COLORADO WATER

Newsletter of the Water Center of Colorado State University

JUNE 2004

Artist's rendering of the Agricultural Research Service Building dedicated on April 20 in Fort Collins (see article on page 28)

INSIDE: SPECIAL ISSUE
Non-Point Source Pollution Management Research and Education Efforts in Colorado

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Knowledge to Go Places

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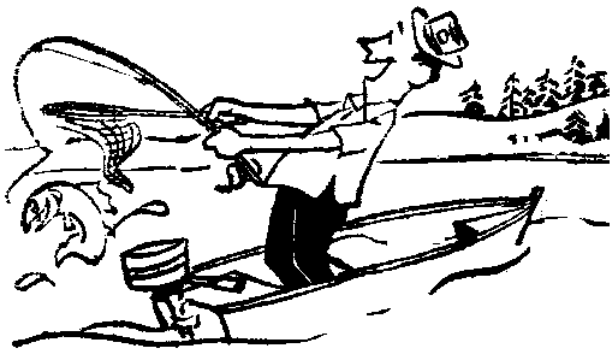

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EDITORIAL

NON-POINT SOURCE POLLUTION CONTROL

by Robert C. Ward, Director
and Reagan Waskom, Water Resources Specialist

All human societies have recognized the need to avoid fouling their water supplies. Sometimes this recognition comes only after much pain, suffering and death. For example, when the industrial revolution brought large numbers of people into European cities in the early 19th century, plagues swept across Europe with deadly frequency. Careful research into the causes of the plagues (e.g. that of John Snow in London in 1854) revealed that contaminated water supplies spread disease and death. This finding led to governments, in both Europe and the U.S., passing public health laws and establishing public health programs to protect human health.

In the mid 20th century, when rivers caught fire and fish kills were common, U.S. governments, at all levels, passed laws and/or established programs to control the discharge of wastewater to rivers, lakes and groundwater. Focus of control efforts, initially, was on point source discharges, i.e. discharges from the outfalls of municipal and industrial wastewater treatment plants.

The federal government assumed a role in managing water quality with passage of the Federal Water Pollution Control Act in 1948, and a strong leadership role after amendments to this Act in 1965. The federal Act became known as the Clean Water Act in the 1970s and it has been reauthorized a number of times, the last time in 1987. The 1987 reauthorization recognized the need to better manage what is referred to as 'non-point sources' (NPS) of pollution, i.e. sources of pollution that do not enter a stream at one point, but rather in a diffuse manner. However, the strategy for managing NPS pollution, since it must necessarily address the actions of individual citizens rather than private and public entities, is based largely on education and demonstration. In other words, through enhanced understanding of NPS pollution pathways (i.e., routes the pollution follows as it begins with individual actions and moves to waterways) and development of 'best management practices' to prevent pollution pathways from forming, it was hoped NPS could be managed in a more collaborative manner than the 'command and control' strategy employed for point sources of pollution.

The push to develop the knowledge and education needed to reduce NPS has been undertaken at all levels of government through a number of programs. This issue of Colorado Water is devoted to reviewing a number of these programs, paying particular attention to the research and education efforts involved.

Research supported by the Agricultural Experiment Station, CWRRI, and USDA Agricultural Research Service, to better understand the pathways of NPS pollution to waterways, is addressing such topics as agricultural chemicals, selenium and nitrogen. Efforts to transmit this knowledge to individuals is described for Cooperative Extension, Colorado's Agricultural Chemicals and Groundwater Protection Program and USDA's regional agricultural water quality efforts.

As the NPS research and education efforts progress, broader understanding of the problem and solutions should enable the U.S. to avoid fouling its water resources and suffering the heavy human and economic costs associated with ignoring pollution problems and the resulting burden of cleanup. Some fifteen years into the "Section 319" approach to NPS, it seems important to evaluate the progress we have made and the quality of our nation's water. This issue of *Colorado Water* seeks to bring our readers up to date on Higher Education's role in the effort to understand and address Non-point Source Pollution.

Non-point source: *A contributing factor to water pollution that cannot be traced to a specific spot. Man-made or man-induced alteration of the chemical, physical, biological, or radiological integrity of water, originating from any source other than a point source. Pollution which comes from diffuse sources such as urban and agricultural runoff. Major non-point sources of pollution include excess farm and lawn nutrients that move through the soil into the ground water or enter local water directly through runoff during heavy rains; uncontrolled storm water runoff from construction sites; forestry operations; animal wastes; and even pollutants released directly into the atmosphere.*

Point source: *Any discernable, confined, or discrete conveyance from which pollutants are or may be discharged, including, but not limited to, any pipe, ditch, channel, tunnel, conduti, well, container rolling stock, concentrated animal feeding operation, or vessel or other floating craft. A stationary location or fixed facility from which pollutants are discharged or emitted. Any sigle identifiable source of pollution. Pollution that comes from a well-defined source.*

Definitions are taken from www.usbr.gov/cdams/glossary.html, Bureau of Reclamation Glossary

Colorado State University Cooperative Extension

NON-POINT SOURCE MANAGEMENT IN COLORADO

by Laurie Fisher,
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Non-point source (NPS) pollution is considered by the U.S. Environmental Protection Agency (EPA) to be the largest water quality problem in the country. Also known as polluted runoff or diffuse pollution, non-point source pollution occurs when water runs over or through the soil, picking up natural and human-made pollutants—excess sediment, salts, chemicals, oil and grease, bacteria and nutrients, even deposits from airborne material. Non-point sources contribute to Colorado's water quality impairments, but the extent of their impact has not been quantified.

Non-point source management is coordinated out of the Water Quality Control Division (WQCD) of the Colorado Department of Public Health and Environment and results from the 1987 amendments to the Clean Water Act. The amendments added Section 319, which required states to identify waters impacted by non-point sources and to develop an implementation strategy to addresses those sources. The activities that contribute to non-point source pollution are as varied as the possible pollutants. Nearly all land use activities have the potential to generate non-point sources, which means nearly all individuals have the ability to prevent NPS pollution.

The Colorado Non-point Source Task Force was established in May 1987 to assist the Water Quality Control Division in the development of both the assessment report and the management strategy. Now called the NPS Council, the advisory/work group is comprised of 25 member entities, including government agencies at all levels; special interest groups representing a number of industries including agriculture and mining; as well as environmental organizations.

Colorado's non-point source program is evolving. The original management strategy contained significant awareness-building activities to provide information on both the problem and the solution to those who could make a difference. Recently, though, the program has linked more closely to the total maximum daily load (TMDL) program. In fact, the goal of the NPS Program is to restore waters impaired by non-point sources and to prevent future impairments.

Before federal funding became available for Section 319, Colorado redirected $1.8 million of its construction grant funding toward remediation of selected non-point source problems. Since federal appropriations began in 1990, more than 250 projects have been supported to research, prevent and remediate non-point source problems or to educate specific audiences. Colorado's allocation has risen steadily over the years; in 2004, approximately $2.3 million was available for new projects.

Requirements for receiving a NPS grants have tightened recently. On-the-ground restoration projects in watersheds with impaired water bodies now must have a watershed plan before funds can be used for implementation. In addition, projects must demonstrate "measurable results," which are defined as either reducing the loads of certain pollutants such as nutrients or sediment, or restoring waters to their full uses. This is a key factor used to evaluate requests for funding.

The annual NPS grant process identifies the targeted priorities for the year. Key concepts are described at http://www.cdphe.state.co.us/wq/nps/npshom.asp. In addition, several other funding opportunities exist to assist implement non-point source remediation projects. For instance, loans are available through the Financial Assistance Program administered by the Colorado Department of Public Health and Environment and the Colorado Water Resources and Power Development Authority. Information on various sources of funding, including Outreach Grants, EPA's consolidated funding process and Colorado's Watershed Protection Fund, is available at www.npscolorado.com/fundingopportunities.htm.

The amount of federal funding granted to Colorado for its NPS program barely scratches the surface of the need. As a result, the NPS program works closely with several state and federal programs to collaborate on NPS management. Examples include:

- the Colorado Agricultural Chemicals and Groundwater Protection Program (commonly known as SB 126);
- Inactive Mines Program of the Colorado Division of Minerals and Geology;
- U.S. Department of Agriculture programs such as the Environmental Quality Incentives Program and the Colorado River Salinity Control Program;
- The Rivers of Colorado Water Watch Network, also known as River Watch.

