIN SECTION, AMERICAN WATER WORKS ASSOCIATION, and ROCKY MOUNTAIN WATER POLLUTION CONTROL ASSOCIATION, Santa Fe, NM. Contact: AWWA/WPCA, 6666 W. Quincy Ave., Denver, CO 80235. (303)794-7711.
- Sept. 25-26 17TH BIENNIAL CONFERENCE ON GROUNDWATER, San Diego, CA. Contact: Office of the Director, Water Resource Center, Riverside (714)787-4327 or the Northern Office at Davis (916)757-8901.

- Sept. 26-29 DAM SAFETY SEMINAR AND INAUGURAL MEETING OF THE CANADIAN ASSOCIATION OF DAM SAFETY OFFICIALS, Edmonton, Alberta. Contact: Barry Hurndall, CADSO. (403)422-1356.
- Sept. 28-29 SEMINAR ON COLORADO WATER LAW, Northglenn, CO. Contact: Colorado Water Congress, 1390 Logan #312, Denver, CO 80203.
- Sept. 30 AG DAY 89, Colorado State University. Contact: College of Agricultural Sciences, Colorado State University, Fort Collins, CO 80523.
- Oct. 1-4 THIRD MULTIDISCIPLINARY CONFERENCE ON SINKHOLES AND THE ENGINEERING AND ENVIRONMENTAL IMPACTS OF KARST, St. Petersburg, FL. Contact: 3rd Multidisciplinary Conference, Florida Sinkhole Research Institute, University of Central Florida, 12424 Research Parkway, Orlando, FL 32826. (407)658-6834.
- Oct. 1-5 ASSOCIATION OF STATE DAM SAFETY OFFICIALS SIXTH ANNUAL NATIONAL CONFERENCE, Albuquerque, NM. Contact: Lori Spragens, ASDSO, P.O. Box 55270, Lexington, KY 40555. (606)257-5140.
- Oct. 2-3 SUMMIT AND EXPO 1989 BACKFLOW PREVENTION, Keystone, CO. Contact: Backflow Prevention Summit & Expo 1989, P.O. Box 33209, Northglenn, CO 80233. (303)451-0980.
- Oct. 2-4 ENVIRONMENTAL REGULATION COURSE, A BASIC COMPREHENSIVE COURSE ON ENVIRONMENTAL REGULATION, Denver, CO. Contact: Executive Enterprises, Inc., 22 West 21st St., New York, NY 10010.
- Oct. 5-7 ROCKY MOUNTAIN GROUNDWATER ASSOCIATION, 18TH ANNUAL CONFERENCE, GEOLOGIC AND HYDROLOGIC CONSIDERATIONS IN ENVIRONMENTAL CONTAMINATION OR CONTAMINATION AND REMEDIATION IN HYDROGEOLOGIC ENVIRONMENTS, Salt Lake City, UT. Contact: Linda Moore, Bureau of Drinking Water/Sanitation, Division of Environmental Health, Utah Dept. of Health, 288 North 1460 West, Salt Lake City, UT 84116. (801)538-6159.
- Oct. 15-19 BLENDING TRADITION WITH OPPORTUNITY, San Francisco, CA. Contact: Water Pollution Control Federation, 601 Wythe St., Alexandria, VA 22314. (703)684-2400.
- Oct. 19-21 PLANNING FOR SHORTAGES - DROUGHT MANAGEMENT, St. Louis, MO. Contact: Larry D. Stephens, USCID Exec. V.P., P.O. Box 15326, Denver, CO 80215 (303)236-6960.
- Nov. 1-11 IRRIGATION WATER MANAGEMENT, Seminar and study tour (Southern Arizona and California). Contact: American Water Foundation, P.O. Box 15577, Denver, CO 80215. Telephone: (303)236-6960; Telex: 168167 USBREC; FAX 303-236-6763.
- Nov. 12-17 NATIONAL SYMPOSIUM ON WATER QUALITY, Orlando, FL. Contact: Vivian Olcott, U.S. Geological Survey, R.B. Russell Federal Bldg., 75 Spring St., Suite 772, Atlanta, GA 30303. (404)331-5174; FTS 242-5174.
- Nov. 16-17 7TH ANNUAL RED RIVER BASIN LAND AND WATER INTERNATIONAL SUMMIT CONFERENCE, "WATER QUANTITY; TOO MUCH - TOO LITTLE," Grand Forks, ND. Contact: The International Coalition, Box 127, Moorhead, MN 56560, (218)233-0292.

