



# COLORADO WATER

Newsletter of the Water Center at Colorado State University

## STRETCHING URBAN WATER SUPPLIES IN COLORADO

See page 5

Defining a Colorado context to identify strategies for landscape water conservation that are acceptable to municipal providers and the green industry...

## URBAN LANDSCAPE IRRIGATION WITH RECYCLED WASTEWATER: PRELIMINARY FINDINGS

See page 7

Paul R. Portney  
President and Senior Fellow  
Resources for the Future  
Washington, D.C.

A special Agricultural and Resource Economics Department seminar has been scheduled during CSU's annual Hydrology Days for 7:00pm, March 11, 2004, in Ammons Hall on the CSU campus. The public is invited to attend.

Dr. Portney will speak on the need for consistent and timely environmental statistics for natural resource decision-making and environmental policy analysis.

Sponsored by the American Institute of Economics  
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## FEBRUARY 2004



"Growth in water reuse has created the need to research the effects of recycled wastewater irrigation on urban landscape soils, plants, and the ecosystem as a whole."

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*EDITORIAL*

## URBAN LANDSCAPE WATER CONSERVATION

by Robert Ward, Director

As the current drought teases us regarding its continued existence and makes it difficult to project future water supplies, Colorado newspapers contain a range of opinions as how the public and professional water managers should respond. This situation is particularly evident in the debates surrounding policies and plans associated with water use on urban landscapes. The newspapers regularly question the impact of, for example, proposed water pricing schemes on the owners of usually older, large landscaped lots; the time to initiate lawn watering restrictions; and the need for bluegrass in a semi-arid climate.

During such debates there is often a desire to employ 'sound science' as a way of placing 'side boards' on some of the highly charged emotions surrounding dialogue on the subject. In other words, what does the peer reviewed literature tell us about facts we can rely upon in managing urban landscapes during a time of drought?

This issue of Colorado Water examines the science surrounding urban landscape water conservation and reports on a number of initiatives currently underway to better define the relationship between urban landscapes and water resources. On page 5, Rachel Barta summarizes her survey of the peer-reviewed literature on urban water conservation, concluding that

the highly applied, site-specific nature of water use on landscapes has not generated a large body of peer-reviewed literature on the subject. She suggests that a partnering of scientists with urban water providers in Colorado, to design and operate systems that measure impacts of different drought mitigation practices, would help produce a larger body of scientific knowledge.

Professor Yaling Qian, on page 7, presents an update on a current CWRI project studying the impacts of using recycled wastewater on urban landscapes. The article on page 15, while noting the value of urban trees in Fort Collins, does not discuss the water use of the trees. The data provided, however, helps society to balance the benefits and costs of urban forests in Colorado.

On page 16, two new CSU landscape architect faculty members are introduced to Colorado Water readers. Christine Dianni and Paul Hellmund bring new perspectives and research capabilities to the question of appropriate and acceptable urban landscapes in semi-arid Colorado. A new sustainable landscape seminar series, organized by Paul and Christine, is described on page 16.

On page 20, the Bureau of Reclamation's National Xeriscape™ Demonstration Program is described. The program is developing data and analyses that help evaluate the cost, yield and reliability

of water-use savings from the installation of water-conserving Xeriscape landscapes.

Eric Schuck. Rebecca Proft and Reagan Waskom, on page 12, describe a current effort to evaluate non-price water demand policies using 2003 data from a number of Front Range municipalities.

Brad Lundahl, with the Colorado Water Conservation Board, on page 21 describes current drought and water conservation projects the CWCB is undertaking. The second annual meeting of the Ditch and Reservoir Company Association (DARCA) provides John Wilkins-Wells the opportunity to describe his work with Canal Companies who are beginning to supply landscape water services to suburban housing developments (see page 35).

Thus, you can see that there are a large number of research efforts and programs to gain new knowledge and understanding of drought mitigation on the urban landscape. CWRI will continue, in close cooperation with university, local, regional, and state water agencies and the Green Industry, to develop and synthesize scientific information about water conservation and drought management on Colorado's urban landscapes.



## USGS WATER YEAR 2002 COLORADO WATER RESOURCES DATA REPORTS

The U.S. Geological Survey's annual Colorado Water Resources Data reports will now be released as online reports. The annual report for water year 2002 is available at the following URLs: Volume 1 <http://pubs.water.usgs.gov/wdrco021>, Volume 2 <http://pubs.water.usgs.gov/wdrco022>. Each volume is a PDF file. Individual or multiple pages can easily be printed from these files. Data pages will contain links to real-time and historical online data. Also available at <http://water.usgs.gov/pubs/wdr/> are the WY 1995-2001 Colorado Water Resources Data reports.

WATER RESOURCES RESEARCH  
NATIONAL COMPETITIVE GRANTS PROGRAM  
FISCAL YEAR 2004 REQUEST FOR PROPOSALS

The Request for Proposals for the FY 2004 National Competitive Grants Program authorized by section 104G of the Water Resources Research Act of 1984 has been released. The RFP may be obtained either by going to <https://niwr.org/NIWR> and clicking on "View the RFP" under "National Competitive Grants Program" or by going directly to [https://niwr.org/2004\\_104G\\_RFP](https://niwr.org/2004_104G_RFP). Proposals are sought in not only the physical dimensions of supply and demand, but also quality trends in raw water supplies, the role of economics in water supply and demand, and institutional arrangements for tracking and reporting water supply and availability. For planning purposes, the amount available for research under this program is estimated to be \$1 million in federal funds, though there has not been a FY2004 appropriation of funds for this program as of the date of this announcement. Any investigator at an institution of higher learning in the United States is eligible to apply for a grant through its State Water Research Institute or Center. Proposals involving substantial collaboration between the USGS and university scientists are encouraged. Proposals may be for projects of 1 to 3 years in duration and may request up to \$250,000 in federal funds. Successful applicants must match each dollar of the federal grant with one dollar from non-federal sources. Proposals will be accepted only through the Internet site at <https://niwr.org/NIWR/>. Prospective applicants must register at that site prior to submitting a proposal. Registrations and proposals will be accepted on the Internet site beginning Dec. 1, 2003. DETAILED INSTRUCTIONS FOR PROPOSAL PREPARATION AND SUBMISSION ARE PROVIDED

The closing date for proposals to be filed on the web site by principal investigators is 5:00 PM, Eastern Standard Time, March 1, 2004.



CWRI ADVISORY COMMITTEE SELECTS PROJECTS  
FOR FY 2005 FUNDING

The Colorado Water Resources Research Institute's Advisory Committee for Water Research Policy (ACWRP) met November 12, 2003, to hear progress reports on FY 2003 research projects and to select projects for FY 2004 funding. The ACWRP heard updates on the following FY 2003 CWRI projects:

- Enhancements to the South Platte Mapping and Analysis Program (SPMAP). Luis Garcia, Principal Investigator.
- Assessing the Effectiveness of Best Management Practices (BMPs) in Controlling Non-Point Source Pollution from Forestland Uses. John Stednick, Principal Investigator.
- Strategies for Mitigating Waterlogging and Salinization in Colorado's Lower Arkansas River Valley. Tim Gates, Principal Investigator.
- Urban Landscape Irrigation with Reclaimed Wastewater, Yaling Qian, Principal Investigator.
- Canal Modernization for Addressing Salinity Issues in the Arkansas Valley, Colorado, John Wilkins-Wells, Principal Investigator.

Proposals submitted to the CWRI FY 2004 research competition were peer reviewed and the proposals and reviews were evaluated by the ACWRP to decide which projects best met the needs of Colorado water managers and users. The following projects were selected to receive FY 2004 CWRI funding:

- Enhancements to the South Platte Mapping and Analysis Program -- Luis Garcia, Colorado State University (in collaboration with South Platte Basin water users and managers).
- Mitigating Salinity Impacts in the Lower Arkansas Valley, Phase 3 -- Tim Gates, Colorado State University (in collaboration with the Agricultural Experiment Station, Cooperative Extension, Natural Resources Conservation Service, Bureau of Reclamation, U.S. Geological Survey, Bent County Soil Conservation District, The Catlin Canal Company, and the Fort Lyon Canal Company).
- Urban Landscape Irrigation with Reclaimed Wastewater, Phase 2: Current Knowledge and Community Experience -- Yaling Qian, Colorado State University (in cooperation with Denver Water).
- Determination of Ecosystem Response Thresholds to Nutrient of Flowing Waters in Montane Colorado -- William Lewis, University of Colorado. (In collaboration with the Water Quality Control Division).
- Salt Chemistry Effects on Indirect Field Salinity Assessment in the Arkansas River Valley, Colorado -- Grant Cardon, Colorado State University.

The ACWRP will be assembling water information needs over the spring in preparation for releasing its FY 2005 Call for Proposals in June 2004, pending available funds. To provide input to CWRI's research planning effort, please contact Robert Ward, CWRI Director, at (970) 491-6308 or [Robert.Ward@Colostate.edu](mailto:Robert.Ward@Colostate.edu). Or speak with a member of the CWRI ACWRP: Rep. Diane Hoppe, Sen. Lew Entz, Russell George, Mark Pipher, Don Ament, David Robbins, Fred Anderson, Sara Duncan, David Merritt, Ralph Curtis, and John Porter.



## RESEARCH



## STRETCHING URBAN WATER SUPPLIES IN COLORADO Strategies for Landscape Water Conservation

by

Rachel Barta<sup>1</sup>

in cooperation with

Robert Ward, Reagan Waskon, Dan Smith

The following article is a summary of CWRI Special Report No. 13, which was prepared in response to the one-day workshop organized April 15, 2003, by GreenCO, the CSU Department of Horticulture and Landscape Architecture, and Cooperative Extension. A follow up workshop is scheduled. A copy of the full draft report is available on the CWRI webpage: <http://CWRI.colostate.edu>.

**D**uring the 2002 drought in Colorado, municipalities relied on a variety of drought response strategies to temporarily and significantly curtail water use. Faced with declining water supplies, municipalities in Colorado primarily used outdoor watering restrictions to decrease demand during the 2002 drought. The rather sudden reduction in water available for landscape water use created a significant economic impact on the landscape (green) industry and water utilities. As might be expected, the negative economic impact on the landscape industry resulted in some tension between the landscape industry and municipal water providers. Now that the drought has somewhat subsided, municipal water providers are seeking improved conservation strategies to mitigate the severity of water reduction impacts and better prepare for future drought episodes.

The purpose of the study was to enhance the dialogue between municipal water providers and the green industry by identifying strategies for landscape water conservation that are acceptable and reasonable to both industries. In an attempt to define a Colorado context for examining these strategies, the study synthesized existing knowledge on the range of options available for reducing landscape water use and reviewed literature regarding the advantages and disadvantages of each option.

In the study, conservation strategies are categorized as price and non-price strategies. Non-price strategies include outreach and education as well as policy and regulation. Price strategies include inclining block rates, water budget based rate structures, and seasonal rate structures. Each strategy was explored in depth for purposes of extracting conservation options that may be beneficial in Colorado. A review of these strategies and an analysis of the advantages, disadvantages, and effectiveness of strategies are provided in the study.

### Non-price Strategies

#### Outreach and Education

There are a variety of outreach and education measures used to conserve water on landscapes. These measures are primarily used to convey information to water users so they can make informed decisions on how to efficiently manage water for landscapes. These strategies generally target one of two approaches to landscape water conservation: (1) improving the efficiency and management by which water is applied to landscapes, and (2) changing landscapes to those that require less water. Education and outreach measures are widely used by water providers and landscape industry professionals, yet not much is known about their direct influence on water conservation beyond the general understanding that they are essential to any conservation effort.

#### Policy and Regulation

Policy and regulation are typically more effective water conservation strategies than outreach and education strategies. However, education and publicity are needed to inform the public about water conservation policies and regulations. Policy strategies are long-term and include measures such as landscape ordinances and codes. Much is still to be understood about how policy strategies affect water conservation efforts. Regulation strategies are commonly used in the short-term for drought response and include measures such as mandatory water use restrictions. One of the major concerns about using policy and regulation strategies for conservation is the negative impact that ordinances and restrictions have on the landscape industry.

### Price Strategies

Even though financial strategies for water conservation are probably the most studied strategy, they are still not widely understood. In employing pricing policies for conservation, municipalities generally have concerns regarding public

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responsiveness to price increases and the ability to manage these policies with other water provider objectives. Nonetheless, conservation-oriented rate structures can be used to send strong messages for water conservation. Conservation-oriented rate structures considered in the study include inclining block rates, water budget based rate structures, and seasonal rate structures.

#### Inclining Block Rates

Inclining block rates are designed to encourage water conservation by increasing water charges for high consumption users, thus providing an incentive to be more efficient. Literature reviewed in the study shows that the effective use of inclining rate structures for landscape conservation requires a consideration of some key issues: price sensitivity, marginal cost pricing, price signaling, and block thresholds.

#### Water Budget-Based Rate Structures

Water budget-based rate structures are inclining block rates linked with individualized volumetric allotments of water to customers. Water budget-based rate structure theory holds that these rate structures: (1) are more equitable than other conservation-oriented rates because costs are allocated according to individual water needs or budgets, not average customer classes, and (2) are more efficient because they provide an individualized water allotment that is based on conservative resource standards. Proponents of water budget-based rate structures state other benefits including: more stable revenue generation, improved customer acceptance, low and consistent water bills, and improved drought response. Both water managers and customers also see water budgets as an equitable way to share limited water supplies, while preserving some amount of customer choice.

Several concerns regarding the effectiveness of using water budget-based rate structures are discussed in the study, including the tendency to base individual allotments on averages and the subjectivity that may be involved in defining conservation standards for allotments. Despite these concerns water budget-based rate structures have the potential to promote long-term conservation and to serve as a drought response tool. The green industry recognizes this approach to conservation as very viable and sustainable for the industry. As a relatively new concept that has not been widely used in Colorado, it has yet to be fully developed and understood.

#### Seasonal Rates

Seasonal water rates are another type of conservation-oriented rate structure that can be used to curtail water use for landscapes. Under this type of rate structure, surcharges are used to cover the costs that are driven by peaking requirements or times of high outdoor water use. There are relatively few studies that show the effectiveness of seasonal surcharges for landscape conservation, because they have not been widely

used for the purposes of curtailing outdoor water use during times of drought.

#### Study Findings

The findings of this study indicate that, in general, there is not sufficient peer-reviewed literature to scientifically evaluate the effectiveness of urban landscape water conservation strategies. While there have been studies of basic urban water conservation principles, applications of water conservation practices by municipalities are highly site specific, are often inconclusive due to confounding factors, and lack a strong backing of scientifically defensible information.

With the above as a caveat, there are several specific conclusions that can be stated as a result of this study:

- Overall, there is a lack of information available regarding the implementation of non-price conservation programs and a lack of detail and consistency of water use information necessary to evaluate changes in demand.
- More research is needed to understand how the interaction of conservation strategy incentives influences the overall reduction in water consumption.
- Failure to account for non-price conservation efforts, primarily outreach and education programs, may result in an overestimation of the effectiveness of price strategies for conservation.
- Education and outreach conservation programs tend to be a part of all conservation efforts and are generally believed to be very important in all conservation programs.
- A majority of conservation studies are site-specific and are not necessarily applicable in all settings.
- There is very little consistency in terminology used by various water managers and members of the green industry regarding water conservation for landscapes.

Because there is a lack of scientific certainty in the existing literature, the study does not recommend specific water conservation strategies that are believed to both reduce water use and protect the financial integrity of water utilities and the green industry. Although water managers have already employed strategies for reducing water use during the drought in Colorado, most have done so without the benefit of strong, scientifically defensible strategies.

While the study does not provide a definitive set of water conservation recommendations, it does provide insight into options that municipalities and the green industry might consider as they seek new and mutually agreeable approaches for urban landscape water conservation. This study recommends that a more scientific, collaborative approach be employed to document water conservation programs and to reduce water use and minimize the impacts to both Colorado's landscape industry and Colorado municipal water providers.



## URBAN LANDSCAPE IRRIGATION WITH RECYCLED WASTEWATER: PRELIMINARY FINDINGS

by

Yaling Qian

Department of Horticulture and Landscape Architecture  
Colorado State University

### INTRODUCTION

As with many large urban areas in the arid and semiarid regions of the U.S., the rapid population growth of Colorado's Front Range continues to place increasing demands on finite and limited water supplies. Many cities and districts are struggling to balance water use among municipal, industrial, agricultural, and recreational users. The population increase has not only increased the fresh water demand but also increased the volume of wastewater generated. Treated wastewater appears to be the only water resource that is increasing as other sources are dwindling. Reuse of treated wastewater for irrigating landscapes is often viewed as one of the approaches to maximize the existing water resources and stretch current urban water supplies (EPA, 1992).