Outreach is an important part of the NPS Program. The League of Woman Voters is concluding its Colorado Water Protection Project, a statewide public relations campaign that involved public service announcements; radio and bus advertisements; and several brochures such as the "Colorado Water Protection Kit." Most of the materials produced for the campaign can be accessed at www.ourwater.org. Students and teachers can obtain a variety of educational materials and resources from the Colorado Foundation for Agriculture at www.growingyourfuture.com. In addition to the statewide activities, each local project funded by a NPS grant is required to have an outreach component. Information about the Colorado non-point source program, including downloadable materials and outreach resources, is available at www.npscolorado.com.

Two documents were published this spring that provide additional information on the NPS Program.

- The 2003 Annual Report describes the activities of the program, funding levels and a complete list of all projects funded since 1990.
- "10 Years of Success: Implementation of Colorado's Non-point Source Program" describes in detail 18 projects completed with funding during the first 10 years of appropriations. The booklet samples projects from each of the five primary program emphasis areas.

Both documents also are available at www.npscolorado.com or in hard copy from nps@state.co.us.

The program will hold its Fourth Annual Forum on September 8, 2004, at the Hotel Colorado in Glenwood Springs. The theme is "Watershed Planning: Blueprint for Action" and will feature sessions on developing a watershed plan; evaluating success in the watershed; and outreach to the community. Presentation of the "Non-point Source Hall of Fame" awards will be made as well. The forum precedes the fifth annual meeting of the Colorado Watershed Assembly.

Non-point source management in Colorado faces several challenges for the future:

- Funding: As mentioned previously, the need for funding far outweighs the availability of federal funds. For instance, the estimate to restore the Animas River from the impacts of historic mining is about $30 million alone.
- Outreach: Many sources of NPS can be prevented by individual action, which require changing patterns of behavior to make pollution prevention the new norm. Until those changes are made, though, public information and education must continue.
- Data: Measuring the results of a restoration project can be expensive but is necessary to meet national requirements; this can be a challenge for a volunteer watershed stakeholder group
- Liability: Recent court decisions have caused volunteer organizations to be somewhat hesitant to participate in the cleanup of inactive mine sites where the discharge from an adit could require a discharge permit. Good Samaritan legislation is needed to relieve volunteers from perpetual Clean Water Act liability.

Despite the challenges, though, progress is occurring through the voluntary actions of landowners and stakeholders in many watersheds. Add to that the actions of individuals in daily life – whether home and garden maintenance, pet care or automotive upkeep – and the cumulative impact moves us a little closer to the ultimate goal of fishable, swimmable waters.

WATER RESOURCES UPDATE NAME CHANGES TO JOURNAL OF CONTEMPORARY WATER RESEARCH AND EDUCATION

Water Resources Update has a new name: *Journal of Contemporary Water Research and Education.* Since its origins in the 1970s as a newsletter the publication has become a well-respected journal with invited issue-focused papers on specific timely topics. The Universities Council On Water Resources (UCOWR) board voted unanimously to reflect this transformation by renaming the publication effective with issue 128 on Small Water Supply systems: Meeting the Challenges of the Safe Drinking Water Act, published in May. Additional issues this year will include Water and Homeland Security and national Flood Policy a Decade after the 1993 Mississippi Flood.

HAZARDOUS SUBSTANCE RESEARCH CENTER'S 2003 ANNUAL REPORT AVAILABLE

Rocky Mountain Region Hazardous Substance Research Center's 2003 Annual Report is now available at http://www.engr.colostate.edu/hsrc/reports.html . The center is one of five in the U.S. funded by EPA to do research and conduct outreach on hazardous substances. The Rocky Mountain Region center is a consortium of CSU and Colorado School of Mines faculty with a focus on remediation of mine wastes. The start-up funding for this center was announced in Colorado Water in December 2001.

WHAT'S THE NORMAL LEVEL OF NITROGEN CONCENTRATIONS IN FOREST STREAMS?

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Between 70 and 80 percent of the water flowing in rivers in the United States originates as rain and snow falling on forests. The nitrogen (N) concentrations in forested streams influence the ecological functioning of the streams, and in extreme cases can pose a threat to water quality for human use.

What concentrations of nitrogen are typical for forest streams in the United States? The answers differ by geographic regions and dominant tree species, and no single region or forest type can represent the spectrum of forest streams in the country. Stream chemistry has been examined for hundreds of forest streams across the United States in the past 40 years. These studies have varied in details such as how often samples were collected, and how many years the streams were examined. The choice of which streams to study was usually not random; in fact, many studies tended to cluster resulting in intensively studied areas. We summarized the water chemistry information for forest streams across the United States to determine patterns within regions, types of forests, and forest management activities.

Nitrate

Nitrate is the most oxidized form of nitrogen in streams, and high concentrations of nitrate are often associated with areas where the terrestrial ecosystems cannot retain all the N added by land use practices (such as fertilization) or high atmospheric deposition. Concentrations of nitrate higher than 10 mg N/L are considered to be unsafe for drinking water, and forests with high concentrations of nitrate in stream water might also be at risk of damage from high rates of nitrogen input from atmospheric deposition (or acid rain).

Across the United States, forested streams averaged 0.31 mg N/L as nitrate (Table 1), with higher concentrations generally in the Northeast (0.50 mg N/L) than in the Southeast (0.18 mg N/L) or the West (0.20 mg N/L). Moderate-to-high concentrations of more than 1 mg N/L have been reported for only for a few forests in the Northeast, and for forests containing nitrogen-fixing alders in the West. Overall, forest streams average about one-tenth the nitrate concentrations found in streams draining agricultural lands.

The regional pattern in nitrate concentrations relates well to the concentrations of nitrate in precipitation across the country, with high rates of deposition in the Northeast. Concentrations in precipitation across the Northeast average about 0.3 mg N/L, about double the concentrations for precipitation in the Southeast and West. However, this regional pattern is also confounded by patterns in vegetation. Northeastern forests are dominated by hardwoods, whereas conifers are more common in the Southeast and West, and hardwood forests tend to have higher concentrations of nitrate (0.46 mg N/L) than conifer forests (0.15 mg N/L).

Ammonium

Ammonium in forest streams may be used as a source of N for the biota, or it may be oxidized to nitrate. Ammonium concentrations generally do not represent a drinking water issue. Across the United States, concentrations of ammonium in streamwater are much lower than nitrate concentrations, averaging just 0.05 mg N/L. Concentrations are lower for streams in the West (mean 0.02 mg N/L) than in the Northeast (0.09 mg N/L) and Southeast (0.05 mg N/L). Ammonium concentrations are again higher in streams in hardwood forests (0.07 mg N/L) than in streams in conifer forests.

Dissolved Organic Nitrogen (DON)

Dissolved organic matter in streams contains nitrogen bound with carbon atoms. Some of this nitrogen and carbon is easily degraded by microbes to release ammonium, but most is in resistant forms that settle out as sediment or flow into downstream reaches. Dissolved organic N poses no threat to drinking water quality, although high concentrations of dissolved organic matter can degrade water quality by producing colored, poor-tasting water.

Across the country, the concentrations of dissolved organic nitrogen (DON) were similar to the concentrations of nitrate, averaging 0.32 mg N/L. Most of the studies that measured DON were in the Northeast, where the values were about half those reported in the few studies in the Southeast and West. As a generalization, the nitrogen forms in streams in the Northeast are about 45 percent DON, 45 percent nitrate, and 10 percent ammonium. In the Southeast and West, DON comprises about 60 percent of the streamwater N, nitrate 30 percent, and ammonium 10 percent. In contrast to nitrate, coniferous forests showed higher concentrations of DON

(0.7 mg N/L) than hardwood forests (0.2 mg N/L). Overall, streamwater N in hardwood forests was dominated by nitrate (60 percent of all dissolved N forms), followed by DON (30 percent) and ammonium (10 percent). In conifer forests, DON accounted for 80 percent of all dissolved N forms, followed by nitrate (17 percent) and ammonium (3 percent).

Time Trends in Streamwater Nitrogen

Decadal-scale trends in streamwater have been characterized for a number of forests. No general time trends were apparent across the United States, but many streams in New England have shown strong declines (of about 2/3) in nitrate concentration over the past two decades. Atmospheric deposition of N did not decline over this period in the Northeast, and the region-wide decline in streamwater nitrate remains unexplained. Freezing and thawing of soils in the 1970s and 1980s may have generated large amounts of nitrate, but other changes in nutrient cycling patterns in the forests may be important.

Variations in Streamwater Nitrogen Within Local Watersheds

These broad regional patterns of variation in streamwater nitrogen concentrations derive from patterns that include substantial variation at local scales, in response to differences in geology, vegetation, and disturbances. Two examples highlight the great variety of nitrogen concentration patterns within the northeastern U.S. The streams in the Catskill Mountains of New York showed a 17-fold range in nitrate concentrations between the lowest and highest streams, and fewer than 20 percent of the streams had nitrate concentra-

Table 1. Mean and median concentrations of nitrate, ammonium, and dissolved organic-N (DON) by region and forest type (n=number of streams included).

