August 2006

Water Research Updates:

Colorado Water Workshop in Gunnison.
Top: University of Colorado Professor Patty Limerick, University of Tel Aviv Professor David Schoor, and Western State College Professor George Sibley. Bottom left: CFWE Executive Director Don Glaser and Department of Natural Resources Executive Director Russ George. Bottom right: Colorado State University Professor David Freeman and Dick Bratton.

TABLE OF CONTENTS

COLORADO WATER
Volume 24, Issue 4 Editor: Rebecca Anderson August 2006

Published by the Colorado Water Resources Research Institute * Colorado State University, Fort Collins, CO 80523
Phone 970/491-6308 * FAX: 970/491-1636 * E-mail: cwrri@colostate.edu

INTERNET SITES
Colorado Water Resources Research Institute: http://cwrri.colostate.edu
CSU Water Center: http://watercenter.colostate.edu
Colorado Water Knowledge: http://waterknowledge.colostate.edu

EDITORIAL

New Challenges and Opportunities in Water Research

Reagan M. Waskom, Colorado Water Resources Research Institute, Interim Director

2006 is shaping up to be another interesting year for Colorado's water management community as we experience record high temperatures coupled with below average precipitation. The water research and education community also faces challenges as we strive to discover new knowledge and technology to support efforts to sustain freshwater availability.

In the 2004 National Research Council report on the role of water research, entitled Confronting the Nation's Water Problems, it is stated that we are now in the third era of water development in the U.S. The first was the era of infrastructure and supply, lasting for almost 200 years. The second era was much shorter, running from the 1970s to the turn of the millennium and could be termed the era of regulating water use. During this period, the Nation's focus changed and very few large water projects were built while other values were sorted out. The third (and current) era of water development in the U.S. appears to be the era of shared supply and shortage. Words like collaborative, adaptive, complexity and scarcity seem to be shaping our collective thinking on the water future that awaits us. In this environment, science and research priorities must occur in tandem with water managers to be relevant in this complex and rapidly changing world.

Three areas I see needing our best thinking and problem solving include: 1) measuring and accounting for water needs and use by humans and the ecosystems that support us; 2) expanding supplies through efficiency, reuse, better management, etc; and 3) understanding the human and community dimensions of water management so that we can actually solve the problems created by a growing population. In other words, we need better characterization of the resource base, long-term integrated planning, and new technologies to increase efficiency of water capture and use. To actually solve water problems, however, we must push new knowledge out to the point-of-use through well organized and accessible information and decision support tools.

The Colorado Legislature validated the need for an increased focus on water research to solve Colorado's water challenges by the passage of SB06-183 this year. The bill, sponsored by Senator Jim Isgar and Representative Kathleen Curry, reauthorized the Colorado Water Resources Research Institute for another ten years and provided a one time funding stream of $500,000 to support water research at institutions of Higher Education in Colorado. Co-sponsors of the bill included Senators Taylor, Entz, Kester and Representatives Buescher, Berens, Hoppe, Liston, Madden, McCluskey, Paccione, Rose, and Todd. The Colorado Water Congress unanimously supported SB 183, indicating the water community's broad support for water research.

CWRRI recently released a request for research proposals to address the water research priorities set by the CWRRI Advisory Committee on Water Research Policy. The priority research topics and details of the program are listed on page 26.

We are grateful to the Colorado Legislature and SB 183 sponsors for entrusting Higher Education with funding to pursue the water research needs of Colorado and we hope to initiate some great projects this year with faculty from around the state. Please note proposals are due in our office by September 18, 2006. For more information, go to: http://cwrri.colostate.edu/

Another interesting recent development at CSU is a current discussion around the formation of what is being termed a "Water Supercluster". Faculty from the Colleges of Engineering, Agriculture, Natural Resources, and Liberal Arts have been meeting this summer to propose a new structure for how CSU could reposition itself to address the water challenges facing Colorado, the West and the World.

The problems associated with rapid urbanization in Colorado are very similar to what is being experienced in many arid regions across the globe. Colorado State's challenge in the field of water resources is to develop human capacity in our graduates through relevant educational programs that are on the cutting edge of water management needs. The Supercluster offers a unique opportunity to refocus our water teaching, research and outreach, recognizing the economic development agenda of water management, as well as its social and environmental goals. A Supercluster at Colorado State could provide a globally competitive interdisciplinary alliance with a strong potential for growth and external funding. I'll keep you up to date through this newsletter as we progress on these initiatives over the next year.

MEETING BRIEFS

Robert Ward Recognized by Universities Council on Water Resources

The Universities Council on Water Resources (UCOWR) held its annual meeting in Santa Fe, New Mexico, July 18-20, 2006. The meeting focused on the theme of "Increasing Fresh Water Supplies" and featured water managers from Southwestern municipalities and members of the academic community discussing their findings on urban water use and conservation.

Robert Ward was honored with the 2006 Warren Hall Medal presented annually by UCOWR. Robert served as Director of the Colorado Water Resources Research Institute from 1991-2005, as well as Director of the Colorado State University Water Center from 1998-2005. Among the many accomplishments cited by UCOR was Robert's leadership in water resources education over his 35 year career at Colorado State University. Robert taught two generations of CSU students in operations research, engineering design and water quality monitoring. His research focused on the design of water quality monitoring systems and he authored two books on water quality monitoring and continues to consult on the subject.

The Hall Medal is the highest honor bestowed by UCOWR and is a memorial to recognize Dr. Warren A. Hall, known worldwide for his active involvement and distinctive scholarly accomplishments in water resources research and education. He was one of the founders of the Universities Council on Water Resources in 1962. Dr. Hall served on the CSU Civil Engineering faculty in the late 1970s and early 1980s. Gilbert White

Robert Ward receives the Hall Medal.

(1995) and Chuck Howe (2003), both with CU Boulder, and Neil Grigg (1998) and Bob Young (2004), both with CSU, have also received the Warren Hall Medal in the year noted by their name.

The 2007 UCOWR annual meeting is scheduled for July 24-26 in Boise, Idaho. In addition to discussing water research and education issues, the 2007 conference will address the theme "Hazards in Water Resources". The abstract submission deadline for the meeting is December 4, 2006. Abstracts should be submitted electronically to: http://www.iwrri.uidaho.edu

Resolving Water Conflict Workshop Draws Diverse Group

A two-day workshop geared specifically to those facing challenging water conflicts attracted a diverse group in late June in Lewisville. The workshop was offered by Mary-Lou Smith of Aqua Engineering, Inc., Fort Collins, and Judy Mares-Dixon of Mares- Dixon and Associates, Boulder.

Participants included agency professionals in state water quality, cooperative extension service and municipal utilities; conservancy district board members; a county commissioner; a ditch company manager; an engineer from the Bureau of Reclamation; an executive from a manufacturing firm, mediation specialists, and representatives from HB1177 basin roundtables.

A wide variety of topics were covered, including the difference in debate and dialogue and how to encourage the use of dialogue, how to deal with difficult individuals, and how to scope the issues and frame the agenda in a water conflict situation. Partipants practiced the skills they were learning by jumping into a real-world yet imaginary scenario involving urbanization on a rural ditch.

Future workshops are being planned in locations throughout the state.

For more information, contact:
MaryLou Smith
Aqua Engineering, Inc.
mlsmith@aquaengr.com
970-229-9668

MEETING BRIEFS

Colorado Water Workshop Examines Water as a "Developed" Resource

Almost 200 people gathered on the campus of Western State College in Gunnison for the 31st Colorado Water Workshop July 26-28, 2007. The meeting's theme, 'The Developed Resource', permitted attendees to explore the fact that Colorado specifically, and the West in general, are, or may be, approaching the limits of water availability. As the Workshop organizer, George Sibley, noted in his opening remarks, there is some polite skepticism about the idea that 'water is a developed resource' in Colorado. However, it was generally acknowledged that we are so close to full development of our water resources that wisdom would seem to dictate that we begin to transition into what Justice Greg Hobbs has called 'learning to share a developed resource'. Sibley noted that such sharing is clearly our future, if maybe not quite our present.

2006 CFWE Water Leadership Class (Left to Right)
Back Row: Michael Wilde, Jacob Bornstein, Greg Dewey, Alan Ward, Richard Raines, John Carney, Tom Iseman. Front Row: Amy Johnson, Emily Hunt, Sasha Charney, Mary Presecan, Jeff Crane. Missing: Kenny Smith and Mark Shively.

Gubernatorial candidate Bill Ritter, David Freeman (CSU), and Richard Bratton talk water.

Joseph Gallegos, a rancher in the San Luis Valley and a Costilla County Commissioner, described how the Hispanic culture uses and values water using more of a shared resource model. David Schorr, a Tel Aviv law professor, analyzed the question of whether distributive justice has been adequately considered, alongside efficiency and public choice, as a factor in explaining the evolution of the property-rights regime in the allocation of water rights in Colorado. Lurline Curran, Grand County Manager, described how a well prepared Front Range was able to implement major out-of-basin diversions, due in no small part to the poor preparation of the residents of Grand County in articulating their water future needs.

Bill Ritter, Democrat candidate for Colorado Governor, and Richard Bratton, a Gunnison attorney and a member of Rep. Bob Beauprez's (the Republican candidate) water

committee, discussed water issues that will be a part of the up coming election. There seemed to be considerable agreement among the two candidates on how Colorado should address its water future, but there was little agreement on the purpose and intent of Referendum A. The candidate's discussion of water was moderated by David Freemen, with CSU's Department of Sociology.

Patricia Nelson Limerick, a member of CU Boulder's History Department, in the banquet address, emphasized, with good humor, that differences in attitudes about water exist now and will continue to exist after the current round of water problems are resolved – and that is OK! She noted that the history of Western water has a rich record of ingenuity, enterprise, and spirit, providing us with a heritage that can steer us toward the best decisions in our time.

Ed Quillen, Denver Post columnist, Colorado Central publisher, regional historian and curmudgeon, described Zebulon Pike's journey into Colorado's southern region in 2006-2007 and described how the Cultural Compass of the Southern Rockies started to swing from south to the east.

Friday morning of the meeting was devoted to examining the current 1177 process – the water round table dialogues seeking agreement on how Colorado will meet its future water needs, in all regions of the state. The session titled "Educating the Democracy" worked from the quote of Alexis de Tocqueville:

"The first duty imposed on those who now direct society is to educate the democracy … to replace its blind instincts with knowledge of its true interests…to adapt government to the needs of the time and place, and to modify it as men and circumstances require."

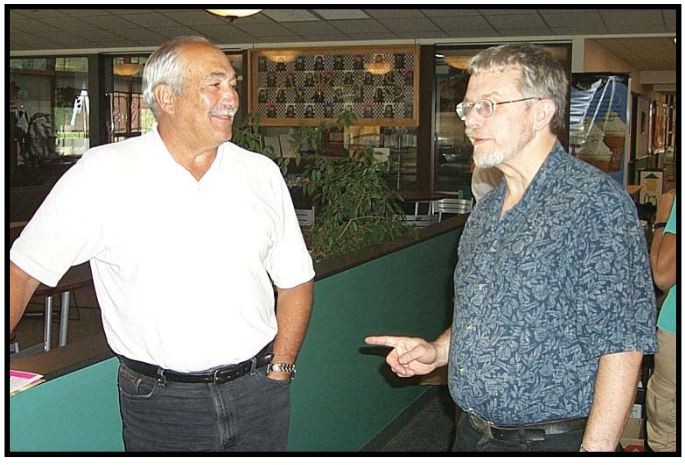
Descriptions of HB 1177, entitled "Colorado Water for the 21st Century Act", were provided by Senator Lewis Entz, Senator Jim Isgar, and Rep. Kathleen Curry. Updates on the Arkansas, Metro, and Gunnison Roundtables were provided by Jeris Danielson, Ray Waterman, and Bill Trampe, respectively. Russ George responded to the updates, noting the time it takes to develop working relationships and gain a common understanding of the complex data and projections involved.

The 2006 Colorado Foundation for Water Education Water Leaders Class met on the Tuesday prior to the Workshop. The meeting was the third of four classes in the program and focused on change and creativity.

The 2006 Workshop was the last to be organized by George Sibley. After five years with the Workshop, George is seeking more time to devote to his writing. George received a standing ovation for his outstanding leadership with the Workshop. Peter Lavigne, who will assume the duties of organizing the Workshop, was introduced at the meeting.

Make plans to attend the 2007 Workshop and join in the highly engaging and insightful dialogue that is the hallmark of the annual water meeting in Gunnison. Tentative dates for the 2007 Workshop are July 25-27, 2007.

Melinda Kassen (Trout Unlimited) and David Schoor (U of Tel Aviv law professor).