Recycled wastewater (i.e., effluent water or reclaimed wastewater) is treated wastewater from the community to meet a permit issued through Federal or State Water Acts. During treatment, suspended solids are removed, pathogens are disinfecting, and partial to substantial reduction in nutrients occurs, depending on the level of treatment. However, recycled water may still contain different levels of dissolved solids, ions, nutrients (N and P), and other elements.

Currently, along the Front Range of Colorado, the bulk of treated wastewater is discharged to rivers and watersheds. Wastewater disposal in rivers has the benefit of maintaining adequate flow and boosting water volumes for downstream users. However, river disposal may accelerate the eutrophication process in natural waters and increase costs to downstream public water systems. The U.S. Geological Survey's National Water Quality Assessment program indicated that one of the principal contamination sources in the South Platte River basin is the discharge of wastewater from wastewater treatment plants (although manure and fertilizer are the largest nutrient sources) (Litke, 1995). Wastewater treatment plants discharge about 72 billion gallons per year of effluent water directly into the streams in the South Platte River basin, which contains 7000 tons of nitrogen and 860 tons of phosphorous. Nitrogen and phosphorus content of the South Platte River are about 2 mg/L and 0.2 mg/L, respectively, upstream from Denver. However, the river nutrient concentration peaks just downstream from each of Denver's largest wastewater treatment plants with a maximum concentration of 13.6 mg/L of NO<sub>3</sub>-N and 2.4 mg/L of P, exceeding the drinking water standard (Litke, 1995 and 1996).

Urban landscape plants, turfgrass in particular, need to be fertilized to maintain color, density, and vigor, although the amount of fertilizer needed annually depends on a number of factors (species, weather, soil, age, and clipping management). Nitrogen, phosphorus, and potassium are three important elements in maintaining a healthy turf stand, with nitrogen causing the greatest response. Research done in the southern U.S. has indicated that dense, well-managed turfgrass areas are among the best bio-filtration systems available for removal of excess nutrients and further reclamation of recycled wastewater (Hayes et al., 1990; Pepper and Mancino, 1994).

Using recycled wastewater for landscape irrigation in Colorado started in the 1960s in Aurora and Colorado Springs to irrigate golf courses. Although the complexity of water rights in Colorado complicates the legal rights to reuse water, in general, imported water (such as water from the West Slope) and non-tributary water (such as water from deep aquifers) are usually available for reuse (Warren and Swanson, 1981). The growing concerns of the future water supply and more stringent wastewater discharge standards to surface water bodies have contributed to the increasing interest in using recycled wastewater for urban landscape irrigation. In Colorado, many cities plan to expand wastewater reuse systems. For example, Denver Water is building a wastewater recycling system that will treat and deliver up to 17,660 acre-feet of water for reuse purposes. Using recycled wastewater for irrigation at several Denver parks (Washington, City Park & Golf Course, Swansea, Schafer, and Dunham Parks) will free up enough drinking water to serve 35,000 households. To protect human health and the environment, the first water reuse regulation (Regulation No. 84) has been developed and became effective in November 30, 2000 in Colorado (State of Colorado, 2000).

The growth in water reuse has created the need to research the effects of recycled wastewater irrigation on urban landscape soils, plants, and the ecosystem as a whole. Funded by the Colorado Water Resource Research Institute, research was initiated in 2003 with the following objectives:

- To assess chemical properties of recycled wastewater for urban landscape irrigation; and
- To evaluate landscape plants and soils that are currently under recycled wastewater irrigation.

### PROCEDURES

Briefly, the procedures of the project have involved:

- Preparing and sending surveys to the wastewater treatment plants that are currently supplying recycled wastewater for urban landscapes along the Front Range of Colorado. Requesting data on effluent water analysis from wastewater treatment facilities, which include total suspended solids, turbidity, biological oxygen demand, chemical oxygen demand, E-coli, and other basic chemical characteristics.
- Collecting water samples from irrigation ponds and irrigation sprinkler outlets on reuse sites to test salinity, individual mineral concentrations, and bicarbonate content.
- Collecting and analyzing soil samples from reuse sites vs. landscape sites that have not used recycled wastewater.
- Visual evaluations of the health of landscape plants on reuse sites.

#### PRELIMINARY RESULTS

- Golf courses are the earliest and leading urban landscape users of recycled wastewater in Colorado. Recently, the reuse practice has been extended to include some of the large parks, open spaces, and greenbelts. Survey data indicated that cost savings was not the main reason for using recycled wastewater for irrigation. Rather the availability and reliability of the water were the driving force for using recycled wastewater for irrigation.
- As the criteria set forth in Regulation 84, water treatment professionals typically use human health-related parameters such as E-coli count, turbidity, total suspended solid, nitrogen and phosphorous content to evaluate water quality. Data from five advanced wastewater treatment plants in the Front Range of Colorado revealed that, although there were variations in water quality between wastewater treatment facilities, in all cases, the water quality of effluent exceeded the regulations in the terms of E-coli count, turbidity, and suspended solid as stated in Regulation 84 (Table 1).

While these water quality criteria do help to protect public health and the environment, they do not address the water chemistry considerations that affect the suitability of treated wastewater for landscape irrigation. Landscape managers are often concerned about salinity and sodicity-related parameters, and other chemical compositions. The chemical constituent of recycled wastewater is dominated by sulfate, bicarbonate, chloride, and sodium. These 4 ions comprise of about 70 percent of total dissolved salts (Table 1). Sodium, bicarbonate, chloride, and boron are typically added to domestic wastewater as results of food processing, water softening, the use of soap and detergent, and/or during the wastewater treatment. These inorganic ions

are not reduced by conventional sewage treatment that is aimed to remove solids, decrease organic matter, disinfect pathogens, and reduce nutrient levels.

- Water testing results (Table 1) were reviewed for suitability in landscape irrigation based on irrigation water quality guidelines established for irrigated agriculture (Table 2). The guidelines in Table 2 were initially adapted from University of California Committee of Consultants to cover a wide range of conditions encountered in California's irrigated agriculture. These guidelines have been adapted for wastewater irrigated agricultural land (Pescod, 1992; Westcot and Ayers, 1985) and for wastewater irrigated urban landscapes and golf courses (Huck, 2000; Harivandi, 1994; Arber and Johnson, 2001).

The average electrical conductivity (EC) of over 30 recycled wastewater samples from 6 reuse sites was 0.84 dS/m and the range was 0.47 to 1.32 dS/m. An electrical conductivity higher than 0.75 dS/m indicates the water may impose negative effects on salt-sensitive plants. Periodic leaching of salts is required to mitigate the potential salinity problem.

Adjusted sodium absorption ratio (SAR) of recycled wastewater from reuse sites ranged from 1.6 to 8.3. Based on the interactive effect of salinity and sodicity on soil infiltration and percolation, most of the water samples collected showed slight to moderate effects on soil infiltration and permeability (Table 2 and Fig. 1). Long-term and continued use of water with a high adjusted-SAR will lead to reduction of soil infiltration and permeability. Additional management (such as gypsum application and frequent aeration) is needed to mitigate these effects.

One of the other concerns of recycled wastewater irrigation is the presence of high levels of particular ions (sodium, chloride, and boron) that are toxic to some trees and shrubs. With sprinkler irrigation, sodium and chloride frequently accumulate by direct adsorption through the leaves that are moistened. Sodium and chloride toxicity could occur on sensitive plants when their concentrations exceed 70 and 100 mg/L, respectively. These concentrations are much lower than toxicity caused by surface irrigation (Table 2). The average sodium concentration of over 30 water samples collected was 99 mg/L, ranging from 30 to 170 mg/L. The average chloride concentration was 95 ppm. Chloride leaches easily through the soil profile and chloride toxicity to turf and landscape plants should be minimal if soil is well drained and salts are regularly leached. However, if the sites have poor drainage, soil percolation is impaired or limited, or have a shallow water table present, chloride applied over time can accumulate to a toxic level.

Table 1. Average water quality values of recycled wastewater from advanced wastewater treatment plants in Colorado.

Parameter	Average	Minimum	Maximum	# of samples	Regulation 84 C Criteria
Human health and nutrient content aspect:					
Total suspended solid (mg/L)	11.7	1	50	130	< 30 as a daily maximum
Turbidity (NTU)	1.64	0.74	3.06	130	< 3 as monthly mean
E-coli form (E.coli/100ml)	9.7	0	90	130	< 126 as monthly mean
NH <sub>4</sub> -N (mg/L)	0.76	0.23	2.05	30	
NO <sub>3</sub> -N (mg/L)	3.62	0.2	9.5	130	
Total P (mg/L)	0.47	0.01	1.8	130	
Salinity, sodicity, and concentrations of specific ions:					
Total dissolved salts (mg/L)	614	300	847	37	
Conductivity (dS/m)	0.84	0.47	1.32	37	
SAR	3.1	1.1	5.8	37	
Adjusted SAR	5	1.6	8.3	37	
Sodium (mg/L)	99	30	170	37	
Chloride (mg/L)	95	53	222	37	
Bicarbonate (mg/L)	112	14	269	37	
Calcium (mg/L)	61	38	101	37	
Magnesium (mg/L)	15	6.9	32	37	
Sulfate (mg/L)	160	71	280	37	
Boron (mg/L)	0.23	0.02	0.41	37	
Iron (mg/L)	0.35	0.04	1.52	37	

- Although typically the wastewater treatment systems have continuously evolved in response to the growth and regulatory requirements, our results indicated that soils from sites where recycled wastewater was used for prolonged time exhibited higher concentration of sodium, chloride, boron, and phosphorous than sites with surface water irrigation (Fig. 2). However, the cation exchange sites occupied by magnesium and potassium were lower. Comparison of soil chemical properties before and 5 years after recycled wastewater irrigation on 2 golf courses also revealed the following findings: a) increased sodium content and sodium exchange percentage; b) increased boron content; and c) increased phosphorous content at the surface depth.

Quality decline of some conifer trees was often observed on golf courses with recycled wastewater for irrigation. Landscape managers also revealed that turf became more susceptible to drought stress after years of recycled wastewater irrigation. It is difficult to draw conclusions about the causes of the decline, although the degree of decline appeared to relate to water quality, species, soil texture, irrigation methods, and drainage effectiveness. More research is needed to define the causes of the decline and to study the tolerance of different landscape plants to recycled wastewater irrigation.

## IMPLICATIONS

While recycled wastewater irrigation in urban landscapes is a powerful means of water conservation and nutrient recycling, potential problems associated with recycled wastewater irrigation do exist. These problems include relatively high sodium and bicarbonate concentrations and the resulting changes in soil physical and chemical properties after long-term application of recycled wastewater. As landscape facilities and development areas plan to switch to recycled wastewater for irrigation, landscape managers must be prepared to face new challenges associated with the use of recycled wastewater. City landscape planners and managers need to understand the hidden costs in managing these landscapes to mitigate problems, such as higher water use for leaching; the need of frequent aerifications to maintain infiltration, percolation, and drainage; application of soil amendments to reduce sodium problems; soil and plant monitoring, etc.

As more recycled wastewater is applied to urban landscapes, salinity problems may increase in the future. The selection and development of salt-tolerant turfgrass and landscape plants will greatly help sites with salinity concerns. Research is ongoing at Colorado State University to determine the salinity tolerance of different turfgrasses and to develop highly salt-tolerant alternative turfgrasses.

Table 2. Guidelines for interpretation of water quality for irrigation. (From Ayers and Westcot, 1985).

Potential irrigation problem	Units	Degree of restriction on use		
		None	Slight to moderate	Severe
<b>Salinity</b>				
EC <sub>w</sub> <sup>a</sup>	dS/m or mmho/cm	<0.7	0.7-3.0	>3.0
Total dissolved salt	mg/L	<450	450-2000	>2000
<b>Permeability (Evaluate using EC<sub>w</sub> and SAR together)<sup>b</sup></b>				
SAR=0-3		and Ecw= >0.7	0.7-0.2	<0.2
=3-6		=>1.2	1.2-0.3	<0.3
=6-12		=>1.9	1.9-0.5	<0.5
=12-20		=>2.9	2.9-1.3	<1.3
=20-40		=>5.0	5.0-2.9	<2.9
<b>Specific ion toxicity (affects sensitive crops)</b>				
<b>Sodium</b>				
Surface irrigation	SAR	<3	3-9	>9
Sprinkler irrigation	mg/L	<70	>70	-
<b>Chloride</b>				
Surface irrigation	mg/L	<140	140-350	>350
Sprinkler irrigation	mg/L	<100	>100	
Boron	mg/L	<0.7	0.7-3.0	>3.0
Bicarbonate (Overhead sprinkling only)	mg/L	<90	90-500	>500
pH	Normal range 6.5-8.4			
Residual chlorine (Overhead sprinkling only)	mg/L	<1.0	1.0-5.0	>5.0

<sup>a</sup> EC<sub>w</sub> means electrical conductivity of the irrigation water.

<sup>b</sup> SAR means sodium adsorption ratio. For recycled wastewater, it is recommended that SAR be adjusted considering bicarbonate and sodium content in the water (Westcot and Ayers, 1985).

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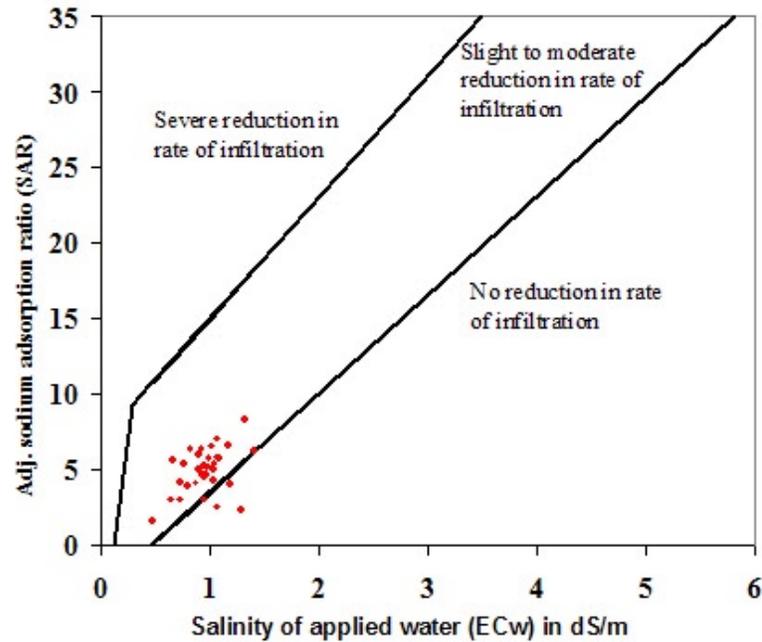


Figure 1. Relative rate of water infiltration as affected by salinity and adjusted sodium adsorption ratio of irrigation water (Adapted from Ayers and Westcot, 1985; and Oster and Schroer 1979). The dots are the data points of 37 water samples collected from Colorado water reuse sites.

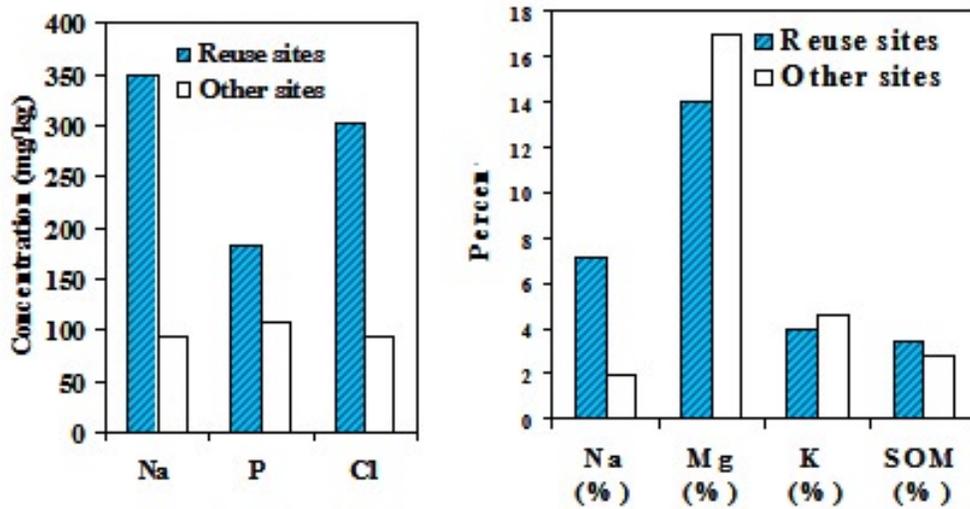


Figure 2. Comparisons of chemical properties of soil samples from sites with long-term recycled wastewater irrigation (reuse sites) vs. surface water irrigation (other sites).