Watershed Type	Nitrate (mg N/L)				Ammonium (mg N/L)				DON (mg N/L)		
	mean	median	n		mean	median	n		mean	median	n
All	0.31	0.15	256		0.05	0.01	94		0.32	0.08	68
Northeast	0.50	0.30	102		0.09	0.03	26		0.38	0.08	54
Southeast	0.18	0.05	64		0.05	0.04	36		0.80	0.78	8
West	0.20	0.03	90		0.02	<0.01	32		0.57	0.50	6
Hardwood forests (all)	0.46	0.31	138		0.07	0.02	31		0.22	0.08	50
Northeast	0.49	0.35	92								
Southeast	0.22	0.11	33								
West	0.81	0.60	13								
Conifer Forests (all)	0.15	0.03	114		0.03	0.01	61		0.68	0.70	14
Northeast	0.53	0.25	10								
Southeast	0.15	0.04	29								
West	0.10	0.03	75								

tions less than 0.2 mg N/L. A few hundred km away, New England streams averaged 0.1 mg N/L as nitrate, with 85 percent of the streams falling below 0.1 mg N/L. The "normal" nitrogen chemistry for New England streams encompasses a very wide range of concentrations.

Effects of forest harvesting, fire, and fertilization

Most studies of forest harvesting effects on stream chemistry have found increases in nitrate concentrations, but some have found no effect or even declines in concentrations. In the 43 harvesting experiments in the United States, control or unlogged watersheds averaged 0.21 mg N/L as nitrate, compared with 0.44 mg N/L for one to five years after logging. Two-thirds of the studies showed increases in nitrate concentrations, and only 10 percent of the studies found increases of more than 0.5 mg N/L. Forest harvesting had no overall effect on concentrations of ammonium in streamwater.

Fire is a major factor in most forests of the United States, including both wildfires and prescribed management fires. Burning typically increases streamwater nitrogen concentrations, but these increases are usually too small and too short in duration to substantially impair water quality.

Forest fertilization commonly increases streamwater nitrogen concentration, but almost all reported increases have remained below 0.5 mg N/L for most cases. These annual average concentrations are lower than the peak concentrations that may occur soon after fertilization; about half of the studies found peak nitrate in excess of 1 mg N/L, and some exceeded 10 mg N/L for short periods of time (mostly in situations where fertilizer fell directly into streams). Fertilization had no effect on annual average ammonium concentrations, though short-term peak concentrations reached 10 mg N/L in cases where fertilizer application to streams occurred.

Overall patterns

The concentrations of nitrogen in forested streams is generally low, well below thresholds for concern about drinking water quality. Most forest streams have roughly equal concentrations of nitrate and dissolved organic nitrogen, with low levels of ammonium. However, no single level or form of nitrogen can be expected to be "normal" for forest streams, because variability is important at virtually all scales: across regions, among vegetation types, and over time within individual streams. The most useful characterizations of normal conditions for forest stream chemistry probably need to include several factors. For example, relatively high concentrations of nitrate should be expected in streams across the northeastern United States because hardwood forests dominate much of these landscapes, and rates of nitrogen deposition in precipitation are high. Perhaps the broad patterns presented here may be most useful for identifying when a stream's chemistry is far from normal; a conifer-dominated stream in the West with high nitrate concentrations might indicate something very unusual in the watershed.

For more information, the full report sponsored by the USDA Forest Service and the National Council for Air and Stream Improvement is available at: http://www.cnr.colostate.edu/~dan/papers/ncasi836.pdf . A summary paper will also appear in the Journal of the American Water Resources Association late in 2004.

USGS NATIONAL WATER INFORMATION SYSTEM DATABASE ACCESSABLE ON-LINE

Colorado water data is now available through the National Water Information System (NWIS), the USGS database for storing water data collected as part of the USGS projects.

All reports are available on http://water.usgs.gov/nawqa (look under "NEW" in the upper right corner). Also available on the website are a listing of USGS contacts in the study areas (for additional information and questions on specific basins), press releases for individual assessments, and chemical, physical, and biological data for all 51 study areas.

The page is designed with "helps" to explain options, procedures and navigational tools. You can select location from a map, and then data types which include projects, streamgages, other agency streamgages, stream water quality, water quality monitors, sediment load,, spring water quality, reservoir water quality, ground water quality, continuous ground water levels, miscellaneous ground water levels, precipitation quantity, precipitation quality.

Colorado State University Agricultural Experiment Station

MOUNTAIN MEADOW MANAGEMENT: POTENTIAL IMPACTS TO SURFACE WATER QUALITY

by Joe Brummer
Research Scientist/Scholar III

Mountain meadows are an important forage resource for the livestock industry in western Colorado. Although these meadows are used primarily for hay production and grazing of livestock, they also provide food and habitat for wildlife, delay return flows to streams and rivers through irrigation, and are aesthetically pleasing, which is important for the tourist industry. Forage production from these high elevation grasslands has been improved over time by installing irrigation systems (primarily flood), adding fertilizer and manure, and seeding improved plant species. Return flows from the flood irrigation practices provide a pathway for the added nutrients to reach adjacent waters. Without proper nutrient and grazing management of these meadows, the potential exists to impact surface water quality. To address this issue, two studies were conducted in the Gunnison Basin of western Colorado during the 2000 and 2001 irrigation seasons (White, 2002).

Monitoring Study

The objective of this field scale study was to monitor water quality of irrigation inflows and return flows from three flood irrigated mountain meadows in the Gunnison Basin that had different levels of fertilization and grazing management (White et al., 2004). Site 1 was rotationally grazed from late October to mid May and biennially fertilized with diammonium phosphate (18-46-0), Site 2 was grazed from late October to early June and unfertilized, and Site 3 was grazed for different lengths of time with varying numbers of animals from mid October to mid May and fertilized using various formulations of nitrogen, phosphorus, and sulfur. All three sites were hayed in late July or early August.

Stream running through a mountain meadow.

Site 3 returned the highest amount of nearly all constituents measured, Site 1 was intermediate in export, and Site 2 ranked lowest in export. Dissolved oxygen concentrations in return flows from all three sites declined over the irrigation season, but river samples were never below the standard, demonstrating re-aeration. Total suspended solids declined quickly and remained at approximately 10 mg L^{-1} throughout the second half of each season, with river samples having the highest levels, inflows having intermediate levels, and return flows having the lowest levels. All three sites were sediment sinks due to the vegetative filtering capacity of mountain meadows. Conversely, total dissolved solids trended upward from very low levels early in the season to maximum levels of approximately 300 mg L^{-1} late in the season. All three sites were sinks for nitrogen because of plant uptake throughout the growing season. The potential for impacts to surface water quality appears to be greatest from fecal coliform and phosphorus additions. A seasonal effect was detected for fecal coliform, with more movement from meadows in the initial flush of irrigation compared to the rest of the season (273 versus 11 cfu 100 mL^{-1} water). At fertilized sites (1 and 3), reactive phosphorus dominated as 70 percent of total phosphorus in runoff, while only 30 percent in return flows at the unfertilized site (2) was as reactive phosphorus. The small amount of reactive phosphorus in return flows from Site 2 was due to the absence of fertilization, creating conditions for a phosphorus sink. Comparing data from this study to data collected 20 years previously revealed phosphorus has increased from 0.004 to 0.061 mg L^{-1} in surface water runoff.

Use of appropriate best management practices can reduce effects of nonpoint source pollution, and this study determined a need for practices focused on phosphorus and fecal coliform abatement. Specifically, annual soil testing, proper timing and application rates of fertilizer, and appropriate grazing management to keep livestock away from return flow waters during irrigation are recommended.

Fertilizer Runoff Study

Based on results from the monitoring study that pointed to a need to reduce phosphorus runoff, a controlled plot study was conducted to investigate the effects of fertilizer application timing on overland flow water quality (White, 2003). Prior research in mountain meadows has focused on fertilizer use for increased hay yields with little regard for the environmental implications of this practice. Monoammonium phosphate (MAP) fertilizer (11-52-0, N-P-K)

was applied at the rate of 40 kg phosphorus (P) and 19 kg nitrogen (N) ha^{-1} to an irrigated mountain meadow near Gunnison, Colorado in the fall (Oct. 26), early spring (Mar. 20), or late spring (Apr. 23). Overland flow water was applied to each plot for one (1) hour in late April with grab samples of runoff taken for determination of both N and P concentrations.