Don Glaser (new CFWE Executive Director) and Peter Lavigne (Western State College faculty member and new Water Workshop organizer).

The Appropriation Doctrine and Water as Property: Lessons for "A Developed Resource"

by David Schoor
Professor, University of Tel Aviv

Delivered at the 31st Colorado Water Workshop
Western State College, Gunnison, Colo.
July 26, 2006

I've been given the task of talking about viewing water as property, and to people with any familiarity with water law, water as property is most strongly associated with the appropriation doctrine, a doctrine which achieved its purest form here, in Colorado, nearly 150 years ago. Now, what I have to say about 1) "the appropriation doctrine", and 2) "water as property", is perhaps not what most people would associate with either of these terms, but I think the organizers of this panel knew my views ahead of time, so I'm going to go ahead and indulge in some heresy.

Unlike myself, most of you here are from the region bounded by the Pacific coast and the 100th meridian - here the appropriation doctrine is a well-known phenomenon. Now, you may or may not know it, but the fame of the doctrine has spread far beyond the confines of its home in practice, and is quite well-known around the world, at least among people dealing with water, or property theory, or both.

Why is that? Well, it seems that over the years, the doctrine has taken on a lot of ideological baggage. In particular, it has become associated with a certain way of thinking about natural resources or even property in general – namely, the idea of creating private rights in the resource, and then letting the market make decisions about how best to allocate those rights. Moreover, under the appropriation doctrine, the initial allocation of the resource is made in a very specific way: according to the rule of priority. "First in time, first in right", goes the maxim, and nothing seems to sum up better the pioneer ethic which is presumed to have held sway in the mid-nineteenth-century American West.

For some, this approach seems like a great idea: water can best be managed, for the greater good, if rights are clearly delineated and if owners can make decisions about what to do with their water, without interference from others. Getting there first, appropriating the water from its unowned state, shows entrepreneurial spirit, and is something the law should encourage and reward, goes this way of thinking. Private-property rights are the key to both efficiency and freedom, and so the appropriation doctrine is a model regime, to which the shapers of the laws of other natural resources should aspire.

Critics, on the other hand, see appropriation as a paradigm of everything that is wrong with privatizing natural resources. The rewards given to initiative and drive come at the expense of other values that might have been given priority, so to speak, values such as community, equality, need, ecological integrity, and so on. Appropriation, on this view, is a symptom of all the ills of the supposed "cowboy culture" of the West.

What I'd like to do in the next 15 minutes or so is set out a different, historical, understanding of the appropriation doctrine, and of what "water as property" might mean for us today, in the age of what Justice Hobbs has dubbed "the developed resource". To do that, I'm first going to talk about the origins of the "Colorado" or "pure appropriation" doctrine, its ideological roots, and its role in keeping the waters of the public domain out of the hands of speculators – here I'll mostly be summarizing what some of you may have already read in the article that was reproduced for you. Next, I'd like to describe how Colorado law applied the principles of the appropriation doctrine in the closing decades of the nineteenth century, when Coloradans first began to face the reality of water as a developed resource - that is to say, many of the state's rivers were, at least on paper, completely over-appropriated. Last, I'd like to conclude with some thoughts about property and water for the future.

So let's start with the origins of the appropriation doctrine. The first myth we have to dispel has to do with the purpose and function of the priority principle. While I have been speaking of the "appropriation doctrine", you may have noticed that I have studiously avoided calling the doctrine by its more common name – "prior appropriation". The reason for my reticence

is that, historically speaking, at the appropriation doctrine's origins, priority was at best a secondary principle; the doctrine was not about grabbing or privatizing the public domain or rewarding aggressive behavior. The guiding principles of the Colorado Doctrine were, rather, equality, need and sufficiency. I'll explain.

After the question of slavery, one of the leading issues troubling the American republic in its first century or so was what to do with the public domain. Two main policies competed for supremacy. The first, promoted by most of the political and financial establishment, as well as land speculators (often the same people), was conservative and simple: auction off public lands in large blocks to high bidders, allowing the winners of the auctions to sell off the land to whomever, and at whatever price, they please. The second, pushed by a coalition of Jeffersonians, Jacksonians, and social reformers of various party affiliations, was more radical: reserve the public lands for actual settlers, allowing them to acquire family farms at a nominal price, or even for free, on the condition that they actually settle and work the land. This policy has been termed "radical Lockeanism" – Lockean, because the institution of private property in land was legitimated by labor performed on that land, in keeping with John Locke's justification for private property – and radical, because the policy was aimed at nothing less than social engineering on a massive scale, looking to create a polity of smallholding farmers, each with sufficient land to give him the economic independence believed necessary to ensure a thriving democracy.

While these two philosophies battled for ascendancy throughout the nineteenth century, the latter, agrarian, view, gradually gained a foothold in the law, at first in various federal Preemption Acts, and most famously in the great Homestead Act of 1861. These laws, as well as many informal rules found in various claim clubs throughout the West, were based on the idea that public property should be distributed as widely as possible among the people who were actually going to use it, not allowed to be grabbed by speculators interested only in turning a profit.

When the first miners arrived in what was to become Colorado, then known as "Pike's Peak", in the summer of 1859, they quickly formed "mining districts", each with its own surprisingly sophisticated code of laws. The texts of over a hundred of these have survived. When it came to the question of property in mining claims, including claims over the water necessary to separate precious metals from the ore, the miners, and later the territorial legislature, reached to the principles of radical Lockeanism, taken from the context of land settlement and applied now to ownership of mines and water.

How did equality, need, and sufficiency come into play? The first equality-enhancing rule was the abolition of the monopoly over surface-water sources previously held by riparian landowners under the common law of property in water. Now anyone, regardless of where or whether they held land, could acquire a right to use water. This was a significant reform for a region in which water sources are few and far between, and insufficient to water all the arable lands.

Second, equality and need were given expression in the rules limiting the amount of water that could be claimed by any one user. Sometimes the informal laws of the mining districts did this in a direct and inflexible manner: just as the Homestead Act declared that no one could acquire more than 160 acre by homesteading, some mining codes explicitly laid out the maximum flow of water that could be appropriated by a miner. More often – and this is the approach that ultimately took hold in Colorado water law – a more flexible standard was adopted: claims were limited to the amount that could be used by the appropriator. He or she might try to claim more than this – and many did – but claims beyond what was actually used would have no legal force.

The final principle – sufficiency – is where the priority rule had its place. In the land context, where every settler was allowed 160 acres, what would happen if two or more settlers claimed the same parcel? The obvious answer was recourse to the equitable rule of first in time, first in right – not as an expression of encouraging grabbing, but as a practical way of providing some security to those who had already acquired their homestead. Similarly, in Colorado's appropriation doctrine, priority was a way of ensuring that those who had acquired their use-limited rights to water, would not have those rights shrunken to the point of invisibility, by the arrival of more and more settlers in the watershed.

As I point out in the article, this interplay between the principles of equality, need and sufficiency, and the proper place of priority in this scheme, can be seen clearly in the rules of the mining districts. Since the Gregory Mining District is sometimes cited – mistakenly, I think – as a demonstration that the mining codes were the source of the appropriation doctrine's priority rule, let's focus on the laws of this district. The misleading passage which led some to see priority as the central rule of the appropriation doctrine, is section 8 of the Gregory District Resolutions of June 1859. It reads: "in all cases priority of claims, when honestly carried out, shall be respected". But the very next section shows that priority was not the whole story – it says: "when two parties wish to use water on the same stream… no person shall use more than one half of the water". How do we reconcile these competing rules of priority and equal division?

The answer can be clearly seen in the section that replaced these two, in February of 1860: "if two or more parties wish to use water on the same stream …, no person shall be entitled to use more than his proportionate share of water, but in case there shall not be water sufficient for all, priority of claim shall

determine the right to such water". "No person shall be entitled to use more than his proportionate share of the water" – that's the equality principle – "but in case there shall not be water sufficient for all, priority of claim shall determine the right to such water" – that's the sufficiency principle at work.

Moreover: not only was priority a secondary principle in Colorado's legal scheme for water rights – which is why I think "prior appropriation" is a misnomer for the system – in some ways the appropriation doctrine actually was a reaction, an antidote, to other, stronger claims of priority.

The main claim of priority in the 1860s and '70s was to be heard not from the miners and small farmers, but from the land speculators, big ranchers, and corporations hoping to gain control of the western water sources, and through them, western land. The priority they claimed was not priority of actual use, but of a different sort. They claimed priority based on ownership of riparian lands, acquired, sometimes hundreds of thousands of acres worth, through various methods, some legal, some less so. Their business plan was simple: buy up riparian lands, which, under the common law in force all over the US, had attached to them the rights to use the water of adjacent sources, and, by controlling the water, gain control of all the lands in the region. Or, alternatively, get the legislature to grant them ownership of the water in a stream. Anyone could acquire 160 acres of dry land from the public domain, but if he wanted to make that land productive, he would have to pay dearly to the monopolists to get some water to irrigate crops.

In this situation, fears abounded of a new "water aristocracy", water "lords" who would turn the small farmers of the country into serfs, gaining control not only of the expected economic bounty of the region, but of the political power that would come with such unbridled economic power. The appropriation doctrine was aimed precisely at breaking this monopoly over the crucial resource. Effectively, it was a massive expropriation of private property: water rights that had been acquired under the common law were stripped from their owners and declared by the Colorado Constitution to be public property. The water was then given, free of charge, to the thousands of settlers converging on the region, under one condition – that they actually use it, not hold it for speculation or future profit.

With this brief sketch – you can find a more detailed analysis in my article – I hope I've convinced you that the appropriation doctrine was, at its root, a radical one, aimed at redistributing property in water in a way that rewarded labor and discouraged speculation. Until now, though, the discussion has focused on the initial distribution of water rights, the stage at which these rights pass from the public domain into private hands. What does this story have to tell us about water as a developed resource, when essentially all the water in a region has already passed into private hands? Does the appropriation doctrine have any relevance after all the water has been appropriated?

Colorado courts and lawmakers faced exactly this question over a hundred years ago, in the 1880s and '90s. Water corporations had laid claim to basically all the available water in the Front Range, and had begun to do the same for the other regions of the state, as well. Fears of "monopoly" and "water aristocracy" were stoked by the press. In the great 1888 case of Wheeler v. Northern Colorado Irrigation Company, Justice Helm, noting that the new situation called for a new water jurisprudence, wrote:
"Hitherto attention has been mainly directed to the adjustment of priorities and differences between individual consumers; but hereafter, owing to the rapid settlement of the eastern part of the state, the status of the carrier and its relations with the consumer will command the most earnest and thoughtful consideration."

What Justice Hobbs' predecessor was saying, was that the issue of appropriation from the public domain had been effectively settled, and was no longer of paramount importance. The question now was whether the principles of the appropriation doctrine could be applied to the new situation of a "developed resource", to regulate the relations of canal company and farmer, in a way that gave the individual irrigator effective ownership of the water, and the profits deriving from it.

The Wheeler case is a good example of the approach of the Colorado courts (and legislature) in this era. Byron Wheeler was a physician and farmer, active in the state Grange, and an organizer of Colorado farmers against the water companies. The litigation he initiated was a test case, designed to attack the constitutionality of one of the most hated practices of the state's water corporations in the 1880s – their sale of what they called "water rights", or what Wheeler and his allies dubbed "royalties", or "bonuses". What was at issue was the companies' not-too-subtle attempt to bypass the price controls that had been imposed on them by statute, authorized by the state constitution. To evade these restrictions, the companies charged farmers, over and above the legal rates for water, a one time per-acre charge for the privilege of entering into a water contract with the canal company. When Dr. Wheeler refused to pay the "royalty" demanded by the company, it refused to supply him with water, and so he sued to compel them to do so.

The state supreme court, which heard the case on appeal, sided with Wheeler and the farmers, against the powerful canal corporations. It did so based on the principles of the appropriation doctrine, namely, that water was the property of the public, and was to be made available to actual users, on an equal basis. The corporation, therefore, could have no property right in the water for which it could charge – it could only charge enough to get a reasonable return on its capital investment and operation costs. Supplying water only to those able to pay the "royalty" – so said the court – constituted illegal discrimination between members of the public who could afford to pay this additional charge, and those who could not.

Wheeler was just one case among many in which the supreme court used the principles of the appropriation doctrine to reallocate water in watersheds that were already, in the 1880s, completely appropriated (this was before the era of the great dams). The primary tool in its doctrinal toolbox was that of beneficial use, the principle that use, and only use, could create a valid water right, and that continued use was necessary for the continued validity of the right. The court was extremely aggressive, stripping registered water-right holders of their speculative holdings (meaning paper rights that were not being used, but rather held in expectation of resale for profit), even when those rights had already been adjudicated. Moreover, even use did not ensure a valid right; as indicated in the 1892 case of Combs v. Agricultural Ditch Company, where the court said:

"No matter how early a person's priority of appropriation may be, he is not entitled to receive more water than is necessary for his actual use. An excessive diversion of water cannot be regarded as a diversion to beneficial use, within the meaning of the constitution. Water, in this country, is too scarce, and consequently too precious, to admit of waste. The constitutional rule of distribution, 'first come, first served,' does not imply that the prior appropriator may be extravagantly prodigal in dealing with this peculiar bounty of nature."

