Colorado Water

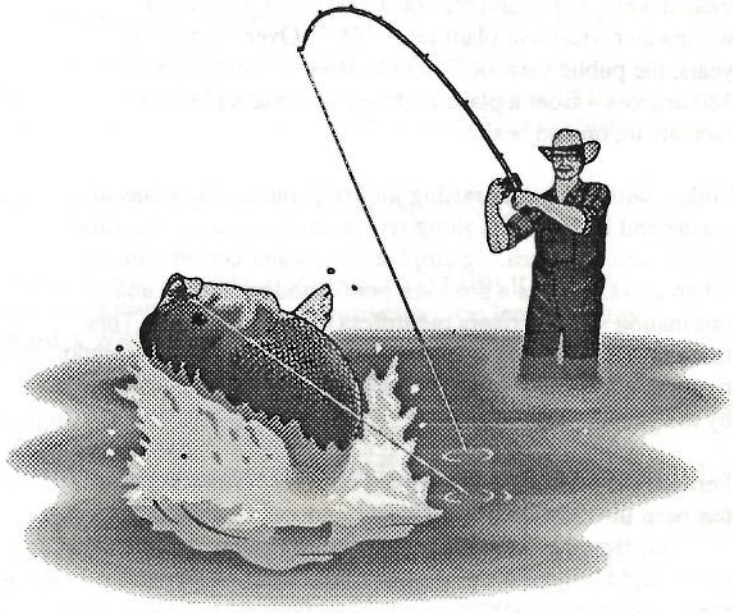
Newsletter of the Colorado Water Resources Research Institute. Fort Collins, Colorado 80523

WATER ITEMS AND ISSUES . . .

August 1996

..... RESTORING
.....OUR RIVERS

..... see page 4



Colorado State University

Restore!

Editorial by Robert C. Ward

While reading several Colorado newspapers over the past six months, I have been amazed at the increasing public support for the general concept of "restoring our rivers." Exactly what "restoration" means seems to vary from river to river and community to community -- from native species habitat restoration to the restoration of a human presence along a town's river banks. The bottom line is, much more public attention is being focused on the general condition of Colorado's rivers.

A number of things appear to be converging to bring this about. I would like to review these trends and point out an excellent, up coming opportunity to learn more about river restoration efforts in Colorado, particularly in the South Platte Basin.

There has always been a public fascination with rivers in Colorado -- a fascination that has gone beyond the need to develop water for public water supply and irrigated agriculture. Historically, this public interest in rivers was directed toward mountain streams, as fishermen appreciated the challenge of a free-flowing river and tourists (local and out-of-state) appreciated the beautiful scenery in which the rivers played a large part. Unfortunately, as the rivers flowed out of the mountains and through the cities, they were not treated well. For example, Fort Collins did not have a wastewater treatment plant until 1948! Over the past 50 years, the public view of Colorado Rivers has changed almost 180 degrees – from a place to dump waste to a place to recreate in, on and beside.

Today, with a growing rafting industry, increasing miles of hiking and biking trails along rivers, intense water education efforts, and an increasing emphasis on water conservation in urban areas, there is a growing public understanding and fascination with all rivers regardless of their location. This fascination is growing into a political will to restore Colorado rivers to a form and setting deemed acceptable and desirable by the public.

Perhaps the most dramatic impact on river restoration efforts has been the creation of the Great Outdoors Colorado (GOCO) Board and its full funding with Lottery money. This has brought large sums of money to the creation of open space and parks which, increasingly, involves restoring Colorado's rivers. It has also attracted the attention of the environmental consulting community, and as a result, more consultants specialize in river restoration. As rivers are restored, recreation and tourist business around the restored river enhances the economic health of a community. One can sense that the increased economic activity surrounding river restoration will build a self-sustaining momentum toward further river restoration and economic activity.

Additional support for river restoration comes from many of Colorado's water managers, who see in such efforts a way to protect native species in Colorado and minimize the probability of their being listed as endangered species (a situation that can move river management into highly skewed situations to address the needs of one species to the potential detriment of others, including the human species). The

COLORADO WATER

Vol. 12, No. 4 August 1996

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COLORADO WATER is a publication of the Colorado Water Resources Research Institute. The scope of the newsletter is devoted to enhancing communication between Colorado water users and managers and faculty at the research universities in the state.

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

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Robert C. Ward, Director

maintenance of a healthy river system is increasingly being viewed as the way to protect existing water rights of Colorado water users.

How do we go about restoring a river? This has been the focus of a number of researchers in both Colorado's higher education system and in federal and state government research labs for a number of years. The results of this research are helping restore our rivers. Included in this issue of *COLORADO WATER* is an example of such research. The article describes the efforts of a group of CSU engineers to assess the degree of similarity between a restored river channel and a "reference" site using hydraulic characteristics of the river. This "reference" site method has been used by biologists for many years to evaluate the biological health of a stream. The goal is to create natural low-flow characteristics in the disturbed river channel that will permit the biology to establish itself as it would in the natural "reference" stream.

What is the ultimate endpoint of river restoration efforts? This is highly debatable, but it is the next question to be answered as Colorado moves to restore its rivers. Gaining insight into the answer will be the focus of the 7th Annual South Platte Forum to be held in Denver October 29-30, 1996. The theme is "Bringing the River Back...To the Future." Note that the title does not say "Bringing the River Back... To the Past." The title recognizes that we can't go back. There are too many of us in Colorado to ever think we can restore the rivers to a condition that existed before large numbers of people arrived. The title, however, does point out the need to decide what we want our rivers to be and how we are going to get there. I highly recommend this meeting to you. The organizers have done an excellent job in bringing together the movers and shakers of many of the river restoration efforts along the Front Range.

What were the goals of the people who built the first wastewater treatment plants along the Front Range? Could they have envisioned today's river restoration efforts as a culmination of their initial efforts? Where will the rivers be in another 50 years? Water management in Colorado is an evolving process, and water-related research, such as that fostered and supported by CWRRI over the years, is a critical element of this evolution.

SIX COLORADO WATER RESEARCH PROPOSALS SUBMITTED

Colorado faculty are principal or co-principal investigators in six proposals submitted to the Regional Water Resources Competitive Grants Program for the Western Region. (As announced in previous newsletters, this regional competition replaced the annual CWRRI Water Research Program for FY1996.) Announcement of awards is expected in August. Proposals that are funded will begin on September 1, 1996. The proposals are:

DO ENVIRONMENTAL DECISION SUPPORT SYSTEMS MAKE A DIFFERENCE? Principal Investigator: Rene Reitsma, Center for Advanced Decision Support for Water and Environmental Systems, the University of Colorado.

FEASIBILITY STUDY FOR THE DEVELOPMENT OF A DECISION SUPPORT SYSTEM FOR A MULTI-STATE RIVER BASIN, Principal Investigator: Luis Garcia, Integrated Decision Support Group, Colorado State University.

VALUE OF RESEARCH AND DATA IN SOLVING WESTERN WATER PROBLEMS, Neil S. Grigg, Civil Engineering, Colorado State University.

PROVIDING RESULTS FROM EPA'S ENVIRONMENTAL EDUCATION PROGRAMS TO PUBLIC SCHOOL EDUCATORS IN THE WESTERN U.S. THROUGH THE INTERNET, Principal Investigator, Ric Jensen, Texas Water Resources Institute; Co-Investigator: Robert C. Ward, CWRRI Director; William Funk, State of Washington Water Research Center; Linda Stevens-Moore, Arizona Water Resources Research Center.

RETURN FLOWS IN URBAN LANDSCAPE IRRIGATION WATER USE, Principal Investigator, Ramchand Oad, Chemical and Bioresource Engineering, Colorado State University; Co-Investigators: Terry Podmore and Harold Duke, Chemical and Bioresource Engineering, Colorado State University; Mohan Reddy and Larry Pochop, Civil Engineering, University of Wyoming.

INSTITUTIONAL ADJUSTMENTS FOR COPING WITH PROLONGED DROUGHT IN THE RIO GRANDE, Principal Investigator: Frank A. Ward, Economics, New Mexico State University; Co-Investigators: Robert Young and Marshall Frasier, Agricultural and Resource Economics, Colorado State University; Ronald Lacewell and John Ellis, Economics, Texas A&M University; J. Philip King, Hydrology, New Mexico State University; Raghavan Srinivasan, Hydrology, Texas A&M University; Thomas McGuckin, Water Economist, New Mexico State University; and Consultants Charles DuMars, Water Lawyer, University of New Mexico and James Booker, Computer Modeler, Alfred University, New York.

WATER RESEARCH

EVALUATING THE RESTORATION OF LOW-FLOW AQUATIC HABITAT

by Brad Florentin, Steven R. Abt and Chester C. Watson

Goose Creek, Colorado, located approximately 97 km west of Alamosa, is considered a gold medal fishery. The Goose Creek stream exhibits natural, restored, and degraded reaches. It was the site selected to evaluate RCHARC, the Riverine Community Habitat Assessment and Restoration Concept. RCHARC is a procedure created to assess the degree of similarity between a restored channel design and a Control Standard River System (CSRS) using the hydraulic characteristics of the stream. Macrohabitat and microhabit data were collected in the three study reaches of Goose Creek for each of the three comparison combinations (natural vs. restored, natural vs. degraded, and restored vs. degraded) and input into the RCHARC computer program.

The following article presents summaries of:

the aquatic habitat and the channel design process,
structures and channel configurations that can enhance aquatic habitat,
channel restoration guidelines,
restoration efforts at Florida's Kissimmee River and at five western streams,
designing a restoration project,
analysis of an 11 km segment of the Goose Creek stream, and
recommendations to enhance the aquatic habitat assessment process.

The project advisory team included Jay Skinner and Steve Puttman, Colorado Division of Wildlife; Freeman Smith and Ellen Wohl, Department of Earth Resources, Colorado State University; Batman Hatami, Colorado Division of Water Resources; and Pat McDermott, Water Resources Division 3. The project was funded by the U.S. Army Corps of Engineers and CWRRI.

AQUATIC HABITAT AND CHANNEL DESIGN

Assessing the quality of aquatic habitat in stream restoration is an important aspect of the channel design process. Aquatic habitats include interdependencies among fish, riverbank vegetation and animals, hydrologic patterns, and hydraulic parameters. Restoration of aquatic habitats is complicated in that it is difficult for engineers, biologists and environmentalists to effectively communicate because each profession has a unique focus and vocabulary to describe the same stream. Stream channel restoration design presently is too qualitative, as few standards or criteria relating to aquatic habitats are universally accepted by restoration proponents. Despite the need, there is a lack of universally accepted, quantitative design standards and criteria for the restoration of aquatic habitat.

***Macrohabitats*--Macrohabitats** for aquatic biota include water and air temperature, water quality, geology, elevation, bed slope and water supply. These habitat components apply to an indefinite stream reach length, providing the template on which stream fauna and flora thrive given favorable microhabitat conditions.

***Microhabitats*--Microhabitat** components of aquatic habitat include velocity, depth, substrate and cover. For example, fish respond to and flourish in microhabitats that are located within favorable macrohabitats. Microhabitats are directly related to the stream hydraulic conditions of channel structure and hydraulic system.

***Channel Structure*--Channel structure** describes the cover and substrate related to the physical characteristics of the channel. Substrate is more influenced by hydraulic parameters than cover, and this relationship is described by the variable Q_{17}, which represents the discharge that is exceeded 17 percent of the time. The Q_{17} variable is the flow that flushes impacted fine sediment out of the substrate. Usually, the channel structure remains unchanged by a variation in discharge.