DROUGHT PLANNING: A COMPLETE PLAN EXPERIENCE FROM THE U.S.

by Peter Macy
Brown and Caldwell

A Drought occurs when supply is reduced to a level that cannot support existing demand. A drought may be caused by natural forces or system component failure, and could last 2 to 3 months or extend over several seasons. While the state of Colorado has suffered a drought since 1982, the 1987-88 dust bowl throughout other parts of the country has raised the question: "are we prepared for a drought?" Presented herein is an overview of the necessary steps and components for completing a drought response plan. The components comprise what has been done successfully throughout the country, especially the experiences of California. A drought response plan requires research, data analysis, planning and implementation. The plan can be divided into three parts, understanding supply and demand setting up a plan, and adopting the plan.

UNDERSTANDING SUPPLY AND DEMAND MANAGEMENT

Decisions relative to drought mitigation will depend on accurate knowledge of available supplies, emergency supplies, demand, and demand management measures.

Supply: Existing supply information should be collected such as facility data, stream flow data, reservoir levels, groundwater table elevations, soil moisture, snow pack, and precipitation records. The reliable yield must be defined for each source including any weak links in getting water to customers such as limited pumping capacity. Supply augmentation methods can be classified into five groups; (1) methods to increase existing supplies, (2) drawing from reserve supplies, (3) methods to increase efficiency, (4) modifications to operations, and (5) cooperative efforts with other agencies. Several examples of these methods are increased use of reclaimed water, using reservoir dead storage, adding or deepening wells, and water exchanges. Evaluate and document the efforts required for supply augmentation. Agreements or contracts should be written up ahead of time for such augmentation methods as water transfers. Costs and time requirements should also be determined.

Demand: Reduction of water demand is directed at the customer uses that are inefficient, wasteful, or able to be temporarily reduced or suspended. A variety of demand reduction techniques are landscape irrigation restrictions and plumbing fixture retrofitting with low-flow devices. An action plan to get the measure implemented must be designed including required personnel, costs, and time frame. Two common measures imposed to effect all customer classes, are rationing and price restructuring.

Rationing: Customer response to rationing programs is more predictable than to other measures, and these are generally the most effective programs to achieve significant demand reduction. In nearly every instance where mandatory rationing is implemented, consumers respond by reducing water use further than is requested. A successful rationing program should be as equitable as possible and customers should be kept informed about the status of the shortage. Pertinent information regarding water use and supply must be published and disseminated at least weekly to maintain customer commitment. Rationing programs are generally patterned after one of four basic allocation schemes: (1) percentage reduction, (2) seasonal allotment, (3) fixed allotment, and (4) specific use bans. A percentage reduction assigns each customer class a consumption reduction goal as a percentage of the consumption level used in a similar billing period during a normal (non drought) season. The seasonal allotment is similar to the percentage reduction except that the consumption reduction goal is varied depending on the time of year.

Rates: Rate structures to encourage water conservation requires individual metering of customers. The ability of a price increase to effect consumption is termed price elasticity. Price elasticity is a measure of the relative influence that a change in price of a given commodity (water) has on the demand for that commodity. Several variables effect price elasticity such as whether the use is indoors or outdoors or whether use is in an affluent or depressed neighborhood. Significant water conservation is unlikely to be achieved through the use of normal rate increases. However, there are several price structures suitable to enhance the effects of a drought response plan such as, seasonal rates, excess use charges, penalty charges, and drought surcharges. Under a seasonal rate schedule a higher unit price is imposed during peak usage months. An excess use charge (or inclining block rate structure) applies a higher unit price to the volume consumed above a set limit. Penalty charges are similar to excess-use charges except that the same unit price is charged for the entire volume consumed and a flat fee is assessed if total usage exceeds a set ceiling. With either of these pricing structures, care must be taken in defining what is excess consumption on the part of various customer classes. A drought surcharge rate may also cause reduction in water use.

FORECAST SUPPLY VERSUS DEMAND

Accurate forecasting requires coordinated efforts between the water utility and those who measure and predict water supplies.

Supply Forecasting: Wholesalers will need to manage source supplies or supplies from primary water suppliers such as the Bureau of Reclamation. Water retailers will need to make their own findings and collect information from wholesalers where appropriate. Supplies from (1) snowpack, (2) groundwater, (3) storage, (4) exchanges, (5) etc., must be determined. An assessment of the total forecasted supply in each month for the coming 12 months should be made. The water manager must also decide how

much of the supply should be carried over as insurance against a possible subsequent drought year.