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## MUNICIPALITIES AND UNIVERSITY FACULTY COOPERATE ON COMMUNICATION AND EVALUATION OF WATER CONSERVATION PROGRAMS

by Reagan Waskom, Eric Schuck and Rebecca Proft

During the drought of 2002-2003, municipalities along the Colorado Front Range implemented a number of voluntary and mandatory water use restrictions to encourage water conservation. Water suppliers and their staff conservation specialists found themselves in a reactive mode in 2002, as city councils and decision makers enacted conservation policies in the midst of much uncertainty.

In preparing for the 2003 outdoor watering season, Front Range water providers, with support from the Colorado Water Wise Council, identified a need for a clearer message regarding conservation programs. Denver Water, in particular, was concerned that media reports on their conservation programs might be confusing to viewers receiving water from other providers operating under a different set of restrictions.

In 2003, individual water utilities across the Front Range made a concerted effort to clearly communicate their specific programs via mail inserts, paid advertising and other outlets. As an additional vehicle to track and communicate the various restrictions enacted by different water supply agencies, Colorado State University was asked to provide a neutral web site that contained up-to-date water restriction information. CSU maintained a drought website at <http://drought.colostate.edu/> that

provided 17 updates on watering restrictions from March to October 2003. The website included watering days and times, rates, penalty information, contacts and other information and received over 17,000 visits during 2003.

Following the successful collaboration of water suppliers and University faculty



on communicating watering restriction programs, there was interest in knowing the effectiveness of the various measures taken to reduce water use. Also, there was interest in evaluating if messages from the largest water supplier in the media-shed (i.e., Denver) indirectly impacted water use in nearby municipalities.

Some early evidence suggested that voluntary measures increased water use in some areas; other indications were that the mere announcement of upcoming restrictions caused a reduction in water use. There is interest in knowing how successful education programs, voluntary measures, mandatory restrictions, and price mechanisms were in achieving demand reduction to cope with water shortages.

Several Front Range water providers agreed to provide CSU with daily water-demand data for the years 2000-2003 in order to analyze the impacts of various measures. Demand impacts will be compared across programs, time and municipality to answer the question of what seems to be most effective on the Front Range.

Given pre-existing water prices and the resistance towards changing these prices, water restrictions largely took the form of daily-use restrictions rather than the imposition of significantly higher water prices. These daily-use restrictions varied both across municipalities and through the summer irrigation season, but usually took the form of limits on the frequency and duration that lawns could be watered.

Since these policies varied widely over space and time, their general effectiveness is by no means clear. This analysis will assess the relative effectiveness of differing water use restrictions on per-capita water use for major municipalities along the Front Range, including Aurora, Denver, Fort Collins, and Greeley. Per capita water use figures will be used to determine the relative effectiveness of restrictions on water consumption using time-series analysis of daily per capita water use. Data analysis results are expected in late March 2004 and will be reported in an upcoming edition of Colorado Water.



## ESTES VALLEY LANDOWNERS PROVIDE A MODEL FOR PROTECTING FORESTS, HOMES AND COMMUNITIES

by Katherine Timm, Colorado State Forest Service

Like many Coloradans, they come from cities and towns from coast to coast. They moved to Colorado for the beauty and the climate and they can't imagine living anywhere else. They also didn't imagine that they'd spend so much of their time limbing and cutting trees to reduce fuels around their homes and in their neighborhood. But they're not complaining. They know their work will pay big dividends in terms of forest health and reducing the potentially catastrophic effects of wildfires.

The fuels reduction efforts of an energetic group of residents in the Windcliff subdivision began 10 years ago. Since then, they've embarked on an ambitious plan to mitigate hazardous fuels on each lot and the common areas. They've not only invested time and energy, they've invested funds to keep the process moving. Over the next three years, they will invest \$50,000 and will apply for grant funds to leverage their investment. And they are coordinating their efforts with the YMCA of the Rockies and Rocky Mountain National Park.

Their love and concern for the land they now call home has provided the impetus to get the work done. And the work has provided an opportunity for these dedicated landowners to create a real sense of community. Ask any of them and they'll quickly tell you that having a common goal has brought them together and fostered a true sense of community. "The work we're doing here has brought us together. I've been in more people's homes here in the last year than 10 years in Pennsylvania," said Jackie Reed, a Windcliff resident who got her first glimpse of the Estes Valley



when she vacationed at the YMCA of the Rockies several years ago.

They'll also tell you that convincing homeowners about the need to mitigate hazardous fuels hasn't always been easy. When Tony Simons, Larimer County wildfire safety specialist, and Mike Babler, Fort Collins district forester, Colorado State Forest Service, first ap-

Above: Larimer County crews use chippers to treat the slash generated by Windcliff residents who are reducing fuels on their property to mitigate wildfire hazards.

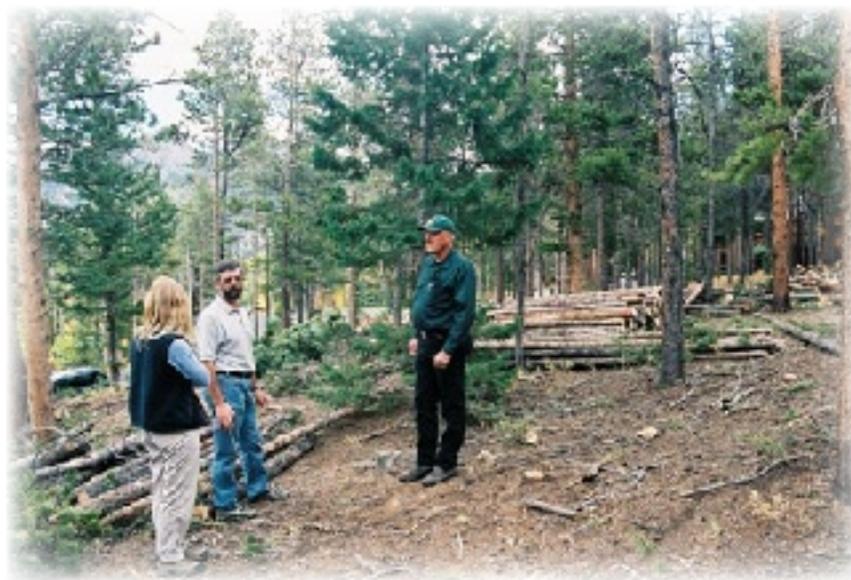
proached Windcliff residents about the benefits of reducing fuels in the subdivision, some of the landowners

were skeptical. They thought Simons and Babler were going to advise them to cut all their trees. "At first, I was worried that they would want us to cut too many trees, but they understood when I said I wanted to keep as many trees as possible," Reed said. Several presentations and many discussions later, the homeowners realized that Babler and Simons were advocating a forest management strategy that promotes healthy forests across ownerships. With Rocky Mountain National Park adjacent to their subdivision, it was a strategy that made sense: thin vegetation to discourage insect and disease epidemics, encourage vegetative diversity, improve wildlife habitat, and create an aesthetically pleasing environment—one that has been mitigated to protect against catastrophic wildfires.

Despite their accomplishments, Joe Walsh, a retired fire chief, Windcliff resident and chair of the Windcliff HOA mitigation committee, will not rest until all the homeowners in their subdivision have reduced hazardous fuels on their properties and the neighboring subdivisions have a mitigation plan in place. Next on his agenda is working with the YMCA of the Rockies and surrounding subdivisions to procure land on which to build a fire station and then raise \$150,000 to build it.

The YMCA of the Rockies, which is bordered by Rocky Mountain National Park on three sides, has also been working with Larimer County, the Colorado State Forest Service and

the National Park Service to implement a mitigation plan in designated areas. The YMCA, which resides on 860 acres of mostly forested land, was founded in 1907. The last time any major mitigation work was completed on the property was in the 1940s. Currently, John Landkamer, superintendent of buildings and grounds, and John Grasso, associa-



Colorado State Forest Service employees monitor fuels treatment work being done in the Estes Valley.

tion safety coordinator, for the YMCA of the Rockies, are targeting 125 acres for treatment in the next two years, and they're coordinating with the NPS, which will treat the adjacent land. "If the National Park Service doesn't treat their land, it wouldn't pay for us to treat ours," Landkamer said.

As with so many private landowners, funding and staffing are the major impediments to getting the mitigation work done. But grant funding through the National Fire Plan has helped, as have the fires that occurred in the summer and late fall of 2003. "When the Big Elk Fire occurred, awareness about the need to reduce fuels increased. As a result, we developed an evacuation plan and have been able to assign staff to help with mitigation work," Grasso said. "The staff love the work and appreciate the importance of what they're doing."

Nonetheless, because of the costs associated with mechanical treatment, they have been doing all the work manually. Their next goal is to get everyone in the area working together so they can hire a contractor to mechanically treat larger areas. They also will continue to work with the NPS to conduct prescribed burns where it's safe and desirable to do so.

In addition to reducing the risk of catastrophic fire and contributing to the overall health of forested lands in the area, they'll also be doing their part to protect the Wind River watershed, an important source of drinking water in the Estes Valley.

Next, Windcliff residents, the YMCA of the Rockies, Larimer County, the Colorado State Forest Service and the

Rocky Mountain National Park will embark on a plan to involve all six subdivisions along the Highway 66 corridor to engage in a comprehensive fuels treatment program. Only then will they feel like they have done all they can to protect valuable natural resources and the residents and visitors of the Estes Valley who treasure them.

#### WANT TO KEEP THOSE WATER PIPES FROM FREEZING?

The American Water Works Association website, [www.awwa.org](http://www.awwa.org) contains information on preventing water mains from freezing, thawing water mains, water main replacement and repair, and safely working in severe cold weather.



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**USDA Forest Service**  
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### 1. Benefit-Cost Analysis of Fort Collins' Municipal Forest

#### Highlights:

- There are approximately 31,000 street and park trees.
- Annual benefits total \$2.17 million (\$70/tree).
- Annual costs total \$997,000 (\$32/tree).
- Increased property value totaled \$1.6 million.
- Reduced stormwater runoff was valued at \$404,000.
- Energy conservation was valued at \$112,000.
- Carbon dioxide reduction and improved air quality was valued at \$43,000.
- Every \$1 invested in trees returns \$2.18 in benefits to residents.

Go to: <http://cufwr.ucdavis.edu/products/cufwr430.zip>

### 2. City of San Francisco, California Street Tree Resource Analysis

#### Highlights:

- There are approximately 100,000 street trees.
- Annual benefits total \$7.5 million (\$77/tree). Costs are about equal.
- Increased property value totaled \$6.9 million.
- Reduced stormwater runoff was valued at \$467,000.
- Improved air quality through pollutant deposition and particulate interception was valued at \$189,000.
- Carbon dioxide reduction was valued at \$38,000.

Go to: <http://cufwr.ucdavis.edu/products/cufwr427.zip>

The above material reprinted in Colorado Water courtesy of Dr. Greg McPherson, Director, Center for Urban Forest Research, Pacific Southwest Research Station, Davis, CA.

NOW AVAILABLE ON THE CWRRI WEBSITE AT [www.cwrri.colostate.edu](http://www.cwrri.colostate.edu)  
 in downloadable PDF files

Completion Report No. 196, Forests and Water: A State-of-the-Art Review for Colorado, by Lee MacDonald and John D. Stednick.

Information Series No. 96, Proceedings, Colorado Drought Conference, December 2002.

## FACULTY PROFILES

### DIANNI AND HELLMUND JOIN CSU LANDSCAPE ARCHITECTURE FACULTY

by Marian Flanagan

Colorado homeowners, municipal parks departments and other property managers increasingly are seeking more efficient ways to use water in urban and suburban landscapes. Recently, the Landscape Architecture Program at Colorado State University added two faculty members who are creatively exploring the many roles of water in landscape design. Christine Dianni and Paul Cawood Hellmund joined the Landscape Architecture Program in 2002 and 2003, respectively, increasing the number of full-time Landscape Architecture faculty members to five.

“We are very pleased to have Christine and Paul join us,” said Dr. Stephen Wallner, Head of the Department of Horticulture and Landscape Architecture. “They further strengthen and diversify our faculty expertise and both bring a keen academic inquisitiveness that is firmly grounded in practice. We are particularly excited to have them bring their creative talents to developing a new course that comprehensively looks at the many aspects of water in the landscape.”

The new course, “Landscape irrigation and water conservation” (H/LA368), looks at water in a holistic fashion (see sidebar). The course examines water in the Colorado landscape, how it gets here, how it is applied to the landscape, and what its quality will be when it leaves. Additionally, the aesthetic qualities, symbolic representation and perceived values of water are studied as elements that heavily impact water use in the landscape.

#### Christine Dianni



This school year Christine will be teaching a landscape design studio, design theory course, introduction to landscape architecture course and, with Paul Hellmund, is developing a new course on water issues in landscape design and management. Her interest in designing “sense of place” relies on knowledge of regional methods of transporting, storing and releasing water. Her research upholds that in order to honor water in the built landscape we must symbolically convey its value. Christine has been studying how water has been conveyed in imagery; namely in film. Additionally, she is studying film to learn how it addresses landscape through narrative, cinematographic methods and direct or indirect commentary on the landscape. This popular art, she believes, provides insight into people’s perception of the landscape, and therefore offers hints as to how we may influence that perception.

Since completing her MLA from Harvard University, Christine taught Career Discovery, co-taught a course at the Boston Architectural Center, and worked at Carter & Burgess, Inc. in Denver. While with this firm, her primary projects were transportation-based planning projects that

Topics included in the new CSU course,  
“Landscape Irrigation and Water Conservation”

Water: a systems view

Historical landscape perspective

Water rights

Water in the Landscape Design

Landscape Irrigation: fundamentals of  
plant/water/soil relationships

Landscape Irrigation: concepts and  
methods

Landscape Irrigation: traditional and  
new applications

Xeriscape

Regenerative design: non-traditional  
irrigation systems including greywater,  
raw water, water harvesting

Storm water management systems  
Constructed wetlands, stream restoration

stemmed from an initial streetscape project for the 28th Street corridor in Boulder. The team completed two Transportation Network Plans: one for the Crossroads Mall area and another for the North 28th Street area. These projects provided long-term, multi-modal transportation recommendations that would allow pedestrians, bicyclists and transit users to more comfortably share the street with vehicles.

Prior to completing her Masters degree, Christine worked in San Diego for Spurlock Poirier Landscape Architects and Wallace Roberts and Todd. She served as a project manager for Habitat for Humanity in Chicago, had a summer internship with the former Peter Walker William Johnson Associates, did trail work for the U.S. Forest Service in Petersburg, Alaska and traveled in Europe for a year.

Christine can be reached at [Christine.Dianni@colostate.edu](mailto:Christine.Dianni@colostate.edu) or 970-491-7283.

#### Paul Cawood Hellmund

At CSU, Paul teaches landscape ecology, environmental analysis, and digital methods, and is developing a new course on water issues in landscape design and management. His research interests are in sustainable design, green urbanism and landscape ecology. He is studying the factors influencing early twentieth century open-space and new-town planning in the American Canal Zone in Panama, where he was born and raised. At CSU he serves as a key advisor in the Latin American Studies Program and is an associate of the Institute for the Built Environment.

Paul has had a varied career as a practicing landscape architect, conservation planner, writer, and teacher. He was a member of professional teams that devised visionary solutions for “new” landscapes to replace former uses at Stapleton International Airport, Lowry Air Force Base, Rocky Flats Weapons Plant,

and the Rocky Mountain Arsenal. For the Stapleton site, working with ERO Resources, he helped develop a series of prototype ecosystems that can be used as models in converting former airport runways and other highly developed lands into “natural” open space.

He has extensive background in both planning and ecology, which he has applied to open space, parks, and refuge planning. He co-authored the 1993 book *Ecology of Greenways*, a guide to the design of linear conservation areas, which won a national award from the American Society of Landscape Architects, and which will be re-published by Island Press in 2004. He also authored the widely used “Planning Trails with Wildlife in Mind,” for Colorado State Parks. His projects have spanned more than 20 years.



Paul obtained a BS in Landscape Design from Colorado State University and completed his MLA at the Harvard Design School. Currently he is design principal with Hellmund Associates and formerly worked with ERO Resources Corp., Design Workshop, and the US National Park Service. He has taught at Harvard University and Virginia Tech.

Paul can be reached at [Paul.Hellmund@colostate.edu](mailto:Paul.Hellmund@colostate.edu) or 970-491-7216.

Landscape Architecture at Colorado State University

Colorado’s only undergraduate program in landscape architecture has seen nearly 30 years of graduates go on to employment and further education at many of the country’s top firms and graduate schools. The emphasis of the program is on the relationship between design, nature, and society. In addition to newly appointed faculty members Christine Dianni and Paul Hellmund, the faculty includes Brad Goetz, Joe McGrane, and Merlyn Paulson.