Hydraulic System Components--Hydraulic system components include depth and velocity, both directly related to discharge. Distributions of flow depths and velocities represent the habitat template upon which the aquatic community is structured. Changes in the frequency distribution of the flow depth and velocity will result in associated changes in the aquatic community. Depiction of a stream reach in terms of frequency distributions of depth and velocity is likely to capture the stream heterogeneity that dictates the aquatic community composition. A diagram representing the habitat classification system is presented in Fig.1.

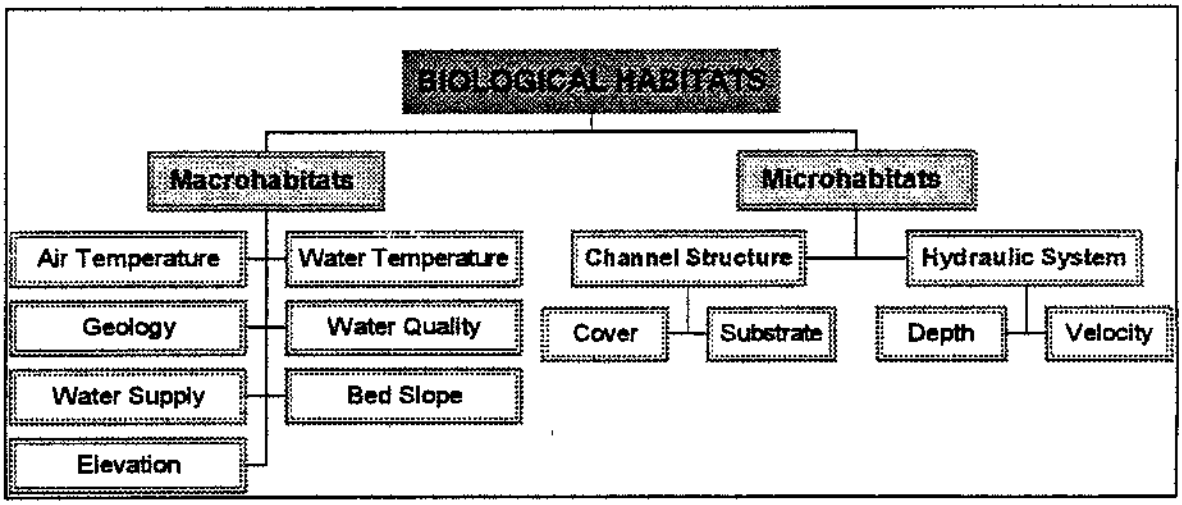


Figure 1. Biological Habitat Categories

STRUCTURES THAT ENHANCE AQUATIC HABITAT

Six structures and channel configurations that enhance aquatic habitat have been identified:

- Eddy rocks slow erosive velocities in the channel, provide protective cover, and provide scour holes downstream of the eddy rocks for aquatic habitat.
- Deflectors, or hard points, stabilize eroding banks by creating slower velocities near the bank. Deflectors also direct the flow away from the bank and, if used on alternating sides of the channel, can promote meandering.
- Grade stabilization dams, or instream checks, decrease the slope of a channel, reducing stream velocities. They also increase the depth of scour holes and oxygen content.
- Gravel riffles enhance and promote stable substrate in erosive stream beds.
- Vegetation provides bank protection and allows a thick network of roots to continue to protect the bank with little or no maintenance.
- Two-stage channels provide aquatic habitat during low flows (one to two-year events) while providing hydraulic efficiency during flood flows (two to ten-year events).

CHANNEL RESTORATION EFFORTS

Restoration of stream habitat is costly, and due to the expense, a comprehensive consideration of the design aspects by the design team is required to ensure success. A typical design team is composed of, but not limited to, engineers, biological scientists, landscape architects and citizen groups.

Restoration Guidelines

The design team must determine the extent of the habitat to be restored. A complete biological habitat restoration requires the reestablishment of historic inflow characteristics. However, other project objectives and requirements may not allow historic inflow characteristics to continue or exist. An example would include a dammed river that provides hydropower. An alternative is to improve the microhabitat components that contribute to the restoration of aquatic habitat, which indirectly can lead to improvement of the riverbank vegetation and wildlife habitats.

Many habitat restoration designs include structural modifications. These modifications, however, have been found inappropriate for three conditions:

- streams that exhibit high sediment loads;
- streams that have high peak flows; and
- streams that contain severely eroding banks.

The Effects of Reduced Flow -- Restoration of Florida's Kissimmee River

Before 1962, the Kissimmee river flowed naturally and unimpeded from Lake Kissimmee to Lake Okeechobee in Florida. The river and floodplain were a haven to 39 species of fish, 19 species of waterfowl and diverse littoral flora. The Kissimmee River was subsequently channelized between 1962 and 1970

Six water control structures were built during the same period. As a result, many of the adjacent marshes and sloughs were drained and the channel was narrowed and deepened. This significantly reduced the habitat for wading birds and waterfowl. The reduced flow through the marshes in the river channel and the impounded water reduced the dissolved oxygen to a toxic level.

To restore the habitat, the Florida legislature enacted the Kissimmee River Restoration Act in 1976. A Corps of Engineers environmental impact statement determined that stage and discharge characteristics should be reestablished as well as the creation of a flow through marsh. As a result, portions of the waterfowl habitat returned, but dissolved oxygen levels did not recover except in one remnant river channel which had been reopened and received regular baseflows. Inflow characteristics could not be fully reestablished, and therefore the habitat was not fully restored.

The Kissimmee River project team provided recommendations for a restoration evaluation program which included the following:

- provide a thorough understanding of ecosystem structure and function, including a predictive capability for most components -- with and without restoration;
- show direct cause-effect relationships between restoration measures and ecological responses;
- include quantifiable biological responses and statistical comparisons; and
- document ecological changes that are of both social and scientific importance.

The Restoration of Five Western Low-Flow Channels

Five western streams have been successfully restored to enhance flood storage, reclamation of extensive mining efforts, recovery from channelization, or recovery from sedimentation damage:

- Rapid Creek in Rapid City, South Dakota;
- Blue River in Breckenridge, Colorado;
- South Platte River near Chatfield Reservoir in Denver, Colorado;
- Wildcat Creek in Richmond, California; and
- San Pablo Creek in Richmond, California.

These successful restoration projects were found to include the following elements:

- a team approach included the cooperation of scientists, engineers, landscape architects and citizen groups;
- a low-flow design criteria was used (see Table 1);
- the design restoration team identified alternatives to take advantage of the multi-purpose nature of many of the habitat-enhancement structures.

TABLE 1. Low-Flow Channel Design Criteria

Design Parameter	*Recommended Criteria*
Low-Flow Design Flow	1- to 2-year recurrence
Minimum Flow Depth	0.3 meters
Bend Radius	3 times channel width for small streams
Meander	1.1<sinuosity<1.5, or match adjacent reaches
Randomly Placed Rocks	Not effective in fine-grained streams. Place where velocity > than 1 m/s, 1-rock per 28 sq. m of channel, 0.6 m min diameter, no greater than channel width.
Pools	Pool to pool interval of 5 to 7 widths, place in bends, pools no longer than 3 channel widths, no shorter than 1 channel width, place on alternating sides.
Riffles	Place in straight reaches, riffle length: ½ to 2/3 pool length, riffle width 10 percent to 15 percent wider than pool. Alternate pools and riffles.
Deflector Wing	Place on max 3-percent channel slope, 6 to 7 channel widths apart, anchor more than 1.2 m into bank, height: 0.15 to 0.30 m above low-flow water surface, install on alternate banks, extend into low-flow channel to channel width. Bank protection may be needed on opposite bank.
Sill	Height of 1/3 design discharge flow depth, keyed into bed minimum of twice height. Bank protection needed 1 to 3 channel widths downstream.
Dike	Length less than 15 percent to 25 percent channel width, space of 3 to 6 times dike length, orient 90 to 150 degrees, height: 0.15 to 0.3 m above low-flow water surface.
Bank Cover	Cover placed at low-flow water surface, place on outer bank, depth greater than 1 m.
Microorganisms	Recommended velocities of 0.3 to 0.8 m/s.
Food Production	Recommended velocities of 0.5 to 1.1 m/s.

Restoration of Warm-Water Incised Streams

Aquatic habitat restoration has been successful in warm-water incised streams using small stone weirs and extending spur dikes to enhance aquatic habitat. In an ongoing study three streams were selected for a stone weir study. One stream was incised, one was incised and weirs placed at specified locations, and one stream was non-incised. The goal was to restore the incised channel to the aquatic habitat characteristics of the non-incised channel. Stone weirs were selected to provide pool habitat in the incised channel. Scour holes resulting from such structures in unstable, incised channels tend to support more species and larger fish than the surrounding channel habitat without structures. One year after restoration, the mean width, depth, and velocity exhibited changes of +56 percent, +150 percent and -56 percent respectively. Although there was not a drastic change in aquatic habitat, the restored stream became similar to the non-incised channel rather than the reference incised channel.

A similar study that involved extending existing spur dikes to restore pool habitat in an incised stream was an immediate success. Only four months after restoration, the scour holes caused by the spur dike extensions had increased depth from about 32 cm to 84 cm. It was also determined that a dike extension angled downstream produced deeper scour holes than an extension angled upstream. The number and size of fish were reported to increase by 50 percent. The extension of the spur dikes had little effect on the bed material size in the main channel.

DESIGNING A RESTORATION PROJECT -- INTRODUCING RCHARC

The Riverine Community Habitat Assessment and Restoration Concept (RCHARC) was developed by John M. Nestler, L. Toni Schneider and Doug Latke, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi to compare aquatic habitats in the mainstem reservoir tailwaters of the Missouri River. RCHARC is a simulation approach for relating the effects of flow alterations on aquatic biota using the stream system as a basis of comparison and a standard against which project alternatives can be evaluated. The model analyzes the effects of river and tailwater operations on the physical environments of native riverine habitat. It allows a quantitative and qualitative analysis of the degree of similarity between a natural reach (Control Standard River System, CSRS) and a restored reach. Aquatic habitat simulation is achieved by selecting a CSRS that has similar macrohabitat characteristics to the restored reach.