Demand: Each agency should use its own forecasting method to predict demand. Demand can be determined by:

- 0 Production records and forecasts.
- 0 Water use records and forecasts.
- 0 Long-term weather forecasts.
- 0 Precipitation records and forecasts.
- 0 Service area population.
- 0 Customer class characteristics.

Drought Impact Assessment: To help motivate plan supporters and determine what level of effort and budget to apply during a drought, a preliminary drought impact assessment is important. What short and long-term impact would a drought cause? Impacted areas such as utility revenues and the landscaping business should be reviewed.

DEFINING A DROUGHT AND DROUGHT RESPONSE

Compare the estimate of drought year water demand to available water supplies. Identify those months, if any, during which a shortage is anticipated. This assessment will enable the utility to forecast what level of supply augmentation and/or demand reduction needs to be achieved in the event of different magnitudes of drought.

Once various drought supply situations have been determined and plotted on a graph, the forecasted demand can be superimposed on it to see what level of supply augmentation and/or demand reduction, if any, would be necessary under such circumstances. The deficit conditions can be graphically represented as shown on Figure 1. This figure illustrates a water shortage by the end of February and supply augmentation in the beginning of May to help with a worsening drought.

Supply Augmentation/Demand Management: The triggering of successive drought phases should be correlated with a series of realistic deficit reduction goals. Most communities have used between three and five phases.

Trigger levels: The specific data used to "trigger" sequential drought response phases must be identified. Then, with deficit reduction goals quantified, the appropriate water-saving measures can be subsequently selected for the demand reduction program. Comparison of forecasted supply and demand provides the basis for initiating or upgrading a drought emergency. A sliding scale for trigger values is often represented graphically. In the drought response plan for the Delaware River Basin, several stages of diversions, reservoir releases, emergency reservoir operations, and conservation measures are keyed to four drought conditions. These conditions are determined from a set of operation curves based on the total remaining available storage in three reservoirs. A typical drought indicator curve is shown on Figure 2.

Deficit reduction objectives for each drought phase are commonly expressed as a percentage of average demand levels or as a quantity (volume or rate) of water saved. A sample phased program has been developed as a guide:

Phase	Water Shortage	Target Water Savings, percent
I	Moderate	5 to 10
II	Severe	10 to 20
III	Critical	20 to 35

Phase I relies upon voluntary action by the water consumers in anticipation of a future drought characterized by a modest water shortage. Subsequent phases are in response to increasingly severe drought conditions. Phase II utilizes some mandatory measures and Phase III involves water rationing. Phase III would be initiated only in rare circumstances and is set at the maximum level of water savings that could be achieved in a community without severe hardship. The phases should be designed to be somewhat flexible. An agency does not necessarily move through each phase in every circumstance. It is more likely that a voluntary program (Phase I) would be tried at the first sign of a drought and then, if the drought worsened, Phase II or III would be entered.

Evaluate Water Saved By Phased Reductions: The water saved by one of the phases will vary from month to month. For instance, the effectiveness of measures emphasizing outside water use reduction will be higher in the warmer months. The estimated water savings from the sample three phase plan can be used to decide which phase to select to reduce demand to match available supply. The following procedure, illustrated in Figure 3 is recommended.

1. Graph projected water supply. Include the analysis of supplemental sources in determining the available water supply for the coming year.
2. Estimate dry year water demand. Apply the percent savings anticipated for each phase to the projected dry year demand (reduction) curve. Graph the results as a series of three adjusted demand curves together with the