Application of MAP fertilizer in the fall significantly reduced concentrations of reactive P and ammonium N in irrigation overland flow compared with early or late spring fertilization (Fig. 1). Reactive P loading was nine to almost 16 times greater when fertilizer was applied in the early or late spring, respectively, compared with in the fall. Ammonium N followed a similar trend with early spring loading more than 18 times greater and late spring loading more than 34 times greater than loads from fall-fertilized plots. Losses of 45 percent of the applied P and more than 17 percent of the N were measured in runoff when fertilizer was applied in the late spring.

Previous studies have documented yield advantages for mountain meadow hay production when fertilizers are applied in the fall. Coupled with results from this study, mountain meadow hay producers should apply fertilizer in the fall, especially P-based fertilizers, to improve hay yields, avoid economic losses from loss of applied fertilizers, and reduce the potential for impacts to surface water quality.

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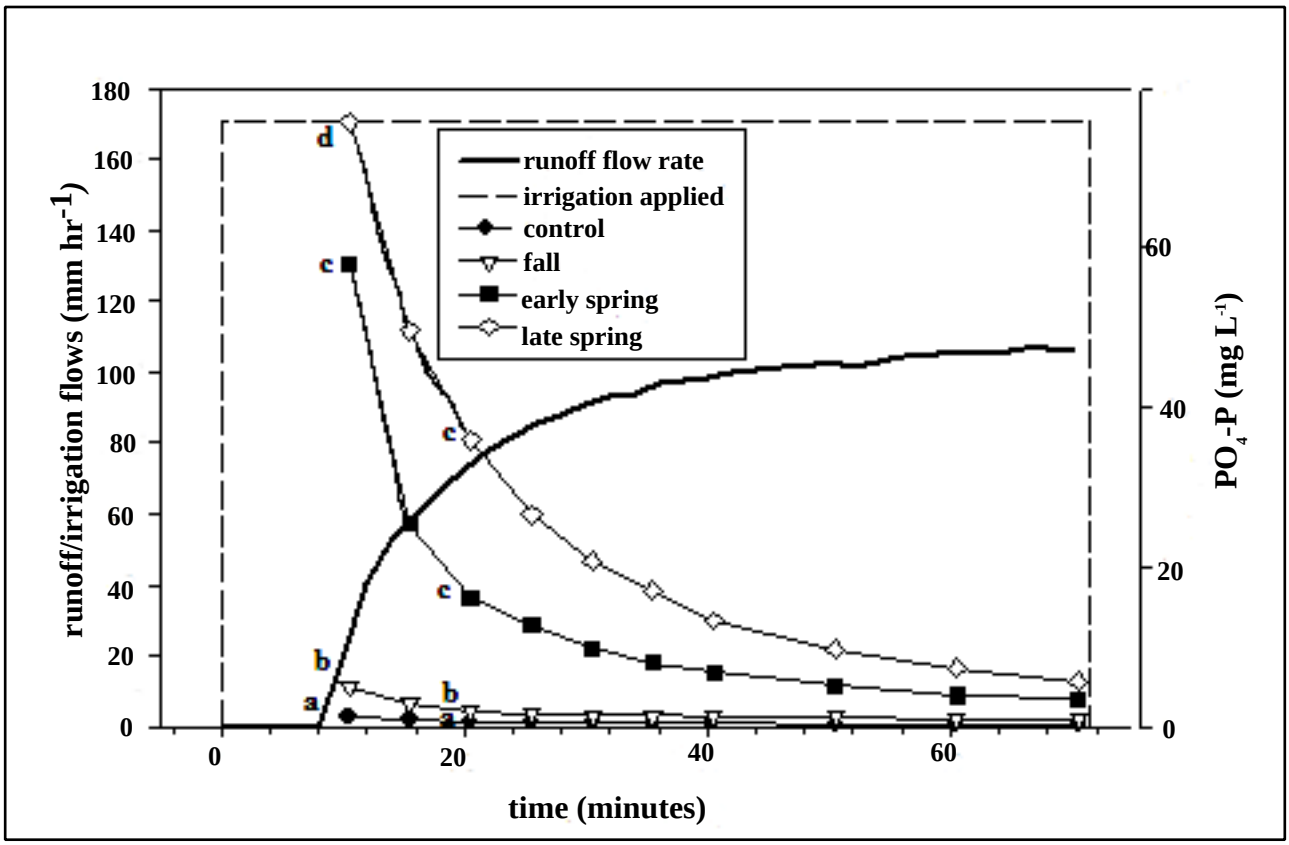

Fig. 1. Runoff hydrograph and reactive phosphorus concentrations in overland flow over the irrigation event as affected by time of application of monoammonium phosphate (11-52-0) fertilizer to a mountain meadow near Gunnison, Colorado. At a given time, means followed by the same letter are not significantly different according to Bonferonni's adjusted probability level of 0.0008 (0.05/60). Mean separations were based on log-transformed data with changes in statistical difference noted by a change in letters.

Colorado State University Cooperative Extension

GRAPPLING WITH SELENIUM IN WESTERN COLORADO

by Jim Loftis
Professor, Civil Engineering
Colorado State University

Colorado State University (CSU) has long been involved in research and extension education on irrigation and water quality issues in Western Colorado. These activities date back at least to the Colorado River Basin Salinity Control Program of the '70s and '80s. CSU remains committed to provide integrated research, extension and education services in the region, currently focusing more on selenium than on salt alone.

Selenium is an important micronutrient found in many vitamin supplements for humans. However, at concentrations above safe levels, selenium is extremely toxic to fish and wildlife. Elevated selenium in streams and rivers has been recognized as an environmental problem in the Upper Colorado and in the Lower Gunnison Basins, of particular concern to endangered fish species. Soluble salts and selenium are derived from the Mancos Shale soils (Figure 1) that predominate the region and are quickly mobilized when excess water is introduced in this naturally arid environment. Massive amounts of irrigation water have been made available by transmountain diversion from the Upper Gunnison River below Blue Mesa Reservoir (Figure 2). In response to elevated selenium concentrations in the Colorado and Gunnison River Basins, the Colorado Water Quality Control Commission adopted numeric standards in 1997. These regulatory actions led to the establishment of the Gunnison Basin Task Selenium Force in 1998 and the Grand Valley Selenium Task Force four years later. The recent expansion of the list of impaired segments and some of the tributaries of the Uncompahgre, Gunnison and the Colorado River network has elevated the selenium issue into regional importance. This has set into motion a new round of debates about the pros and cons of regulatory mandates and has added urgency to the search for effective ways to deal with the pollutant. Logically the local selenium Task Forces must play a central role in providing a forum for productive debate and search for solutions. Fortunately, they have been instrumental in organizing local efforts to characterize and monitor selenium effects, identify strategies for the adoption of remediation options, and develop and deliver educational programs.

Figure 1. Salt derived from Mancos Shale deposits is highly visible near Montrose, Colorado.

Colorado State University researchers and Cooperative Extension specialists play a key role in the selenium Task Forces by providing focused research, technical information, and public outreach. Currently funding support for these activities is provided by USDA under the Integrated Research and Extension Grants program and from the Colorado NonPoint Task Force under the 319 Grants Program.

Research

Colorado State University researchers, Jim Loftis and Luis Garcia in Civil Engineering and Eric Schuck in Agriculture and Resource Economics, are actively involved in selenium-related research along with graduate students Blair Hanna and Michael Gossenauer. These researchers are developing modeling approaches to predict the basin-scale water quality, water quantity, and economic impacts of proposed selenium remediation strategies. A basin-scale modeling approach is critical since changes in water use in one part of the basin may have impacts on both quality and quantity at multiple points downstream. They are also developing monitoring and statistical approaches that can best evaluate the impacts of management efforts to reduce selenium loads and improve stream standards compliance. Their research efforts have concentrated on the Uncompahgre Valley near Montrose and have been enhanced with field data collection by the U.S. Geological Survey and by students and teachers from Montrose High School. Through outreach and education the project will provide vital information to agencies, planners, and the stakeholders on the effectiveness of remediation alternatives.

Extension and Outreach

In support of the Selenium Task Forces, Cooperative Extension seeks to develop and implement educational programs for the adoption of irrigation management and water conservation practices. Aung Hla, Extension Irrigation Specialist located in Montrose, is leading these efforts. An important goal is to prevent the creation of new selenium sources associated with conversion of "undeveloped" and "agricultural" lands, to "residential", "hobby farms", "ranchettes", "golf course" and "commercial" properties. New selenium sources can be many times more severe than older sources from existing irrigated farms since selenium leaching rates tend to start very high and decay over time to lower steady-state conditions.

While trying to put a lid on new selenium "hot spots", Aung is also busy developing a set of Best Management Practices for irrigation and water conservation, helping the Selenium Task Forces organize field demonstration and public education programming, and building both technical and institutional relationships with the many players involved in the selenium issue.