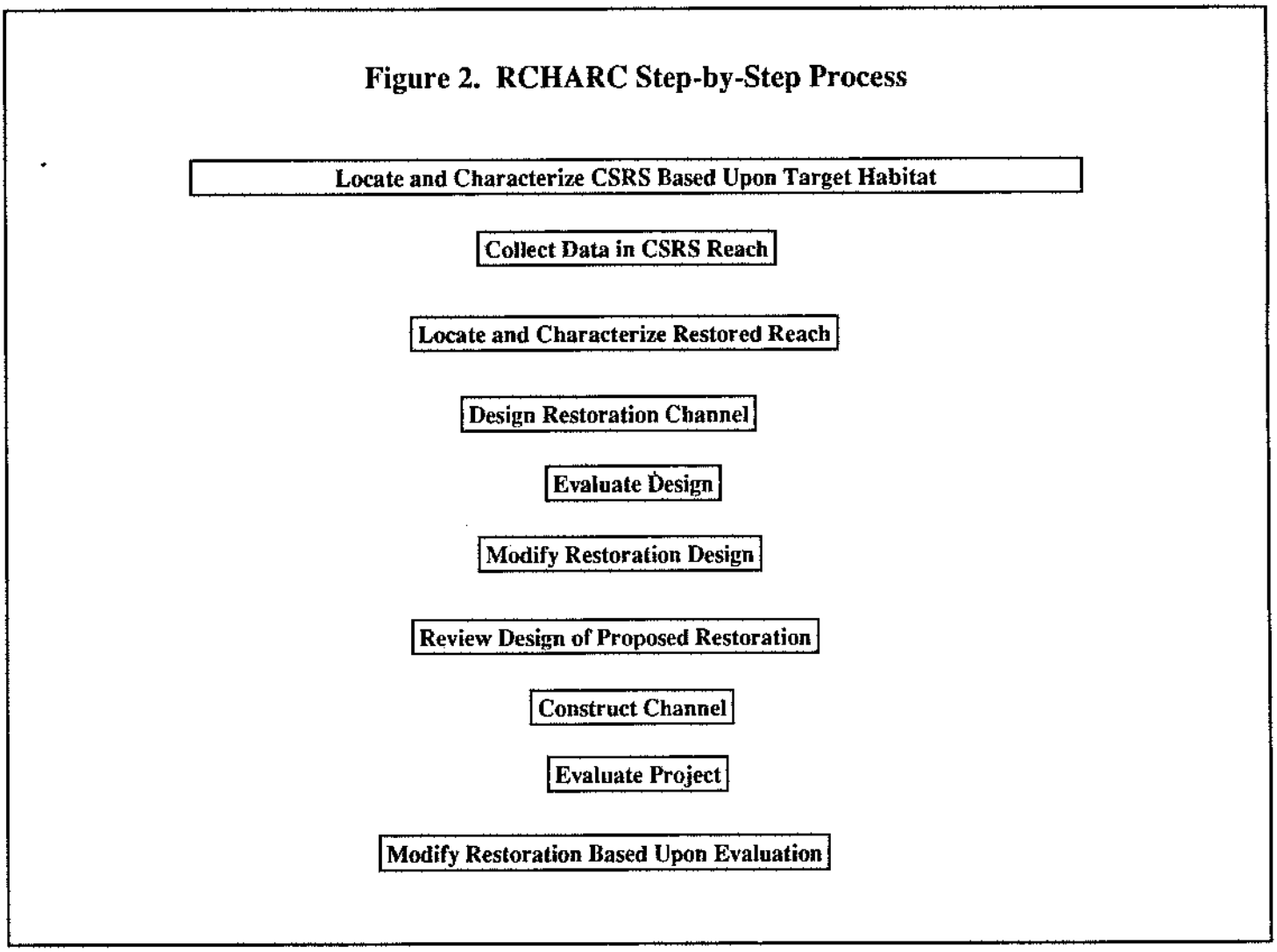
The original RCHARC program is a series of subprograms written in SAS, a computer program for statistical computations. RCHARC utilizes the subprogram PHABSIM/IFG4 to calculate simulated velocities for a cross-section given calibration velocities, discharge, cross-section geometry, and water-surface elevation. IFG4 must use field-collected velocities to calibrate the simulated velocities. HEC-2 is used in conjunction with the RCHARC model to calculate water surface elevations throughout the stream assuming steady, gradually varied flow. The HEC-2 program cannot directly assess habitat; however, it can be used to compute the parameters that influence habitat. RCHARC uses the depths at each cross section that are obtained from the output of HEC-2 simulations.

The RCHARC process has advantages over previously developed models.

- RCHARC output may be used to compare hydraulic (velocity and depth) conditions and habitat similarity between proposed channel reaches.
- Similar hydraulic parameters at specified discharges indicate similar habitat and should also lead to similar sediment transport capacities.
- When depth and velocity frequency distributions are dissimilar between comparison reach conditions, habitat enhancement features, including dikes, boulders, pools, riffles, drops, etc. may be considered. Alternative designs can be introduced and assessed. The process is repeated until a design is achieved which meets both habitat and flood conveyance objectives.
- The combined RCHARC/HEC-2 channel assessment procedure requires a team approach when evaluating comparison reaches. Biologists, landscape architects, engineers and geomorphologists may be needed to fully assess aesthetics and habitat, to classify stream characteristics, and to design flood control structures.

Ten steps must be performed to apply the RCHARC process to a stream (see Fig. 2).

Figure 2. RCHARC Step-by-Step Process



GOOSE CREEK -- A DESCRIPTION OF THE RESEARCH SITE

The headwaters of Goose Creek originate in the Weiminuche Wilderness on the upper plateau in the San Juan mountain range. Goose Creek empties into the Rio Grande River immediately upstream of Wagon Wheel Gap, Colorado. The section of Goose Creek assessed in this study extends from the wilderness boundary to the confluence of Goose Creek with the Rio Grande River. Three separate and unique reaches were selected for observation and field characterization:

The natural reach, located immediately downstream of the wilderness boundary; had not been structurally modified other than by natural processes. The seclusion has resulted in an environment that is primarily controlled by the natural flows and forces of the tributary watershed. he average width is approximately 8.41 meters. The natural reach typically exhibited a higher average velocity than that of either the restored or the degraded reach, with a diversity of pine trees, willows and aspen along the banks.

The restored reach, located near the midsection of the study segment, was restored by a property owner to develop a haven for fishing. Prior to restoration, cattle degraded the stream banks and vegetation, impacting the natural aquatic habitat. Restoration features include drop structures, boulder and log bank protection, and willow plantings indicative of the natural reach. The stream indicated a greater meander pattern than the natural reach, with a top width of approximately 8.66 meters. The boulder-lined meanders encourage the stream to remain in one channel, while large boulders were placed in the typically small cobble and coarse gravel bed. Grasses and willow plantings dominate the banks of the restored reach.

The degraded reach, located about 2 km downstream from the restored reach, is adjacent to an abandoned mine. The tailings from the mine have contaminated the habitat. The stream banks have severely eroded and bank vegetation has not survived the adverse environment. The degraded stream reach is not stable and exhibits a tendency to have shallow depth and a large top width averaging about 11.05 meters. Algae and moss grow on the channel bed, which is composed of small cobbles and coarse gravel.

GOOSE CREEK ANALYSIS USING RCHARC

The RCHARC-generated three-dimensional bivariate surfaces display a comprehensive view of the depth-velocity pair distributions as shown in Figures 3, 4, and 5. A qualitative analysis can be performed to predict the peak distribution for each reach since the surface of the distribution can be observed. The three-dimensional bivariate surfaces allow visualization of the uniform depth-velocity pair distribution of the degraded reach and the skewed distribution of depth-velocity pairs displayed by the natural and restored reaches.

Comparison of Habitats for the Three Reaches

The data collected in the three reaches were input into RCHARC to compare the similarity of the reaches.

The classified habitats for each of the three reaches are within ±5 percent in the classified habitat of shallow pool, raceway, medium pool, and deep pool. Of the remaining classified habitats, the natural reach exhibits the highest percentage of the three reaches in the fast riffle category. The restored reach exhibits the highest percentage of the three reaches in the undefined habitat classification. The highest percentage in the slow riffle category was exhibited by the degraded reach, while the degraded reach exhibits the lowest percentage in the categories of fast riffle and the undefined habitat.

All reaches demonstrated a good degree of habitat similarity for depth-velocity pairs. The restored reach and the degraded reach have similar bed material gradations. The natural reach and the degraded reach have the least similar bed materials, although the comparisons indicate all reaches have a good degree of similarity for bed materials. Results indicated that the restored reach and the degraded reach are the most similar hydraulically of the three comparison combinations. The natural reach and the degraded reach are the least similar. All reaches, however, exhibit a good degree of similarity for the comprehensive hydraulic characteristics of the stream.

Bed material comparison may be a decisive factor in selecting a restoration design alternative. A comparison of the restored vs. degraded reaches is least similar of the three comparisons based only on depth-velocity pairs. Bed material of the restored reach and the degraded reach are the most similar of the three comparison reach combinations. The bed material comparison more completely describes the effectiveness of a restoration design alternative when combined with depth-velocity pair comparisons.

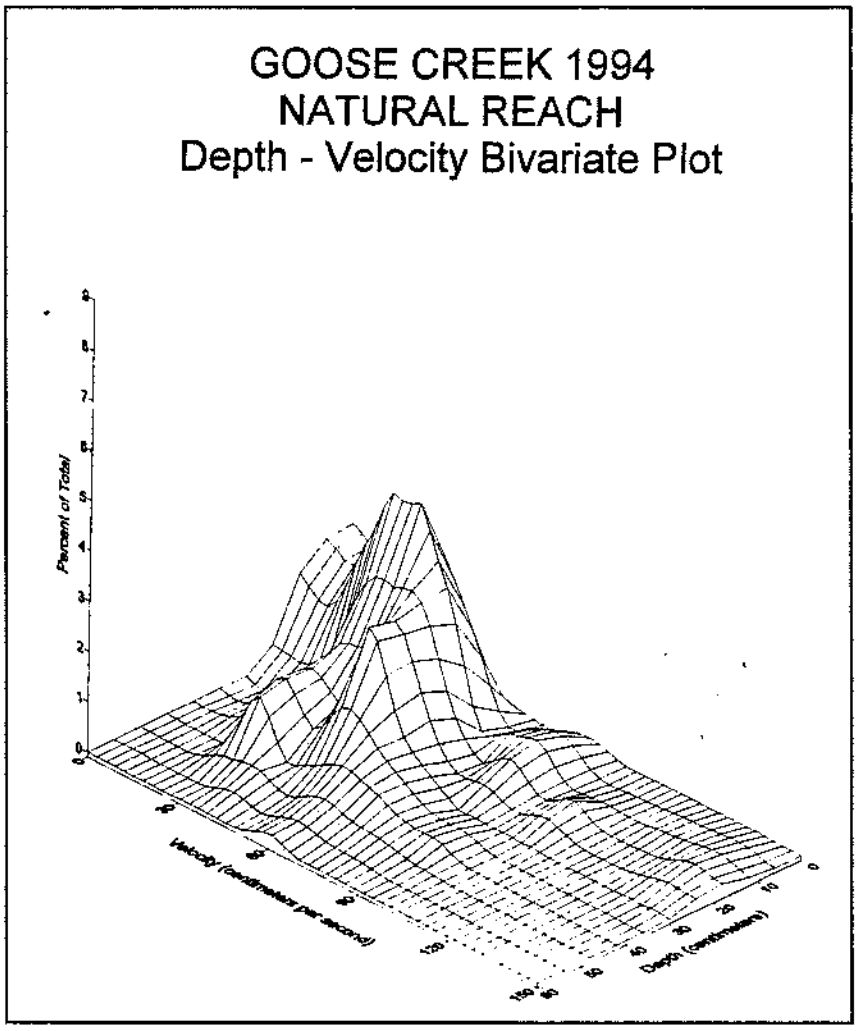


Figure 3. Natural Reach - Generated 3-D Bivariate Plot

Modifications to the RCHARC Process

A modified RCHARC program was developed to streamline the process when field data are available. As modified, field data can be input without processing through the IFG4 subprogram.

The modified RCHARC process parallels the RCHARC process, except IFG4 is bypassed and the data are directly input into the modified RCHARC program.

RCHARC was enhanced to be a stand-alone, executable program in a spreadsheet format to facilitate a user-friendly workspace.

A comparison of the RCHARC program output and the modified RCHARC program output for the habitat classifications for natural, restored and degraded reaches showed similar results (see Table 2, next page).

RECOMMENDATIONS TO ENHANCE RCHARC

Based upon the Goose Creek study, the investigators recommend the following enhancements for the RCHARC program and aquatic habitat assessment process.

- The SAS program in RCHARC records and analyzes empty depth-velocity pairs. When reaches are compared, one of the empty sets is replaced by a small value to better describe the difference between the two reaches. The presence of recorded empty sets inflates the dissimilarity coefficient for the reaches being compared.

- The user of the RCHARC program must be familiar with SAS to operate the program. Since many members in a design team may not be familiar with SAS, the RCHARC program should be written in a more common computer language.