In this and other cases, the court effectively partially expropriated water rights that were based on appropriation and use, when the amount claimed was more than necessary for the original use. This was a far-reaching rule, striking not only at speculators, but also at bona fide appropriators who may have found a way to efficiently stretch their appropriation to water additional lands. But the court's hostility to speculation, and its ideology of spreading the state's water wealth as widely as possible, led to this extreme position. In this and in other water issues, the Colorado court was willing to sacrifice efficiency, in order to advance the principles of equality and need.

I could give many more examples of how the late-nineteenth-century state supreme court bent and shaped the law, in keeping with the ideology of wide distribution of the resource, but I want to get away from this historical discussion to briefly raise some thoughts about what we might learn from this story, that might be of some use, today, in the new, post-modern era of the developed resource.

First, I want to point out, that the goal of economic efficiency and growth, which some claim should be the guiding light for courts and other makers of law and public policy, has no roots, from a historical point of view, in Colorado water jurisprudence. The history of the Colorado Doctrine's early years shows that lawmakers were preoccupied with advancing other goals, primarily that of ensuring a wide distribution of the resource, and that they did so even when they were aware that they were severely cramping the efficiency of the system. Courts and legislatures need to understand that the raison d'etre of the appropriation doctrine, was the wide distribution of water and its economic benefits that it made possible. To the extent that we want to work within the tradition of the doctrine, specific issues such as water transfers and new supply projects should be evaluated by this distributive criterion. Now it may be argued that the practices of the past, have but limited relevance to the needs of the present and future, but that is not the general tenor in American legal discourse today, especially when it comes to property rights.

Second, regarding the nature of those property rights. The Colorado Constitution states clearly that the waters of the state are the property of the public, and the courts took this very seriously when it came to working out the nature of appropriative rights. They learned from this, for instance, that previously valid rights would revert to the public domain to the extent that they were no longer needed by their appropriator. They also invoked the principle of public ownership to justify draconian regulation of canal corporations, to invalidate polluting uses, and so on. Somewhere along the line, though, this approach seems to have weakened. Maybe it is time to bring it back.

Third, the fact that we are dealing today with a developed, that is to say, a fully appropriated, resource, should not blind us to the fact that new aspects of that resource's use, and value, are constantly being discovered, and so need to be distributed anew. For instance, environmental issues of water quality, habitat for endangered and other species, and so on, have come to the fore only relatively recently, and lawyers have been grappling with the question of how to integrate these concerns within the framework of the appropriation doctrine. From a theoretical point of view, these environmental values can be viewed as resources, and that means that the question of property rights in them has to be settled. Again, I would argue, if we take the appropriation doctrine seriously, the principles of public ownership and broad distribution of the benefits of the resource should be applied.

Finally, I want to point out something about private property rights and privatization of water resources. There is a lot of concern in the world today about the privatization of water sources and infrastructures, and about what private control of these critical assets might mean for the general population. Leaving aside the practical difficulties in creating water markets, which I happen to believe are deeply ingrained and insurmountable, the Colorado experience can teach the world that private rights in water, need not be all they are cracked up to be, either by their promoters, or by their detractors. With a proper view of the essentially public nature of the resource, courts and regulators have a variety of legal tools at their disposal, to ensure that a system of private rights works to serve the interests of the public, not against those interests.

Engineers Without Borders in El Salvador

Water here, water there, is there water everywhere?

by Dena Hicks, Project Manager, EWB-CSU
Kris Bruun, Senior Design, EWB-CSU

According to the United Nations, everyone needs at least four liters of clean water per day to live a healthy life. It is especially important for children to have access to clean water in order to avoid illness. Unfortunately, not everyone in the world has the wealth or the resources to acquire these basic essentials of life. Though they are worlds apart, El Salvador and Colorado both need sources of clean water.

Engineers Without Borders at Colorado State University (EWB-CSU) is non-profit student chapter that is dedicated to helping developing communities around the world with their engineering needs. As a whole, EWB-CSU is active in providing sustainable engineering projects ranging from water distribution and sanitation to providing sources of energy and shelter. Ultimately, the students' goal is to incorporate the community in all phases of the project to ensure the sustainability and longevity of the system.

San Antonio Abad is a small village of approximately 500 people whose average family income is only four dollars per day. Potable water is accessible to the community by walking a kilometer to the highway and paying for it. Otherwise, many residents in the community obtain water for everyday use from hand-dug wells, yet this water does not meet El Salvador drinking water standards and the quantity do not meet the needs of the village. The primary goal of this project is to provide the village with an inexpensive, reliable, and clean source of water. Three major steps must be taken to achieve this goal: 1) technical design, 2) funding, and 3) implementation. The project is currently in the technical design phase. Several members of the group have been actively searching out alternative sources for funding. One significant support network has been the Fort Collins Rotary Club. Overall, more financial support will be necessary to finish all required aspects of this immense project.

San Antonio Abad, El Salvador. National University of Santa Ana, El Salvador students and EWB-CSU site assessment.

San Antonio Abad, El Salvador. Members of the EWB-CSU site assessment team glancing at the construction of a hand dug well.

With the assistance of a Peace Corps volunteer, the community applied for technical help from EWB to design a water supply system. A group of engineering and natural resource students at Colorado State University (CSU) accepted the application as both a personal volunteer mission and an engineering senior design project. The commitment of the EWB-CSU group is limited to providing a technical design to the village. However, the group intends to see the project through to completion.

During the university spring break, the week of March 12-18, 2006, the team traveled to the village of San Antonio Abad to assess the situation there during the dry season. The team spent the week hard at work performing the following tasks in order to acquire preliminary information needed to design a viable water system for the community:

- Measured conductivity, turbidity, sulfate, phosphate, nitrate, ammonia, copper, total coliform (bacteria) and metal

analysis of sample household wells,
- Surveyed existing well elevations and their water depths,
- Surveyed potential well and tank locations,
- Conducted individual household surveys about current water quantity, quality and associated health problems,
- Discussed potential solutions to water problem with village,
- Initiated relationships with students and professors at the National University of El Salvador in Santa Ana, local Peace Corps volunteers, and the recently elected mayor of Candelaria de la Frontera.

Subsequent trips are tentatively planned for additional data collection, presentation of alternatives to the village and ultimately project implementation.

When facing complex development projects, it is important to form teams from a wide range of professionals and students. The EWB-CSU team consists of engineering and natural resources students and a university professor, though they are actively soliciting the participation of professional engineers in the local community. Mentoring is an integral part of producing technically sound design options from which the structures can be implemented. Any and all individuals with experience designing water distribution systems are more than welcome to share their incite with the current design team.

Please feel free to contact the project managers with any questions.

Project Managers:
Dena Hicks, dhicks@lamar.colostate.edu
Keelin Schaffrath, keelin@warnercnr.colostate.edu

San Antonio Abad, El Salvador residents carrying water.

Celebrate the Water Resources Archive's 5th Anniversary with "A Wall of Water"

To celebrate its momentous five-year anniversary, the Water Resources Archive is hosting "Water through Time: An exhibit recalling Colorado water events" through September 8 in room 202 of the Morgan Library on the CSU campus.

Commemorating the Archive's five years of collecting, preserving, and promoting the history of water within the State of Colorado, the exhibit marks historic water events documented within its 40 archival collections.

The exhibit presents the Invention of the Parshall Flume (1921-1922); the Signing of the Colorado River Compact (1922); the Arrival of the Dust-Bowl Droughts (1930-1940); the Completion of the Colorado-Big Thompson Project (1957); the Commencement of the Fryingpan-Arkansas Project (1962); and, most notably, photographs and other artifacts documenting the tragic Big Thompson Flood (1976, which marked its own 30th anniversary in July.

The exhibit is open from 8:30-4:30, Monday through Friday. Join us to study the important events from our state's past to better understand water's place in our future, a perspective made possible only by the Water Resources Archive.

For more information, please call the Archive directly at 970-491-1844.

Measuring Water in Boxes: Five Years of the Water Resources Archive

by Patricia J. Rettig
Head Archivist, Water Resources Archive, Colorado State University Libraries

Managing water involves a variety of measurements, from gallons to acre-feet to cubic feet per second. Measurements of a water archive are no less diverse. With the fifth anniversary of the Colorado State University Water Resources Archive having arrived, a look at various measurements will indicate its accomplishments.

Collections
One of the best measurements of the Water Resources Archive is its collections. The Archive was established as part of the University Libraries on July 1, 2001, with a mission to "provide access to, promote and preserve the water heritage of Colorado." The core of this has to do with collecting and preserving historical materials concerning the development of Colorado's water resources, in all aspects. This includes any individual or organization in the state that works in relation to water, no matter where the water is, as well as anyone anywhere working in relation to Colorado's water.

Starting from scratch, the Archive has accumulated forty collections, which translates to over 900 boxes (plus drawers and tubes) measuring more than 1,170 linear feet—quickly approaching a quarter mile. Individual collections range in size from one box to over 170 boxes. The collections acquired display diversity in terms of geographic and chronologic coverage in addition to general topics. Subject strengths are civil engineering topics, policy and law.

Finding Aids
Another good measure of the Water Resources Archive is its finding aids, which are detailed descriptions of each collection's contents. Collections require finding aids in order to be used by researchers. For its forty collections, the Archive has created 23 finding aids and makes them available online and in print. The online ones can be cross searched by keyword, making discovery more efficient. They can also be found through general Internet search engines as well as through various library databases.

Website
These days, an institution is nothing without a website. The Water Resources Archive created its website in February 2002, though "site" might be an overstatement—it was only three pages. Now, the site has nine core pages, which in turn link to four e-newsletters, 23 finding aids and four digital object "sub-sites" containing numerous additional pages. Web statistics for the recent three years show a significant rise in the number of visits to the website, receiving a high of more than 4,000 visits during the spring 2006 semester. This is an indication that the Archive is increasingly well known and used.

Digitization
A current trend in libraries and archives is digitization of unique materials to increase worldwide access, and the Water Resources Archive is no stranger to this. It began offering digital contents from its collections in January 2005 through a small virtual exhibit called "Father of the Flume: Ralph Parshall." Though only a few select items were digitized, the online exhibit provided interpretive context and added unique content to the Internet.

Larger scale digitization began in fall 2003 with the assistance of an Institute of Museum and Library Services grant to the Greater Western Library Alliance for creation of the Western Waters Digital Library (WWDL). CSU's contribution, called the Colorado's Waters Digital Archive and made available in fall 2005, consists of fourteen reports done for the Colorado Water Resources and Power Development Authority found in the Ival Goslin Collection. Encompassing nearly 3,000 pages, the reports are now e-books which can be accessed around the world.

The Archive also offers two other virtual exhibits, both created in spring 2006. One is a traveling exhibit, "Carpenter and the Compacts," put online as web pages. The other, "Dot Carpenter: The Woman Behind the Man," is more in depth and features over fifty archival items placed in context with narrative text, captions and family trees.

Researchers
The Water Resources Archive collects and preserves materials so people can use them; therefore, research usage is another key measure of the Archive. No usage statistics were kept during the first two years, but they are easily remembered since researchers could be counted on one hand for each of those years. In contrast, the Archive has had more than a dozen research contacts for the Delph Carpenter Papers alone in the eight months that collection has been open. The Archive has experienced increasing demand over the recent three years as the number of boxes used has risen from 10 to 44 and then, most recently, to 90 boxes during the 2005-2006 academic year.

Patrons predominantly find the Archive through Internet searches, reference desk referrals, previous outreach contacts or word-of-mouth suggestions from colleagues. The variety of researchers ranges from CSU history and engineering graduate students to local water lawyers to a person of unknown profession calling from

New York. One researcher from Nebraska stayed for a three-day visit, thus helping out the local economy. Subjects of interest are also wide ranging, from maps of area ditches to groundwater data to various river compact issues.

Follow-up with patrons is not always achieved, so knowing how Archive materials are ultimately used is often not possible. Some uses are for personal research, but others do turn up in more public ways. A photo from the Ralph Parshall Collection can be seen on a Cache la Poudre River Corridor signboard on their trail west of Lee Martinez Park. The Larimer County District Court Map Collection was cited by Rose Laflin in her report on the Poudre River (Irrigation, Settlement and Change on the Cache la Poudre River, 2005). Also, Dan Tyler's biography of Delph Carpenter (Silver Fox of the Rockies: Delphus E. Carpenter and Western Water Compacts, 2003) relied heavily on those papers, though before they came to the Archive, but his next book (working title: Love in an Envelope) will cite the Water Resources Archive as the source of the Carpenter family love letters.