For more information, see [www.colostate.edu/depts/larch/](http://www.colostate.edu/depts/larch/)

AMERICAN WATER RESOURCES ASSOCIATION, COLORADO SECTION  
2004 annual symposium

INTERSTATE COMPACTS AND TREATIES:  
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Friday, April 30th, 2004, Arvada Center

More details to follow at

[www.awra.org/state/Colorado/](http://www.awra.org/state/Colorado/)

## MEETING BRIEFS



### FOUR STATES IRRIGATION COUNCIL HOLDS 51<sup>ST</sup> ANNUAL MEETING

Marc Catlin, President of the Four States Irrigation Council, welcomed over 160 attendees to the 51<sup>st</sup> annual meeting of the Council, held January 14-16, 2004, at the University Park Holiday Inn in Fort Collins. A large number of commercial exhibits accompanied a series of thorough and well delivered presentations regarding issues facing irrigators in Colorado, Kansas, Nebraska and Wyoming. During the presentations, a number of comments were made about needs for new knowledge to address emerging issues as well as help solve long-standing conflicts. The following summarizes a few of the talks given at the meeting.

Don Wilhite, Director of the Drought Mitigation Center in Lincoln, Nebraska, described the evolution of drought planning as it has moved from a response orientation to one of mitigation. He stressed the need for truly reliable climate and water supply assessments as well as a need for higher resolution analysis in support of policy decision making. On this last point he sees policy makers using national-scale drought maps to determine drought relief payments. The maps were not prepared for this purpose and will need more development before they provide the resolution that supports, in a sound science manner, such decision making.

Larry Todd, Director of Security, Safety, and Law Enforcement with the Bureau of Reclamation (BOR) described the evolving relationship between security and water. BOR security program components consist of physical security, personnel security, information security and cyber security.



Above: Tom Gill, Bureau of Reclamation, shares a moment with Todd Bolt, USDA-Natural Resource Conservation Service.

John W. Keys, III, Commissioner of the Bureau of Reclamation, reviewed a number of efforts being undertaken by BOR to stretch water supplies, including the Water 2025 initiative, a search for use of excess capacity, and a new Challenge Grant Program to fund water conservation efforts. He also reviewed efforts to further refine the shoulder and peak flow needs of the Black Canyon of the Gunnison National Park, efforts to automate water systems in the Grand Valley, and completion of Horsetooth Reservoir modernization work.



From left: Noble Underbrink, Head, Collections Systems Dept., West Slope, No. Colorado Water Conservancy District (NCWCD); Brian Werner, PIO and Meeting Coordinator (NCWCD); and Mike Applegate, Applegate Group and President of NCWCD's Board of Directors get together during meeting



From left: John W. Keys, Commissioner, Bureau of Reclamation examines products displayed by John Putnam and Dale Krause, commercial exhibitors.

Roger Patterson, Director of the Nebraska Department of Natural Resources, provided an update on Nebraska's Water Policy Task Force's efforts to be more proactive in blending ground and surface water management into one strategy. The Task Force is recommending that the Department of Natural Resources, annually, determine if a river basin is fully appropriated. If a preliminary evaluation indicates full appropriation, no new water rights will be issued and no new wells will be permitted. Next, the Department of Natural Resources, working with the local Natural Resource District, will develop an integrated management plan for ground and surface waters to maintain a balance in the basin between water supplies and water uses.



## COLORADO WATER CONGRESS ANNUAL CONVENTION -- 2004

An overflow crowd convened for the Colorado Water Congress's (CWC) 46<sup>th</sup> Annual Convention January 29-30, at the Holiday Inn in Northglenn. CWRRI organized two sessions: (1) water infrastructure and water quality; and (2) new tools to conjunctively manage ground and surface water. In the first session, Jim Loftis and Tim Gates, with CSU's Civil Engineering Department, presented results of CWRRI projects while Reagan Waskom, State Water Resources Extension Specialist, described USDA programs to manage water quality. In the second session, Luis Garcia, with CSU's Civil Engineering Department, updated the CWC on recent improvements to his CWRRI co-sponsored South Platte Mapping and Analysis Program and its use in implementing Senate Bill 73. Tom Sale, also with CSU's Civil Engineering Department, described his efforts to characterize the Denver Basin Hydrostratigraphy using visual logs.

Robert McGowan, Professor and Chairman of the Department of Management in the University of Denver's Daniels College of Business, moderated a dialogue of 20 Colorado water leaders on "Water Development after Referendum A – Now What?" Jim Martin, Director of the Natural Resources Law Center at the University of Colorado, Boulder, was a member of the panel. A video tape of the dialogue is available from the Colorado Water Congress (303/837-0812).

Steve Schulte, Professor of History at Mesa State College in Grand Junction, briefly reviewed the life of Wayne Aspinall, as presented in much more detail in his recently published book *Wayne Aspinall and the Shaping of the American West* (published by the University Press of Colorado -<http://www.upcolorado.com/index.asp>). George Sibley, Director of Western State College's annual Colorado Water Workshop, interviewed a number of Colorado water professionals as he plans the program for the 2004 Workshop (July 28-30, 2004). For updated information on the Workshop, see: <http://www.western.edu/water/>

Pictures clockwise, individuals from left: George Sibley, Professor at Western State College and Chair, Colorado Water Workshop; Eric Kuhn, General Manager, Colorado River Water Conservation District; Chips Barry, Manager, Denver Water.



Michael McHugh, Managing Partner, New West Environmental, L.L.C.; Tim Gates, Civil Engineering Department, CSU

Colorado Senator Lewis Entz, Colorado Representative Diane Hoppe, Dick MacRavey, Executive Director, Colorado Water Congress, Dillon Cowan, Junior in Civil Engineering at CSU and winner of the 2004 MacRavey Water Education Scholarship, Karla Brown, Executive Director, Colorado Foundation for Water Education, and Ronald A. Hellbusch, President, Colorado Water Congress.



## FEATURES



### NATIONAL XERISCAPE DEMONSTRATION PROGRAM UPDATE

Some Common Xeriscape Plants

by

Jon Medina

Technical Service Center

U.S. Bureau of Reclamation, Denver



Apache plume  
(*Fallugia paradoxa*)

The Bureau of Reclamation entered into cooperative agreements, collectively called the “National Xeriscape<sup>(tm)</sup> Demonstration Program” (NXDP), to develop data and analyses from specific field projects on the cost, yield and reliability of water use savings from the installation of water-conserving Xeriscape landscapes. Xeriscape is defined here as a landscaping approach that uses drought resistant grasses and plants, efficient watering systems, and proper maintenance practices, to create an aesthetically pleasing landscape while maintaining desired attributes such as recreation and cooling.

Cooperative demonstration projects of landscape water conservation have been or are being conducted at Austin TX, Phoenix AZ, Las Vegas NV, Denver CO and vicinity, and Fargo ND. It is anticipated that the NXDP results will supply municipalities of the western United States with additional information to consider the implementation of Xeriscape programs as part of their water supply solutions.



Silver Sagebrush  
(*Artemisia* sp.)

The primary goals of the NXDP are to:

- Conduct consistent investigations at multiple sites in different geographic and municipal settings of the West.
- Conduct a summary evaluation (known as meta-analysis) of demonstration features common to all field projects.



Ornamental xeric planting on bank eliminates runoff, water waste and the potentially hazardous mowing of a turf planting.

Four key questions that require answers to assess the viability of Xeriscape as an alternative in water supply planning are:

- How much water is saved on an annual and seasonal basis when a Xeriscape landscape design is properly installed and maintained? That is, what is the annual and seasonal yield of Xeriscape to the water supply system?
- What is the cost of the implementation of Xeriscape both for new construction and as a retrofit to existing landscapes?
- How reliable are Xeriscape water savings? Once implemented, does the pattern of conservation savings remain stable or do water consumption patterns change with the age of the landscape?
- What marketing strategies affect the implementation of Xeriscape in a community? What is the mix of market incentives, regulatory controls, and educational programs that facilitate the development of Xeriscape as an alternative to the traditional landscape?

Data from the field projects currently are being compiled and evaluated. Data analyses results are expected by April of 2004.

The trademark for Xeriscape is held by Denver Water.



## CURRENT DROUGHT AND WATER CONSERVATION PROJECTS FOR THE COLORADO WATER CONSERVATION BOARD

by Brad Lundahl

Section Chief, Office of Water Conservation and Drought Planning  
Colorado Water Conservation Board

The Colorado Water Conservation Board's Office of Water Conservation was established by the Colorado General Assembly in 1991 to enhance the efficiency with which water is used and to make water available for all beneficial uses in Colorado.

Since its inception, the Office of Water Conservation has been largely responsible for collecting and maintaining water conservation plans from various water entities across Colorado. More recently, drought mitigation duties were added to the responsibilities of the Office of Water Conservation and the name of the section was changed to the Office of Water Conservation and Drought Planning to reflect the need for the state to become more involved in managing the monitoring, impact assessment, response, and mitigation of prolonged drought events.

Over the last two years, the Office of Water Conservation and Drought Planning has been involved in several projects related to water conservation, drought planning, and water supply evaluation. Two of these projects are significant and warrant further discussion.

### Drought Assessment

The first is the Colorado Drought and Water Supply Assessment (Drought Assessment). The Drought Assessment is the first project of its kind conducted by the state, and is designed to determine whether Colorado has enough water to meet its existing and future demands.

The Drought Assessment project began in 2002 and involved developing a survey to gather water supply information from over 500 water suppliers across the state. The survey asked water suppliers to describe their water situation in such terms as their current water use, carry-over storage capabilities, limitations to water supplies, drought planning and drought impacts, concerns for future water supply planning, and structural and non-structural project needs. The results gathered represent the opinions of water suppliers in every major water basin and every water user type, and portray a solid understanding of the status and needs of the state's water suppliers.

The Drought Assessment has been completed and the final report will be available from the Colorado Water Conservation Board in March, 2004.

### Technical Assistance to Covered Entities

The second project, entitled "Technical Assistance to Covered Entities," was initiated in response to the emerging results of the Drought Assessment project which showed a need for the state to provide technical and financial assistance to those local entities, or "covered entities," that have a responsibility for water conservation and drought planning. The Board has set aside funds to be used to increase the number of local entities with water conservation and drought plans and to improve the nature and breadth of water conservation practices at the local level. The CWCB Board believes that the current practices of local water conservation planning within the state could be improved in some locations and accepts a role in helping local entities to improve their water conservation and drought planning by providing technical and financial assistance to them.



For more information on water conservation, drought planning, or any of the projects mentioned above, please contact Brad Lundahl, Section Chief, Office of Water Conservation and Drought Planning, Colorado Water Conservation Board, 1313 Sherman St. #723, Denver, CO 80203, [Brad.Lundahl@state.co.us](mailto:Brad.Lundahl@state.co.us) or 303/866-3441

## CWRRI University Water News

University of Colorado

GROUNDWATER IN THE WEST – June 16-18, 2004  
25th Annual Summer Conference

Natural Resources Law Center, University of Colorado School of Law  
Boulder, CO 80309-0401



The Natural Resources Law Center is sponsoring its 25th summer conference June 16–18, 2004. This year's conference will explore one of the most important resource management issues of the 21st Century: groundwater law, policy, and management issues throughout the West. Wednesday evening's keynote presentation – Robert Glennon, author of "Water Follies: Groundwater Pumping and the Fate of America's Fresh Water" – will be free and open to the public. Registered participants are invited to bring materials for distribution (free only). Limited space will also be available to registrants for free-standing display materials and to place materials on the conference CD-ROM to be distributed after the conference.

Outline of Agenda -- (as of January 21, 2004)

### Wednesday, June 16, 2004 -- A PRIMER ON WESTERN GROUNDWATER

- 8:30 Registration and Coffee  
9:30 Welcomes and Announcements -- Dean David Getches and Jim Martin, Director, Natural Resources Law Center
- Session 1. Groundwater: Science Basics -- Moderator: Jim Martin, Natural Resources Law Center  
9:45 - 10:30 Survey of Groundwater Supplies and their Depletion -- Alan Burns, U.S. Geological Survey  
10:30 - 11:15 Survey of Groundwater Quality Issues -- Mike Wireman, Regional Groundwater Expert, EPA Region 8  
11:15 - 11:45 Groundwater - Surface Water Interactions -- Thomas Maddock III, Department of Hydrology, Univ. of Arizona  
11:45 - 12:15 Questions, Comments, and Discussion  
12:15 - 1:30 Lunch (provided)
- Session 2. Groundwater: Law Basics -- Moderator: Kathryn Mutz, Natural Resources Law Center  
1:30 - 2:15 Overview of Groundwater Management Laws in the Western U.S. -- Gary Bryner, Natural Resources Law Center and Brigham Young University  
2:15 - 3:00 Survey of Federal Groundwater Rights -- John Leshy, Hastings College of the Law, University of California  
3:00 - 3:30 Break  
3:30 - 4:15 Survey of Indian Groundwater Issues -- Rodney Lewis, General Counsel, Gila River Tribe  
4:15 - 5:00 Modeling and Expert Witnesses in Adversarial Settings -- (to be announced)

### Evening Program

- 5:00 - 6:30 Reception Sponsored by Hydrosphere Resource Consultants, Book Display, and Informal Poster Session  
6:30 - 8:00 Keynote Address and Book Signing (open to the public) -- Robert Glennon, University of Arizona, author of Water Follies: Groundwater Pumping and the Fate of America's Fresh Water

### Thursday, June 17, 2004 -- REGIONAL GROUNDWATER ISSUES: PAST, PRESENT AND FUTURE

- 8:00 Coffee  
8:15 - 8:30 Announcements
- Session 3. Groundwater for the Industrial West – Moderator: Kathryn Mutz, Natural Resources Law Center  
8:30 - 9:15 Black Mesa -- Harris Sherman, Arnold and Porter and Counsel to the Hopi Tribe  
9:15 - 10:00 Coalbed Methane: Overview of ownership and water quality issues -- Tom Darin, Jackson Hole Conservation Alliance  
10:00 - 10:30 Break
- Session 4. Transboundary Groundwater Issues -- Moderator: Doug Kenney, Natural Resources Law Center  
10:30 - 11:15 Western States' Compacts: Should Groundwater Be on the Table? -- Rachael Paschal Osborn, Gonzaga Law School  
11:15 - 12:00 U.S. – Mexico Groundwater: A Shared Resource? -- Steve Mumme, Colorado State University  
12:00 - 1:00 Lunch (on your own)
- Session 5. Regional Panels -- Moderator: Jim Martin, Natural Resources Law Center  
1:00 - 2:30 Groundwater Resources of the Plains: From the Edwards to the Ogallala -- Ron Kaiser, Texas A&M University, and Raymond Supalla, Department of Agricultural Economics, University of Nebraska  
2:30 - 3:00 Break

3:00 - 4:30 Groundwater Resources of the Lower Colorado Region -- Michael Fife, Hatch and Parent, Pat Mulroy, General Manager, Southern Nevada Water Authority (invited); Timothy Henley, Manager, Arizona Water Banking Authority

4:30 - 5:00 Question, Comments and Discussion

Evening Program

6:00 - 9:00 Flagstaff Barbeque

Friday, June 18, 2004 -- GROUNDWATER: INNOVATIVE SOLUTIONS FOR COLORADO AND THE WEST  
-- Available for Separate Registration

8:00 Registration and Coffee

8:30 - 8:45 Welcome and Announcements

Session 6. A Colorado Groundwater Primer -- Moderator: James Corbridge, University of Colorado School of Law

8:45 - 9:00 Groundwater Resources in Colorado: The Groundwater Atlas -- Matthew Sares, Chief, Environmental Geology Section, Colorado Geological Survey

9:00 - 9:45 Introduction to Groundwater Law in Colorado -- David Harrison, Moses, Wittemyer, Harrison and Woodruff PC

9:45 - 10:15 Surface-Groundwater Conflicts on the South Platte: Effect of Drought on Laws, Regulations and Water Use  
Steve Simms, Colorado Office of the Attorney General

10:15 - 10:45 Break

10:45 - 11:15 Groundwater Management: Lessons from Colorado v. Kansas -- David Robbins, Hill & Robbins PC (invited)

11:15 - 11:45 Potential for Conjunctive Use in the South Denver Metro Region: Tri Party Alliance -- Patricia Wells  
General Counsel, Denver Water (invited)

11:45 - 12:00 Discussion

12:00 - 1:00 Lunch (provided)

Session 7. The Future of Groundwater in the West -- Moderator: Jim Martin, Natural Resources Law Center

1:00 - 2:00 Ken Salazar, Colorado Attorney General (invited)

2:00 - 3:30 Don Ament, Colorado Department of Agriculture

Russell George, Colorado Department of Natural Resources

3:30 - 4:00 Questions, Comments and Discussion

For additional information access the NRLC website at <http://www.colorado.edu/Law/centers/nrlc/events.htm>,  
phone 303/492-1286, or email [nrlc@colorado.edu](mailto:nrlc@colorado.edu).