- The IFG4 subprogram is included in the RCHARC process to produce simulated depth-velocity pairs. However, it is not necessary when field-collected depth-velocity pairs are available. The IFG4 subprogram should be excluded when field-collected data are available.

- A comparison of bed material should be included in the RCHARC program to better describe the similarity of aquatic habitats.

- Flume and field studies should be conducted to determine the effects that hydraulic structures (boulder clusters, spur dikes, boulder-lined bank, etc.) have on-stream habitat.

TABLE 2. Habitat Classification Differences - Natural Reach

	Modified RCHARC	RCHARC	Difference in Percentage
Percent of reach that is undefined habitat	11.124 %	14.092 %	2.968 %
Percent of reach classified as "SHALLOW POOL"	33.533 %	35.103 %	1.570 %
Percent of reach classified as: "SLOW RIFFLE"	27.450 %	19.402 %	-8.048 %
Percent of reach classified as: "FAST RIFFLE"	27.352 %	30.984 %	3.632 %
Percent of reach classified as: "RACEWAY	0.405 %	0.119 %	-0.286 %
Percent of reach classified as: "MEDIUM POOL"	0.137 %	0.298 %	0.161 %
Percent of reach classified as: "DEEP POOL"	0.000 %	0.000 %	0.000 %

TABLE 3. Habitat Classification Differences - Restored Reach

	Modified RCHARC	Current RCHARC	Difference in Percentage
Percent of reach that is undefined habitat	16.082 %	14.449 %	-1.633 %
Percent of reach classified as "SHALLOW POOL"	30.059 %	40.467%	10.408 %
Percent of reach classified as "SLOW RIFFLE"	25.898 %	15.564 %	-10.334 %
Percent of reach classified as "FAST RIFFLE"	25.238 %	27.938 %	2.700 %
Percent of reach classified as "RACEWAY"	0.486 %	0.856 %	0.370 %
Percent of reach classified as "MEDIUM POOL"	2.238 %	0.726 %	-1.512 %
Percent of reach classified as "DEEP POOL"	0.000 %	0.000 %	0.000 %

TABLE 4. Habitat Classification Differences - Degraded Reach

	Modified RCHARC	Current RCHARC	Difference in Percentage
Percent of reach that is undefined habitat	8.051 %	17.752 %	9.701 %
Percent of reach classified as "SHALLOW POOL"	35.255 %	40.122 %	4.867 %
Percent of reach classified as "SLOW RIFFLE"	37.288 %	25.772 %	-11.516 %
Percent of reach classified as "FAST RIFFLE"	17.173 %	16.355 %	-0.818 %
Percent of reach classified as "RACEWAY"	0.676 %	0.000 %	-0.676 %
Percent of reach classified as "MEDIUM POOL"	1.557 %	0.000 %	-1.557%
Percent of reach classified as "DEEP POOL"	0.000 %	0.000 %	0.000 %

- The RCHARC (or modified RCHARC) design process should be applied in a field design and construction situation.
- A Quantitative coefficient, other than the Canberra Metric Coefficient, should be developed and incorporated into the RCHARC program.
- The significant degree of similarity between stream reaches should be studied.

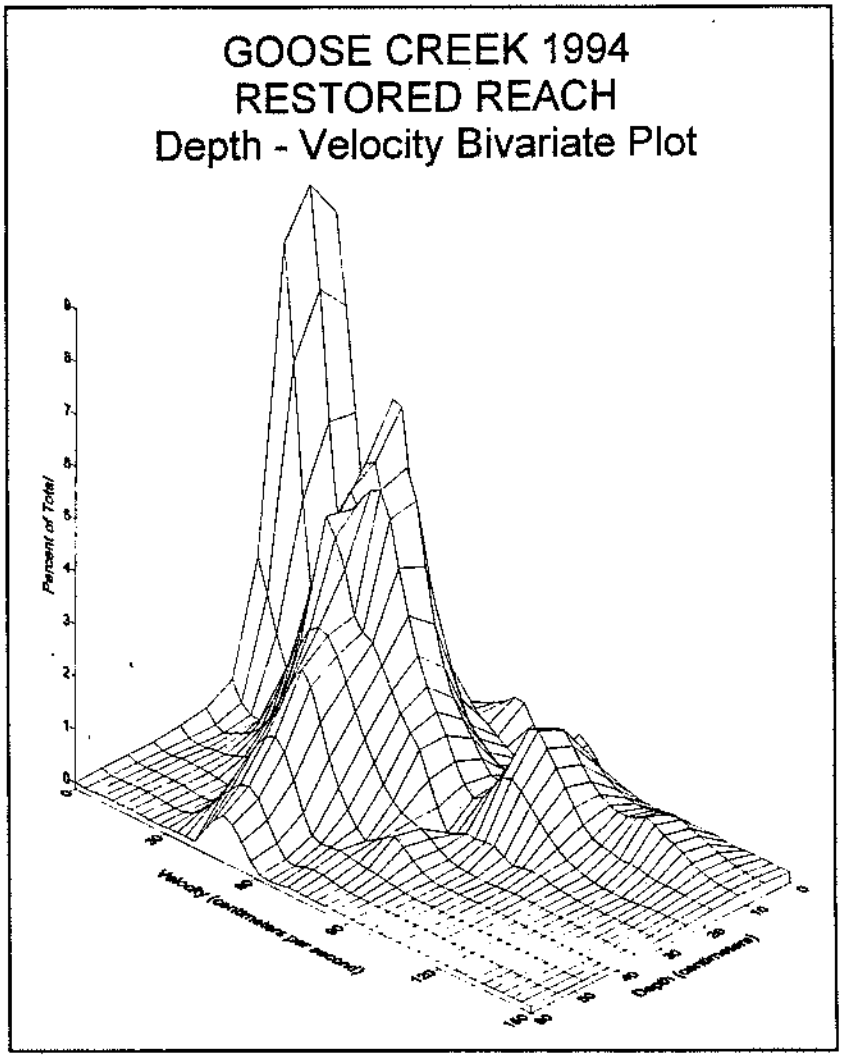


Figure 4. Restored Reach - Generated 3-D Bivariate Plot

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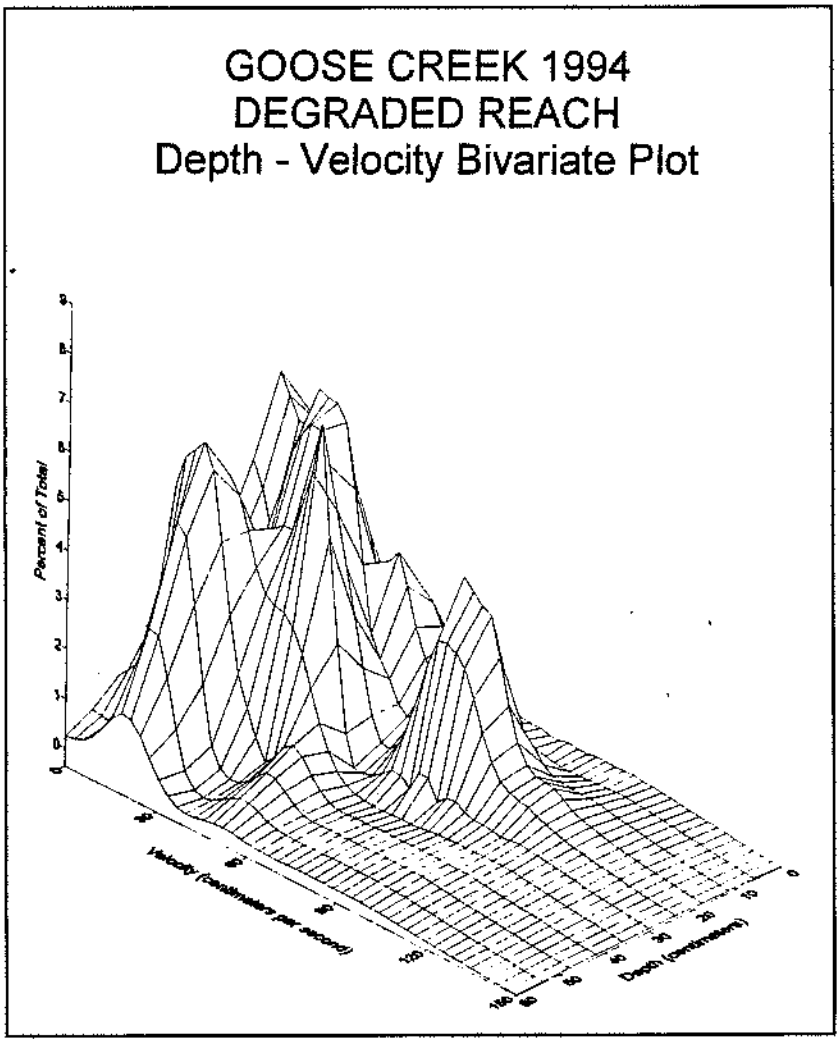

Figure 5. Degraded Reach - Generated 3-D Bivariate Plot

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JAMES BOOKER RECEIVES 1996 BOGGESS AWARD FOR PAPER ON SEVERE SUSTAINED DROUGHT

The American Water Resources Association has presented its 1996 Boggess Award to James Booker for his paper, **Hydrologic and Economic Impacts of Drought under Alternative Policy Responses**, published in the October 1995 issue of the Water Resources Bulletin. The theme of that special issue of the Water Resources Bulletin was coping with severe sustained drought in the southwestern United States, describing research that was conducted under the auspices of the Powell Consortium.) The award is for the best paper published in AWRA's Water Resources Bulletin in 1995. Booker's paper provides detailed estimates of the economic damages that would result from an extreme drought in the Colorado River Basin and suggest s policy approaches that hold particular promise for reducing damages.

James Booker obtained his Ph.D from the Department of Agricultural and Resource Economics at Colorado State under the direction of Dr. Robert A. Young. Research conducted by Young and Booker has been recognized in previous national awards from the Universities Council on Water Resources (Outstanding Water Resources Dissertation by Booker) and the American Water Resources Association (Young received AWRA's 1992 Icko Iben Award for "Outstanding contributions to the promotion of communications among the various disciplines of water resources"). James Booker currently is a faculty member at Alfred University, Alfred, New York.

STORM WATER MANAGEMENT
MANAGING QUANTITY AND QUALITY

Participants will get hands-on experience and become familiar with the newest real-world water resource simulation techniques at a workshop scheduled in Boulder, Colorado on August 12-14, 1996. The workshop will provide participant training with the EPA model XP-SWMM, which incorporates both the latest technical solutions based on local and international research and object-oriented graphical tools to significantly reduce storm water design and analysis effort.

James P. Heaney, Professor of Civil Engineering, University of Colorado and Faculty Associate, Center for Advanced Decision Support for Water and Environmental Systems (CADSWES) is one of the original developers of the EPA SWMM and will be a workshop instructor. Heaney conducted a CWRRI project on the cost-effective management of urban runoff quality. He also is conducting research on design of urban storm water management systems for the Environmental Protection Agency and is leading a Water Environment Research Foundation study on research needs in urban storm water management.

WP-SWMM is a generation jump, based on the firm foundation of the U.S. EPA SWMM model developed progressively since the early 1970s, and is proficient in:

- Urban and Rural Hydrology
- Storm and Sanitary Sewer Hydraulics
- Storm and Sanitary Sewer Hydraulics
- Storm and Sanitary Water Quality Modeling
- Interconnected Pond Routing
- BMP,CSO,SSO, and NPDES Modeling
- Culvert and Bridge Analysis
- Watershed Management

With XP-SWMM's features one can: combine data and graphics in one environment; link to GIS, AutoCAD, and databases; handle large looped networks with many outlets; and utilize built-in decision support and guidance. Other features include: sophisticated physically based modeling; embedded expert system; and intuitive model creation and operation.