Outreach

The Water Resources Archive conducts ongoing outreach to further the mission of preserving and providing access to the documentation of Colorado's water heritage. Main outreach efforts have included articles, e-newsletters, brochures, exhibits, events, tours, presentations and meetings. The Archive's biggest event, the opening of the Delph Carpenter Papers in November 2005, drew an audience of nearly 100. Archive staff have done a number of presentations at various water and archives conferences and meetings, including ones held by DARCA, the Colorado Water Congress, the Four States Irrigation Council and the Colorado Bar Association, among others. The water archivist has met less formally with far-flung individuals as diverse as W. D. Farr in Greeley and Lynn Herkenhoff of the Southwestern Water Conservation District in Durango.

Outreach is conducted more locally by giving tours to groups who are meeting on campus. Also, instruction sessions are conducted with various university classes—mainly history students—to teach them about archives in general and the Water Resources Archive in particular.

Fundraisers

The Water Resources Archive could not achieve all of its success without funds. While receiving institutional funds, the Archive still relies heavily on donations to aid in the processing, preservation and digitization of materials as well as the creation of exhibits. A fundraising campaign, spearheaded by Dan Tyler, was conducted by letter to provide for the cleaning equipment, supplies and staffing needed to remove mold from the Carpenter papers. Exceeding the goal, that campaign raised over $45,000. In January 2006, the Archive hosted its first fundraising event. Called Water Tables, the evening featured twelve table hosts from various water professions and drew nearly 100 dinner guests. Quickly decided to be the "first annual" Water Tables, the event raised over $8,000 and inestimable goodwill. The second annual Water Tables Benefit Banquet is being planned for Saturday, January 27, 2007.

Staff

The remaining key measure for the Archive is its staff. Accomplishments have been achieved through one head archivist, two part-time archivists, three department heads, eight student assistants and associated professional staff, administrators and other Libraries departments. For the daily work of the Archive, Patty Rettig was hired on a half-time basis as project archivist for the first year, and then her position was made full time as head archivist. Involved in everything from working with donors on acquiring collections (and lifting boxes!) to creating finding aids, from training student assistants to doing all types of outreach, Archivist Rettig has expertly guided the Archive since its inception.

The Archive has fortunately had eight student assistants solely dedicated to it over the years. One came as an unpaid intern earning class credit, but the rest were paid employees, willing and eager to learn about archival work. Six of the eight were trained to process collections and create finding aids, and they have all chipped in on more routine tasks such as endless photocopying and transporting heavy boxes. Much credit should be given to these students as well as to Libraries employees in other departments for helping in their own particular ways.

The Flow Continues

Measurements indicate that the Water Resources Archive is doing well after just five years. By collecting, preserving, making available and promoting the documentation of Colorado's water history, the Archive has found its niche as the only repository in the state specifically focused on this important subject. In the next five years, the Water Resources Archive will become even more widely known as the preeminent repository for Colorado water history.

To achieve this, much work remains. Assistance could be ensured by providing ongoing funding for a graduate student, ideally through an assistantship offered through an appropriate academic department. Also, the imminent creation of an advisory board will help with outreach, fundraising and acquisitions. Ongoing outreach activities will also help, but additional strategies should be examined, such as how to inform researchers and potential donors in other states.

Finally, the Water Resources Archive would benefit from strengthened collaborations with the water and research communities. Working with other repositories locally and nationally and collaborating more closely with campus departments and state water organizations would be fruitful for all constituents.

If you would like to make a comment or suggestion—or would like to measure the Water Resources Archive for yourself—visit the website http://lib.colostate.edu/archives/water/ or contact the author 970-491-1939 or Patricia.Rettig@ColoState.edu.

Dolores River Tamarisk Action Group Battles Woody Invasive Plants on the Dolores River

by Steve Miles and Gayel Alexander, Dolores Soil Conservation District
Katherine Timm, Colorado State Forest Service

The River of Our Lady of Sorrows

The Europeans' first encounter with the Rio de Nuestra Senora de los Dolores, or "River of Our Lady of Sorrows," occurred in August 1776 when they were seeking passage from Santa Fe, New Mexico, to California. A little more than a century later, an ambitious project was initiated to divert the Dolores River for irrigation into the Montezuma Valley, which resulted in the creation of the Montezuma Valley Irrigation Company. Eventually, a tunnel and 125 miles of canals were constructed to meet the expanding needs of the resident farming community.

In 1977, the citizens of Montezuma County decided that the valley needed more irrigated lands and a controlled source of water. As a result of their efforts, the Bureau of Reclamation sponsored the Dolores Project, which was later authorized by Congress. A short time later, construction began on the McPhee Dam and Reservoir. The project added 27,000 acres of irrigated land for farmers and 7,500 acres of irrigated land for the Ute Mountain Ute Indian Tribe.

One of the last large in-stream dam projects constructed by the Bureau of Reclamation, McPhee Reservoir is the second largest in Colorado and has a high water level of 6,924 feet and approximately 50 miles of shoreline. (Blue Mesa Reservoir claims the title as Colorado's largest body of water.) The reservoir provides storage and is the transportation system for the entire Montezuma Valley Irrigation Co., its shareholders, and the farmers of the Dolores Project, and the Ute Mountain Ute Tribe. Because it is a trans-basin diversion, it also is an ideal distribution system for spreading invasive, non-native woody plants such as tamarisk and Russian olive into the Dolores River and drainage and San Juan River Watershed.

Volunteers and D-TAG members spent several afternoons cutting, painting, and dragging tamarisk at the McElmo demonstration site. Just a half-acre of cut tamarisk created enough slash to fill a box car.

The Beginning of the Invasion

Since the advent of the current drought in 1997—10 years after the first water deliveries from the reservoir—McPhee has failed to reach full water pool. Low water levels have allowed a large infestation of tamarisk to become established. The infestation stretches from high water line to minimum pool level and has the potential to further degrade habitat around the reservoir. It also is a seed source that can spread tamarisk throughout irrigated lands served by the reservoir. When the drought ends and the reservoir spills, seed will spread and establish tamarisk along a pristine 30-mile stretch of the Dolores River below McPhee Reservoir that currently is tamarisk-free. Below this area, tamarisk stretches for miles until it reaches the intersection of the Dolores and Colorado Rivers above Moab, Utah.

Tamarisk invasion threatens the Dolores River riparian system, agricultural lands, waterways, 125 miles of canals, and 80,000 acres of land. It also degrades the ecosystem because it crowds out native plant species; increases salinity of the surface soil making it unsuitable for use by other plants; results in wildlife habitat that is less diverse; significantly increases non-beneficial water consumption; widens flood plains, clogs stream channels, and increases sediment deposition; diminishes human enjoyment of and interaction with the river environment; and increases wildfire risk to communities because of the plants' potential to exhibit extreme fire behavior.

Fighting Back - Formulating a Plan

Recognizing the serious threat of tamarisk and other invasive woody plants to this important water source, the Dolores River Tamarisk Action Group (D-TAG) was formed in 2005

to develop a strategy to eradicate tamarisk and Russian olive from McPhee Reservoir and all tributaries above the reservoir. D-TAG is comprised of a broad range of public and private partners including numerous private landowners, the Town of Dolores, USDA Forest Service, Bureau of Land Management, Bureau of Reclamation, Colorado Division of Wildlife, Colorado State Forest Service, Montezuma Valley Irrigation Co., Dolores Water Conservancy District, Montezuma County Board of Commissioners, Montezuma County Weed Program, Habitat Partnership Program, Colorado State University Cooperative Extension, The Tamarisk Coalition, The Nature Conservancy, Mesa Verde National Park, Southwestern Water Conservation District, the Dolores, Dove Creek and Mancos Soil Conservation Districts, and the many irrigation users served by the McPhee Reservoir.

The Project and Scope of Work

The main seed source of tamarisk is found in the 11-mile stretch of Lost Canyon above McPhee Reservoir. Dense tamarisk thickets exist in the first 3 miles above McPhee and less dense, scattered stands co-exist with other non-native woody plants upstream. Additional scattered thickets of tamarisk also are found on the main stream above McPhee.

The Lost Canyon Tamarisk Control Project is the first of several in Montezuma County that D-TAG is targeting for treatment. This drainage was chosen for treatment first because it is the seed source of tamarisk for McPhee Reservoir and associated canals and irrigated land within the service area, which spans more than 60,000 acres. Lost Canyon is the upper limit of tamarisk habitat, so the opportunity of re-infestation by upstream seed source is greatly reduced. And because a small number of landowners are involved, D-TAG anticipates a high degree of participation and success.

The first phase of the eradication project involves developing a comprehensive inventory map to pinpoint invasive woody tree populations above the McPhee Reservoir and within its high waterline. D-TAG will use existing soils maps, topography, exposure, and on-ground GPS surveying to assess density and specific site topography. This information will help identify the most appropriate control methods.

Scattered individual trees encountered on the upper reaches of the watershed that provide a downstream seed source will be removed first. In addition, demonstration sites will be chosen for educational purposes in strategic locations on the river.

Subsequent phases involve working downstream, removing target trees from the remainder of the watershed, continued monitoring, re-treatment maintenance as needed, and landowner education.

Approximately 25 landowners own a total of 31 parcels up the Lost Canyon Tributary of the Dolores River. Landowners are integral to the success of the project and will be involved in helping with inventories of their lands, eradication of tamarisk on their land, future monitoring, follow-up control, and sharing the cost of treatment.

The Dolores Soil Conservation District, with direct involvement from key conservation partners, is responsible for managing and organizing the project. In addition, Montezuma County and several departments within the county are supplying maps of infested areas, interpreting GPS/GIS data, contacting landowners for permission to conduct inventories, and supplying information and educational materials to landowners.

Several other conservation partners are writing grants, helping with landowner education, conducting inventories, applying

D-TAG PROGRESS UPDATE

D-TAG has made significant progress on its plans to eradicate tamarisk in Montezuma County. During the past 18 months, D-TAG has:

- Raised more than $45,000 in grants
- Begun extensive mapping of tamarisk and Russian olive, which provided a reliable inventory of densities, accessibility, and location of infestations
- Completed the inventory of tamarisk in Montezuma County
- Recruited Dr. Dan Bean with the Palisade Insectory to provide a presentation on biological control of tamarisk and other noxious weeds
- Completed spraying of tamarisk on about 50 miles of shoreline at McPhee Reservoir
- Spent several afternoons with volunteers cutting, painting, and dragging tamarisk (1/2-acre was enough to fill a box car)
- Created a demonstration plot on private land at the top of McElmo Creek
- Contacted nearly 100 percent of the landowners along Lost Canyon to inform them about plans to treat tamarisk and encourage their participation

The group hopes to complete control efforts on Narraguinnep and Totton Reservoirs this summer, as they are a major seed source for the irrigation supply in the valley. They also hope to implement several different control treatments to determine the most effective methods, and schedule treatments for implementation over the next three months.

For more information about D-TAG, contact Steve Miles or Gayel Alexander, Dolores Soil Conservation District, at 970.565.9045.

herbicides, assisting with monitoring and follow-up, conducting public meetings, and providing matching grant funds.

Project Methods
All tamarisk in the proposed project area are found on alluvial soils; however, they are at different stages of maturity and some areas are difficult to access. Consequently, control methods must be flexible to address different situations and will require the use of innovative treatment techniques. Extensive use of trained volunteers is key to success.

Recommended management methods for controlling tamarisk include chemical, mechanical, and cultural techniques. All chemical methods will be applied at recommended rates. A foliar-applied chemical method with riparian approved habitat and a non-ionic surfactant will be applied to the younger tamarisk, which accounts for approximately 2/3 of the infestation in the project area. The stump-cut method, which combines chemical and mechanical treatments will be used on the larger, more mature tamarisk. When this method is employed, tamarisk is cut to within two inches of the soil surface and Garlon-3A with Impel oil, which is a penetrant, is quickly applied to the freshly cut stump. Cut brush is piled above the high water mark and run through a chipper, if possible. Optimal timing of both application methods will maximize coverage and efficacy. Chemical control "mop-up" will continue during subsequent years.

Cultural management methods will be employed to ensure long-term control of tamarisk and restoration of affected areas. Private landowners will receive information on best management practices and guidelines to revegetate the area and establish desirable plants such as native grasses, willows, and cottonwoods.