A relative newcomer to Colorado, Aung joined CSU Cooperative Extension in 2003 from a very similar position in North Dakota. In a few short months, he has already become an effective technical resource and advocate for irrigation water management in western Colorado. Given the fast pace of political developments and the often intense competing pressures for economic development and environmental protection in this region, Aung is certain to have his hands full. (For an introduction to Aung K. Hla see page 31.)

American Water Resources Association
2nd National
Water Resources Policy Dialogue
Loews Ventana Canyon Resourt
Tucson, AZ
February 14-15, 2005

Convened by AWRA and sponsored by eleven Federal water agencies including NRCS, ARS, Forest Service, Bureau of Reclamation, USFWS, National Weather Service, National Ocean Service, EPA, FEMA, and the Corps of Engineers**.**

More informaion at:
http://www.awra.org/meetings/Tucson2005/index.html

AMERICAN WATER RESOURCES ASSOCIATION COLORADO SECTION

2003-2004 Scholarship Recipients

The 2003-2004 Academic Year recipients of the AWRA Colorado Section Rich Herbert Memorial Scholarship were selected from an outstanding field of applicants. Presentations will be made by these students at the May Program of the Colorado Section of AWRA. A brief description of the three recipients follows, in alphabetical order:

Brian J. Kappen is a MS student in the Department of Geosciences at Colorado State University. His advisor is Dr. William E. Sanford and the topic of his research is Determination of ground and surface water interaction in ephemeral wetlands through chemical and isotopic characterization. Brian's work will involve extensive data collection and analysis to define water balances between ground and surface waters at two very different wetland complexes in the San Luis Valley.

Tara L. Kelley is an MA student in the Department of Geography and Environmental Studies at the University of Colorado at Colorado Springs and an employee of Colorado Springs Utilities. Her advisor is Dr. John Harner and the topic of her research is Feasibility of implementing a residential reuse program in Colorado Springs. Tara's work will explore the many facets involved in establishing the feasibility of using reclaimed water for residential irrigation in Colorado Springs.

Tristan P. Wellman is a Ph.D. student in the Department of Geology and Geological Engineering at the Colorado School of Mines. His advisor is Dr. Eileen Poeter and the topic of his research is Improving water management of complex fractured aquifer watersheds using low cost field data. Tristan's work will involve extensive field and laboratory data collection and sophisticated computer modeling that hopefully will lead to the identification of low cost field indicators of fracture architecture so that simple equivalent continuum simulation models can be employed.

FEATURE

COLLABORATIVE APPROACH TO SELENIUM ISSUES IN WESTERN COLORADO

by Mike Baker
Team Leader, U.S. Bureau of Reclamation

The word "selenium" continues to cause the blood pressure to rise for many people in western Colorado, despite some successes of collaborative programs to address the issue. This article discusses the history of the issue and how it is being dealt with in the Colorado and Gunnison River basins of western Colorado.

Selenium, an essential trace element occurring naturally in the environment, is found in rocks, soils, water, and living organisms. In the western United States, it is most common in marine sedimentary rocks like the Mancos shale formation in western Colorado and the Pierre shale in eastern Colorado. Selenium is highly soluble, mobile, and biologically available in arid regions having alkaline soils, typical of western Colorado's irrigated valleys. It is a beneficial (indeed essential) nutrient for animals and other living organisms. However, selenium deficiency (too little) as well as toxicity (too much) can cause adverse effects in fish and wildlife.

Origin of the selenium issue

Kesterson! To the selenium crowd, this was the origin of the issue in the West. Despite selenium playing a very recognizable role in the poisoning of livestock, up until 1983 it was not well known except to some ranchers and veterinarians. This changed when irrigation drain water from Bureau of Reclamation projects in California's San Joaquin Valley was dumped into terminal reservoirs which became the Kesterson National Wildlife Refuge. The original idea was to transport this waste water to the San Francisco Bay, but the drain system was never completed due to environmental and cost issues. Scientists initially looked at the quality of this water which was high in salinity and declared it safe for wildlife. However, they did not analyze for selenium. After just a few years of depositing the water into the Refuge, problems were discovered. U.S. Fish and Wildlife Service (FWS) personnel found many unhatched bird eggs and deformed young birds. The cause was determined to be high selenium concentrations in the birds and their eggs. Selenium had been leached by irrigation water from selenium-bearing shales within the agricultural areas, carried to the ponds, and concentrated by evaporation. Public interest was heightened by newspaper headlines and a story carried on CBS's *60 Minutes* news program. Citizens wondered whether similar problems were occurring elsewhere in the West.

National response to the issue

Because these problems were caused by a Federally constructed irrigation project, the Department of the Interior directed the U.S. Geological Survey (USGS), FWS, Bureau of Indian Affairs, and Bureau of Reclamation to determine if there were other potential irrigation-drainage related problems at Federal projects in the West. This effort became known as the National Irrigation Water Quality Program or NIWQP.

Figure 1. Mancos shale with salt crystals on top

Under the NIWQP, data were examined from approximately 600 areas in the 17 western states involving either Federal irrigation projects or wildlife refuges. Through a phased process, areas of concern were identified and additional data were collected. The studies analyzed water samples as well as sediment, fish, bird eggs and embryos, and food-chain items. The analysis included an extensive list of contaminants including trace elements (selenium, lead, arsenic, mercury, etc.) and pesticides. Eventually, this process identified five areas in the western states that were in need of remediation to reduce potential impacts to species protected under the Endangered Species Act (ESA) or the Migratory Bird Treaty Act. The primary concern in western Colorado was that selenium was impacting and damaging waterfowl and endangered fish. Approximately 60 percent of the selenium entering Lake Powell originates in this area.

EPA was also reviewing the many studies recently performed throughout the country that examined selenium impacts. As a result of that review, the criteria for protection of aquatic species was adjusted downward to a present level of 4.6 parts per billion for all waters of the United States. States were required to adopt these criteria into their water-quality standards.

Response to the issue in Western Colorado

NIWQP studies began in western Colorado in 1987, and in 1994, a decision was made by the Department of the Interior

that remediation was needed for Federal projects in the Grand Valley and for the Uncompahgre Project area of the Gunnison River basin. Planning efforts were begun in 1995, but the prevalence of selenium in almost all irrigation drainage and many ponds in these areas made addressing the problem very difficult. Eventually, priorities were identified and an approach developed by the local NIWQP Core Team. The approach focused the limited resources of the program on backwater and bottomland habitat of the endangered fish in the Grand Valley and also on reducing concentrations in the mainstem Gunnison River. Addressing the lower Gunnison segment primarily involves reducing loads from the Uncompahgre Project area. These are some of the most important habitat areas for recovery efforts aimed at reviving populations of razorback sucker and Colorado pikeminnow. Some studies of the razorback sucker strongly suggest severe impacts are occurring in these areas due to selenium.

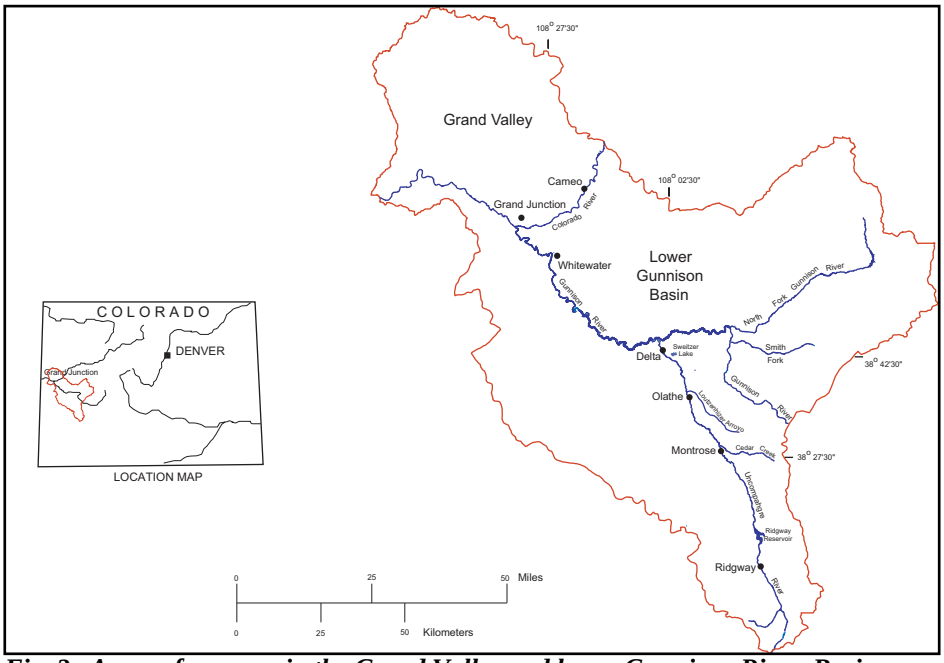

Fig. 2. Areas of concern in the Grand Valley and lower Gunnison River Basin

In the Grand Valley, the NIWQP conducted a process to identify the best measures for reducing selenium concentrations in the backwater and bottomland sites. The most logical and cost effective measures have turned out to involve the diversion of contaminated waters and/or dilution with cleaner river water. To date, two wildlife areas have been remediated. Planning was underway for two other sites when funding for the NIWQP was sharply reduced in 2003. Funding for this program is not anticipated in future years.