Other workshop instructors are Robert Dickinson, Currently Vice President of XP Software in Tampa, Florida and formerly of the University of Florida; Tony Kuch, Technical Support and Training Engineer for XP Software; and Michael Schmidt, currently Technical Director for the Southeastern U.S. and Coordinator of storm water model development and training, Camp, Dresser, and McKee, Inc., Jacksonville, Florida.

The workshop is sponsored by: the University of Colorado, Department of Civil, Environmental and Architectural Engineering and CADSWES; XP Software; Camp, Dresser, and McKee; the U.S. Environmental Protection Agency, Region 8; the Federal Emergency Management Agency, Region 8; ASCE Urban Water Resources Research Council, and CWRRI.

(While notice of this workshop probably will reach readers after the workshop has been held, we provide a summary for those interested in urban storm water management. For more information contact: James P. Heaney at Phone 303/492-3276; FAX 303/492-1347; E-mail heaney@spot.colorado.edu.)

WATER RESEARCH AWARDS

A summary of water research awards and projects is given below for those who would like to contact investigators. Direct inquiries to investigator c/o indicated department and university.

COLORADO STATE UNIVERSITY
Fort Collins, CO 80523

***Diagnosis of Whirling Disease in Colorado Trout**, Robert P. Ellis, Microbiology. Sponsor: Colorado Division of Wildlife.

Watershed Research, Glenn E. Haas, Nat Resource Recreation & Tourism. Sponsor: DOI-National Biological Survey.

Long-Term Ecological Measurements in Loch Vale Watershed, Rocky Mountain National Park, Jill S. Baron, Natural Resource Ecology Lab. Sponsor: DOI-NPS-National Park Service.

Statistical Analysis of Aerial Photography Database from the GCES-II Test Flow Program, Jennifer A. Hoeting, Statistics. Sponsor: DOI-NPS-National Park Service.

*Biosphere-Atmosphere Interactions - A Study of the Energy, Water & Carbon Cycles, David A. Randall, Atmospheric Science. Sponsor: NASA-Goddard.

*The National Atmospheric Deposition Program (NRSP-3), Richard B. Flagler, Natural Resource Ecology Lab. Sponsor: USDA-CSRS-Coop. States Research Service.

Effects of Baselevel Rise on Facies Architecture in Modern Braided River Deposits, Frank G. Ethridge, Earth Resources. American Chemical Society.

Sediment at Westlake Lake, James F. Ruff, Civil Engineering. Sponsor: Ventura County California.

*Population & Environment in the U.S. Great Plains, William J. Parton, Natural Resource Ecology Lab. Sponsor: University of Texas at Austin.

*The Influence of Flow Diversions on Macroinvertebrates..., James V. Ward, Biology. Sponsor: USDA-USFS-Rocky Mountain Experiment Station.

Large-Scale Water Budgets for the United States, Jorge Ramirez, Civil Engineering. USDA-USFS-Rocky Mountain Experiment Station.

Kingfisher..., Glenn E. Haas, Natural Resource Recreation & Tourism. Sponsor: Colorado Division of Wildlife.

Hydrologic Effects of the Grand Ditch on Rocky Mountain National Park, Lee H. MacDonald, Earth Resources. Sponsor: DOI-NPS-National Park Service.

GIS Survey of the Gunnison Research Area, Ralph B. McNerney, Career Services. Sponsor: DOI-BLM-Bureau of Land Management.

Operational/Management Technical Support Offpost Pump & Treat System, James W. Warner, Civil Engineering. Sponsor: DOD-ARMY-Rocky Mountain Arsenal.

Development of New Information & Education Products / Collaborational Research, Alan P. Covich, Fishery & Wildlife Biology. Sponsor: Colorado Division of Wildlife.

GOES-I/M Product Assurance & Advanced Product Development , Thomas H. Vonderhaar, CIRA, Atmospheric Science. Sponsor: DOC-NOAA-National Oceanic & Atmospheric Administration.

Air-Sea Interaction Remote Sensing Processes, Thomas H. Vonderhaar, CIRA, Atmospheric Science. Sponsor: DOC-NOAA-National Oceanic & Atmospheric Administration.

Atmospheric Analysis & Dynamical Modeling Over the TOGA/COARE Region, Wayne H. Schubert, CIRA, Atmospheric Science. Sponsor: DOC-NOAA-National Oceanic & Atmospheric Administration.

Reduction of Losses of Nitrogen by Surge Irrigation, Richard Bartholomay, Cooperative Extension. Sponsor:: DOI- Bureau of Reclamation.

*Structural & Functional Roles of Course Wood Debris in Tropical Stream-Riparian-Upslope, Alan P. Covich, Fishery & Wildlife Biology. Sponsor: NSF-Biological Centers.

*Regional-Global Interactions Project, Roger A. Pielke, Atmospheric Science. Sponsor: UCAR-NCAR-National Center for Atmospheric Research.

Denver Water Board Inventory, Christopher A. Pague, Fishery & Wildlife Biology. Sponsor: Denver Board of Water Commissioners.

Non-Degree Training in Watershed Hydrology & Water Resources - GIS, Freeman M. Smith, Earth Resources. Sponsor: Republic of China-Ministry of Education.

*Consumptive Use Model, Luis Garcia, Chemical & Bioresource Engineering. Riverside Technology,,Inc.

Water Quality & Ecosystem Studies in Northwest Alaska, Daniel E. Binkley, Forest Sciences. Sponsor: USDA-U.S. Forest Service, Forest Research.

Supplement to existing award.

UNIVERSITY WATER NEWS

RESEARCH CHANGES VIEWS OF STREAM FISH MOVEMENT

For decades, fish ecologists have thought resident stream fish are sedentary. But Kurt Fausch, a Colorado State professor and fish ecologist, and his students are challenging the sedentary perspective. More than 200 undergraduate and graduate students have helped with Fausch's studies over the last eight years. Josh Nehring, an undergraduate work-study student, created a fish inoculator that enables masters student Ted Labbe to permanently mark small fish. Labbe injects a fluorescent silicon dye under the skin that shows up under a black light. This mark enables Labbe to determine the movements of recaptured fish. Labbe is studying the Arkansas darter, a two-inch-long fish that lives in Colorado plains streams. He is trying to determine how much habitat of what type will be needed to sustain this rare and relatively unstudied species.

Fausch and Labbe's research will help Colorado Division of Wildlife managers protect critical refuge areas in streams and choose sites for reintroducing the species. Assisting Labbe is undergraduate Ryan Smigh, an honors student, who has conducted laboratory experiments on the darter's thermal tolerance and requirements for vegetated habitat. Fausch and

his students have found substantial movement of trout in Colorado mountain streams.

Steve Riley and Charles Gowan, Ph.D. students, conducted a long-term experiment on six Colorado mountain streams to evaluate the common management practice of placing log structures in streams. Fisheries managers had long thought that the resulting pools and cover increased the number of large trout for anglers. The students found that populations increased mainly because adult trout moving through the study area stayed in the better habitat. Gowan recently published a paper with U.S. Forest Service scientist Dr. Mike Young, Fausch and Riley that "challenges the dogma that stream trout commonly live their entire lives in reaches less than 50 meters," says Gowan. "Our data show that trout regularly moved up to 1.25 miles, which is important for planning habitat work, nature reserves, and fishing regulations." Amy Harig, a Ph.D. student, is studying native cutthroat trout locked above barriers in high-altitude streams. Working with U.S. Forest Service and Colorado Division of Wildlife biologists, Harig is determining how much and what kind of habitat will be needed to sustain the small, remaining cutthroat trout populations and to support new populations created by transplanting fish.

Research 1996, The Contribution of Research to Undergraduate Teaching, Colorado State University. Condensed from an article by Deidre Hand

EDITOR'S IN-BASKET

NEW $300 MILLION FUND FOR RURAL AMERICA

The 1996 Farm Bill, passed by Congress in April, includes a Fund for Rural America – an entitlement program that redirects funds from subsidies for commodity programs toward rural development, conservation and research. The fund will provide $300 million of new funding over a three-year period in the form of competitive grants administered by the USDA Cooperative State Research, Education and Extension Service (CSREES).

One-third of the $300 million will go to rural infrastructure; one-third is slated for research, extension and education; and the remaining third will be granted at the discretion of the Secretary of Agriculture in the areas designated in the legislation.

According to the legislation, the objectives of the grants for research, extension and education are to:

- Increase international competitiveness, efficiency, and farm profitability;
- Reduce economic and health risks;
- Conserve and enhance natural resources;
- Develop new crops, new crop uses, and new agricultural applications of biotechnology;
- Enhance animal agricultural resources;
- Preserve plant and animal germ plasm;
- Increase economic opportunities in farming and rural communities; and
- Expand locally-owned value-added processing.

The grants may go to a federal research agency, a national laboratory, a college or university or a research foundation maintained by a college or university, or a private research organization with an established and demonstrated capacity to perform research or technology transfer.

The legislation also provides that not less than 15 percent of the funds available shall be awarded to eligible colleges, universities, or research foundations that currently rank in the lowest one-third of federal research fund recipients.

CSREES is now determining priority areas under which it will announce requests for proposals. It is expected that funds will be available as of January 1, 1997. All grants will require matching funds.

NASULGC Newsline, June 1996

WATER SUPPLY

The Surface Water Supply Index (SWSI) developed by the State Engineer's Office and the USDA/SCS is used as an indicator of mountain-based water supply conditions in the major river basins of the state. It is based on stream flow, reservoir storage, and precipitation for the summer period (May-October). During the summer period streamflow is the primary component in all basins except the South Platte, where reservoir storage is given the most weight. The following SWSI values were computed for each of the seven basins on July 1, 1996 and reflect conditions during the month of June.

Basin	May 1, 1996 SWSI Value	Change From Previous Mo.	Change From Previous Yr.
South Platte	+3.2	+0.3	-0.7
Arkansas	+2.8	-0.7	-1.6
Rio Grande	-2.8	-2.7	-5.5
Gunnison	+0.9	-1.9	-2.9
Colorado	+1.8	-1.5	-0.9
Yampa/White	+1.0	-1.8	-1.9
San Juan/Dolores	-2.8	-3.0	-5.7

SCALE

-4	-3	-2	-1	0	+1	+2	+3	+4

Severe Drought	Moderate Drought	Near Normal Supply	Above Normal Supply	Abundant Supply

DROUGHT IN THE UNITED STATES

From Donald A. Wilhite, Director, National Drought Mitigation Center—Large portions of the southern Great Plains and southwest United States are in the midst of a very severe drought. This drought involves primarily the states of Arizona, New Mexico, Texas, Oklahoma and Kansas, and parts of Colorado, Utah, Nevada and California. The dry conditions have persisted in parts of this region for two or three years, and some meteorologists are expecting these conditions to continue. Impacts in Texas, for example, have been estimated at $2.4 billion in direct losses to date; indirect losses are estimated at about $6 billion.

...Since 1982, there has been steady growth in the number of states with drought plans. Currently, 28 U.S. states have drought plans...It is interesting to note the spatial correspondence between the severely affected drought area in the Southwest and southern Plains states and the states *without DROUGHT PLANS*

Drought Network News, June 1996

In Colorado, as of June, precipitation for the water year was running about 50 percent of the long-term average. For the first time, the 24-month index is reflecting dryness in the southern part of the state and in some small pockets around Castle Rock and Denver. The one bright spot is reservoir storage, which statewide on June 1 was 130 percent of average.