Potential Environmental Impacts of Treatment
Eradication of tamarisk using Habitat or Garlon 3A will enable reestablishment of desirable grasses and shrubs in Lost Canyon, which will benefit wildlife and help restore the hydrologic function of the drainage. The herbicide Habitat is labeled for the control of undesirable emergent and floating vegetation in and around standing and flowing water. Imazapyr, the active ingredient in Habitat, is classified by the EPA as a low-toxicity chemical that has few harmful effects on invertebrates and bees; is practically non-toxic to fish, mammals, and birds; and is rapidly excreted by mammals.

Expected Benefits
Tamarisk removal along Lost Canyon will prevent the displacement of desirable riparian vegetation and make more water available to landowners and agricultural producers who receive irrigation water from McPhee and Narraguinnep Reservoirs. Tamarisk control also will improve groundwater quantity and quality in Lost Canyon by removing a major source of evapotranspiration, and will make additional water available for municipal uses in Dolores and Cortez. Recreational users will have better access to the reservoir for swimming and fishing. Currently, tamarisk is making it nearly impossible to access a 50-mile stretch of reservoir. This area is easily identified by the extensive amount of fishing line and the number of lures that are tangled in the tamarisk.

Project Evaluation
Close monitoring by the Montezuma County Weed Program supervisor and D-TAG will encourage tamarisk eradication using the methods described earlier, and improve and maintain a more native habitat. This, in turn, will eliminate the seed source that now threatens to contaminate more than 125 miles of canals, as well as the pristine riparian environment immediately below McPhee Reservoir on the Dolores River.

Monitoring will be done on a seasonal basis through visual inspections or personal contact with landowners. Current methodology calls for evaluating the treated area one year following treatment and every two years thereafter.

D-TAG anticipates that it will be able to quantify the effect of the control within Lost Canyon and around McPhee Reservoir by monitoring the areas from high to low water levels in the fall of 2006. D-TAG also has inventory records of the area and will be able to overlay new data on the current GIS inventory.

Nolan Doesken Appointed Colorado State Climatologist

Nolan Doesken has been appointed as the Colorado State Climatologist as of July 1, 2006. He has served as the Assistant State Climatologist since 1977. Roger Pielke, Sr., the previous State Climatologist, has retired from Colorado State University as of June 30, 2006 and has accepted a Senior Research Scientist position at CIRES at the University of Colorado – Boulder. Nolan can be reached at 491-8545 or Nolan@atmos.colostate.edu. The URL for the Colorado Climate Center is www.climate.atmos.colostate.edu

Sustainable Cropping Systems for Transition from Full Irrigation to Limited Irrigation and Dryland

by Neil Hansen
Associate Professor, Department of Soil & Crop Sciences, Colorado State University

The combination of climate variability, drought, recent rulings regarding groundwater augmentation, and increasing urban competition for water has created water shortages for irrigated agriculture in Colorado and is driving the need to increase the efficiency and sustainability of water use. A statewide water supply survey predicts that as much as 428,000 irrigated farm acres could be converted to dryland cropping or pasture within the next 25 years. The conversion of irrigated land to dryland creates both economic and environmental concerns. Net economic returns can decrease by as much as 75% when irrigated corn grain or alfalfa is converted to dryland winter wheat. In addition to farm level economic effects, the loss of irrigated farmland will have far reaching indirect effects on entire communities that support irrigated agriculture. Environmental concerns associated with conversion of irrigated land to dryland include soil erosion, dust, and landscape modification. The transition from irrigated land to dryland creates potentially large areas of dry, unprotected and highly erodible soil. Because of the economic and environmental concerns associated with converting irrigated land to dryland, water conservation options other than complete land fallowing are desirable. Under the direction of a research team at Colorado State University, a cooperative research and demonstration project has been developed with the objective of sustaining profitable cropping systems in the environment of increasing competition for a limited water supply.

The project evaluates a range of alternative cropping approaches that reduce the consumptive use of irrigation water. Working together across disciplines, the project will evaluate agronomic management of reduced water use systems and the economics of alternative systems. The project will evaluate alternatives to full conversion to dryland.

Agronomic concepts being evaluated as approaches to save water include alternative crop rotations and the use of limited irrigation. Changing the cropping mix to decrease the magnitude of consumptive use within a growing season is one alternative to drying up land. Feed crops such as corn grain, corn silage, and alfalfa dominate the existing irrigated acreage in the South Platte and Arkansas basins. These crops have high water demand because they are produced during the warmest period of the year, they have long growing seasons, and they are produced under conditions of complete canopy cover for most of their growing season. Adjusting the crop mix to decrease the length or alter the timing of the growing season can reduce consumptive water use while minimizing loss of farm income and the exposure of soil to erosion. Changing fully irrigated corn, alfalfa, or vegetable cropping systems to include winter annual crops has the greatest potential to decrease consumptive water use. Winter annual crops that have a high potential for reducing consumptive use include winter wheat, forages and oil seed crops. Sunflower is another viable crop alternative to corn when water is limited (Schneekloth, 2005).

Limited irrigation research and demonstration sites under sprinkler and furrow irrigation at CSU-ARDEC.

A second approach to reducing consumptive water use is the concept of limited irrigation or deficit irrigation. With limited irrigation, less water is applied than is required to meet the full evapotranspiration demand of the crop. These systems are a hybrid of irrigation and dryland cropping systems and are currently of great interest to Colorado farmers. Successful limited irrigation systems are based on the concept of: 1) managing crop water stress, 2) timing irrigation to correspond to critical growth stages for specific crops, 3) maximizing water use efficiency by improving precipitation capture and irrigation efficiency, and 4) matching crop rotations with local patterns of precipitation and evaporative demand. Limited irrigation cropping systems can be more profitable than dryland crops and can be implemented to reduce consumptive water use. However, these systems require more management and by nature involve managing water stress within the crop growing cycle. In addition to learning new management

Limited irrigation research and demonstration sites under sprinkler and furrow irrigation at CSU-ARDEC.

concepts, learning to live with water stressed crops requires a psychological adjustment for crop producers. The project is evaluating limited irrigation approaches for corn, wheat, and sunflowers.

For perennial forage crops like alfalfa, the best approach to water savings is partial season irrigation. For partial season irrigation, a forage crop like alfalfa is fully irrigated to obtain the first or second harvest and then irrigation would be stopped, allowing the crop to go dormant. Because of cooler temperature and good growth during March, April, and May, the highest water use efficiency comes from the first alfalfa cutting. These systems will yield less than fully irrigated systems, but will focus on maximizing the yield per unit of water used. The research will also evaluate how the new water management approaches affect alfalfa quality and stand persistence.

Implementing these various concepts for saving irrigation water can be the foundation of a new approach to supply a growing urban population with water while maintaining a viable agricultural and rural economy in Colorado. However, many questions remain as to how this new model could work. Among these questions are economic unknowns. For example, what are expected profits from alternative irrigation systems? What crop rotations will be most beneficial and how much water savings will there be? How can water savings from alternative cropping systems be documented and verified? How do the proceeds from selling a portion of water rights today and adopting an irrigation system for future cropping compare with maintaining current operations or eliminating irrigated cropping? Beyond these farm level questions are questions about how different models of transferring agricultural water to municipal and industrial uses will affect local and regional economies. The economic portion of this study will evaluate these questions using a variety of techniques including enterprise analysis, state of the art economic forcasting models, and models that project farm level changes to community and regional scales.

Project Background and Support

The CSU led cooperative project was initiated in 2005 to address the many agronomic and economic questions associated with a future of agricultural water transfers. With initial funded from the Colorado Agricultural Experiment Station and the Water Resources Research Institute, a field research project was started at the CSU Agricultural Research Development and Education Center (ARDEC) to demonstrate limited irrigation techniques and water saving cropping systems. This project includes researchers from CSU and the USDA-ARS, with specialists in cropping systems, soil science, irrigation, pest management, and agricultural and resource economics. Since that time, the project has expanded to include many partners and sponsoring agencies and additional research locations and foci.

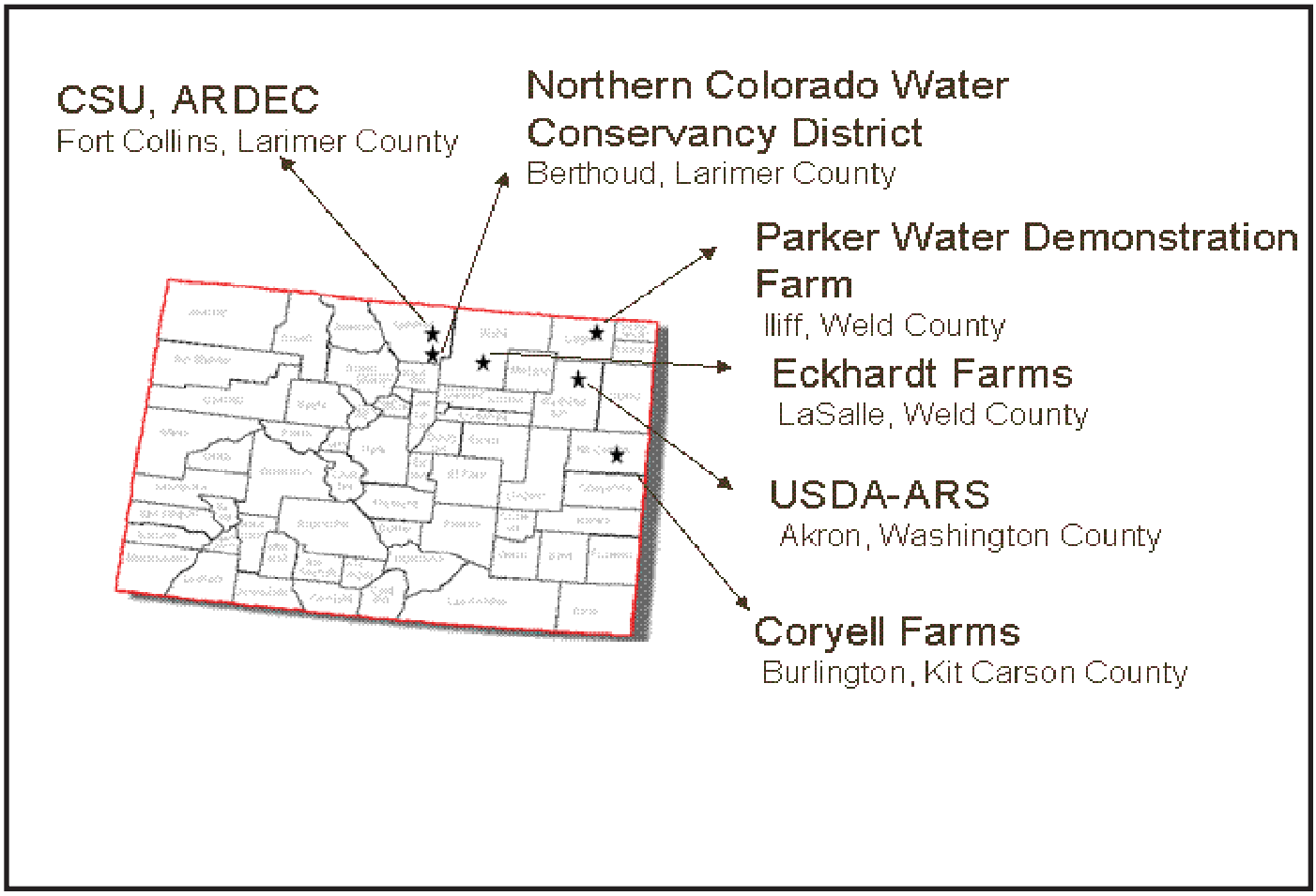
The USDA-NRCS is a key partner on this project. The NRCS is interested in the conservation aspects of both soil and water resources and is lending its technical expertise to assure the project is successful. In addition, the NRCS has provided funding for the project through their Conservation Innovation Grant program (CIG). The CIG funding allowed the project to expand to an on-farm demonstration of limited irrigation. The on-farm demonstration is being done in cooperation with Eckhardt Farms near LaSalle and involves understanding how limited irrigation practices can work for a farm that produces both high value vegetable crops and field crops. Eckhard Farms produce onions and sugarbeets as well as corn and some small grains. The demonstration involves the use of limited irrigation corn, cover crops for fallow, and rotation with high value crops.

Several Water Conservancy Districts are working with CSU to help sustain irrigated agriculture in Colorado. Northern Colorado Water Conservancy District (NCWCD) has dedicated the use of a state of the art linear move sprinkler irrigation system at their headquarters in Berthoud to study partial season irrigation for alfalfa. Central Colorado Water Conservancy District is partnering with CSU to help extend results from the research project to their members through meeting and publications. The Republican River Water Conservation District is cooperating with CSU and Coryell Farms on a farm scale limited irrigation demonstration and research project near Burlington. This project consists of a full center pivot irrigated field parceled into limited irrigation for corn,

sunflower, soybean, and winter wheat. The project will monitor water conservation with crop rotation compared to limited irrigation for continuous corn.