In the Gunnison Basin, reducing loading from the irrigated areas became the focus of the NIWQP. From the ongoing salinity control efforts in the Grand Valley, experience had shown that the lining or piping of irrigation canals and laterals had a significant salinity reduction effect. However, it was unknown how this type of project would affect selenium. With this in mind, the Uncompahgre Valley Water Users Association, Colorado River Basin Salinity Control Program and NIWQP undertook a demonstration project in an area southeast of Montrose known as the Montrose Arroyo basin. Beginning in 1998, the project replaced unlined ditches with 7.5 miles of buried PVC pipe. Results exceeded expectations as a reduction of 27 percent in this small area's selenium load was observed. Landowners were also pleased with the new systems, thus confirming piping as one of the most desirable techniques for selenium control. Other measures aimed at reducing deep percolation from on-farm irrigation activities were also viewed as advantageous.

Figure 3. Selenium deformity in razorback sucker larvae on left; normal one on the right

During this same time period, the Colorado Water Quality Control Commission (WQCC) adopted new water-quality standards for streams in the Gunnison basin. Because of elevated selenium concentrations, several stream segments including the lower Gunnison River and lower Uncompahgre River were placed on a list of impaired waters (a.k.a., the 303d list). With this listing, came the requirement for determination of a Total Maximum Daily Load (TMDL). The WQCC believed this work should be done in conjunction with a local stakeholders group, and with that concept in mind, the State initiated discussions with local water interests which eventually led to the formation of the Gunnison River Basin Selenium Task Force (GRBSTF) in early 1998.

The GRBSTF is a voluntary coalition of Federal, State, city and county agencies, irrigation interests, conservation groups, educational institutions and interested individuals. GRBSTF's mission states that the group is "committed to finding ways to reduce selenium within the affected reaches while maintaining the economic viability and lifestyle of the Lower Gunnison River Basin." Operating from a pro-active position, the GRBSTF utilizes a consensus decision-making process in which all members have to be able to "live with" the decision. Additionally, the group agreed they would focus on solutions and let the State take the lead on preparation of the TMDL with consideration of local viewpoints.

The GRBSTF and the NIWQP joined efforts to identify and implement a program aimed at meeting water-quality standards in the lower Gunnison and Uncompahgre Rivers, which would also have positive impacts for endangered fish. With input from local citizens, over 200 ideas were identified and examined. This led to the group pursuing funding for a number of projects which included several applications to the State's Non-Point Source program for EPA Section 319 funding. Thus far, the GRBSTF, private individuals, NIWQP and the Bureau of Reclamation have been involved and helped fund many efforts including the following demonstration projects, all aimed at reducing selenium loading to local streams:

- Polyacrylamide (a.k.a. PAM) which is sprayed into irrigation ditches to reduce seepage
- Phyto-remediation which involves planting crops to remove selenium from the soils
- Pond lining to reduce seepage
- Hydrogel which is applied in furrows to reduce water use and deep percolation
- Center-pivot sprinklers which reduce water use and deep percolation

The GRBSTF has also secured funding for:

- a part-time coordinator,
- characterization studies to collect data on selenium sources,
- a study of how land use changes might affect selenium loading, and
- development of Best Management Practices for non-agricultural selenium sources.

In addition, the group receives significant technical assistance from individuals and agencies including the Natural Resources Conservation Service, USGS, and the Bureau of Reclamation. Efforts are continuing to obtain technical and financial resources to implement the group's remediation plans.

In the Grand Valley, another selenium task force was formed in 2002 in response to the 303d listing of tributaries to the Colorado River. These previously ephemeral "tribs" primarily carry irrigation return flows but have also become habitat for many native and non-native species. The Grand Valley group has primarily focused on determining if there are reasonable methods for meeting selenium standards on these tribs. Recently, the group was successful in funding a part-time coordinator and obtaining grant funding for further characterization of selenium sources.

In April 2004, additional segments including the mainstem Colorado River and many tributaries in the lower Gunnison Basin were added to the 303d list, compounding the number of issues to be addressed by both task forces.

Successes

Collaboration and a willingness to look for reasonable solutions have been keys to progress on the selenium issue in western Colorado. The joining of Federal, state and local government agencies, the irrigation community, conservation groups, educational institutions and interested citizens has made for strong organizations which garner respect and funding from various sources. This strength has been instrumental in some of the major activities that are reducing selenium loading and concentrations. One example is an outgrowth of the Montrose Arroyo Demonstration Project. Gunnison Basin interests observed the results and success of this project and rallied around it. Environmental interests, irrigators, and local governmental agencies continue to lobby for Congressional funding, and they have been very successful, garnering $1.5 million over the last 2 years to continue piping irrigation laterals in the Uncompahgre Valley.

The two task forces jointly have received more than $1 million in Section 319 funding from the state of Colorado for demonstration projects and studies. Both groups are now moving to have the public more involved in solutions and more in tune with the concept of wise water use. Essentially, all the selenium reduction strategies focus around improving the efficiency of water use.

Figure 4. Piping irrigation laterals

Future challenges

One of the biggest challenges for these groups is continuing the collaborative process and maintaining interest without the imminent threat of a "regulatory hammer." At this point in time, no government entity is requiring action on these non-point source selenium problems. Efforts to date are the result of a lot of interested parties being proactive. Part of the reason for this is that many water efficiency improvements are beneficial in other ways, such as in reduced operational costs and in reducing water shortages for thirsty crops during the current drought. Additionally, many feel they can lessen concerns about future regulation of non-point sources of pollution and ESA conflicts by taking action now.

Addressing selenium issues in the tributaries is another challenge. Since most of the water in these "tribs" is from irriga-

tion returns, it is proving very difficult to identify reasonable solutions, but efforts are continuing and all ideas are welcome.

Funding for technical assistance and projects is becoming increasing difficult to obtain from governmental sources. State & Federal budget cuts are reducing the resources previously available to the task forces while competition for grant funding is increasing.

Finally, implementation of many measures will require water education and information programs. The local task forces are considering new efforts to address the problem from a wise-water use perspective, and this may well be a major part of their future direction.

WATER SUPPLY

The Surface Water Supply Index (SWSI) developed by the State Engineer's Office and the USDA Natural Resources Conservation Service is used as an indicator of mountain-based water supply conditions in the major river basins of the state. It is based on streamflow, reservoir storage, and precipitation for the winter period (November through April). During the winter period, snowpack is the primary component in all basins except the South Platte basin, where reservoir storage is given the most weight. The following SWSI values were computed for each of the seven major basins for May 1, 2004, and reflect the conditions during the month of April

The SWSI values rose in all basins compared to last month's values, a response to widespread above normal April precipitation. Snowpack, measured as a percent of average, increased during April in all basins except the Colorado and Yampa/White. In spite of that increase, the statewide May 1 snowpack is still on 68% of normal, and is below normal in all basins except the Rio Grande (which is 102% of normal). The low elevation snowpack is already gone in the Colorado and Yampa/White basins. In other areas of the state the April weather helped delay the spring snowmelt runoff. The runoff period is still expected to be earlier than normal statewide, and the spring through summer runoff forecasts are for flow below normal volumes of water.

Basin	5/1/04 SWSI Value	Change From Previous Month	Change From Previous Year
South Platte	+0.5	+2.2	+1.1
Arkansas	-2.1	+1.2	-0.3
Rio Grande	+0.8	+1.7	+4.0
Gunnison	+0.5	+2.1	+2.2
Colorado	-2.1	+0.5	-2.5
Yampa/White	-3.1	+0.2	-1.8
San Juan/Dolores	+0.8	+1.3	+3.8

SCALE								
-4	-3	-2	-1	0	+1	+2	+3	+4
Severe Drought		Moderate Drought		Near Normal Supply		Above Normal Supply		Abundant Supply

NATIONAL SMALL FLOWS CLEARINGHOUSE SILVER ANNIVERSARY YEAR

In celebration of the National Small Flows Clearinghouse (NSFC) Silver Anniversary, Nikki Stiles (writer and special events coordinator at NSFC) is asking for quotes from long-time customers to include in the publications *Pipeline* and *Small Flows Quarterly*. Specifically, she wants to know what kind of impact you feel the clearinghouse has had on small communities and the small wastewater industry over the years. Please send your perception of the value of the NSFC along with your name, title, and where you are from to Nikki Stiles by email: atnstiles@mail.nesc.wvu.edu.