State Drought Review and Reporting Task Force, Len Boulas, Chairman

WET SPOTS ON THE WEB

FIND WATER DATA QUICKLY AND EASILY -- SEE WHAT'S ON-LINE!

The following is a listing of internet resources from the electronic update service, Headquarters Library, Environmental Protection Agency, by Richard Huffine – huffine.richard@epamail.epa.gov.

Wetlands, Oceans and Watersheds Online
URL=http://www.epa.gov.OWOW

Browse through EPA newsletters, fact sheets, brochures, publications, regulations, press releases and Congressional testimony; order EPA publications online; request STORET water quality data; join in a nonpoint source discussion group; visit Know Your Watershed and Surf Your Watershed; and more.

EPA's Watershed Tools Directory
URL=http://www.epa.gov/OW/watershed/tools

A collection of 250 watershed tool summaries canvassed from EPA headquarters and regions, other federal agencies, states, and watershed organizations.

Water Environment Web
URL=http://www.wef.org

A guide to the Water Environment Federation's programs, activities, and services and related water news.

U.S. Fish and Wildlife Service List Servers
URL=http//www.fws.gov/servers.html

Lists all Fish and Wildlife Service list servers.

Environmental Law Institute Online
URL=http://www.igc.apc.org/eli/
Information on the institute, its publications, programs and people

Community-Based Environmental Protection Network
URL=http://www.epa.gov/ecosystems

Provides communities with information about efforts to protect ecosystems and address human health issues.

National Park Service Home Page
URL=http://www.nps.gov/

Includes information on programs and partnerships to protect America's parklands.

The following URLs are from the May 20, 1996 issue of FOCUS, Know Your Watershed.

National Watershed Network
URL=http://www.etic/purdue.edu/watershed/watershedoptions.html
Provides search by state and key word for the watershed you want to locate. The *National Watershed Exchange* iha a compilation of materials available from and for watershed groups, with keyword search capability to narrow search results.

Final Guidance Manual for Concentrated Animal Feeding Operations (NPDES regulations)
http://PIPES.chsg.saic.com/npdesgui.htm. Located under the NPDES forum at http://PIPES.ehsg.saic.com/. There are also specific areas with EPA publications on Combined Sewer Overflow (CSO), watersheds and more.

National Drought Mitigation Center Web Site
URL=http://enso.unl.edu/ndmc

The Climatology section is now up and running, featuring climographs of seasonal precipitation and temperature patterns for various U.S. cities and links to other on-line climatology resources. The Drought Watch section now includes Standardized Precipitation Index maps and links to the Palmer Drought Index, the Crop Moisture Index, and many other drought-monitoring tools and web sites. A recent addition to the Mitigation section is information about the authority and actions of the Bureau of Reclamation during the drought of the late 1980s and early 1990s in the western states. Scheduled to go on-line in coming months will be key sections from the Army Corps of Engineers' *National Study of Water Management During Drought*, and information about various states' drought plans.

Quality of Life in the Global Environment, Part 1
SHARING THE EARTH'S WATER SUPPLY
A Choices and Challenges Forum

Live via Satellite -- PBS Adult Learning Satellite Service
October 17, 1996 – 12:30 - 3:00 p.m. ET

WATER PUBLICATIONS, DATABASES, VIDEOS

CWRRI REPORTS

Water Research in the Rockies: A Historical Retrospect -- Special Report No. 11

This report describes the origins and development of the Rocky Mountain Hydrologic Research Center, Allenspark, Colorado (formerly the Rocky Mountain Hydraulic Laboratory). The RMHL was organized under the laws of the State of Colorado in 1945 with a primary goal of providing experience to young engineers interested in learning the techniques of hydraulic research. Over the years numerous experiments were conducted on scour, open channel hydraulics and hydraulic drops. In 1985 the RMHL entered into an agreement with the U.S. Geological Survey whereby the USGS would assume full responsibility for the operation and maintenance of the laboratory. The USGS chose to take part in the laboratory because of its proximity to the Denver Federal Center and the USGS Central Region Water Resources Division/National Research Program headquartered in Denver. In celebration of the 50th Anniversary Annual Meeting, a two-day technical program was held at the YMCA Camp of the Rockies in Estes Park, Colorado on September 22-23, 1995. The RMHRC continues to hold annual meetings, publish abstracts of papers presented, and support field research at or near the RMHL. The report was prepared by CWRRI Graduate Student Jill Marsh under the direction and guidance of Marshall Flug, current president of the RMHR

To obtain a copy of the report contact Marshall Flug, Phone 970/226-9391; FAX 970/226-9230; or E-mail Marshall_Flug@NBS.GOV.

USGS REPORTS

Contact the U.S. Geological Survey, Earth Science Information Center, Open-File Reports Section, Box 25286, Mail Stop 517, Denver Federal Center, Denver, CO 80225 or call 303/236-7476.

Water Quality Assessment of the Rio Grande Valley, Colorado, New Mexico, and Texas – Occurrence and distribution of Selected Pesticides and Nutrients at Selected Surface-water Sites in the Mesilla Valley, 1994-95, National Water Quality Assessment Study Unit. Water-Resources Investigations Report 96-4069.

Sources and Loads of Nutrients in the South Platte River, Colorado and Nebraska, 1994-95, by David W. Litke. Water-Resources Investigations Report 96-4029.

An Accounting System for Water and Consumptive Use Along the Colorado River, Hoover Dam to Mexico, by Sandra J. Owen-Joyce and Lee H. Raymond. Water-Supply Paper 2407.

Assessment of Metal Transport Into and Out of Terrace Reservoir, Conejos County, Colorado, April 1994 through March 1995, by Patrick Edelmann and Sheryl Ferguson. U.S. Geological Survey Water-Resources Investigations Report 96-4151 (Interim Report).

VIDEO EXAMINES POLLUTION FROM RUNOFF

The greatest threat to America's drinking water supplies – nonpoint source pollution – is documented in a half-hour educational video recently released by the Oregon State University Extension Service. *WE ALL LIVE DOWNSTREAM* examines urban and rural runoff and the problems it creates for surface and groundwater. Nonpoint source pollution is carried by rain, snowmelt and irrigation and flows from a variety of sources including farms, forests, city streets, construction sites, mines and septic systems. Experts say America's growing population has made urban and rural runoff the most serious threat to our nation's drinking water supplies. *WE ALL LIVE DOWNSTREAM* was videotaped primarily in Oregon's Tualatin River Basin, but the program has implications for most every watershed in the country. The video (VTP 021) costs $30 (including shipping) and may be ordered from: Publications Orders, Extension and Experiment Station Communications, Oregon State University, 422 Kerr Administrative Services Building, Corvallis, OR 97331-2119.

DO YOUR PART TO REDUCE SUMMER WATER USE

XERISCAPE AND SAVE!

The word "Xeriscape" was coined by a task force of the Denver Water Department, Associated Landscape Contractors of Colorado and Colorado State University. It is derived from the Greek word "xeros," meaning dry, combined with the suffix in "landscaping." The word may sound strange, but the principles are not: group plants according to water needs, zone watering so no plant gets more than it needs, use mulch, and plant no more grass than is needed.

The need to conserve water in the West took on a greater urgency after the drought of 1977 and a realization that nearly 50 percent of water used by the average household is for grass and plants. In Colorado Springs, residents use 40 million gallons of water a day during the nongrowing season; during the summer, average daily use triples to more than 120 million gallons, according to the utilities department' Ann Seymour, volunteer coordinator of the xeriscape program for Colorado Springs Utilities, advises: "If your yard is fence-to-fence bluegrass, and the only time you walk on the lawn is when you mow it, you may want to reconsider your garden design." She offers the following tips:

- Consider what the lawn is used for – and how often – and determine how much area needs to be turf.
- Consider using more drought-resistant grasses and plants in outlying areas.
- Replace bluegrass (highest water user in typical landscape) along fences with low water-use plants.
- Avoid narrow strips of turf, hard-to-maintain corners and isolated islands of grass that need special attention.
- Mulch as much as possible. This reduces water use by decreasing soil temperature and amount of soil exposed to wind.
- Keep rocked or graveled areas to a minimum as they increase the temperature of the air and soil. Large expanses of black plastic also waste water through runoff.

GT OnLine, 7/8/96

GARDENERS HAVE XERISCAPE OPTIONS WITH CD-ROM

The Arizona Water Resources Research Center (WRRC) has come up with a great new way to spiff up the landscape of your yard or commercial property WRRC staff have created *Desert Landscaping: Plants for a Water-Scarce Environment*, a multi-media CD-ROM plant selector that lets users browse through award-winning gardens and landscapes, and pick from more than 600 low water-use plants that adapt perfectly to the desert and drought conditions.

Desert Landscaping features more than 1,500 full-screen color photos, including wide shots and close-ups of plants. An audio feature gives pronunciations of both the botanical and the common names of the plants. Users can compare groups of similar plants. A plant selector will help choose appropriate species based on size and growth rate, soil and sun requirements, irrigation needs, the plants' place of origin, allergens, wildlife interactions and dozens of other useful elements. Links to landscaping tips and an illustrated bibliography of plant books also are provided.

Gary Woodard, Associate Director at WRRC, located in the College of Agriculture at the University of Arizona, was the project manager for *Desert Landscaping*. Besides Woodard and the staff at WRRC, the project also includes the expertise of a 22-member advisory panel that encompasses experts from academia and landscape professionals. The venture was made possible in large part with support from the Tucson office of the Arizona Department of Water Resources. Computer requirements for the CD-ROM are a 486-based or faster PC with 4mb RAM (8mb recommended) and a 2X CD-ROM. A Mac version is due in the fourth quarter. *Desert Landscaping is available at a cost of $25. Call Gary Woodard at 520/792-9591, or E-mail woodard@ccit.arizona.edu.*

EARTH SYSTEM SCIENCE PATHFINDER

NASA announces the release of the Earth System Science Pathfinder (ESSP) Announcement of Opportunity (AO) in support of the Office of Mission to Planet Earth (MTPE). This program is intended to identify and develop small science-driven missions...that are not being addressed by current programs. Access on Home Page at http://www.hq.nasa.gov/office/mtpe/ under "MTPE Research Announcements" or via anonymous ftp at: ftp.hq.nasa.gov/pub/mtpe. To obtain paper copy call 202/358-3552 and leave voice mail message including your full name and address, zip code and telephone number. Address questions to Kevin Niewoehner, Phone 202/358-0751, FAX 202/358-2769, E-mail kniewoeh@mtpe.hq.nasa.gov.

WATER NEWS DIGEST

UPDATE -- WWPR ADVISORY COMMISSION

The Western Water Policy Review Advisory Commission reports in its July 9 newsletter that it has:

- completed a series of nine scoping sessions throughout the West,
- held a second meeting of the full Commission in Denver,
- initiated work on several studies describing the status of water resources in the West, and
- completed a framework for several investigations of both major river basins and local watershed initiatives.

The Commission's scoping sessions were well attended, with attendance ranging from approximately 30 to 60+, and everyone had an opportunity to speak at each workshop. Summaries of comments from each workshop are available from the Commission upon request. The sessions were held in Phoenix, AZ, Lewiston, ID, Sacramento, CA, Omaha, NB, Casper, WY, Denver, CO, Oklahoma City, OK, Salt Lake City, ZUT, and Albuquerque, NM.