The interest in developing a new approach to meet the water needs of both growing urban communities and irrigated agriculture in Colorado has led to the formation of another important partnership. Parker Water and Sanitation District serves the water needs of more than 22,000 Front Range residents south of Denver. Like many Front Range communities, Parker Water is planning for future growth in population and water needs and has recognized that meeting projected water needs will require acquisition of water currently used for agricultural irrigation. Parker Water is committed to water conservation and protection of nonrenewable resources and has a strong interest in maintaining viable agricultural and rural communities in Colorado. Parker Water is partnering with the CSU team to develop and demonstrate a model system of how agriculture and urban water users can work together in a win-win approach. Parker is sponsoring the development of limited irrigation research and demonstration farm to be managed cooperatively with CSU and local farmers in the Illiff and Procter area of the South Platte River Basin. They are also helping forge the path to make new water saving irrigation practices feasible in the legal and political environment in Colorado. The hope is that a positive model can be developed for other urban water suppliers to follow when acquiring agricultural water rights.

Agricultural water in Colorado is under extreme pressure that will limit agricultural production and could increase soil erosion and degradation. As water is transferred to urban/industrial use and as producers experience limited well water availability due to augmentation requirements, they need assistance and guidance in maintaining viable agricultural enterprises under a limited irrigation water environment. This technology transfer and demonstration project will provide producers with viable economic alternatives to land abandonment or dryland agriculture.



Locations of limited irrigation research and demonstration sites in Colorado.

FACULTY PROFILE

Dr. Neil Hansen, Associate Professor Department of Soil & Crop Sciences

Dr. Neil Hansen joined the Colorado State University faculty in 2004 as an Associate Professor in the Department of Soil & Crop Sciences. His teaching responsibilities include SC420 and SC421, Crop and Soil Management Systems I and II.

Dr. Hansen earned his B.S. in Agronomy in 1992 and his M.S. in Agronomy in 1994 from Brigham Young University. He completed his Ph. D. in Soil Physics at the University of Minnesota in 1998. He comes to CSU from the University of Minnesota where he worked in the Dept. of Soil, Water, and Climate as a soil scientist and water quality specialist.

Although Dr. Hansen has a great deal of interest in dryland cropping systems, he quickly realized the need to address the loss of irrigation water in his research and outreach programs. Neil subsequently developed a cooperative research and demonstration project with the objective of sustaining profitable cropping systems in the environment of increasing competition for a limited water supply.

The CSU led cooperative project was initiated in 2005 to address the many agronomic and economic questions associated with a future of agricultural water transfers. With initial funded from the Colorado Agricultural Experiment Station, a field research project was started at the CSU Agricultural Research Development and Education Center (ARDEC) north of Fort Collins to demonstrate limited irrigation techniques and water saving cropping systems.

Since that time, the project has expanded to include many partners and sponsoring agencies and additional research locations. The Colorado NRCS has provided funding for the project through their Conservation Innovation Grant program. Northern Colorado Water Conservancy District (NCWCD) has dedicated the use of a linear move sprinkler irrigation system at their headquarters in Berthoud to study partial season irrigation for alfalfa. Central Colorado Water Conservancy District is partnering with CSU to help extend results from the research project to their members through meeting and publications. The Republican River Water Conservation District is cooperating with CSU and Coryell Farms on a farm scale limited irrigation demonstration and research project near Burlington.

The interest in developing a new approach to meet the water needs of both growing urban communities and irrigated agriculture in Colorado has led to the formation of another important partnership with Parker Water and Sanitation District. Parker is sponsoring the development of limited irrigation research and demonstration farm to be managed cooperatively with CSU and local farmers in the Illiff and Procter area of the South Platte River Basin.

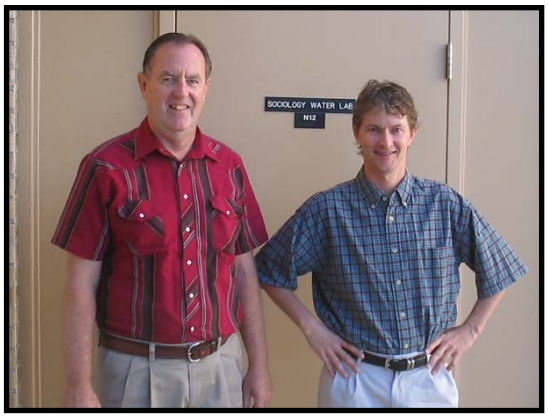
Dr. Hansen can be contacted at neil.hansen@colostate.edu

Evaluating Colorado's Water Banking Experiment

by John Wilkins-Wells, Ph.D., Sociology Water Lab, Colorado State University
Troy Lepper, M.S., Sociology Water Lab, Colorado State University
Lauren Grasmick, Ph.D.

Background

The Colorado State University Sociology Water Lab has been conducting research on water banking in the West, comparing and contrasting the recent Arkansas Valley water banking initiative with the Upper Snake River water bank (Idaho) and numerous new water banking initiatives in the Central Valley of California. The Arkansas Valley water banking initiative has had limited success. Meanwhile, water banking in Idaho and California proceeds with renewed interest. Why has the Colorado experience faltered? Our study is attempting to understand what went wrong with Colorado's recent effort at water banking. The study is funded by the Colorado State University Agricultural Experiment Station and the U.S. Bureau of Reclamation.



Sociology Water Lab Director John Wilkins-Wells and graduate student Troy Lepper.

In 2001, the State of Colorado passed HB-1354 authorizing the creation of a water bank in the Arkansas Valley. It was conceived as a pilot program with a well-thought out administrative procedure protecting third party injury and utilizing state-of-the art computer access. However, very shortly after the passage of the bill, communities in the lower Arkansas Valley proceeded with a totally separate initiative. This involved the creation of the Lower Arkansas Valley Water Conservancy District (LAVWCD) in 2002. The lower basin is represented by that reach of the Arkansas River extending from Pueblo to the Colorado-Kansas state line.

Although not a water bank, the new conservancy district was a defensive response to the proposed purchase by a Louisiana-based investment firm of 40 percent of the water rights in the Fort Lyon Canal, the largest canal company in Colorado. Therefore, it was largely an emergency initiative designed primarily to keep decreed water from migrating out of the lower valley through purchases and exchanges. It developed a successful but limited land conservation easement program and later began purchasing water outright from local landowners. The conservancy district generally expresses no interest in allowing water transfers out of the lower basin. Meanwhile, the State's pilot water bank has been terminated for lack of utilization.

Purpose of Study

The current study focuses on: 1) understanding the different design principles represented by the two initiatives for the purpose of shedding light on what appears more suitable as a future water marketing mechanism for the Arkansas Valley; and 2) comparing these Colorado experiences with those of the Central Valley in California. Due to new environmental requirements under the Central Valley Project Improvement Act (1992), along with intense urban development in the San Joaquin Valley, a depleting groundwater supply, and renewed state funding, irrigation districts and municipalities throughout the Central Valley are rushing to jointly develop groundwater banking management plans. Many of these plans are being designed after the Arvin-Edison Water Storage District program that has existed for many years. These may constitute important comparative lessons to examine carefully what went wrong in Colorado.

The Sociology Water Lab's perspective on water banking rests on the notion that it is simply one of a family of water marketing and transfer institutional mechanisms used to move water around the landscape. As water marketing experiments occur throughout the West, water users and organizations must sort through locally unique circumstances and constraints to find suitable mechanisms. State efforts to form these institutions should be approached with great care, which means allowing for maximum participation and inclusiveness in the process of building the desired institutional arrangement and ensuring that it is welfare-enhancing rather than exploitative of local community interests. There is a certain degree of historical path dependency inherent in these initiatives. The local water culture or tradition, water supply, age and temperament of the landowners, population trends and other pressures often determine what is likely to be the best approach, rather than exclusively relying on sound administrative or engineering design. This can generally only be accomplished by aggressively soliciting from local residents what their communities will accept. Furthermore, it is believed that a more

comprehensive approach that includes water banking in conjunction with field fallowing programs, interruptible supply agreements, water exchanges, conservation easements, and perhaps some canal consolidation, has a greater potential for addressing the needs of the lower Arkansas River basin than relying solely on a water bank.

Methodology
The approach that the Sociology Water Lab has taken to understand what happened with the water banking initiative in Colorado is to carefully assess the social interaction approaches used by those initiating the program. Was the initiative largely bottom up or top down in its execution? How much were local people really consulted? Was the design of the water bank a template programmed to be replicated throughout the state, or was emphasis placed on customizing the initiative to local circumstances. Was an effort made to build upon local water customs such as water rental systems, or were "outside experts" simply given a free hand? The study has interviewed water users and ditch company representatives from the lower basin, as well as having attended numerous public meetings and visits with state agencies in an effort to understand the social interaction approaches used.

Findings
Institutional change in an already complex social environment was apparently more difficult than the Colorado Legislature anticipated. Although there was some notable public involvement to determine what the Arkansas Valley needed, the effort largely appears to have been politically motivated by outside interests. The collaborative process should have involved primarily agricultural landowners, since they own most of the lower valley's water supply. Recent efforts at water marketing throughout the West are frequently driven by interests wishing to transfer water out of agriculture, rather than looking at ways to better secure agriculture's future and the sustainability of the communities that the water bank is nominally designed to serve.

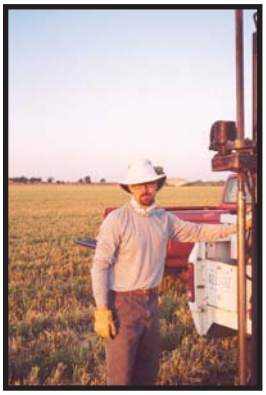
It was the opinion of many of the lower Arkansas Valley water users, especially those representing the interests of mutual ditch companies, that their input into the creation of the water bank was largely overlooked. For example, issues such as how the bank should be regulated and who would constitute the key decision makers were not adequately addressed. This in turn created an institutional climate pervaded by a lack of trust between the mutual ditch companies and those responsible for creating the water bank. The mutual ditch companies, after all, manage the water in these joint stock companies that was to be traded by shareholders through the bank. This appears to have been a major disconnect in the design and initiation of the program. This lack of trust adversely conditioned the entire program, culminating in a relatively insignificant amount of people depositing water in the bank and with no actual trades being conducted over the five year trial timeframe. Meanwhile, the conservancy district that was formed as a locally inspired alternative has been remarkably successful.

Summary and Conclusions
What previous research findings in water management and institutional development might have helped the State of Colorado create a marketing mechanism that would have sufficiently addressed the needs of the Arkansas Valley? First, public involvement in the creation of the water bank did not reach all significant stakeholders, which in turn raised legitimacy issues with those left out of the process. More public meetings like the ones utilized in the Statewide Water Supply Initiative would have helped alleviate this problem. Secondly, a water banking program that utilized a variety of mechanisms to move water around the landscape would appear to have been more flexible than a water bank that focused solely on short-term water leases. Thirdly, a water bank that only utilized stored water located in the valley's winter water storage program excluded potential water wheeling between mutual companies, and between these companies and other entities. Direct flow rights could not be leased in the pilot water bank, which prevented mutual ditch companies like the High Line Canal Company from leasing water to the City of Aurora; an action which occurred anyway, but through other means. This kind of short term wheeling was the type of transaction that could have allowed the exploration of exchange agreements between mutual companies. There were obviously Colorado-Kansas compact issues to consider in allowing this sort of water wheeling, but this should not have prevented the bank's administrators from experimenting with procedures that could have measurably justified its very existence.

In the end, the State of Colorado has decided to move away from water banking in the Arkansas Valley. In 2005 the board of the Southeastern Colorado Water Conservancy District elected to no longer manage the water bank, leaving a water marketing void that still needs to be filled. If the water users in the lower Arkansas Valley are going to successfully create a water market that benefits the entire basin, then another organization, most likely the Lower Arkansas Valley Water Conservancy District, is going to have to step up to the plate. Right now the conservancy district is moving in that direction with such concepts as a "super ditch company" and the like. Only time will tell if these will be successful initiatives, but one thing is certain, it will not be easy. Institutional change is a time consuming and laborious process, but the longer that process continues, the more it is likely to gain legitimacy and ultimately find its place in the already complex institutional world of the Arkansas Valley River Basin. The ultimate criteria in evaluating such an effort should be that it is participatory, inclusive and welfare-enhancing for those whose property is being transacted.