Rocky Mountain WATER AND WASTEWATER Plant operators school  
Intermediate and Advanced Courses  
March 22-26, 2004 -- University of Colorado at Boulder

For further information contact Sara Tanner or Jean Martin, Office of Conference Services, University of Colorado at Boulder, 454 UCB, Boulder, CO 80309-0454, phone 303/492-5151, FAX 303/492-5959, e-mail [sara.tanner@colorado.edu](mailto:sara.tanner@colorado.edu) or [jean.martin@colorado.edu](mailto:jean.martin@colorado.edu). Register online at <http://housenet.colorad.edu/confreg/mwww04.html>



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The 2003-04 Wren and Tim Wirth Forum

Free and open to the public, and reservations are not required. Seating is limited, and will be filled on a first-come, first-served basis.

Mar. 17, 2004 7:00 p.m., Location TBA

Manuel Lujan, Jr. – Lujan served as Secretary for four years (1989-1993) under President George W. Bush. He helped implement the President's "no net loss" of wetlands.

Apr. 20, 2004 7:00 p.m., Glenn Miller Ballroom

Bruce Babbitt – Babbitt served as Secretary for eight years (1993-2000) under President Clinton.

See the Center of the American West Website at: <http://www.centerwest.org>.

*CU-DENVER water news*

University of Colorado at Denver  
Continuing Engineering Education Program  
Spring 2004

Call 303-556-4907 or visit [www.cudenver.edu/engineer/cont](http://www.cudenver.edu/engineer/cont)  
and click on the Course Information link to learn more about these courses.

## Civil Engineering

## Professional Development

## NCES 8322: River and Floodplain Modeling with HEC-RAS version 3.1.1

This 3-day course presents the latest version of HEC-RAS and its applications to model streams, rivers, and floodplains under a flood flow condition. The first day will focus on how to compute water surface profiles for a river network; Day 2 will cover culvert and bridge hydraulics and modeling techniques; and Day 3 will illustrate how to manage HEC-2 data files and GeoRAS for a floodway analysis by various methods. Workshops are designed to have hands-on operations using HEC-RAS to analyze common and practical floodplain problems. Participants will have an opportunity to prepare input files and analyze output during workshops. Class will meet Wednesday through Friday, March 17 through 19, 2004; from 8:00 a.m. to 4:30 p.m. on Wednesday and Thursday and 8:00 a.m. - 3:30 p.m. on Friday. It will be held on the Auraria campus in downtown Denver. Course instructors are Vernon Bonner, James C.Y. Guo, and John Liou. The cost is \$945.

## NCES 8221: Urban Flood Channel Design

This two-day course presents state-of-the-practice channel design procedures and criteria for flood mitigation in metropolitan areas. The course not only covers design methodologies for various types of channels but also provides hands-on operations of the latest version of the UDCHANNEL and UDCULVERT computer models. This course begins with a review of basic open channel hydraulic principles and then extends their application to designs of grass channel, riprap reach, concrete channel, composite channel, curve channel, and channel transition. Culvert hydraulics and design charts are also discussed as an inlet and outlet device to a flood channel. Both steady flow condition for channel design and unsteady flow condition for hydrograph routing will be illustrated with numerical examples. This course will be presented as an intensive computer aided design workshop in order to deliver hands-on working knowledge. Class will meet Thursday and Friday, May 20 and 21, 2004; from 8:30 a.m. to 4:30 p.m. at CU at Interlocken at Level 3 Communications in Broomfield. The course instructors are Ben Urbonas, James C.Y. Guo, and Ken MacKenzie. The cost is \$595.

## NEW Training seminar

The University of Colorado at Denver  
March 17, 18, and 19, 2004

River and Floodplain Modeling with HECRAS  
[ HECRAS and GeoRAS The Latest Version-3 ]

presented by Vern Bonner, Author of HECRAS, John Y.D. Liou, FEMA Hydrologist,  
and James C.Y. Guo, Professor at CU-Denver

This course is designed for water resource professionals who involve in hydrology, hydraulics, urban drainage, floodplain management, river modeling, culvert crossing and bridge designs. The course and hands-on workshops cover the basic principles for river hydraulics, floodplain flow modeling techniques, and FEMA floodway.

Hydraulic Principle for Water Surface Profiles	Bridge Hydraulics and Modeling
HECRAS Input Data Requirements	Culvert Hydraulics and Modeling
Preparation of HECRAS Input File	Importing GIS, HEC-2, and other data.
Water Surface Profiles by HEC-RAS	Floodway Delineation and Analysis
Analysis of HEC-RAS Output	Troubleshooting with HEC-RAS

All attendees will receive a course notebook and a software CD containing: the latest version of HEC-RAS computer program, User's, hydraulic reference and computer application manuals, steady & unsteady sample-data files, and the GeoRAS procedures and documentation.

Enrollment is limited to 30 registrants and will be accepted on a first-come, first-served basis. The enrollment fee is \$945 per person. For more information about the course and registration, go to <http://www.cudenver.edu/Academics/Colleges/College+of+Engineering+and+Applied+Science/Continuing+Education/default.htm>.

*UNC water news*

The University of Northern Colorado will offer an online, graduate Earth Systems: WATER course in the summer as follows:

ESCI 575-970 Earth Systems: WATER (3 semester hours of graduate credit). June 7-July 30, 2004. Course instructor: Dr. Michael Taber. This is an online, problem-based course in earth sciences focusing on water resources. The course will fulfill Colorado Model Content Standards in Earth and Space Science, as well as serving as a model for problem-based, technology-based pedagogy. Students in the course should have a basic science background. For more information, contact Dr. Taber at [michael.taber@unco.edu](mailto:michael.taber@unco.edu). Registration information may be obtained at <http://www.unco.edu/center/online.htm> after posting of the summer courses in February of 2004.

*CSM water news*

**SOURCE REMOVAL OF CONTAMINANTS** -- Since August 2002, the Water Science and Technology Board of the National Research Council has conducted a study on the effectiveness of source remediation for cleaning up contaminated ground water and soil at hazardous waste sites. The study is focusing on recalcitrant organic compounds, including dense non-aqueous phase liquids and chemical explosives. At its fourth meeting recently held in Irvine, California, the committee heard presentations on the water quality benefits of mass removal from Tissa Illangasekare, Environmental Science and Engineering, Colorado School of Mines; Tom Sale, Civil Engineering Department, Colorado State University, and others. The study is sponsored by the Army Environmental Center. For more information, contact Laura Ehlers at 202/334-3422 or [lehlers@nas.edu](mailto:lehlers@nas.edu).

**WATER SUPPLY**

There are no extreme SWSI values at this time, reflecting a snowpack that is near normal. Statewide, the snowpack averaged 95 percent of normal on January 1, with variations reflected by the Gunnison basin averaging 105 percent of normal and the South Platte basin averaging 67 percent of normal. Both stream flow and reservoir storage are below normal throughout the state,

which is a cumulative result of several years of dry conditions. Cumulative storage for all reservoirs graphed in this report is 76 percent of normal, which is an improvement on the 58 percent of normal value stored last year at this time. Above normal winter snowpack and/or spring and summer rain will be required to boost stream flows and replenish surface and ground water storage to more normal levels.

**T**he Surface Water Supply Index (SWSI) developed by the State Engineer's Office and the USDA Natural Resources Conservation Service is used as an indicator of mountain-based water supply conditions in the major river basins of the state. It is based on streamflow, reservoir storage, and precipitation for the winter period (November through April). During the winter period, snowpack is the primary component in all basins except the South Platte basin, where reservoir storage is given the most weight. The following SWSI values were computed for each of the seven major basins for January 1, 2004, and reflect the conditions during the month of December.

Basin	1/1/04 SWSI Value	Change From Previous Month	Change From Previous Year
South Platte	-0.8	+1.4	+1.9
Arkansas	-1.8	+0.2	-1.1
Rio Grande	+0.4	-0.4	+1.2
Gunnison	-0.2	+1.0	-0.2
Colorado	-1.1	0.0	-1.0
Yampa/White	+0.9	-1.6	+1.7
San Juan/Dolores	+0.6	+0.1	+1.3

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

Severe  
Drought

Moderate  
Drought

Near Normal  
Supply

Above Normal  
Supply

Abundant  
Supply

**RESEARCH AWARDS**

A summary of research awards and projects is given below for those who would like to contact investigators. Direct inquiries to investigators c/o indicated department and university. The list includes new projects and supplements to existing awards. The new projects are highlighted in bold type.

COLORADO STATE UNIVERSITY, FORT COLLINS, COLORADO  
Awards for November 20, 2003 to January 28, 2004

PI	Department	Sponsor	Title
Broner, Israel	Civil Engr.	NRCS	CropFlex Modification & Enhancements
Culver, Denise	FWB	CDNR	Survey of Critical Wetlands & Riparian Areas in Delores County, Colorado
Burke, Ingrid	FRWS	NASA	Application of Remotely Sensed Imagery to Assessing the Probabilities & Carbon Consequences of Fire
Kummerow, Christian	Atmos. Sci.	NASA	Risk Mitigation Studies for Evolving Data & Information Systems Related to Rainfall Missions
Sanders, Thomas	Civil Engr.	NPS	Preservation, Protection, & Management of Water Aquatic Resources of Units of the National Park System
Pielke, Roger	Atmos. Sci.	NASA	Ensemble Simulations of Regional Climate Incorporating Explicit Vegetation Dynamics ...
Grunau, Lee	FWB	USFS	Region 2 FY04 Threatened, Endangered, & Sensitive Database Project
Cotton, William	Atmos. Sci.	CWCB	Numerical Simulations of Snowpack Augmentation for Drought Mitigation Studies in the Colorado Rocky Mountains
She, Chiaoyao	Physics	NSF	CEDAR: Seasonal Variations in Mesopause Regional Temperatures; Zonal & Meridional Winds; Climatology & Variability...
Johnson, James	Biology	CDNR	Reference Conditions in Rocky Mountain Wetlands
Cifelli, Robert	Atmos. Sci.	NSF	Bringing CoCoRaHS to the Central Great Plains: An Informal Science Education Project for Rural Communities

FEDERAL SPONSORS: BLM-Bureau of Land Management, COE-Corps of Engineers, DOA-Dept. of the Army, DOD-Dept. of Defense, DOE-Dept. of Energy, DON-Dept. of the Navy, DOT-Dept. of Transportation, EPA-Environmental Protection Agency, HHS-PHS-Public Health Service, NASA-National Aeronautics & Space Administration, NBS-National Biological Survey, NOAA-National Oceanic & Atmospheric Admin., NPS-National Park Service, NRCS-Natural Resources Conservation Service, NSF-National Science Foundation, , USAID-US Agency for International Development, USBR-US Bureau of Reclamation, USDA/ARS-Dept. of Agriculture, Agricultural Research Service, USDA/NRS-Dept. of Agriculture, Natural Resources Service, USFS-US Forest Service, USDA-USFS-RMRS-Rocky Mountain Research Station, USFWS-US Fish & Wildlife Service.

STATE/LOCAL SPONSORS: CDA-Colorado Department of Agriculture, CDNR-Colorado Dept. of Natural Resources, CDPHE-Colorado Dept. of Public Health and the Environment, CDWL-Colorado Division of Wildlife, NCWCD-Northern Colorado Water Conservancy District. OTHER SPONSORS: AWWA-American Water Works Assn., CID-Consortium for International Development.

OTHER SPONSORS: ADEC-American Distance Education Consortium.

UNIVERSITY DEPARTMENTS, INSTITUTES AND CENTERS: Colorado State: BSPM-Bioagricultural Sciences & Pest Management, CBE-Chemical & Bioresource Engr., CFWLU-Cooperative Fish & Wildlife Unit, CSMTE-Center For Science, Mathematics & Technical Education, CIRA-Cooperative Inst. for Research in the Atmosphere, DARE-Dept. of Agric. & Resource Economics, ECE-Electrical & Computer Engineering, ERHS-Environment & Rad. Health Sciences, FWB-Fishery & Wildlife Biology, FRWS-Forest Rangeland Watershed Stewardship, HLA-Horticulture & Landscape Architecture, NREL-Natural Resource Ecology Lab, NRRT-Nat. Resources Recreation & Tourism, RES-Rangeland Ecosystem Science, SCS-Soil & Crop Sciences. University of Colorado: ACAR-Aero-Colorado Center for Astrodynamic Research, AOS-Atmospheric & Oceanic Sciences, CADSWES-Center for Advanced Decision Support for Water and Environmental Systems, CEAE-Civil, Environmental, and Architectural Engineering, CIRES-Cooperative Institute for Research in Environmental Sciences, CRCMAST-Cooperative Research Center for Membrane Applied Science & Technology, EEB-Ecology & Environmental Biology, EPOB-Environmental, Population & Organismic Biology, IAAR-Institute for Arctic & Alpine Research, IBS-Institute of Behavioral Science, ITP-Interdisciplinary Telecommunication Program, LASP-Lab. For Atmos. And Space Physics, PAOS-Program in Atmospheric and Oceanic Sciences.

COLORADO STATE UNIVERSITY, FORT COLLINS, COLORADO  
Awards for November 20, 2003 to January 28, 2004 cont'd.

PI	Department	Sponsor	Title
Hanan, Niall	NREL	Univ. of TN/ Battelle LLC	ARM Carbon Modeling & Land Surface-Atmosphere Model Applications
Douglas, Marlis	FWB	CDW	Rio Grande Cutthroat Trout Genetics
Sale, Thomas	Civil Engr.	School of Mines	Effects of Remediation on Water Quality & Source Longevity
Collett, Jeffrey Jr.	Atmos. Sci.	NSF	Investigation of the Organic Composition of Fogs & Clouds
Abt, Steven	Civil Engr.	USFS-RMRS	Bedload Transport in Gravel-bed Rivers & Channel Change
Romme, William	FRWS	USFS-RMRS	Carbon Cycling at the Landscape Scale: the Effect of Changes in Climate & Fire Frequency on Age Distribution, Stand...
Knight, Richard	FWB	USFS	Snag Study Two
Poff, N. LeRoy	Biology	EPA	Linking Watershed Characteristics with Flow Regime & Geomorphic Context to Diagnose Water Quality Impairment...
Crooks, Kevin	FWB	Nature Conservancy	Evaluating NCCP Connectivity & Movement Corridors Using Simulation Modeling of Carnivore Movement
Binkley, Daniel	FRWS	NATO	Trees & Soil Interactions, Implications to Global Climate Change
Paustian, Keith	NREL	EPA	Improved Agricultural Soil Greenhouse Gas Inventories for Central American Countries
Smith, Freeman	FRWS	USFS-RMRS	Mapping Snow Properties: A Multi-Scale Approach
Deo, Shripad	CIRA	NOAA	Applied Research in Support of Implementation of National Weather Services
Dennis, Frank	CSF	USFS	Upper South Platte Buffer Lands Good Neighbor Agreement
Fausch, Kurt	FWB	DOI	Colorado River Cutthroat Trout Translocation Research
Macdonald, Lee	Geosciences	USFS	Monitoring Runoff & Erosion in the Upper South Platte Restoration

UNIVERSITY OF COLORADO, BOULDER, COLORADO  
Awards for November, 2003

PI	Department	Sponsor	Title
Emery, William	ACAR	Jet Propulsion Lab	Merging Infrared Sea Surface Temperature with Satellite Altimetry to Map Ocean Currents in Two Coastal Domains
Weil, Jeffrey	CIRES	Lawrence Livermore Nat'l. Lab	Evaluating the National Atmospheric Release Advisory Center (NARAC) Modeling System
White, James	IAAR	NSF	Carbon, Climate, and Society
Zagona, Edith	CADSWES	TVA	TVA PRYSM Maintenance
Seastedt, Timothy	IAAR	NSF	The Niwot Ridge Long-Term Ecological Research Program: Controls on the Structure, Functions and Interactions of Alpine and Subalpine Ecosystems of the Colorado Front Range
Cassano, John	CIRES	NASA	Greenland: Reanalysis of the Energy Budget of the Ice Sheet
Arbetter, Todd	Aerospace Engr.	NASA	Investigation of the Assimilation of Ice Motion Data in Sea Ice Models
Woodhouse, Connie	IAAR	Natl. Park Fdn.	Regional Versus Local Controls on Pinyon-Juniper Woodland Expansion on the Colorado Plateau: The Role of Climate, Atmospheric CO <sub>2</sub> , and Land Use Change

UNIVERSITY OF COLORADO, BOULDER, COLORADO  
Awards for November, 2003 cont'd.