Colorado State University Cooperative Extension

COORDINATED AGRICULTURAL WATER QUALITY PROGRAMMING FOR THE NORTHERN PLAINS AND MOUNTAINS REGION

by Lloyd Walker
Civil Engineering
Colorado State Univeristy

The Coordinated Agricultural Water Quality Programming for the Northern Plains and Mountains Region project is a collaborative effort among the 1862 Land Grant Universities of the six states comprising EPA Region VIII - Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming. The long-term goal of this regional collaboration is to protect and improve water resources by facilitating development, delivery and implementation of new and existing practices throughout the Region. To accomplish this goal, the project addresses two key areas: 1) Coordination/facilitation among the six state partners and 2) Implementation of issues-based regional water quality projects to address key stakeholder needs. Objectives under each key area are designed to increase the integration of water quality research, education and extension. The project creates a structure for regional and national coordination and leveraging of resources to reduce program development costs, and makes research, education and extension resources of the Land Grant University system more accessible at the local level. It supports collaboration with partner agencies with common goals, and optimizes delivery of educational programs to agricultural producers and agriculturally-impacted communities across the region.

Water quality and water quantity are high priority issues throughout EPA Region VIII. This large geographic area encompasses highly diverse eco-regions and land uses, from mountain alpine tundra and forests to prairie watersheds. The dominant water quality pollutants from agricultural activities in the Region include nutrients, salinity, pesticides, microbial pathogens, and sediment. Project personnel are currently conducting research and educational programs to address reduction of these pollutants and resulting impairments to both surface and ground water resources across the Region. Many of these same water quality problems are also coincident with rapid growth and development in the Region. As population growth continues, demand on finite water supplies and the risk of adverse impacts on the quality of those resources steadily increase. Additionally, severe drought has affected much of the Western U.S. during the last three years, further straining resources. Emerging water quality issues in the Region include sodic and saline discharge water from coalbed methane development, pharmaceuticals and antibiotics in animal waste effluents, selenium leaching from marine shale underlying irrigated lands, atmospheric deposition of contaminants in watersheds, and the need to document the impact of conservation management practices on water quality. The existence of common water issues serves as the basis for regional coordination to efficiently allocate and target personnel and funding resources for problem identification, education, management and resolution.

The USDA-CSREES Northern Plains and Mountains Region water quality project, initially funded in 2000, has fostered regional teamwork and new collaborations by regular teleconferences, frequent email exchange, semi-annual face-to-face meetings, collaborative programs of regional scope, and planning and presenting at the national annual meeting. Partnerships are in place at the campus level to engage additional faculty without traditional agriculture or extension appointments as resources for the regional programs. Expanded participation on state level water quality issue teams raises the profile of the regional project among those partners and optimizes the use of Land Grant University resources. Federal agencies, notably EPA, Forest Service, BLM, NRCS and USGS, have become more active partners as the scope of our program becomes known to them. Local stakeholders also have become aware of the regional program and have provided guidance on program direction as team members engage with K-12 educators, other youth educators, and watershed groups.

Leveraging available regional funding has added significantly to the scope of the program. Through grants or other contractual arrangements, the regional program is currently working with over 4 million leveraged dollars to address water quality issues. This leveraging reflects the effectiveness of the regional program from the perspective of those partners providing the leverage funds.

Successful regional collaborations include a regional website, developed and maintained by North Dakota State University (NDSU) to provide marketing, public information, communication, and to serve as an archive of materials developed by the project. A series of informational factsheets has been produced and mailed to 700 key opinion leaders, elected officials, and stakeholder groups within the Region. These factsheets cover water quality topics of concern in the Region. Coalbed methane (CBM) educational programs were presented in Colorado by regional partners in response to a local need due to the water quality issues associated with developing this resource. Regional team members participat-

ed in the planning and delivery of a second tri-state CBM conference in Montana in January 2004. An educational session on water management and salinity was developed and provided to practicing agronomists from throughout the U.S. by the regional partners at the 2003 annual meeting of the American Society of Agronomy. Regional participation in the Missouri River Basin Consortium (MRBC) continues to develop with our state coordinators well represented in the planning committee.

Other activities of the states and the regional partnership include:

- Participatory research with crop producers to test nutrient and pesticide BMPs
- Education about and monitoring of lake functions
- Annual producer meetings to gain input and participation in research projects
- Integrating water quality education into undergraduate and graduate teaching
- Training of K-12 teachers in the use of GIS and development of a GIS curriculum
- Research and education on coalbed methane development and related water quality issues
- Developing GIS mapping tools to assess aquifer sensitivity, land use and water quality, and impervious area development
- Research on remote sensing for improving nutrient and pesticide management
- Developing monitoring protocols and water quality standards at the request of state legislature, state environmental agencies, and other stakeholders
- Addressing water quality issues of small acreage managers
- Coordination and partnerships for water quality training with 1994 Institutions
- Education about pesticide and fertilizer BMPs
- Addressing critical drought issues including rangeland, livestock management, and managing smallholder and homeowner landscapes
- Delivery of a conference on international issues of water quality on the Red River
- Production of a variety of educational products (fact sheets, reports, videos, websites addressing water quality issues)
- Research on wetland plants for use in phytoremediation
- Research on the use of PAM to minimize soil erosion on lands affected by wildfires

***Ground water**: Water that flows or seeps downward and saturates soil or rock, supplying springs and wells. The upper level of the saturated zone is called the water table.*
Source: Bureau of Reclamation Glossary, http://www.usbr.gov/cdams/glossary.html .

The USDA-CSREES Northern Plains and Mountains Region water quality project has, in its first four years, established a successful and well functioning network that did not previously exist. State Extension and Experiment Station personnel working on water quality now have a regional contact and a framework established that ensures our representation and participation at all important agricultural water quality meetings, committees, and working groups in the Region. The continuation of the regional project will build on this groundwork to foster regional expertise in diverse areas of water quality without duplication or unnecessary overlap.

FORT COLLINS CHILDREN'S WATER FESTIVAL

On May 18th, approximately 1,400 third-grade students from area schools attended the 13th Annual Fort Collins Children's Water Festival. The event, co-sponsored by the Northern Colorado Water Conservancy District and Fort Collins Utilities, was held at Colorado State University's Lory Student Center. Volunteers presented a variety of educational exhibits and hands-on activities for a fun-filled day of stimulating water knowledge.

Tyrone Smith of the Louis Stokes Alliance for Minority Participation (CO-AMP) assisted Marian Flanagan of The Water Center in a classroom activities designed to introduce youth to different career opportunities in the water industry. The students dressed up in costumes and posed for snapshots. The CSU Water Center would like to express its sincere appreciation to Ty Smith for his help in presenting the "Careers in Water" program and for taking Polaroid pictures of the groups for souvenirs. Thank you, Ty for your participation again this year!

The 20th Colorado Water Workshop
at Western State College of Colorado, in Gunnison will be
July 28-30, 2004

Go to
http://www.western.edu/water/
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Colorado State University Cooperative Extension

PREVENTING GROUND WATER NPS POLLUTION FROM AGRICULTURAL CHEMICALS - A COOPERATIVE APPROACH

by Troy Bauder, Extension Specialist, Soil and Crop Sciences, Colorado State University
Rob Wawrzynski, Ag Chemicals and Groundwater Protection Coordinator,
Division of Plant Industry, Colorado Department of Agriculture
Brad Austin, Colorado Department of Agriculture
and Reagan Waskom, CWRRI Water Resources Specialist

Colorado's 4.5 billon dollar agriculture industry encompasses some 28,000 farms and ranches, covering almost 32 million of the state's 66 million acres. Approximately 3 million of these acres are irrigated and intensively farmed for row crops and forages, utilizing inputs of pesticides and commercial fertilizers to achieve high yields. Colorado's aquifers are vulnerable to impairment from these agricultural inputs depending upon hydrogeological properties, chemical properties, and recharge from irrigation. To mitigate this potential contamination, Colorado has chosen to use a combined effort of regulation, education, and groundwater monitoring. This effort was initiated in 1990, when the Colorado Legislature passed Senate Bill 90-126, the Agricultural Chemicals and Groundwater Protection Act. The Colorado Department of Agriculture (CDA), the lead agency, Colorado State University Cooperative Extension (CSUCE), and the Colorado Department of Public Health and Environment (CDPHE) are cooperating agencies in the implementation of this program (GW Program). The GW Program is funded by a tonnage tax on fertilizer sales and a product fee for pesticides registered in the state.