Soil Salinity and Chemistry in the Lower Arkansas River Basin

by Curtis Cooper
Ph.D. Graduate, Department of Soil & Crop Sciences, Colorado State University



As part of a continuing examination of salinity in the lower Arkansas River Basin, soil chemical samples were collected to help understand how laboratory methods can affect the soil salinity and how the soil salinity chemistry affects on-site salinity measurements. Salinity issues in the lower Arkansas River Basin, in Southeastern Colorado, are complicated in part because of salt accumulations in the soil and ground waters and for periodic droughts, which decrease water availability and add to the crop stress. Soil salinity in the lower basin varies across the region, but soils are classified primarily as saline or saline-sodic.

Electrical conductivity is an essential indicator of soil quality. An examination of the methods used to measure electrical conductivity (EC) was done to determine how laboratory analysis related to in-field ECs. Methods were tested using combinations of soils with different salinity levels, saturation with surrogate irrigation waters with a range of chemical concentrations, and/or soils ground or retaining aggregates. Baseline soil EC levels were based upon standard procedures where soil extracts are saturated with distilled water (ECe) and found no significant difference between ground and aggregated treatments for the low salinity soil ECe.

When the low salinity soils were saturated with surrogate irrigation waters, the response ECs varied as the surrogate irrigation water concentrations increased. The sum of the surrogate irrigation water EC and the baseline soil ECe did not equal the measured EC (of soils saturated with surrogate irrigation water) when it was above approximately 3.5 dS m^{-1}, this suggests that gypsum is not dissolving significantly above this ECe. Soils with high salinity (ECe >8 dS m-1) lacked structure and aggregates and could not be compared to ground soils. None of the tests with the high salinity ground soils had the sum of the baseline soil ECe and the surrogate irrigation water EC equal to the measured EC (of soils saturated with surrogate irrigation water). Laboratory methods may not represent the actual ECs that occur in the field, but the standardized measurement process offers a consistency that cannot be replicated in-field because of fluctuations in irrigation water quality.

In related research, a soil sample was repeatedly saturated then extracted to determine salt removal/leaching potential from a calcareous and gypsiferous soil. The calcium concentrations remained relatively constant over 14 extractions while sodium concentrations decreased with each extraction, as did the SAR. The ECe decreased from above 8 dS m^{-1} in the initial extraction to approximately 4 dS m^{-1} by the 9th extraction, and remained stable to the 14th extraction. This stable ECe over the later extractions suggest that mineral reservoirs of gypsum and calcite remain in the soil and become the primary salt sources during the later extractions. This result suggests that leaching will not easily lower the soil EC to below approximately 4 dS m^{-1} due to the mineral reservoirs in the soil. However, interactions between the irrigation water chemistry and salinity minerals can complicate or negate expected leaching potential. Fortunately, gypsum and calcite are not as problematic for crop growth as sodium minerals, so there is a net benefit from the leaching. As a rule of thumb, the ECe of gypsiferous and calcareous soils can be about 2 dS m^{-1} above crop recommendations for soils dominated by sodium salts at similar productivity levels.

Another aspect of the research examined how mineralogical variations associated with salinity influence the calibration of the electromagnetic induction meter because the ions (salts) are the primary carriers of the electromagnetic resonance. When dissolved salts fall out of solution as a solid, their influence on the electromagnetic resonance is decreased. Current EM38 (Geonics, Ontario, Canada) calibration equations for the lower Arkansas River Basin rely upon electromagnetic measurements in the vertical position (EMv) and water content measurements to calculate the ECe that is commonly used in recommendations.

The calibration equations to transform EMv data to ECe data were developed using either depth averaged or depth weighted salt concentrations and/or predicted pore water salt concentrations from Visual Minteq. The four equations developed used either depth weighted or averaged magnesium concentrations and SAR and/or Visual Minteq adapted magnesium and SAR. All of these equations are effective across the entire Upstream and Downstream sub-regions. Validation of these equations found that their predictability is equivalent to the current sub-region equations. Including the chemistry in the calibration equations explains some of the unevenness of the between the EMv-ECe calibration and indicates where the initial complications arise.

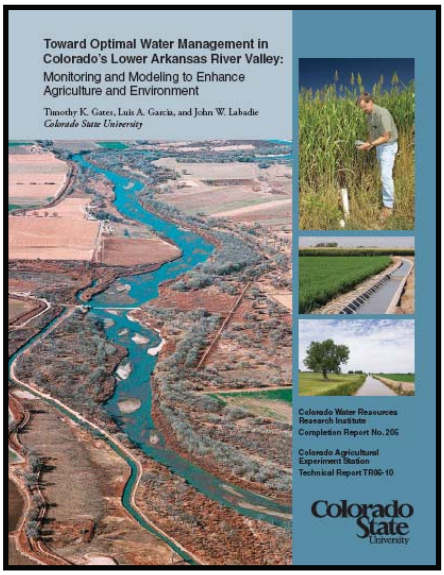
Research in the lower Arkansas River Basin continues and includes examining the effects of drain tile installation, and improving and expanding management models that will help with future recommendations for efficient water use.

PUBLICATION ANNOUNCEMENT
CWRRI Completion Report No. 205

Toward Optimal Water Management in Colorado's Lower Arkansas River Valley:
Monitoring and Modeling to Enhance Agriculture and Environment

by Timothy K. Gates, Luis A. Garcia, and John W. Labadie, Colorado State University
Department of Civil & Environmental Engineering

For several years, Colorado State University has been documenting flow and water quality conditions in Colorado's Lower Arkansas River Valley with the goal of providing data and models that water users and managers can use to enhance both agriculture and the environment in the the Valley. Extensive measurements are being made in the field, and some previously gathered data are still undergoing analysis. Models of the irrigated stream-aquifer system are under development, calibration, and refinement. Potential strategies for improving conditions in the river valley are being formulated and investigated. Small-scale pilot testing of solutions are scheduled to begin during the summer of 2006.



The results presented in this technical report are published as a benchmark to document completion of the first phase of this work. They also provide broad information in support of current decision making in the river valley and hopefully will stimulate feedback and discussion. Some of the information presented here is provisional since it is still undergoing refinement and expansion; hence, this document is made available in PDF format on worldwide web at CSUArkRiver.colostate.edu and will be updated periodically. Portions of the detailed database and modeling tools also will be made accessible at this Web site.

Excerpt from the Executive Summary
The Arkansas River has long sustained a belt of valuable agricultural production, an appealing rural lifestyle, and scenic vistas across Colorado's southeastern high plains. Now, it seems that without sound and timely intervention, the Lower Arkansas River Valley eventually may succumb to the ill effects of shallow ground water tables (waterlogging), excessive salt buildup, and high selenium (Se) concentrations, both on the land and in the larger river ecosystem. Options for mitigating these problems, that are based upon an accurate knowledge of field conditions and that comply with legal and economic constraints, are needed to ensure sustainability of the Valley's productive agricultural base, to preserve and revitalize its rural communities, and to enhance the overall river environment.

This document describes results of the first phase of on-going research by Colorado State University that seeks to develop insight into the current water-related problems and to identify promising solution strategies for consideration by water managers and users in deciding how to best meet the needs of the Lower Arkansas River Valley. Extensive field data and modeling tools are being developed and incorporated into a decision-making framework that focuses on meeting multiple criteria: (1) maximize the net economic benefits to agricultural production via reduction in salinity and waterlogging; (2) minimize salt and Se concentrations in the river at key locations, including the Colorado-Kansas state line; and (3) maximize "liberated" water via reduction in nonbeneficial consumptive use from high water tables under fallow alluvial land and from invasive phreatophyte vegetation (Tamarisks) along the river corridor.

To access this document, please visit:

www.CSUArkRiver.colostate.edu
or
http://cwrri.colostate.edu/

Colorado Water Resources Research Institute FY 2007 Request for Proposals

CLOSING DATE: SEPTEMBER 18, 2006

The Colorado Water Resources Research Institute (CWRRI) announces the FY 2007 Water Research competition. The research program is open to faculty in any institution of higher education in Colorado that has 'demonstrated capabilities for research, information dissemination, and graduate training … to resolve State and regional water and related land problems.'

The FY07 CWRRI Request for Proposals is supported by the State of Colorado, with supplemental funding provided through the U.S. Geological Survey, pending federal budget allocations. It is anticipated that approximately $450,000 in funds will be available for the FY07 competition. CWRRI research funds are awarded through a competitive process guided by the CWRRI Advisory Committee on Water Research Policy. Proposals that contain matching funds from Colorado water and water-related organizations are strongly encouraged.

Priority Research Topics: For the FY 2007 competition, the CWRRI Advisory Committee for Water Research Policy has identified needs for new water knowledge that will assist in answering the following questions:

- What are feasible strategies and options for irrigated crop production systems facing limited water supplies and what are the agronomic, economic, and social impacts resulting from the transfer of agricultural water?
- What possibilities exist for more efficient use of ground and surface waters in Colorado's irrigated valleys, given compact and augmentation requirements? How can we refine current augmentation accounting procedures and methods for replacing depletions caused by ground water pumping?
- What are the implications of climate and hydrologic variability for Colorado water managers and users? For example, there is an apparent trend towards less winter snowfall on the Eastern Plains and warmer/drier springs. What improvements can be made to the current methods of developing water forecasts and quotas to help avoid basin and ditch system water availability shortfalls?
- What are the best available methods for quantifying environmental and recreational water needs and flows? Which methods work best in which situations?
- How can we more accurately measure and predict the total water balance on a local and regional basis, including the soil moisture and ET components?
- How have forest fires and large areas of beetle-kill trees impacted water yields at the watershed scale?
- What are the impacts of emerging contaminants in wastewater and how can they be mitigated to protect human and aquatic health?
- What are the best methods to evaluate and quantify water quality impacts resulting from large-scale water transfers?
- What are the impacts of increased wastewater reuse on landscapes and downstream uses?
- How can nutrient standards for constituents such as ammonia be implemented in a way that protects Colorado's rivers and lakes and reduces financial impact on small water treatment systems?
- What are the direct and indirect water related impacts and water needs surrounding energy development and production in Colorado?

Proposal Review Process: All proposals are due in the CWRRI office by September 18, 2006. Proposals will be peer reviewed before final review and ranking by the CWRRI Advisory Committee for Water Research Policy. The general criteria used for proposal evaluation include: (1) scientific merit; (2) responsiveness to RFP; (3) qualifications of investigators; (4) originality of approach; (5) budget; and (6) extent to which Colorado water managers and users are collaborating.

Proposals, in both hard and electronic copy, are to be submitted by 5:00pm, September 18, 2006, to the Colorado Water Resources Research Institute office. Projects must not exceed 24 months in duration or $50,000 in total budget request. Project start date will be January 1, 2007.

For complete information, go to: http://cwrri.colostate.edu/

GS 592 - WATER RESOURCES SEMINAR

Fall 2006 theme:
Current Topics in Colorado Water Law

Monday, 4:10 – 5:30pm
A-206 Clark Building
Colorado State University, Fort Collins, CO

The appropriation and administration of Colorado's water resources rests upon 140 years of territorial and state law. This body of law prescribes how we put water to beneficial use in an arid land that never has enough water to satisfy all of the appropriated and environmental uses. The Doctrine of Prior Appropriation has guided the State for many years but the recent drought exposed a number of water management challenges that required new legislation and court rulings to allow water administration to continue evolving.

The purpose of the 2006 Water Resources Seminar is to examine the changing nature of Colorado water law and to ground students in basics of how our water legal system works. More specifically, the seminar will:

- Describe the theories, history and background of Colorado water law;
- Examine the role and function of the water court system and legislature;
- Discuss strengths and weaknesses of the law in surface and ground water administration;
- Examine current topics in Colorado water law, including: ground water use and augmentation, environmental and recreational flows, municipal acquisition and transfer of agricultural water, endangered species needs, interstate compacts, water quality protection and other topics.

Faculty and guests are welcome to attend and participate.