PI	Department	Sponsor	Title
Wahr, John	CIRES	NSF	Water Balance Estimates from Time-Variable Satellite Gravity
Zhang, Tingjun	CIRES	NSF	Changes in Freeze-Thaw and Permafrost Dynamics and their Hydrological Implication over the Russian Arctic Drainage Basin
Serreze, Mark	CIRES	NSF	Long-Term Observations - A Hydrological Observing System for the Pan-Arctic Landmass
Maslanik, James	ACAR	NASA	Estimation of Arctic Melt Pond Coverage on Sea Ice Using EOS Data...
Zagona, Edith	CADSWES	USBR	RIVERWARE Model System Improvement
Howe, Charles	IBS	NOAA	Climate-Informed Water Bank
Strzepek, Kenneth	CEAE	USDA	A Global Water and Food Policy Model
Sievering, Herman	IAAR	USDA	Impact of Canopy Nitrogen Deposition on Forest Carbon Storage...
Nerem, R. Steven	ACAR	NOAA	The Contribution of Tide Gauges to Sea-Level Changes...

#### NEBRASKA WATER POLICY TASK FORCE MAKES RECOMMENDATIONS

In 2002 the Nebraska Legislature created a Water Policy Task Force to evaluate the effectiveness and make recommendations on any needed changes to the law governing the integrated management of surface water and hydrologically-connected ground water. The Legislature also asked the Task Force to make recommendations on water transfers, leasing and banking, and on how to address inequities between surface water and ground water users.

**Task Force Recommendations:** The Water Policy Task Force presented its report to the Governor on December 18, 2003. The Task Force recommends that the basic components of existing surface water and ground water law be left in place, but that Nebraska adopt a stronger, more proactive approach to the integrated management of surface water and hydrologically connected ground water. Key goals of the Task Force recommendations were to address potential problems between ground water and surface water users before conflicts arise and to manage the water resources of the State to sustain a balance between hydrologically connected water uses and water supplies.

Key components of the Task Force Recommendations are that the State:

- Maintain the basic framework of the existing laws. The Task Force, in formulating its recommendations, chose to work within the state's existing basic institutional and legal framework governing the use of surface and ground water and its recommendations are intended to build and improve upon this framework.
- Modify existing law to be more proactive and require certain management actions be taken by NDNR and the NRDs when a basin is determined to be over appropriated or fully appropriated.
- Identify the Platte River Basin above Elme Creek, Nebraska as being over appropriated. The Task Force recommends that the NDNR and NRDs develop a basin-wide plan that will guide the plans of individual NRDs that will incrementally reduce the difference between the present level of development and the fully appropriated level of development in that basin.
- Provide adequate funding to develop a sound scientific basis for management decisions and fair implementation of the integrated management plans. The Task Force believes that adequate funding is essential if the proposed program is to be successful both in avoiding such conflicts and in addressing current inequities between surface water and ground water users.
- Allow temporary and permanent transfers or leases of surface water and groundwater.

Copies of the report and proposed legislation may be obtained on the NDNR website at <http://www.dnr.state.ne.us> or by contacting the Department of Natural Resources.

Nebraska Resources Newsletter, Fall-Winter 2003-2004, Nebraska Dept. of Natural Resources.



## WATER NEWS DIGEST

by Marian Flanagan

CLIMATE CHANGE

### Heat, pollution alter climate

Details presented at the fall meeting of the American Geophysical Union support growing evidence that heat and pollution rising from urbanization have affected climate and precipitation patterns. In California, eastward-blowing pollution induces a precipitation deficit across a large swath of the Sierra Nevada equal to about 1 trillion gallons of water a year, according to Daniel Rosenfeld of Hebrew University in Jerusalem. The Sierra Nevada is a major source of water for much of California, which relies on it to supply its cities and farms. The warmth and grit generated in urban areas can have the opposite effect on local precipitation and actually boost rainfall levels in large cities like Atlanta and Houston.

The Associated Press/Pueblo Chieftain 12/13/03

### ENDANGERED SPECIES

#### Endangered and Threatened Species in the Platte River Basin

The WSTB is supporting the Board on Environmental Studies and Toxicology on a study of four endangered and threatened species of the Platte River Basin. The Committee assembled is charged by the sponsors, Bureau of Reclamation and Fish and Wildlife Service (FWS), to review the government's assessments of how current Platte River operations and resulting hydrogeomorphological and ecological habitat conditions affect the likelihood of survival and/or limit the recovery of four endangered species: the interior least tern, Northern Great Plains breeding population of the piping plover, the whooping crane, and the pallid sturgeon. The committee will also consider (1) whether other Platte River Habitats do or can provide the same values that are essential to the survival and /or recovery of these species and (2) scientific foundations for the current federal designation of the Central Platte habitat as "critical habitat" for the whooping crane and Northern Great Plains breeding population of the piping plover. The study will further examine the scientific aspects of (1) the processes and methods used by the FWS is developing its Central Platte River instream flow recommendations; (w) characteristics described in the FWS habitat suitability guidelines for the Central Platte River; and (3) the Department of the Interior's conclusions about the interrelationships among sediment movement, hydrologic flow, vegetation, and channel morphology in the Central Platte River. The committee's report is currently in review and should be released to the public in early spring, 2004. The committee is chaired by William Graf of the University of South Carolina. For more information, please contact Lauren Alexander at (202)334-3422 or [lealexander@nas.edu](mailto:lealexander@nas.edu).

Water Science and Technology Board (WSTB) newsletter, Volume 21, No. 1, Jan.-Feb. 2004

### INSTREAM FLOWS

#### Water board eyes Pine River flows

The Colorado Water Conservation Board may acquire an interest in Pine River water below Vallecito Reservoir to improve the water-dependent environment. "We're talking (with the Pine River Irrigation District and the Southern Ute Indian Tribe) about a guaranteed winter flow in the Pine River," said Dan Merriman, head of the agency's stream and lake protection section. The district owns 5/6 of the water in the 125,000-acre-foot Vallecito Reservoir, and Southern Ute Indian Tribe owns the remainder. The majority of the water irrigates crops and waters stock. Households are on wells. Under 1973 legislation, instream flow the designation of water for other than traditional uses such as agriculture or power generation was authorized as a beneficial use of water. Then last year, a new law allowed it to seek an interest in existing water rights to improve the natural environment. Now, the question before the state's water board is whether to seek its own appropriation on the Pine or strike a deal with the irrigation district and the Utes. A water appropriation would be junior to all previous claims. By reaching an agreement with the owners of the water in Vallecito Reservoir, the agency could cut in line, so to speak, acquiring the seniority of its partners. In fact, the irrigation district and the Utes propose just that. In a January 2003 letter to the water board, they say: "The water could be stored and released using the Vallecito Reservoir priority decreed in Case Number B1248 on Nov. 13, 1935, which states: water (is) stored in said reservoir for the benefit of the members and users thereof entitled thereto and application for irrigation, domestic, stock water and other beneficial uses." The irrigation district and the Utes suggested that each entity donate water monthly to the state agency. The amount would depend on flow into the reservoir, contracts for water and weather forecasts.

Durango Herald 12/12/03

### WATER CONSERVATION

#### Boulder -- Search for ways to handle future droughts begins

Boulder City Council members have asked that water budgets be explored as a fairer way to encourage water conservation, giving users a preset amount of water each month for a base rate, then charging an increasing premium on water used above a customer's allocation. Four of the residential rate-structure options in the consultant's report are water budgets, which would let customers choose when and how to water and more fairly help identify people ignoring outdoor watering restrictions. Equity is one of the water department's top goals in the rate-structure study, said Ned Williams, the city's utilities chief. All the alternatives will go before the city's Water Resources Advisory Board for public input and if all goes well, the board and the utility department each plan to choose a rate structure to recommend to the City Council. The soonest the city might switch is early 2005.

Boulder Daily Camera 1/12/04

## WATER QUALITY

## South Florida Water Management District v. Miccosukee Tribe of Indians/Clean Water Act

Water Managers in a number of western states worry that a U.S. Supreme Court case involving a pumping operation on the edge of Florida's Everglades could complicate, if not limit, water diversions by making them subject to federal pollution regulations. The Everglades, where sugar growers, water districts, Indian tribes and environmentalists negotiated an \$8 billion program to save the park's ecosystem, depend on both periodic salt water tides and an adequate flow of fresh water from Northern Florida. The fresh water must be pumped from the north, and the Miccosukee and environmental groups say South Florida plans to send water containing alarming levels of phosphorus. At issue is a pumping station that sends polluted drainage water from the suburbs of Fort Lauderdale across a levee into the adjacent Everglades. SFWMD Chairman Nicolas Gutierrez says, "The intent of the law is aimed squarely at industrial polluters who actively add contaminants to the nation's water; not to public water agencies merely moving water throughout an interconnected system for the public good." Thousands of homes would be flooded without the pumping. But Indian leaders and environmentalists say a loss for them would rubber-stamp practices that let water suppliers pollute rivers. SFWMD attorney Scott Glazier says, "This is going to affect people from coast to coast, no matter how they rule." On January 14, the U.S. Supreme Court heard oral arguments in the Miccosukee case regarding Clean Water Act (CWA) permitting requirements under the National Pollutant Discharge Elimination System (NPDES) and pumping polluted water for flood control purposes into the Everglades drainage by a local water district. An editorial in the Denver Post says, "Legal scholars sometimes criticize the current Supreme Court for issuing narrow rulings, but in this instance, a narrow decision may be the wisest. The high court could support what appeals courts already concluded: Suppliers that divert water from one drainage to another eventually have to clean up any messes they create. But the courts also have given water suppliers plenty of leeway to come up with plans and financing to implement the orders. Moderation would be in the best interests of Colorado – and the Everglades."

Source: Western States Water 1/2/04, 1/16/04; Denver Post 12/23/03, 1/12/04

## Poudre River oil sheen to be investigated, cleaned up

An approximately 1/8-mile section of the Poudre River through Old Town, Fort Collins will be diverted until spring for investigation and preliminary cleanup of contamination that has left an oily sheen on the water. Xcel Energy and the Environmental Protection Agency announced the work. Xcel has agreed to conduct the investigation and cleanup, which will cost an estimated \$1.5 million. While the river work is in progress EPA will conduct a parallel investigation to determine the size of the contamination plume or plumes entering the river. That work, at an additional cost of \$85,000 to \$250,000, will be paid for under Superfund. Drinking water intakes for the cities of Fort Collins and Greeley are located upstream from the affected area.

Fort Collins Coloradoan 1/24/04

## Surge in data adds 30 rivers, streams to pollution list

Colorado has listed 125 polluted streams and rivers in need of cleanup. The list of "impaired" waters includes water segments in every major river basin, including the Colorado and the South Platte, and names nearly two-dozen contaminants harming fish and water quality. One example is selenium, a naturally occurring element, poisonous to fish, which leaches out of the soil and into rivers following excessive irrigation. Dozens of streams are laced with toxic metals such as copper, zinc and mercury from abandoned mines. Others are affected by fertilizers from agricultural lands or by sewage-treatment plants. Regulators at the Health Department's Water Quality Control Division say the growing list of troubled waters doesn't mean that Colorado's streams are getting dirtier, but that better data collection is opening their eyes to the extent of the problem. A surge in data has added 30 rivers and streams to the previous list in 2002. The proposed 2004 list will be finalized in this spring after public debate. Under provisions of The Clean Water Act, a cleanup plan is required for waters that make it on the list. A secondary list of waters, called the "monitoring and evaluation list" is growing, as well. Waters on that list need more study to determine whether they should be moved on to the cleanup list, or can be left alone. The latest total of water bodies on that list: 143.

Rocky Mountain News 12/8/03

## Ground water testing targets Lower Ark basin

Brad Austin, head of the Colorado Department of Agriculture's ground water monitoring program, told the Lower Arkansas Valley Water Conservancy District that a ground water monitoring effort will be conducted in the area next year. Austin presented board members with a brief summary concerning agricultural chemicals and the ground water protection program. The sampling is performed in close coordination with extension agents, water conservancy districts and local officials. Well samples are analyzed for selected pesticides and basic inorganic elements, including nitrates. This year, Austin said, his group wants to drill 20 new monitoring wells in the Arkansas Valley from Pueblo to the Kansas line as part of a long-term campaign to show how surface chemicals affect ground water. Wells will be drilled to 20 feet into the water table. In other business, the conservancy district board of directors agreed to contribute \$2,000 to an Arkansas Valley headwaters cloud-seeding program in cooperation with other water groups such as the Southeastern Colorado and Upper Arkansas Valley water conservancy districts and Colorado Springs Utilities. The program will seed clouds in the upper Arkansas River Basin.

The Pueblo Chieftain 12/11/03

## WATER SUPPLY/DEVELOPMENT

## Southern California, Nevada face water cuts

Department of Interior projections show that the current drought, now in its 5<sup>th</sup> year, could result in suspended deliveries of so-called surplus

water to Nevada and Southern California. Bennett Raley, Assistant Interior Secretary for Water and Science, said projections of expected water levels in Lake Mead indicate that if the drought persists, by December the lake level would fall to just two feet above where the federal would be required to suspend deliveries of surplus water.

Fort Collins Coloradoan 12/13/03, Denver Post (from New York Times) 12/12/03

Front Range municipal water planners hear results of examination of water use  
Western Resource Advocates, a Boulder-based environmental law and policy center, released results of its study, Smart Water, A Comparative Study of Urban Water Use Across the Southwest, in December.

Using 2001 data, an examination of water use in 13 Western cities found the following average usage for outdoor watering. Don Wojcik, water analyst for the study, said many common-sense conservation measures were tried during the drought, including surcharges, public education, and rebates for landscaping and appliances that use less water. Those principles need to be applied all the time, however, not just during a drought, he said.

Water for lawns, trees and gardens
Denver 90 gallons/day
Boulder 70 gallons/day
Tucson 38 gallons/day
El Paso 53 gallons/day
Phoenix 75 gallons/day
Las Vegas 113 gallons/day

Denver Post 12/10/03

Bureau of Reclamation studies effects of Aurora's water deals

The city of Aurora is seeking to exchange the water it holds in Pueblo Reservoir for storage space in Twin Lakes Reservoir, near Leadville, where it intends to transport the water to the Platte River Basin. Public comment will help define how extensively Aurora must study the environmental consequences of its proposed long-term contracts to store water in Pueblo Reservoir and exchange it for water in upstream mountain lakes. The potentially precedent-setting contract is the first proposed "long-term" contract to use Fryingpan-Arkansas Project storage space for water transfers to another basin. Effects of the proposed contracts on several endangered species in the Lower Arkansas River Valley, on water quality throughout the basin, and on recreation at Pueblo Reservoir are unknown at this time, USBR says. In the second contract, Aurora is seeking to exchange the water it holds in Pueblo Reservoir for storage space in Twin Lakes and Turquoise Reservoir, where it has existing facilities to transport the water to the South Platte River basin. Cumulative effects of Aurora's exchange and other proposed water projects, such as Colorado Springs' Southern Delivery System, will be studied whether the process remains a simple Environmental Assessment or a more comprehensive Environmental Impact Statement, USBR said. Reclamation isn't saying whether prospective water transfers out of the basin, such as High Plains' contemplated sales of water purchased from Fort Lyon Canal shares, would be considered in the cumulative effects assessment. Anyone wishing a copy of the Bureau's scoping document for the environmental assessment or who has questions about the process can contact Lamb by phone at (970) 962-4326 or by e-mail at [klamb@gp.usbr.gov](mailto:klamb@gp.usbr.gov). A copy of the document also is available at [www.usbr.gov/gp/pubinv1.csm](http://www.usbr.gov/gp/pubinv1.csm) by following the scoping-document link to scoping document for the city of Aurora. Those wishing to file a public comment must send written comments to Will Tully at Bureau of Reclamation, 11056 West County Road 18E, Loveland, CO 80537. Comments may also be faxed to Tully at (970) 663-3212 or e-mailed at [wtully@gp.usbr.gov](mailto:wtully@gp.usbr.gov).

The Pueblo Chieftain 1/11/04

Water district hails 2 new purchases

The Lower Arkansas Valley Water Conservancy District has recently signed contracts to purchase 40 shares of Twin Lakes Reservoir and 30 shares from the Colorado Canal Co. John Singletary, the district's vice president, said he is especially proud of the Twin Lakes deal -- "the Twin Lakes water is special because the storage is up high, it has transmountain water and has already been through court. We can use the water to help a number of entities in the Lower Arkansas Valley."

The Pueblo Chieftain 12/12/03

City wants to enlarge mountain reservoir

The Greeley Water and Sewer Board has decided to enlarge Milton-Seaman Reservoir and scrap a proposal for another water-storage project. The decision is a leap toward Greeley's goal of adding 36,000 acre-feet worth of pit and reservoir storage by 2020. Water officials are gambling that the Milton-Seaman project -- at a cost of at least \$45 million -- is a better option environmentally and logistically than a water storage plan the Northern Colorado Water Conservancy District is organizing to build two new reservoirs: one north of Galeton in Weld County and another north of Fort Collins. The water district's project and Milton Seaman reservoir project will cost about the same, but water department employees and board members say environmental and timing factors make the Milton Seaman project more appealing.