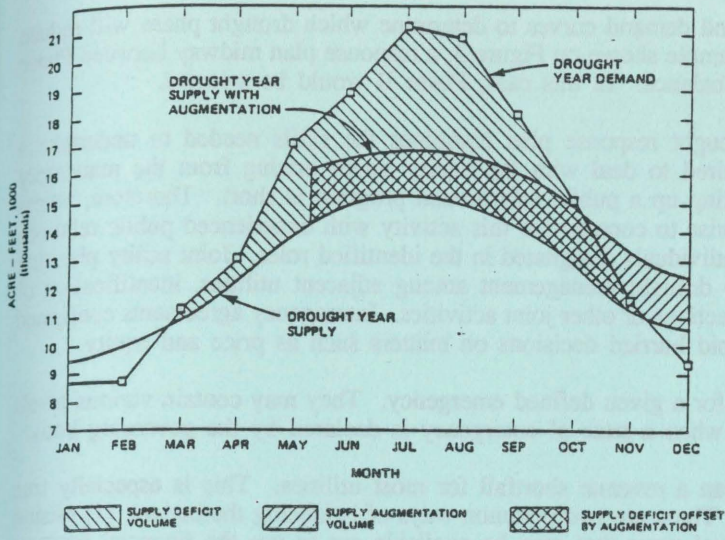
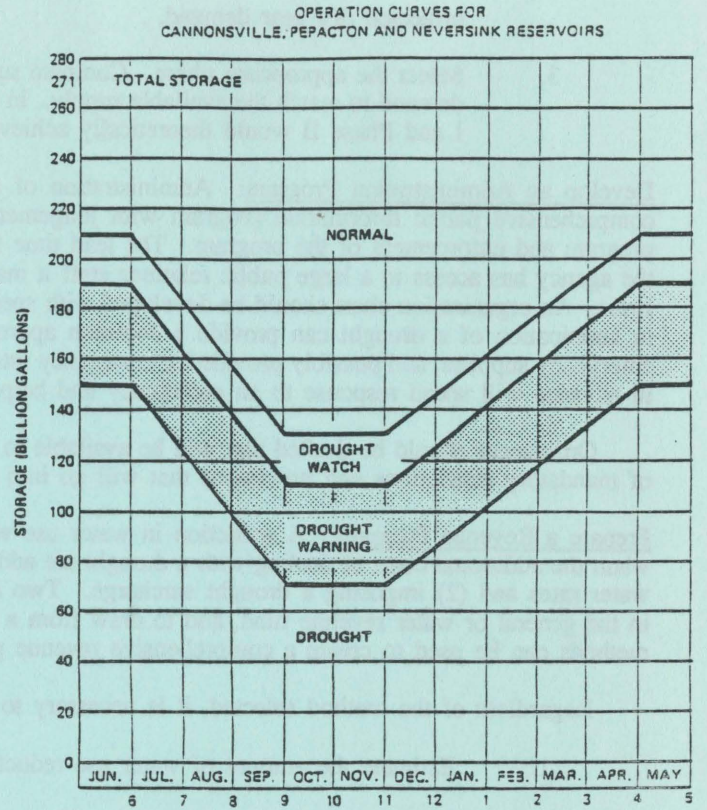


Figure 1 Projected Supply Deficit Conditions



Source: Commonwealth of Pennsylvania, Department of Environmental Resources, Office of Resources Management, Bureau of Water Resources Management, Pennsylvania Drought Contingency Plan for the Delaware River Basin, March 1985.