21-Aug	Justice Greg Hobbs, Colorado Supreme Court	History of Colorado Water Law: Adaptation and Evolution
28-Aug	Dan Smith and Reagan Waskom	Overview of Colorado Water Resources, Development, and Use; Law of the River
4-Sep	Labor Day	No Class
11-Sep	Bob Trout, Attorney	Colorado Water Law Principles (Part 1)
18-Sep	Bonny Colby, U. of Arizona	Interjurisdictional Water Settlements, A Venue for Water Management Innovation
25-Sep	Bob Trout, Attorney	Colorado Water Law Principles (Part 2)
2-Oct	Steve Sims, Attorney	Municipal Perspective on Acquiring and Developing Water Rights - Exchanges & Change of Use (Case Study: Aurora)
9-Oct	David Robbins, Attorney	Interstate Compacts and Federal Water Law (Case Study: Arkansas River Settlement)
16-Oct	Rep. Kathleen Curry, Colorado House Member	The Legislative Process and the Evolution of Water Rights (Case study: Recreational Flows)
23-Oct	Bill Brown, Attorney	Water Right Transfers & Adjudication: How the Water Court System works
30-Oct	Melinda Kassen, Attorney	Defending Environmental Needs and Water Quality
6-Nov	Andy Jones, Attorney & Tom Cech, Central Colorado Water Conservancy District	Current Issues in Groundwater Law and Administration (Case Study: South Platte Basin)
13-Nov	Mike Shimmin, Attorney	Colorado Groundwater Law
20-Nov	Thanksgiving Break	No Class
27-Nov	Ken Knox, Deputy State Engineer	Implementing Colorado Water Law (Case Study: San Luis Valley)
4-Dec	Mark Squillace, CU Natural Resources Law Center	Other State Approaches to Water Administration and Adjudication

Colorado's Future 2006 Conference
Taking the Plunge: Research as a Tool for Water Stakeholders

Copper Mountain Resort
October 6, 2006
8:30am – 5pm

What is good data? What is bad data? When does data matter? Identifying what information is needed, understanding how best to use research, and knowing the limitations are critical to developing sound water basin needs assessments, prioritizing projects, and negotiating differences among interests.

The one-day conference will consist of three interactive workshops focused on research, data collection, and decision making. Each workshop features a guidebook of materials, opportunities for hands-on learning, and discussion time.

Who should attend?

- Any water basin roundtable member who is actively involved or interested in a basin needs assessment.
- Any person in the water community who would like to engage in thoughtful consideration of the strengths and limitations of data.
- Any person who would like to consider how research fits within the larger social and value dimensions inherent in planning and policymaking.

Please save October 6, 2006, to attend this conference. Registration will open early August. The agenda and on-line registration is at www.cipp.colostate.edu under "Conferences" tab. If you prefer to register by mail, please contact Brian Compagnone at 970-491-2982.

For more information, call Lyn Kathlene at the Colorado Institute of Public Policy, CSU, 970-491-2544 or email lyn.kathlene@colostate.edu

Tentative Agenda and Proposed Workshops

8:30 to 9 am	Registration and continental breakfast
9 to 9:15 am	Welcome
9:15 to 9:45 am	Keynote Speaker
9:45 to 10 am	Break
10 to 11:45am	Workshop I
11:45 to 1 pm	Box lunch with speaker
1 to 1:15 pm	Break
1:15 to 3 pm	Workshop II
3 to 3:15 pm	Break
3:15 to 5 pm	Workshop III

Workshop I
Assessing and Applying Research

- State/university/private researchers talk about water research and how it can be used
- How to evaluate the credibility and usability of data

Workshop II
Accessing Available Data and Collecting New Data

- Provide real-time presentation on the Colorado Decision Support Systems (CDSS) http://cdss.state.co.us/DNN/Home/tabid/36/Default.aspx and other databases as identified
- How do to a basin needs/assets assessment

Workshop III
Using Research in a Collaborative Decision-making Process

Upper Yampa Water Conservancy District Scholarship Awarded to CSU Student

The Upper Yampa Water Conservancy District (UYWCD) continues to fund a scholarship in support of CSU students preparing for careers in water-related fields. The scholarship program is administered by the CSU Water Center.

The scholarship provides financial assistance to committed and talented students who are pursuing water-related careers at CSU. The UYWCD $2,500 scholarship is open to any major at CSU. Criteria for the scholarships require the recipient to be a full-time student enrolled at CSU; financial need may be considered; preference is given to students from the Yampa Valley area; and a minimum GPA of 3.0 is required. The scholarships are for one year.

The Upper Yampa Water Conservancy District Scholarship Recipient for the 2006-07 academic year is Frederick A. Busch. A senior majoring in Civil Engineering at CSU, Frederick is from Cedaredge, Colorado. His areas of interest in water include hydrology, irrigation engineering and water conservation. Fredrick currently works as a structural engineering lab assistant at the CSU Engineering Research Center and has experience in metal fabrication and heavy machinery repair from working in the family business in Cedaredge. Past accomplishments include leadership on high school sports teams and receiving the American FFA Degree at the National FFA Convention in 2005. He also obtained his private pilot license in 2004. Frederick plans to pursue a Master's Degree in Civil Engineering, with emphasis on hydrology, and hopes to pursue a career in water on the Western Slope of Colorado.

We had a number of outstanding applicants for this year's Upper Yampa Water Conservancy District scholarship and we congratulate Frederick and wish him success in his studies. The on-going support of CSU students by the UYWCD is acknowledged and greatly appreciated.

Managing Drought and Water Scarcity in Vulnerable Environments Creating a Roadmap for Change in the United States

18 - 20 September 2006
Longmont, Colorado

Drought-related impacts can be expected to increase in intensity in the twenty-first century as human population increases and land uses change.

This conference will evaluate current drought-related problems, anticipate future issues, and generate the basis of a Roadmap for Change -- a concise, impartial document which will contain recommendations for public policy, research, and funding needs.

Due to the participatory nature of this meeting, registration will be limited to 250.
Register for the Meeting (online registration closes 14 September 2006).

RESEARCH AWARDS

Colorado State University, Fort Collins, Colorado
Awards for July 2006 to August 2006*

Carlson, Kenneth H--Civil Engineering--ST-Infonox, Inc.--Testing of Micro-Sensor Technology for Security Monitoring of Drinking Water Distribution Systems--**$68,620**

Rathburn, Sara L--Geosciences--USDA-USFS-Forest Research--Analytical Framework for Assessing Effects of Stream Hydrology on Fish Habitat and Riparian Vegetation on Mountai...--**$10,000**

Jacobi, William R--Bioagricultural Sciences and Pest Management--Denver Water Department--Water Usage by Cottonwood Trees --**$11,620**

Winkelman, Dana--CO Co-OP Fish and Wildlife Research Unit--Montana State University--Investigating Competition Among Lineages of T. Tubifex and the Potential for Biological Control of Whirling Disease --**$20,167**

Julien, Pierre Y--Civil Engineering--USDA-USFS-Rocky Mtn. Rsrch Station - CO--Hydraulic Geometry and Sediment Transport of the Rio Grande--**$39,008**

Westra, Philip--Bioagricultural Sciences and Pest Management--Boulder County Parks & Open Spaces--Small Research Grant GPA Mapping Invasive Plants on Riparian Sites--**$20,000**

Johnson, James Bradley--Anthropology--Colorado Department of Natural Resources--Reference Conditions in Rocky Mountain Wetlands--**$2,000**

Julien, Pierre Y--Civil Engineering--DOC-NOAA-NWS-National Weather Service--TREX/CASC2D Watershed Model Training Technical Support--**$21,000**

Gates, Timothy K--Civil Engineering--Desert Research Institute--Evaluation of the Use of Polyacrylamide to Reduce Seepage Losses from Earthen Irrigation Canals, Part I--**$30,000**

Hawkins, John A--Fish and Wildlife Biology--DOI-Bureau of Reclamation--Yampa River Nonnative Fish Control: Translocation of Northern Pike from the Yampa River--**$263,934**

Winkelman, Dana--CO Co-OP Fish and Wildlife Research Unit--Colorado Division of Wildlife--Aquatic Studies (Water Pollution and Native Plains Fishes) (Exhibit D) FY06/07--**$16,602**

Bestgen, Kevin R--Fish and Wildlife Biology--DOI-Bureau of Reclamation--Evaluating Effects of Non-Native Predator Removal on Native Fishes in the Yampa River--**$92,268**

Bestgen, Kevin R--Fish and Wildlife Biology--DOI-Bureau of Reclamation--Verification of Stocked Razorback Sucker Reproduction in the Gunnison River via Annual Collections of Larvae--**$20,000**

Bestgen, Kevin R--Fish and Wildlife Biology--DOI-Bureau of Reclamation--Interagency Standardized Monitoring Program Assessment of Endangered Fish Reproduction in Relation to Flaming--**$93,446**

Bestgen, Kevin R--Fish and Wildlife Biology--DOI-Bureau of Reclamation--Effects of Flaming Gorge dam Releases on Lodore/ Whirlpool Canyon Fish Community--**$48,839**

Qian, Yaling--Horticulture and Landscape Architecture--DOI-Bureau of Reclamation--Assessment of Inland Saltgrass Plant Performance --**$15,000**

Bestgen, Kevin R--Fish and Wildlife Biology--DOI-Bureau of Reclamation--Entrainment of Larval Razorback Sucker --**$40,841**

Tranel, Jeffrey E--Cooperative Extension--Washington State University--Planning for Reduced Water Availability to Colorado Agriculture--**$39,448**

Bauder, Troy A--Soil and Crop Sciences--Colorado Department of Agriculture--Training and Education for Agricultural Chemicals and Groundwater Protection--**$165,000**

---

*Due to technical difficulties, some grants received in July may not appear on this list.

Research awards from institutions of higher education in Colorado other than Colorado State University are provided by self-report of the Principal Investigator. If you have water related research awards to report, send them to cwrri.colostate.edu

CALENDAR

Sep. 6 or 7	**Nonpoint Source Forum 2006: More than Brochures—Real Change.** Denver, CO. For more information and registration, go to http://www.npscolorado.com
Sep. 10-14	**Dam Safety '06. Boston.** For more information, go to www.damsafety.org or call 859-257-5140.
Sep. 18-20	**Wetlands Restoration Dialogue,** Fort Lauderdale, FL. For more information go to http://www.awra.org/meetings/
Sep. 18-20	**Managing Drought and Water Scarcity in Vulnerable Environments: Creating a Roadmap for Change in the United States.** Longmont, CO. Geological Society of America. For more information, see http://www.geosociety.org/meetings/06drought/registration.htm
Sep. 25	**The Law of Ecosystem Restoration: National Policy Implications of the Clark Fork River Basin Natural Resource Damage INRD) Program,** Missoula, MT. For more information to go http//www.umt.edu/publicland/Conference.htm
Sep. 26-28	**3rd International Symposium on Integrated Water Resources Management.** Ruhr-University, Bochum, Germany. International Commission on Water Resources Systems. For more information go to http://conventus.de/water/
Oct. 25-28	**Ground Water and Surface Water Under Stress: Competition, Interaction, Solutions**. Boise, Idaho. For more information go to www.uscid.org/
Nov. 1	**Deadline for paper submissions to Fourth International Conference on Irrigation and Drainage: Role of Irrigation and Drainage in a Sustainable Future**. Sacramento, CA. for more information go to http://www.uscid.org/
Nov. 2-3	**Advanced Topics in Floodplain Management.** CU/Denver. For more information go to www.cudenver.edu/engineer/cont.
Nov. 6-9	**American Water Resources Association 2006 Annual Conference.** Baltimore, MD. For more information go to www.awra.org/meetings/Baltimore2006/.
2007	2007
Jan. 22-23	**American Water Resources Association Third National Water Resources Policy Dialogue.** Arlington, VA. For more information, go to http://www.awra.org/meetings/DC2007/index.html.
Jan. 25-26	**Colorado Water Congress 49th Annual Convention.** Denver, CO. For more information go to: www.cowatercongress.org, or phone 303/837-0812, or email macravey@cowatercongress.org .
Jun. 25-27	**SWRA Summer Specialty Conference: Emerging Contaminants of Concern in the Environment: Issues, Investigations, and Solutions**, Vail, CO. For more information go to http://www.awra.org/meetings/Vail2007/index.html
Sep. 30 to Oct. 5	**Fourth International Conference on Irrigation and Drainage: Role of Irrigation and Drainage in a Sustainable Future**. Sacramento, CA. for more information go to http://www.uscid.org/

Nonpoint Source Forum 2006
More than Brochures -- Real Change

One Workshop, Choice of Days

September 6 or 7, 2006 -- PPA Event Center, Denver, CO

Most people know that to protect the environment they should recycle more, water their lawns less, get out of the car and take a multitude of other steps to reduce their ecological footprint. This is the starting point.

The workshop covers four key areas:

1) How to identify the barriers to a desired behavior, such as reducing lawn watering or pesticide use
2) How to use behavior change "tools" to design more effective programs
3) How (and why) to pilot test a program
4) How to evaluate the impact of a program once it has been implemented

For more information and registration, go to http://www.npscolorado.com/

17th Annual South Platte Forum

From the Gold Rush to the Urban Crush

The Past, Present and Future of the South Platte River Basin

October 25 - 26, 2006
Longmont, Colorado - Radisson Conference Center

Registration is only $100 if you register before October 1

For more information
www.southplatteforum.org
or contact
Jennifer Brown at 402-426-0362
Jennifer@jjbrown.com

Colorado State University
Colorado Water Resources Research Institute
Colorado State University
Fort Collins, CO 80523

PRESORTED
STANDARD
US POSTAGE PAID
FORT COLLINS CO 80523
PERMIT NUMBER 19