Greeley Tribune 12/18/03

County looks to buy land

Douglas County is negotiating to acquire a piece of property on which to store water to reduce demand on groundwater aquifers. The county is preparing water from Denver Water reservoirs under a plan known as "conjunctive use, or sharing excess mountain snowpack runoff in years during which more snow falls than Denver Water's reservoirs can hold. The 14 agencies that participated in the study are now working to create a single board to hammer out a deal with Denver Water to bring mountain snowmelt to the southern metro area. The Douglas County Water

Resource Authority, the Colorado River Water Conservation District and Denver Water authorized the study, and 11 municipalities, sanitation districts and metropolitan districts funded the study. Much of the infrastructure, such as pipelines, are already in place to distribute water that might come from the mountains, but some new pipelines and other facilities, such as storage facilities and treatment plants, would need to be built. The next step toward making conjunctive use a reality is to get a resolution from the study participants' boards, and after that, compensation deals must be worked out with Denver Water and the Colorado River Water Conservation District for using their facilities and possibly replacing water to keep Western Slope supplies steady.

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Douglas County News-Press 12/18/03

#### Suburbs plan \$127 million water system

East Cherry Creek Valley Water and Sanitation District (ECCVWSD) plans to spend \$127 million to bring water to the south-metro area to replace an aging groundwater system that's been swamped by growth. The heart of the project is construction of a 20-mile pipeline that would deliver newly purchased agricultural water from Weld County to the district's water plant at E-470 and Smoky Hill Road. As planned, new water supplies could arrive by the summer of 2006. If other communities agree to join in and expand the system, the project could serve as a major new source of water to thousands of Arapahoe and Douglas County residents. To cover the \$127 million price tag, the district will double tap fees on new homes during the next 10 years, bumping them from \$12,000 to \$24,000, according to Dave Kaunisto, manager of the ECCVWSD. The district will also raise an existing \$19 water-replacement fee on the base bills of current residents to \$22. ECCVWSD serves about 50,000 people in parts of Centennial and unincorporated Arapahoe County. To keep up with growth rates of 30 percent and more, water districts have drilled thousands of wells into the aquifers, stressing underground supplies and bringing the area to the brink of a major water crisis. Colorado Attorney General Ken Salazar has urged state lawmakers to create a regional water authority to unite the districts in the area and help develop a comprehensive water-sharing plan with Denver. But such a plan, which would include a regional pipeline and treatment system, could cost \$2 billion or more and take more than a decade to negotiate and build. For some water districts, that's too long. The new system will deliver 5,500 acre-feet per year in agricultural water purchased from a no-longer-functioning ranch in Weld County. The water, purchased in part from the United Water and Sanitation District and the Farmers Reservoir and Irrigation Co., will be stored in a shallow, underground formation known as the Beebe Draw northeast of Denver, treated at a plant near Barr Lake and then transported through the new 20-mile pipeline to East Cherry Creek Valley Water and Sanitation District.

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Rocky Mountain News, December 19, 2003

#### Water district gets nod from county planners

The La Plata Archuleta Water District has taken its first step toward placement on the May ballot. In a 4-1 vote, the La Plata County Planning Commission recommended approval of a service plan for the water district. The La Plata Archuleta Water District gave a service plan to the county in September. At that time, the task force believed it would gain access to 2,000 acre-feet of water annually from the Pine River Irrigation District. In October, however, shareholders of the Pine River Irrigation District voted against leasing water to the La Plata Archuleta Water District. The task force still may be able to lease water from shareholders who are willing to sell it to the district, said Wayne Monson, with R.S. Wells, the firm in Greenwood Village that will manage the district. The task force delivered a revised copy of the plan to the county on Dec. 3. The revised service plan lists several possible sources of water, but the district has not secured any definite sources. The task force filed for 30 cubic feet per second of water from the Animas River and 10 cfs from the Piedra River to help supply the system. The task force also may ask the Southern Ute Indian Tribe if it can lease a portion of the tribe's share of Vallecito Reservoir water. The district would cover 400 square miles of land in southeastern La Plata County and southwestern Archuleta County. The task force also has a \$6 million low-interest loan and a \$2 million grant from the federal government that it believes it may lose if the district doesn't go before voters by May.

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Durango Herald 12/12/03

#### Russell George named to head Department of Natural Resources

Russell George, who has headed Colorado's Division of Wildlife for the past 3 ½ years, has been named to head the Department of Natural Resources (DNR). Born and raised in Rifle, George earned his undergraduate degree from Colorado State University and his law degree at Harvard. He returned to Rifle to practice private law and also was a municipal court judge. He was first elected to the Colorado House in 1992, eventually becoming House speaker. George moves to his new post January 12, 2004.

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Rocky Mountain News 1/10/04

#### Judge agrees with UGRWCD on conditional water right

On Dec. 26, Judge J. Steven Patrick ruled in favor of the Upper Gunnison River Water Conservancy District's application for conditional water rights in the Gunnison River at the Twin Bridges for the Gunnison County-built whitewater park. The UGRWCD applied for the conditional right so that kayakers of different levels of expertise could use the park at different times of the year. The Colorado Water Conservation Board had objected to the application, which was for a variable range, following typical run-off history at 2-week intervals from May 1-Sept. 30 each year. The range runs from 570 cubic feet per second (cfs) May 1-15, peaks at 1,500 cfs at early June, when the river normally runs upwards of 4,000 cfs, then drops to 270 cfs the end of September. The CWCB had countered with a request for a flat 250 cfs for that entire period. At the end of the 5-day trial, Judge Patrick ruled that the 1,500 cfs was a reasonable amount and not wasteful. The UGRWCD Board has made compromises, which include refraining from making a call for the water park from 10 p.m. to 6 a.m. each day. Also, the board agreed not to call for water when the Gunnison Tunnel or Redlands has a call on. The CWCB has 45 days to appeal the ruling.

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GunnisonTimes.com, 1/1/04

**CSU SEMINARS**

For examples of water seminars being conducted on the Colorado State University campus, see below.

**WATER IN THE SUSTAINABLE LANDSCAPE: CONSERVATION AND BEYOND**

Monday Night Speaker Series -

CSU Department of Horticulture and Landscape Architecture

Lectures will be 5-6:00 p.m. on Monday nights, January 26 - March 8,  
in A202 Clark Building, Fort Collins

For a map to the Clark Building, see:

[http://www.map.colostate.edu/maincampus.html?main\\_4-4](http://www.map.colostate.edu/maincampus.html?main_4-4)

Free and convenient parking is available to the south and southeast of the building

This is a Monday night speaker series for landscape professionals and students sponsored by the Colorado State University Department of Horticulture and Landscape Architecture, CSU Institute for the Built Environment, and the Colorado Water Resources Research Institute.

DATE	SPEAKER	TOPIC
02/16/04	Robert C. Ward, Director, CSU Colorado Water Resources Research Institute	Water law and local ordinances
02/23/04	Brent Mecham, No. Colo. Water Conservancy District	Irrigation in an age of water conservation
03/01/04	Larry Roesner, CSU Professor, Stormwater Engineer	Stormwater as a resource, constructed wetlands
03/08/04	Jim Knopf, Author, Landscape Architect, Boulder	Xeriscape and bioregional design
04/05/04	Richard Hansen, Sculptor and Landscape Architect, Pueblo	Watermarks

Richard Hansen (Colorado State University-Pueblo) writes: "As a student of poetry who became a studio artist who then became a landscape architect, I still try to make poems. Only the medium has changed. The resistance of stone and the constant pulsing of water have so shaped me, water and stone have swept me away. My attention, my creative work, has become more and more centered around an ongoing series I call Watermarks. Explored in drawings, sculptural elements, and site design; I am seeking to make the movements and elusive character of water legible in the designed landscape while improving the ecological health of the site." See: [www.rhwatermarks.com](http://www.rhwatermarks.com).

For more information contact: Paul Cawood Hellmund, [Paul.Hellmund@colostate.edu](mailto:Paul.Hellmund@colostate.edu)  
or Christine Dianni, [Christine.Dianni@colostate.edu](mailto:Christine.Dianni@colostate.edu)



DEPARTMENT OF FISHERY AND WILDLIFE BIOLOGY  
FW692 GRAD-FACULTY SEMINAR SERIES, SPRING 2004

Location & Time: Fridays, 3:10-4:00 PM in Wagar 133

DATE	SPEAKER	TOPIC
02/20/04	Ellen Wohl, Dept. of Geosciences, CSU	Geomorphic Perspectives on the Riverscape
04/02/04	David Orabutt, Jr., Colorado Cooperative Fish and Wildlife Research Unit, CSU	Exotic Northern Pike Populations and Habitat in Colorado's High Elevation Trout Reservoirs
04/09/04	Dr. C. Lavett Smith, Curator Emeritus, American Museum of Natural History, NY	Characteristics of coral reef fish assemblages
04/30/04	Marci Koski, Dept. of Fishery and Wildlife Biology, CSU	Modeling the interactive effects of climate change and eutrophication on the growth of juvenile kokanee salmon ( <i>Oncorhynchus nerka</i> ). (tentative)

For more information contact: Marlis R Douglas ([Marlis.Douglas@colostate.edu](mailto:Marlis.Douglas@colostate.edu))

## SPRING 2004 LUNCH SEMINAR SERIES

Department of Agricultural and Resource Economics (DARE) & Department of Economics  
U.S. Forest Service, Rocky Mountain Research Station

When: Fridays 12:10-1pm (unless noted)

Where: 110 Animal Science

Pizza &amp; Soda Served

DATE	SPEAKER	TOPIC
02/20/04	Susanne Scheierling, DARE, CSU	A Meta Analysis of Irrigation Water Elasticities: What Does the Data Show?
02/27/04	Adam Smith, Colorado State University	Economic Value of Water to Homeowners in a Suburban Lake: The Case of Lake Sherwood
03/05/04	Edna Loehman, Purdue University	Water Utility Pricing and Local Collective Action
Special Thursday March 11 <sup>th</sup> ; 7pm. Ammons Hall Topic: Numbers Tell the Tale: The Role of Data in Environmental Policymaking Speaker: Paul Portney, President, Resources for the Future, Washington DC.		
03/12/04	Susan Howell, College of Natural Resources, CSU	Willingness to Pay to Reduce Forest Fires: A Comparison of Boulder and Larimer Counties
04/02/04	John Marangos, Dept. of Economics, CSU	The Impact of Drought on Uncertainty and Agricultural Investments in Australia
04/23/04	Eric, Schuck, DARE, CSU	Economic Effects of Moving to Volumetric Water Pricing from Acreage-Based Fees
All seminars support provided by the American Institute of Economics		

## CWCB Document Retrieval System Online

The Colorado Water Conservation Board (CWCB) Document Retrieval System is now available. CWCB has documents related to six sections of the agency: Administration, Stream and Lake Protection, Water Supply Protection, Flood Protection, Water Supply Planning and Finance, and Conservation and Drought Planning. Go to <http://cwcb.state.co.us/> and Click on Water Resource Information Center. To get a better understanding of the document classes, please read the information regarding each of the CWCB sections.

## Windy Gap Firing Project

The Bureau of Reclamation has completed the Windy Gap Scoping Summary Report and a summary of the comments received during scoping. A copy of the document in .pdf format can be downloaded from:

<http://www.usbr.gov/gp/pubinv1.cfm>

Hard copies are on file at selected libraries in Broomfield, Boulder, Grand, Larimer, and Weld Counties. The above website provides a complete list of these libraries. If you have questions or would like to request a hard copy of the Scoping Summary Report, please contact:

Kara Lamb at 970/962-4326 or [klamb@gp.usbr.gov](mailto:klamb@gp.usbr.gov)

## USCID ORGANIZES UPCOMING WORKSHOPS AND CONFERENCES

The U.S. Committee on Irrigation and Drainage announces the following workshops and conferences:

Conference on Water Rights and Related Water Supply Issues, Oct. 13-16, 2004, Salt Lake City, UT.

Third International Conference on Irrigation and Drainage, March 30-April 2, 2005, San Diego, CA.

The theme of this conference is Water District Management and Governance.

A Call for Papers will be posted on the uscid website soon: [www.uscid.org/05call.html](http://www.uscid.org/05call.html).

**MEETINGS**

**PRESERVING OUR HERITAGE - SECURING OUR FUTURE**  
**2nd Annual DARCA (Ditch and Reservoir Company Association) Convention**  
 February 26-27, 2004  
 University of Northern Colorado, Greeley

Thursday, February 26

- 8:00 a.m. Registration & Continental Breakfast  
 9:00 a.m. Welcome & Opening Remarks  
 9:15 a.m. So What's My Ditch Company Worth?  
           Cecil McPherron, Anderson & Whitney  
           Kevin McCarty, McCarty Land & Water Valuation, Inc.  
           Robert Krassa, Krassa & Miller, LLC  
           Don Rosenbrock, Brighton Ditch Company  
 10:35 a.m. Networking and Vendor  
           Sponsored by: City of Greeley, Water and Sewer Department  
 11:00 a.m. Financial Opportunities for Ditch Companies  
           John Akolt - General Counsel, Farmers Reservoir and Irrigation Company (FRICO)  
 Noon Lunch  
 12:30 p.m. Luncheon Speaker  
           The Fort Lyon Canal Company: Preserving our Heritage, Securing our Future  
           Dale Mauch - President, Fort Lyon Canal Company  
 1:15 p.m. Climate & Drought Overview  
           Nolan Doesken - Assistant State Climatologist, Colorado Climate Center, Colorado State University  
 2:15 p.m. CFWE Education Update: Resources and References  
           Karla Brown - Executive Director, Colorado Foundation for Water Education  
 2:30 p.m. Applying for CWCB Funds  
           John Van Sciver - Marketing Director, Colorado Water Conservation Board  
 3:00 p.m. Networking & Vendor  
 3:30 p.m. Legislative Update  
           John Stencel - President, Rocky Mountain Farmers Union  
 4:30 p.m. Ditch Stock Transfers Without a Certificate  
           Randolph W. Starr - Attorney At Law

Friday, February 27

- 8:30 a.m. Breakfast with the Board  
           Annual Board Meeting  
           Sponsored by: Bernard, Lyons, Gaddis & Kahn  
 9:15 a.m. Canal Company Management of Secondary Water Systems  
           John Wilkins-Wells - Assistant Professor, Senior Research Scientist, Colorado State University  
 10:15 a.m. Break  
 10:45 a.m. Canal Drownings: A Persistent Problem for Canal Companies  
           Walter F. Epley, Colorado State University  
 11:00 a.m. Recent Applications of Geographical Information Systems (GIS) to Canal Company Management  
           Tom S. Sheng - Senior Water Resources Engineer and President, Computer Assisted Development, Inc.  
 11:45 a.m. Lunch  
 12:15 p.m. Luncheon Presentation  
           Images of Drought in Colorado - 2002  
           Jerry Kenny - Environmental and Resource Management Section Manager, HDR Engineering  
 1:00 p.m. Water Measurement with Flumes and Weirs with Telemetry Options  
           Stephen Smith - Chairman & Vice President, Aqua Engineering  
 2:00 p.m. How the Water Ditch Invented Colorado Communities  
           Honorable Gregory Hobbs - Justice, Colorado Supreme Court  
 3:00 p.m. Closing Remarks

Registration: \$125 by Jan. 31, \$150 after Jan. 31. For more information contact Jennifer Brown, 970-576-8680, [jennifer@jjbrown.com](mailto:jennifer@jjbrown.com) or visit [www.darca.org](http://www.darca.org).

2004 INTERNATIONAL SYMPOSIUM ON SOCIETY  
& RESOURCE MANAGEMENT : Past and Future  
Keystone, Colorado -- June 2-6, 2004



Since the first ISSRM at Oregon State in 1986, this conference has emerged as the most prominent recurring international conference addressing the human dimensions of natural resource management. The 2004 ISSRM will be organized by subject themes that have appeared on a recurring basis during previous ISSRM meetings. To highlight each topic area, symposium organizers have invited summary-of-knowledge papers from past participants. These papers will be published as an edited book that will be distributed at the symposium. Furthermore, these papers will be presented at various times during the symposium.

Subject Themes / Summary of Knowledge Areas -- The 2004 ISSRM will build on work and research presented at previous ISSRM meetings, and coincide with a book that provides a summary of knowledge on each of the following themes:

- Social Sciences in Natural Resource Management: topics include philosophical perspectives, conservation psychology, global perspectives of natural resources, culturally diverse perspectives, changes in the profession, and others.
- Elements of Policy-Making, Planning and Management: topics include policy and planning frameworks, social impact assessment, environmental communications, recreation planning, and others.
- The Era of Participatory Democracy: topics include collaborative resource management, partnerships, and public involvement.
- Social Science Perspectives within the Multiple Resources: topics include social aspects of agriculture, coastal and watershed management, human dimensions of wildlife, human dimensions of fisheries, social aspects of forest and range management, and conflict.
- Enduring Conceptual Approaches and Methodological Issues: topics include human ecology, normative approaches to natural resource management, economics of natural resources, depreciative behavior, landscape aesthetics, community concept, wildland-urban interface and environmental psychology.