Figure 2 Graphic Method of Drought Staging Based on Reservoir Levels

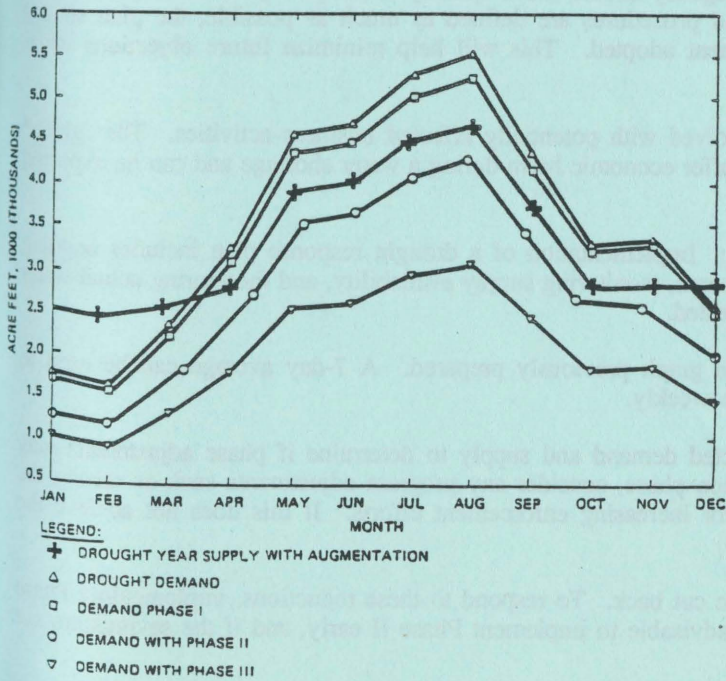


Figure 3 Projected Supply/Demand and Phased Reductions

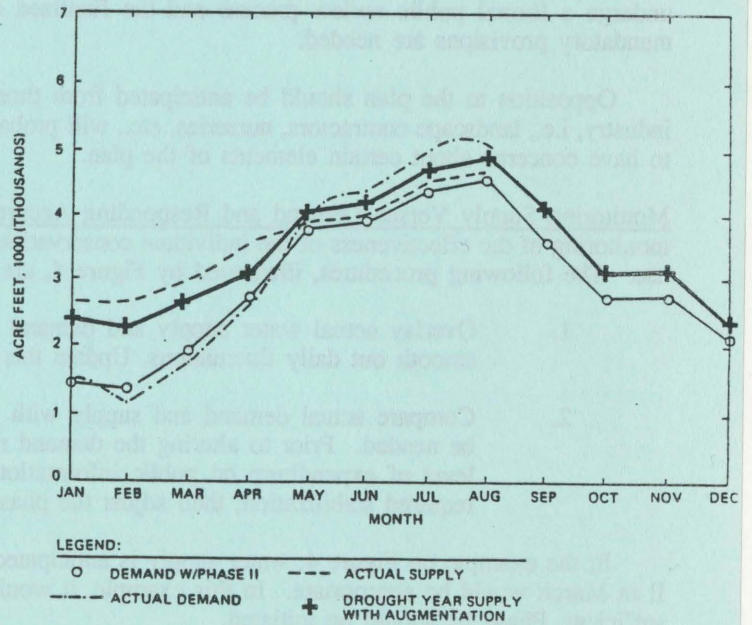


Figure 4 Available Supply/Actual Demand and Required Phase

projected dry year demand.

3. Select the appropriate phase. Compare supply and demand curves to determine which drought phase will reduce demand to match the available supply. In the example shown on Figure 3, a response plan midway between Phase I and Phase II would theoretically achieve this balance. In this case, Phase II would be selected.

Develop an Administration Program: Administration of the drought response plan combines the skills needed to undertake a comprehensive public information program with judgement required to deal with the equity issues arising from the mandatory program and enforcement of the program. The lead time for setting up a public information program is short. Therefore, unless the agency has access to a large public relations staff it may be wise to contract for this activity with experienced public relations firms. An organization chart should be developed with specific individuals designated in the identified roles. Joint utility planning in anticipation of a drought can provide a common approach to drought management among adjacent utilities, identification of emergency supplies, and possibly provide for emergency interconnections or other joint activities. Interagency agreements confirmed in advance will speed response to an emergency and help to avoid hurried decisions on matters such as price and equity.

Ordinances should be drafted that will be available to adopt for a given defined emergency. They may contain various levels of mandatory restrictions and provisions that will go into effect when a state of emergency is declared by the governing body.

Prepare a Revenue Program: A reduction in water use will mean a revenue shortfall for most utilities. This is especially true when the additional costs of dealing with a drought are added in. There are two common ways of balancing the budget: (1) raising water rates and (2) imposing a drought surcharge. Two additional ways that may be available are to use the financial reserves in the general or water revenue fund, and to draw from a designated drought emergency account. Various combinations of these methods can be used to create a comprehensive revenue program.

Regardless of the method selected, it is necessary to include the following actions as part of the revenue program:

1. Estimate the amount of water use reduction that will be achieved and the associated lost revenue.
2. Design a rate adjustment or drought surcharge that will cover the anticipated revenue deficit.
3. Monitor actual revenue and compare with forecasted revenue; adjust drought surcharges as needed (but not too often).

Adopt The Drought Response Plan:

Once it is decided that a drought plan is needed, the water agency should move quickly to adopt a plan. The process can usually be completed within 1 to 3 months. When all issues and procedures are defined as much as possible, the plan should undergo a formal public review process and the finalized document adopted. This will help minimize future objections when mandatory provisions are needed.

Opposition to the plan should be anticipated from those involved with potentially affected business activities. The "green" industry, i.e., landscape contractors, nurseries, etc., will probably suffer economic harm during a water shortage and can be expected to have concerns about certain elements of the plan.

Monitoring Supply Versus Demand and Responding Accordingly: Implementation of a drought response plan includes ongoing monitoring of the effectiveness of the individual conservation measures, monitoring supply availability, and monitoring actual water use. The following procedures, illustrated by Figure 4, are suggested.

1. Overlay actual water supply and demand on the graph previously prepared. A 7-day average can be used to smooth out daily fluctuations. Update this graph weekly.
2. Compare actual demand and supply with projected demand and supply to determine if phase adjustments may be needed. Prior to altering the demand reduction phase, consider any program adjustments such as raising the level of expenditure on public information and/or increasing enforcement efforts. If this does not achieve the required stabilization, then adjust the phase.

In the example on Figure 4, water supply is anticipated to be cut back. To respond to these reductions, implementing Phase II in March would be appropriate. In this example, it would be advisable to implement Phase II early, and if the savings are not sufficient, Phase III should be initiated.

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