At its second meeting on May 16-17, the Commission heard presentations on several current water management programs from: Jim Lochhead, Executive Director, Colorado Department of Natural Resources; David Holm, Director, Colorado Water Quality Control Division; Scott Smith, Coors Brewing Company; Dan Luecke, Environmental Defense Fund; Max Dodson, Region 8 Environmental Protection Agency; Jeff Keidel, Upper Arkansas River Coordinator; Jack Garner, Eastern Plains Area Manager, Bureau of Reclamation; Rick Gold, Deputy Regional Director, Upper Colorado Region, Bureau of Reclamation; and Wayne Solley, U.S. Geological Survey.

River Basin Studies. The Commission will soon begin several studies focusing on water management at the river basin and watershed level. Studies of six river basins are anticipated, addressing such topics as:

- the most critical water-related problems in each river basin;
- how each basin is addressing those critical problems;
- innovations that are helping solve water problems in an integrated fashion;
- mechanisms for incorporating local watershed initiatives into basinwide water management;
- the role of federal agencies in addressing the basin problems; and
- recommended for needed changes.

Local Watershed Initiatives. Because of the considerable interest today in local watershed initiatives, the Commission will undertake a study to examine the same kinds of questions with a local focus.

The next Commission meeting is scheduled for November 22, 1996 in San Diego, CA. For information about the Commission contact Project Manager Dr. Curtis Brown at 303/236-6211 X502.

WWPR Advisory Commission Newsletter, 7/9/96

EPA ISSUES DRAFT FRAMEWORK ON EFFLUENT TRADING

The Environmental Protection Agency has issued a draft framework on acceptable pollutant-trading activities in watersheds to encourage cost-effective improvements in water quality. The draft framework identifies five types of acceptable trades in a watershed context: point to point, intra-plant, pretreatment, point to nonpoint, and nonpoint to nonpoint.

The most difficult problem EPA identified is how to handle nonpoint to point source trades. The framework sets forth three situations where nonpoint to point source trades may be feasible. The first is in the context of establishing a total maximum daily load (TMDL) for a watershed. The second opportunity may be in the context of "other analyses and remediation plans similar to TMDLs," provided they "link contributions to ambient conditions and determine needed reductions and remedial activities necessary to meet water quality standards." The third option may occur when a point-source permittee arranges for a trade in order "to meet the ambient water quality conditions expected to result from implementing its effluent limits." Such a situation would involve the permittee looking for other sources of the controlled pollutant and arranging for those sources to remove a specified amount of that pollutant. Pilot efforts are contemplated to see how these trades will be implemented in specific watersheds.

The trading process would allow facilities that can reduce pollutants at lower cost to accumulate credits by reducing beyond permit requirements. Such credits could be sold to other facilities. Some small dischargers could purchase credits at lower cost than acquiring the technology needed to help them meet water quality standards.

Western States Water, 6/21/96

WATER SUPPLY AND DEVELOPMENT

Animas La Plata Revived

On July 30 the U.S. Senate revived the Animas-La Plata Water Project after Colorado Sen. Ben Nighthorse Campbell warned his colleagues not to renege on promises to American Indians. The Senate voted 65-33 to support Campbell and kill an amendment that would have cut $9.5 million in 1997 congressional spending for the system of canals and reservoirs in southwestern Colorado. The U.S. House approved an identical amendment last week by a vote of 221-200. The vote sets the stage for a showdown later this summer, when House and Senate members meet to iron out differences in energy and water spending bills.

Denver Post, 7/31/96

Judge Says EPA Right on Two Forks

U.S. District Court Judge Richard Matsch ruled on June 5 that the Environmental Protection Agency did not act "capriciously and arbitrarily" when it blocked Two Forks dam construction because of environmental concerns. Additionally, Matsch ruled that eight suburban water districts do not have legal standing to proceed with the case without the support of the Denver Water Board.

Associated Press, Denver Post, 6/7/96

Homeowners Say Studies for Meadow Hollow Reservoir Incomplete

The proposed Meadow Hollow Reservoir is one of four options being considered by the municipal subdistrict of the Northern Colorado Water Conservancy District to deliver water through the Colorado-Big Thompson Project for the cities of Boulder, Broomfield, Estes Park, Greeley, Longmont, Louisville, Loveland and Superior. Two initial studies of the proposed site southwest of Loveland, a quarter-mile south of Carter Lake, have found no natural features or artifacts that would stop reservoir plans. However, homeowners whose property would be flooded by the reservoir criticize the site studies as incomplete. Members of the Meadow Hollow Preservation Association said one issue more serious than the studies indicate is the Blue Mountain-Little Thompson Fault near the proposed dam site. Property owners also hired consultants who identified 40 to 60 Arapaho or Cheyenne burial sites, ancient Indian campgrounds and a game drive used for hunting. The project manager for the initial studies, to be presented at an August 1 water board meeting, said the studies were not intended to catalog every feature found in the meadow, but to give water planners a basic understanding of the site and the feasibility of building a reservoir there. If constructed, the reservoir could have a 300-foot-high dam and a capacity of up to 60,000 acre-feet of water, cost about $100 million, and take 10 years to complete. Participating cities would pay for the reservoir.

Denver Post, 7/29/96

Park Officials, City of Estes Park Disagree on Dam

Estes Park, the town at the east entrance to Rocky Mountain National Park, wants to resume operation of a hydroelectric dam inside park boundaries next year. Town officials say the small dam, originally built before the creation of the park in 1915, will allow it to stop spending $50,000 a year on electricity from outside utilities. Federal regulators and the Park Service previously agreed to permit the town to restart operation of the hydroelectric plant that was destroyed by a flood. The dam can legally divert most of the water from Fall River as it tumbles by the park's Aspen Glen campground. Estes Park plans to divert up to 260 gallons each second from the River, run the water through a mile-long pipeline and hydroelectric plant, then return the flows to the river outside the park.

The Cascade Dam was built along the Fall River in 1905 by F.O. Stanley to generate electricity for his home and the famous Stanley hotel in Estes Park. In 1982 another private dam, at Lawn Lake, collapsed in the park, unleashing a disastrous flood that left millions of dollars in damage and destroyed Estes Park's hydroelectric dam on Fall River. In 1986, the National Park Service let Estes Park rebuild its dam, but the town didn't make the costly repairs needed to resume operation of the hydropower plant. In the meantime, trout began to thrive in Fall River. Estes Park then completed $500,000 of repair work and started planning to resume operation of the hydroelectric plant. But Park officials say the earlier agreement won't provide enough water to keep fish alive in a mile of Fall River. Park officials are trying to stop the town with appeals to the mayor, the Federal Energy Regulatory Commission and the Solicitor's Office of the U.S. Interior Department.

Associated Press, Fort Collins Coloradoan 7/12/96

Northern Colorado Looks at Joint Water Commission

Larimer County Commissioner Janet Duvall and Fort Collins Mayor Ann Azari will try to create a joint water commission to focus on ways to preserve the area's water supplies. Duvall and Azari met in June with Mike Applegate and Bill Brown, representatives of Northern Colorado Water Conservancy District, to discuss ways of protecting water supplies. Brown said Colorado water law does not prohibit one region of the state from drawing water away from another region. One key issue in Larimer County, he said, is to develop a program that encourages farmers who want to get out of agriculture not to sell off their water rights to cities. One possibility is for cities and counties to buy those rights and lease them back to farmers to maintain agriculture in the area. Brown said that option, however, is probably too expensive. Another possibility is Section 1041, which allows counties to impose tough conditions on the removal of water. Brown noted that Boulder County has already implemented its Section 1041 power to protect its water supplies. Duvall, Azari and the conservancy district representatives said

they would meet again to discuss a joint commission which might include representatives of city and county boards and commissions and others with water expertise.

Fort Collins Coloradoan, 6/5/96

WATER QUALITY

Congress Faces August 1 Deadline to Renew Act

With Congress seemingly unable to settle differences over amendments to the Safe Drinking Water Act, final passage of the Act before the August 1 deadline is in jeopardy. Congress already has agreed to create a $725 million loan fund for small water systems in peril, including $225 million for last year and $500 million for this year, but the money only becomes available if the Act is renewed by August 1. If Congress fails to act or to extent that deadline, the funds could be diverted to other uses.

Fort Collins Coloradoan 7/25/96

Waterborne Pathogens Shift Priorities

While the Environmental Protection Agency has focused on cancer-causing chemicals in drinking water, microscopic waterborne bacteria, pathogens and viruses are emerging as another threat to the nation's drinking water supplies. According to CDC estimates, between 900 and 1,000 people a year die and another million people become sick from microbial illnesses from drinking water.

The Associated Press, Denver Post 7/11/96

NAWQA Study Shows South Platte Contamination

The U.S. Geological Survey's study of the South Plate, part of the National Water Quality Assessment Survey of 60 river basins across the nation, found:

- Uranium and radon levels in 49 of 87 wells along the South Platte were above the proposed national standards for drinking water.
- More than a dozen pesticides were found in ground and surface waters but the average concentration did not exceed federal safety standards for drinking water.
- MTBE (a gasoline additive used as a fuel oxygenator to reduce carbon monoxide in car emissions) was found in 79 percent of the urban wells and 3 of the mountain wells.

Most Front Range cities draw drinking water from mountain reservoirs upstream from the test area. None of the urban groundwater in which MTBE was found was used for drinking water. Although health experts said there is no immediate health threat, they expect the pollution to worsen as Colorado's population grows.

Associated Press, Fort Collins Coloradoan 6/24/96

Buffalo Creek Runoff Causes Problems for Denver Water

Buffalo Creek's 100-year old water system was knocked out in early July by flooding, shaking loose a lot of ash and debris from the Buffalo Creek fire in May and flushing it into the South Platte River. To counteract the effect of the runoff, the Denver Water Department increased the amount of chlorine and alum used to treat the water at the Marston Treatment Plant. Although the procedure affected the smell and taste of the water, a Denver Water spokesperson said the water posed absolutely no health risks, and said the Denver water supply should be back to normal in a day or two. The Buffalo Creek system, owned by a private company, is expected to be repaired by early September.

Special to the Denver Post 7/17/96

USBR Report Supports Colorado's Claim of Water Waste

On June 25, the Bureau of Reclamation's El Paso office reported that only 17.3 percent of the more than 4.6 billion gallons of Rio Grande water sent to the El Paso irrigation system in January and early February went to farms. The rest was dumped unused into the river downstream. The carefully worded document didn't directly accuse the El Paso district, nor did it declare that water was wasted. It said only that delivery records "indicate a low efficiency of less than 20 percent of diverted water reaching the farm headgates." When Colorado challenged the early releases, El Paso officials said they needed the water to flush farm ditches for spring irrigation. El Paso also said it was diluting the Rio Grande's brackish flow so the city's water treatment plants would operate more efficiently. The early releases prevented the Elephant Butte Reservoir from spilling. By treaty among Colorado, New Mexico and Texas, an overflow would have erased for the rest of the year an obligation to send more water to Texas.

Denver Post 7/22/96

Kansas Says Nebraska Uses More Water Than Its Share

The question of whether water wells that tap into the Ogallala Aquifer in Nebraska have an impact on the Republican River Basin has prompted Kansas officials to threaten to sue. David Pope, director of the Kansas Division of Water Resources, said the Republican River compact must consider how groundwater irrigation wells in the Ogallala Aquifer interact with the water resources of the Republican River Basin. Water consumption reports are usually based on wells in the Republican River valley, and wells along the aquifer aren't included in the reports. Nebraska officials said that has never been done before.