For additional information visit the website [www.cnr.colostate.edu/2004ISSRM/](http://www.cnr.colostate.edu/2004ISSRM/).

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16<sup>TH</sup> HIGH ALTITUDE REVEGETATION WORKSHOP  
University Park Holiday Inn, Fort Collins, Colorado--March 3-4, 2004

The High Altitude Revegetation Committee, through Colorado State University, organizes this biennial Workshop and an annual Summer Field Tour. All speakers are specially invited. Keynote speaker will be Dr. W. Carter Johnson, widely noted plant ecologist from South Dakota State University. He will speak about his research work along the central Platte River Valley in Nebraska. The workshop will include poster papers and commercial exhibitor displays. Poster papers regarding any aspect of high-altitude revegetation are invited. Contact Russ Haas, Phone 701/530-2026, E-mail [russ\\_haas@nps.gov](mailto:russ_haas@nps.gov); Mindy Wheeler, Phone 801/699-5459, [mindywheeler@cs.com](mailto:mindywheeler@cs.com); or Krystyna Urbanska in Switzerland, FAX 632-1215, E-mail [urbanska@geobot.umnw.ethz.ch](mailto:urbanska@geobot.umnw.ethz.ch). To reserve commercial exhibit space, contact Mark Schuster, Phone 303/572-5523 or Mark Phillips, Phone 303/665-2618. Cost is \$195 and includes lunches, banquet and proceedings. Full-time student is \$25, which includes proceedings but no meals. For general information about the workshop, contact Gary Thor, Phone 970/484-4999, E-mail [garythor@colostate.edu](mailto:garythor@colostate.edu), or go to the website at [www.highaltitudereveg.com](http://www.highaltitudereveg.com).

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2004 WATER WELL TESTING CLASS -- May 5-7, 2004

The Colorado Division of Water Resources is planning a workshop/class on Water Well Testing intended for well drillers, pump installers and other persons interested in performing water well measurement tests pursuant to Well Measurement Rules of the State Engineer for the Arkansas River Basin, Designated Ground Water Basins, and for well measurement programs in other areas of the State. The class will be held in Pueblo May 5-7, 2004. The cost of the class is \$250 for three days of classroom instruction and field exercises. The class is designed to give an overview of groundwater hydrology, well hydraulics, water measurement methods, methods of collecting and analyzing data for determining power coefficients, well efficiency, system head considerations, reporting requirements, totalizing flow meter verification and more. Attendees will be allowed to take a test at the end of the class to obtain Division of Water Resources approval as a water well tester. Interested individuals may respond to be placed on the mailing list to receive the upcoming formal announcement and registration packet by writing Ms. Janet Kuzmiak, at the Colorado Division of Water Resources, 310 E. Abriendo Ave, Suite B, Pueblo, Colo. 81004 or by e-mail at [janet.kuzmiak@state.co.us](mailto:janet.kuzmiak@state.co.us) or by telephone at 719-542-3368 x 2101.

OGALLALA AQUIFER SYMPOSIUM  
 Monday, February 23, 2004  
 Wray High School Auditorium – Wray, CO

Water Conservation - Saving Water Today for Tomorrow

This symposium will enlighten you about the “Big Picture” of the Ogallala Aquifer and bring you up to date with the current water use and management practices; as well as provide food for thought on the issues concerning the future and protection of this most valuable resource.

Registration: 8:00 – 8:50 a.m.

Session 1 – 9:00 a.m.

Water Supply Update

- Declines in the Central Great Plains
- Impacts of Weather
- NWAQA Study

Session 2 – 10:45 a.m.

Republican River Litigation - Update from States

- Colorado
- Nebraska
- Kansas

12:00 p.m. Lunch & Exhibits

Session 3 – 1:15 a.m.

Water Legislation Update

- What’s on the drawing board?
- What are the major considerations?
- How can your voice be heard?

Session 4 – 2:00 a.m.

Water Conservation Programs

- NRCS Programs
- ET/Web-based Scheduling
- Drip Systems

Session 5 – 3:30 p.m.

Water Savings – Ag. Producer Panel

- Water Management
- Tillage Practices
- Useful Technology



Who should attend? Ag producers, elected officials, city council/ managers, electric association boards, conservation district boards, ground water management boards, people associated with water use issues and citizens of the region.

For more information contact:

Joel Schneekloth  
970/345-0508

Ron Meyer  
719/346-5571

Gisele Jefferson  
970/345-2287

Commercial booths and exhibits - \$150  
 For more information call 970/345-2287

Name \_\_\_\_\_  
 Address \_\_\_\_\_  
 City/State/Zip \_\_\_\_\_  
 Business Phone \_\_\_\_\_  
 FAX \_\_\_\_\_  
 Home Phone \_\_\_\_\_

Registration Fee: Lunch, Breaks, Handouts

Before Feb. 2nd \$15/person or \$25/two  
 (two meals and one set of handouts)

Late Registration Fee - \$25/person or \$35/two

Payable to:

Golden Plains Area Extension  
 181 Birch Avenue  
 Akron, CO 80720



24<sup>th</sup> Annual American Geophysical Union  
HYDROLOGY DAYS  
March 10 - March 12, 2004  
Cherokee Park Room, Lory Student Center  
Colorado State University, Fort Collins, Colorado, USA

Sponsored by Hydrology Section of the American Geophysical Union

Hydrology Days has been held on the campus of Colorado State University each year since 1981. Hydrology Days is a unique celebration of multi-disciplinary hydrologic science and its closely related disciplines. The Hydrology Days vision is to provide an annual forum for outstanding scientists, professionals and students involved in basic and applied research on all aspects of water to share ideas, problems, analyses and solutions. The focus includes the water cycle and its interactions with land surface, atmospheric, ecosystem, economic and political processes, and all aspects of water resources engineering, management and policy.

HYDROLOGY DAYS AWARD--The Hydrology Days Award is presented each year to an individual in recognition of his/her contributions to hydrology and related fields. The 2004 Hydrology Days Award will be presented to Prof. Dr. András Szöllösi-Nagy of UNESCO.

Borland Lecturers

Dr. Jerson Kelman, Director President of National Water Agency of Brazil  
Professor Everett V. Richardson, Colorado State University  
Professor Daryl B. Simons, Colorado State University

Sponsored by the American Institute of Economics

Paul R. Portney, President and Senior Fellow  
Resources for the Future, Washington, D.C.

CONFERENCE FORMAT--A three-day program for Hydrology Days will include contributed papers, a few invited papers, student papers, and a poster session. Oral presentations will be scheduled for 30 minutes, including discussion. Standard audio-visual equipment (overhead and slide projectors and computer projection equipment) will be provided. Written papers are not mandatory.

STUDENT AWARDS--Awards and prizes will be given for the best student papers as oral and poster presentations in the following categories: B.S., M.S. and Ph.D. Criteria for judging: clarity of presentation, technical soundness and originality of contribution, relevance to hydrologic practice, and quality of written paper if submitted for the Proceedings.

REGISTRATION FEES --Regular: \$100 by February 27, 2004, and \$150 after February 27, 2004. Registration includes: technical sessions, exhibits, posters, two luncheons, refreshment breaks and two copies of the Proceedings.

Students FREE

COSPONSORS: American Geophysical Union (AGU) Hydrology Section and the Front Range Branch, American Society of Civil Engineers (ASCE), Water Resources Engineering Division and the Colorado Section, American Water Resources Association.

The deadline for abstracts has been extended to February 27, 2004. Submit your abstract [online](http://hydrologydays@engr.colostate.edu) at [hydrologydays@engr.colostate.edu](mailto:hydrologydays@engr.colostate.edu). See [sample document](#) for format specifications. For information contact: Professor [Jorge A. Ramirez](#), Civil Engineering Department, Colorado State University, Fort Collins, Colorado, 80523-1372. Telephone: (970)491-7621 Fax: (970) 491-7727 E-mail: [hydrologydays@engr.colostate.edu](mailto:hydrologydays@engr.colostate.edu)



### CONFERENCE FOCUSES ON EDUCATING CHILDREN AND ADULTS ON WATER RESOURCE ISSUES

The Colorado Foundation for Water Education is pleased to present the first annual 2004 Water Educators' Conference, Apr. 6–7, in Glenwood Springs, Colorado.

Municipalities, watershed groups, conservancy districts and many others all across Colorado are leading the charge to educate both children and adults about the importance and management of the state's water resources. For all those involved, this conference provides an excellent opportunity to meet your peers, share new ideas, and avoid duplication of effort!

A diverse group of speakers will spark new ideas and share their experiences in reaching new audiences, designing a better water festival or conducting more successful public outreach campaigns. The first day is devoted to sharing new ideas for children's water festivals and developing strategies to increase participation. Day two focuses on improving both K-12 and adult water education programs. An evening reception on Tuesday, Apr. 6, provides opportunities to meet Colorado educators and view their educational programs. Exhibit booths are available for anyone who would like to share their activities, publications, or water festival stations.

For conference agenda or registration details, contact CFWE at (303) 377-4433, Young Hee Kim at [youngk@cfwe.org](mailto:youngk@cfwe.org), or visit [www.cfwe.org](http://www.cfwe.org).

The Colorado Foundation for Water Education was created in 2002 to promote better understanding of water resources through education and information. The Foundation does not take an advocacy position on any water issue.



### TOUR THE COLORADO RIVER: KNOW WHERE IT GOES!

The Colorado Foundation for Water Education presents its first Upper Colorado River Basin Tour, June 23 – 25.

Often referred to as the "lifeline of the Southwest," the Colorado River supplies water to seven states, two countries and more than 25 million people. From Wyoming to Mexico, this watershed plays an integral role in the region's development and communities. Come see where it all begins.

"Whether your job is in engineering, law, science, or politics, there is no substitute for getting out into the field and touring the river, talking to the people whose lives and livelihoods rely on these resources, and listening to their concerns. From the headwaters to the Utah line, this tour is designed to increase your technical knowledge and practical appreciation of this vitally important watershed," says Karla Brown, CFWE executive director.

A variety of experts will share their viewpoints on Colorado's water issues including water supply, quality and conservation. Participants will get to know the river firsthand as they raft through Glenwood Springs and tour water storage facilities, water diversion projects and regions of critical water resources debate. The tour also includes educational activities highlighting recreation water use in the Vail area, as well as agricultural activities in the Grand Valley.

Cost for the trip is \$495 for a single-occupancy room and \$395 for double-occupancy room. The cost includes registration, transportation and lodging during the tour, meals, all activities and background materials. Scholarships are available for students, teachers, media members and non-profit organization members.

Seating is limited, register today! For registration or scholarship details, contact CFWE at (303) 377-4433, Young Hee Kim at [youngk@cfwe.org](mailto:youngk@cfwe.org), or visit [www.cfwe.org](http://www.cfwe.org).

## CALENDAR



Feb. 25-26	APPLICATION OF TECHNOLOGY TO WATER MEASUREMENT AND MANAGEMENT, Scottsdale, AZ. Contact USCID by phone at 303/628-5430 or e-mail Larry Stephens at <a href="mailto:stephens@uscid.org">stephens@uscid.org</a> . Final program and online registration form will be available on the USCID website -- <a href="http://www.uscid.org">www.uscid.org</a> .
Feb. 26-27	2ND ANNUAL CONVENTION, DITCH & RESERVOIR COMPANY ALLIANCE (DARCA), Greeley, CO. For details, visit <a href="http://www.darca.org">www.darca.org</a> or contact: Karen Rademacher, 970/535-0690, <a href="mailto:karen@darca.org">karen@darca.org</a> .
Mar. 3-5	16TH HIGH ALTITUDE REVEGETATION WORKSHOP, Fort Collins, CO. Contact: Gary Thor, Phone 970/484-4999, E-mail <a href="mailto:garythor@colostate.edu">garythor@colostate.edu</a> .
Mar. 4-5	FINDING SOLUTIONS TO MULTI-JURISDICTIONAL WATER CONFLICTS, UNL College of Law, Lincoln, NE. Information and online registration options are available at: <a href="http://www.snr.unl.edu/waterconference2004">www.snr.unl.edu/waterconference2004</a> .
Mar. 4-5	WATERING YOUR FUTURE -- ARKANSAS RIVER BASIN WATER FORUM 2004, Canon City, CO. Email: <a href="mailto:jane.wustrow@co.usda.gov">jane.wustrow@co.usda.gov</a> or phone 719/543-8385.
Mar. 10-12	2004 AGU Hydrology Days, Colorado State University, Fort Collins, CO. For detailed information, point your web browser to the following URL address: <a href="http://HydrologyDays.ColoState.edu/">http://HydrologyDays.ColoState.edu/</a> . The web page also provides information about on-line registration and on-line submission of abstracts and papers.
Mar. 11-12	COLORADO WATER LAW SUPERCONFERENCE, Denver, CO. Contact: Water Law Institute, CLE International. Register online at <a href="http://www.cle.com">www.cle.com</a> or call (800) 873-7130.
Apr. 6-7	COLORADO FOUNDATION FOR WATER EDUCATION'S 1ST ANNUAL WATER EDUCATORS' CONFERENCE, Glenwood Springs, CO. Visit <a href="http://www.cfwe.org">www.cfwe.org</a> for conference agenda and registration details. Contact: Young Hee Kim at 303/377-4433 or <a href="mailto:youngk@cfwe.org">youngk@cfwe.org</a> .
May 12-14	ROCKY MOUNTAIN REGIONAL LAKE AND RESERVOIR MANAGEMENT CONFERENCE, "LAKES AND RESERVOIRS: THE AQUATIC 'GOLD' OF THE WESTERN LANDSCAPE, Sheraton Denver West Hotel, Denver, CO. See the website at <a href="http://www.clrma.org">www.clrma.org</a> , or contact Sharon Campbell at <a href="mailto:sharon_g_campbell@usgs.gov">sharon_g_campbell@usgs.gov</a> .
May 17-19	AWRA Spring Specialty Conference, GIS AND WATER RESOURCES III, Nashville, TN. For information see the website at <a href="http://www.awra.org">www.awra.org</a> .
May 17-20	BUILDING AND SUSTAINING SUCCESSFUL MONITORING PROGRAMS, Chattanooga, TN. For information see the NWQMC website at <a href="http://www.nwqmc.org">www.nwqmc.org</a> .
June 1-6	2004 INTERNATIONAL SYMPOSIUM ON SOCIETY & RESOURCE MANAGEMENT : Past and Future, Keystone, CO. For additional information visit the website <a href="http://www.cnr.colostate.edu/2004ISSRM/">www.cnr.colostate.edu/2004ISSRM/</a> .
June 13-17	AWWA ANNUAL CONFERENCE AND EXPOSITION: ONE WORLD, ONE WATER, Orlando, FL. For information on the conference and registration, visit <a href="http://www.awwa.org/ace2004">www.awwa.org/ace2004</a> or call toll-free 1-800-926-7337.
June 23-25	COLORADO FOUNDATION FOR WATER EDUCATION'S 1ST ANNUAL UPPER COLORADO RIVER BASIN TOUR, Keystone, CO. For tour details visit <a href="http://www.cfwe.org">www.cfwe.org</a> or contact Young Hee Kim at 303/377-4433, <a href="mailto:youngk@cfwe.org">youngk@cfwe.org</a> .
July 28-30	29TH COLORADO WATER WORKSHOP, Western State College, Gunnison, CO. Watch the website <a href="http://www.western.edu/water/">www.western.edu/water/</a> for more information.
Sept. 26-29	DAM SAFETY 2004, Phoenix, AZ. Assoc. of State Dam Safety Officials, phone 859/257-5140, FAX 859/323-1958, E-mail <a href="mailto:info@damsafety.org">info@damsafety.org</a> .
July 20-22	UCOWR/NIWR 2004 ANNUAL CONFERENCE, Portland, OR. Contact: Gary Johnson, Idaho Water Resources Research Institute, Phone 208/282-7985 or E-mail <a href="mailto:johnson@if.uidaho.edu">johnson@if.uidaho.edu</a> or Ari Michelsen, Texas A&M University, 915/859-9111 or E-mail <a href="mailto:a-michelsen@tamu.edu">a-michelsen@tamu.edu</a> . Website: <a href="http://www.uwin.siu.edu/ucowr">www.uwin.siu.edu/ucowr</a> .
Oct. 13-16	WATER RIGHTS & RELATED WATER SUPPLY ISSUES, Salt Lake City, UT. See the USCID website at <a href="http://www.uscid.org/oridcall.html">www.uscid.org/oridcall.html</a> .

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