Fort Collins Coloradoan 6/8/96

MEETINGS

BRINGING THE RIVER BACK ... TO THE FUTURE: URBAN AND RURAL WATERSHED MANAGEMENT
The 7th Annual South Platte Forum -- October 29-30, 1996

People view rivers with different visions. A fisherman visualizes a vicious strike while the tourist sees a shady picnic or a cool swim. The hydrologist sees hydraulic control where the boater pictures riding the perfect wave. A farmer envisions the blood of a healthy and productive field, while an engineer considers stormwater quality, flood hazard and pier scour. Being many things to many people has not come easy for our nation□s rivers, and a toll has been taken as natural processes occurring in and around rivers have been altered to accommodate human use. Recently, people have taken notice, and resources have been brought to bear to restore what we've damaged, and to preserve what's left. But physical, social, economic, and political constraints make restoration to pristine, pre-settlement conditions impractical or impossible. So where do we go? How do we get there?

The **7th Annual South Platte Forum** will examine the existing and proposed management of waterways within our basin. We will answer the practical questions about planning and development of improvement projects, such as:

- What initiated the project?
- How was it funded?
- Have public goals been met?
- Does integrated resource management really work?

Your participation in this year's Forum will help focus the collective vision defining the future for the South Platte Basin. Specific topics to be presented at the one and one-half day conference include:

- Restoration, preservation and enhancement project planning, development, and funding, including the role of Great Outdoors Colorado (GOCO);
- Integrating multiple objectives: specifically, the compatibility of wildlife habitat, recreation, aesthetics, source and non-point source pollution prevention, and flood control;
- Criteria for success;
- Monitoring and adaptive management;
- Defining "the future" for South Platte Basin rivers and water bodies.

There will be an informal social hour following the first day of presentations. A field trip to Denver's South Platte urban corridor the following afternoon will allow participants the opportunity to see project implementation while it happens.

Confirmed speakers include:

Denver Mayor Wellington Webb and
Mr. Ken Salazar; Parcel, Mauro, Hultin & Spaanstra, P.C.

For information about the conference or exhibit space, call or write:

David Graf, Coordinator
Colorado Water Resources Research Institute
410 University Services Building, CSU
Fort Collins, CO 80523
Phone 970/491-6308
FAX 970/491-2293

CONFERENCE ON NONPOINT SOURCE POLLUTION IN COLORADO
September 24-25, 1996, Denver, Colorado

Peter H. Coors, Chief Executive Officer of Coors Brewing Company, has announced that an informal coalition of businesses, government and educational organizations will sponsor the first in a series of conferences about nonpoint source pollution in Colorado on September 24-25. In addition to Coors, members include Colorado State University, Colorado Department of Public Health and Environment, U.S. Environmental Protection Agency, Colorado Water Quality Control Commission, Colorado Water Conservation Board, Colorado Nonpoint Source Task Force, Colorado Soil and Water Conservation Society, and Denver Regional Council of Governments. The first conference will take place on September 24-25 at the Raintree Plaza Hotel in Longmont. Speakers from the private and public sector, state and federal government will share case histories, information and policy perspectives. A field trip will give participants the opportunity to see successful application of best management practices in urban and rural environments. Attendees will gain insights into three critical areas:

- The extent of water quality problems in agricultural and urban settings.
- The technologies currently available for both types of problems.
- The future of regulatory and voluntary, watershed-based control efforts.

Future conferences will be held in different locations around the state to address the diversity of Colorado's water supplies, sources and users.

ROCKY MOUNTAIN HYDROLOGIC RESEARCH CENTER 51ST ANNUAL MEETING
THEME: ECOLOGICAL ISSUES IN MOUNTAIN WATERSHEDS
September 20-21, 1996
YMCA Camp of the Rockies, Estes Park, Colorado

The meeting will encourage interdisciplinary communication among professionals representing hydrology, engineering, environmental science, and other related issues in the Rocky Mountain Region. There will also be a tour of the research facility, the Rocky Mountain Hydraulic Lab along the North St. Vrain Creek. Topics for the meeting:

- Watershed and River Basin Management
- Rainfall and Snowmelt Runoff in Mountain Watersheds
- Hydraulics, Sediment Transport and Geomorphology of Mountain Streams
- Climate, Climate Change and Weather Modification in the Western United States
- Hydrologic and Engineering Field Methods at Remote and Mountain Sites
- Paleohydrology and Paleoclimatology
- Ecologic Measurements and Methods
- Water Rights and Water Supply
- Watersheds and Wetlands
- Water Resources and Environmental Policy
- Other Topics of Hydrologic, Engineering, Ecological or Environmental Interest

Registration is expected to be no more than $25. For information contact Donald K. Frevert, Phone 303/236-0123, extension 225, FAX 303/236-0199 or E-mail dfrevert@do.usbr.gov.; or Marshall Flug, Phone 970/226-9391, FAX 970/226-9230, or E-mail Marshall_Flug@NBS.GOV.

CALLS FOR PAPERS

AWRA/UCOWR Annual Symposium
WATER RESOURCES EDUCATION, TRAINING AND PRACTICE:
OPPORTUNITIES FOR THE NEXT CENTURY
Keystone, Colorado – June 29-July 3, 1997

The symposium, a co-venture of the American Water Resources Association (AWRA) and the Universities Council on Water Resources (UCOWR), will constitute a form for the presentation of information (oral, poster, water exhibits, and educational material displays) summarizing the current state-of-the-art in both water resources education and practice. The symposium will also look at where we should be going to meet the demands of the future.

Is Today's Educational System Providing the Curriculum and Experiences Needed in Water Resources for the Next Century?--Papers are encouraged that cover all aspects of water resources education from K-12, higher education, life-long learning (continuing education), public education, and outreach perspectives. Primary and secondary education issues may include innovative classroom instruction and use of volunteer monitoring. Higher education topics will include a variety of approaches (engineering, natural resources, biology, social sciences, and multi-disciplinary) to water resource curriculum with allocated accreditation issues. The increasingly important role of continuing education, public education, and outreach will be addressed.

What Lessons Can We Learn from Current Projects Dealing With the Complexities of Integrated Watershed Management?--Papers are encouraged that summarize case studies concerning integrated watershed management. A variety of new topics are being infused into what was once the domain of classically trained engineers. These emerging fields include the integration of physical hydrology and biology (e.g., biohydrology and ecological integrity). Social, political, and economic issues are also playing an increasingly significant role in management decisions as is evidenced by the growing use of watershed forums where all stakeholders are encouraged to become partners in the solutions. All of these considerations are becoming integral aspects of many watershed management plans.

Anyone interested in contributing a paper, poster, video, or software demonstration should submit an abstract (200 words or less) by ***SEPTEMBER 30, 1996*** [include author's name(s), affiliation(s), complete address(es), phone, fax and e-mail]. On a separate sheet of paper please not the corresponding author and the individual who will present the paper at the meeting. Mail abstracts to:

Dr. John J. Warwick, Technical Chairperson
University of Nevada-Reno
1000 Valley Road
Reno, NV 89512-0180
FAX: 702/784-1953
E-mail: keystone@dream.unr.edu

Dr. John Stednick, General Chairperson, AWRA
Dr. Robert Ward, General Chairperson, UCOWR

WEFTEC'97
Oct. 18-22, 1997, Chicago, IL

Join water quality and wastewater treatment professionals to learn about the latest developments and to see cutting-edge technology. For abstract format instructions contact: Water Environment Federation, Attn: WEFTEC '97 Program, 601 Wythe Street, Alexandria, VA 22314-1994, Phone 800/666-0206, FAX 703/684-2471, or E-mail confinfo@wef.org. Deadline: December 16, 1996.

CALENDAR

Sept. 8-11	1996 ANNUAL CONFERENCE, ASSOCIATION OF STATE DAM SAFETY OFFICIALS, Seattle, WA. Contact: ASDSO, 450 Old East Vine St., 2nd Floor, Lexington, KY 40507. Phone 606/247-5140, FAX 606/323-1958.
Sept. 11-14	APPLICATIONS OF GEOGRAPHIC INFORMATION SYSTEMS (GIS) TO THE SUSTAINABILITY OF RENEWABLE NATURAL RESOURCES, Jackson, WY. Contact: Renewable Natural Resources Foundation, 5430 Grosvenor Lane, Bethesda, MD 20814-2193. Phone 301/493-9101, FAX 301/493-6148, Internet RNRF@AOL.COM.
Sept. 19-20	INTEGRATES WATER RESOURCES MANAGEMENT: NORTHWESTERN NEW MEXICO AS A CASE STUDY, Farmington, NM. Contact Cathy Ortega or Cynthia Rex at 505/646-1813.
Sept. 20-21	ECOLOGICAL ISSUES IN MOUNTAIN WATERSHEDS, ROCKY MOUNTAIN HYDROLOGIC RESEARCH CENTER 51ST ANNUAL MEETING, Estes Park, CO. Contact: Marshall Flug, National Biological Service, Phone 970/226-9391, FAX 970/226-9230, Internet Marshall_Flug@NBS.gov OR 970/491-6016 at CSU campus and FAX. Internet: skiflug@lamar.colostate.edu.
Sept. 22-25	RIVERTECH '96, 1st International Conference on New/Emerging Concepts for Rivers, Chicago, IL. Contact: Rivertech '96, IWRA, University of Illinois, FAX 217/333-9561, E-mail: nbarrett@uiuc.edu.
Sept. 22-26	32ND ANNUAL AWRA CONFERENCE AND SYMPOSIUM, Fort Lauderdale, FL. Contact: American Water Resources Association, Phone 703/904-1225, FAX 703/904-1228, E-Mail: awrahq@aol.com.
Sept. 26-27	COLORADO WATER LAW SEMINAR, Northglenn, CO. Contact: Colorado Water Congress, Phone 303/837-0812.
Oct.29-Nov. 1	THE CLEAN WATER COMPLIANCE INSTITUTE, Breckenridge, CO. Contact: Government Institutes, 4 Research Place, Rockville, 1MD. Phone 301/921-2345, FAX 301/921-0373, E-mail giinfo@aol.com.
Oct. 31-Nov. 2	HYDROGEOLOGY OF THE SAN LUIS VALLEY AND ENVIRONMENTAL ISSUES DOWNSTREAM FROM THE Nov.2 SUMMITVILLE MINE, a field trip in conjunction with the 1996 Geological Society of America Annual Meeting, Denver, CO. For information call Isobel McGowan (303/477-5338), Doug Cain (719/544-7155 X130), Kathleen Smith (303/236-5788) or Alan Davey (719/657-3304).
Nov. 3-6	THE IRRIGATION ASSOCIATION'S 17th ANNUAL INTERNATIONAL IRRIGATION EXPOSITION and ASAE'S TECHNICAL CONFERENCE, San Antonio, TX. Contact: The Irrigation Association, 8260 Willow Oaks Corp. Dr., Suite 120, Fairfax, VA 22031. FAX 703/573-1913.
Nov. 14-15	COLORADO SECTION, SOCIETY FOR RANGE MANAGEMENT, 1996 ANNUAL WINTER MEETING, Colorado Springs, CO. Held in conjunction with the Colorado Chapter of the Soil and Water Conservation Society. Contact: Ken Lair, Phone 303/236-2886 x210.
Nov. 18-20	109TH ANNUAL MEETING, NATIONAL ASSOCIATION OF STATE UNIVERSITIES AND LAND GRANT COLLEGES, San Diego, CA. Contact: NASULGC, One Dupont Circle, NW, Suite 710, Washington, DC 20036-1191. Phone 202/778-0818, FAX 202/296-6456.
Dec. 5-7	COMPETING INTERESTS IN WATER RESOURCES – SEARCHING FOR CONSENSUS, Las Vegas, NV. Contact: U.S. Committee on Irrigation and Drainage (USCID), 1616 Seventeenth St., Suite 483, Denver, CO 80202; Phone 303/628-5430, FAX 303/628-5431, E-mail stephens@uscid.org.