The GW Program uses three tools to prevent groundwater contamination:

1. Regulation - Rules and regulations for the storage and handling of bulk agricultural chemicals.
2. Education – Outreach, training and education to facilitate voluntary adoption of Best Management Practices (BMPs) appropriate to local conditions is a primary goal of the GW Program. This effort is targeted at both agricultural and urban users of fertilizers and pesticides.
3. Monitoring – The GW Program has established a statewide ground water monitoring network. This effort has been supported by several extensive aquifer vulnerability assessment analyses.

The GW Program seeks to prevent contamination from both point and non-point sources of agricultural chemicals. As such, the regulatory component of this program focuses on educating chemical users on the proper storage and handling of fertilizers and pesticides. Thresholds for bulk storage and handling of fertilizers and pesticides were established in 1994 (see http://www.ag.state.co.us/DPI/GroundWater/home.html for complete rules). Since 1997, facilities that exceed these minimum thresholds have been inspected by the CDA. To date, over 1,000 inspections at more than 200 facilities have been performed with a 90 percent compliance rate. Cooperation from the regulated industry has aided the success of this part of the GW Program.

The GW Program has compiled a broad set of research-based BMPs encompassing nutrient, pest, and water management. These BMPs were published in a notebook form and are updated as needed and expanded to include additional guidelines. Using this notebook as a template, local BMP committees have developed BMPs for the San Luis Valley, the Front Range area of the South Platte Basin, the West Slope, and the Lower South Platte River Basin. Building on these efforts, crop specific BMPs, Barley Management Practices for Colorado and Best Management Practices for Colorado Corn, were published in 1997 and 2003, respectively. To address NPS pollution concerns from urban users, the GW Program has published a series of fact sheets home and garden chemical use. In developing these BMPs, the GW Program utilized extensive input from crop and livestock producers, the agricultural industry, the Natural Resources Conservation Service, local Extension faculty, water districts, and others.

The GW Program has worked to achieve adoption of these BMPs through a variety of outreach methods. The BMPs and other outreach and training publications are distributed widely through local outlets and via the internet (http://www.colostate.edu/Depts/SoilCrop/extension/WQ/). Results from on-farm field demonstrations and applied research are also used to convince growers and other chemical users of the agronomic and economic feasibility of BMPs.

Measuring the success of these outreach efforts is valuable to determine the effectiveness of the GW Program's work and to prioritize resources on areas or topics where adoption is deficient. The GW Program has collected data on BMP adoption in two mailed surveys, one in 1997 and one

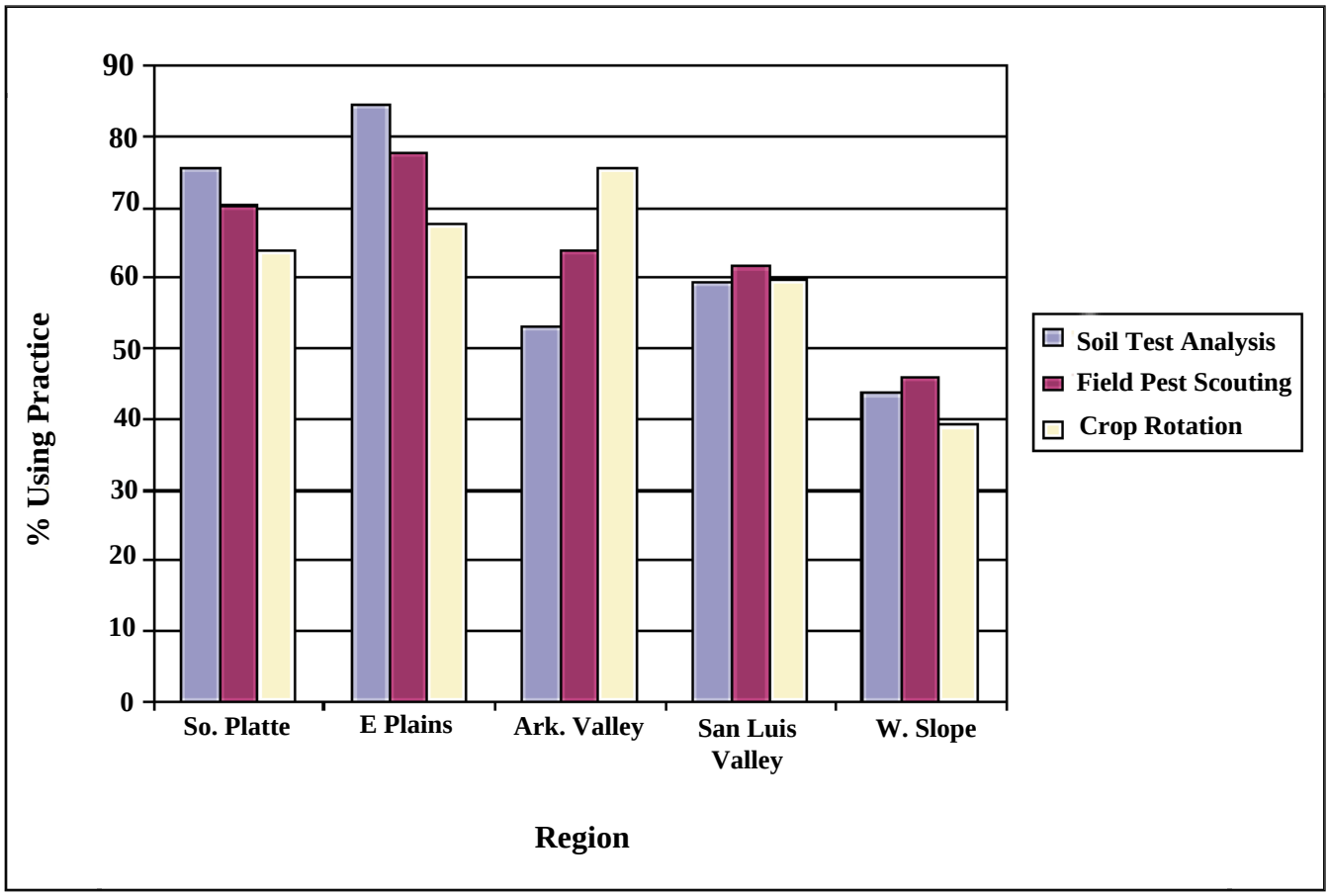

Fig. 1. Adoption rates of selected BMPs among fertilizer and pesticide users. Average from 1997 and 2001 surveys.

in 2002. The results from these surveys have shown that growers are using key BMPs (e.g. soil testing, pest scouting) at a reasonable level for their situation. Adoption rates are typically higher for many BMPs among growers using commercial fertilizer and a pesticide, indicating the GW Program is reaching its target audience. As expected, large differences in adoption rates exist among regions of the state and type of producers.

Groundwater systems in the major agricultural regions of Colorado have been surveyed by the GW Program (Figure 2). The GW Program's approach has been to sample every major agricultural region to assess contamination and then focus resources on watersheds or aquifers where impacts have been found. Aquifers with significant impairment from nitrate-nitrogen or pesticides are then sampled annually or on a rotational basis. From these efforts, over 4,600 samples have been analyzed from more than 935 domestic, irrigation, and monitoring wells. Collaboration with other agencies and organizations has been critical. Ground Water Management and Water Conservancy Districts, the State Engineer's Office, the U.S. Geological Survey, local Cooperative Extension Offices and others have assisted by facilitating access to monitoring wells, identifying landowners, and cooperative sampling.

Monitoring by the GW Program has revealed that the majority of wells sampled are not impaired by agricultural chemicals. Pesticides were not detected in roughly three-quarters of the wells sampled and less than one-half of one percent had detections of any pesticide above a defined drinking water standard. Pesticide detections varied widely by region. Nitrate-nitrogen is more common in Colorado groundwater, with impairment varying from no wells above the EPA's drinking water standard of 10 mg L^{-1} nitrate-nitrate in Jackson County to 34 percent of the wells sampled in the S. Platte aquifer.

To address impairment concerns in the Weld County portion of the S. Platte alluvial aquifer, the GW Program established an annual long-term monitoring network to establish trends in groundwater quality. Recent trend analyses have shown that while nitrate-nitrogen concentrations in an annually monitored irrigation well set are stable, triazine herbicide (atrazine, cyanazine, prometone) levels are declining.

Monitoring results are used for determining the existing ground water quality, verify aquifer vulnerability maps developed by the GW Program (Bauder et al., 2002; Ceplecha, 2001; Hall, 1998; Rupert, 2003), and to evaluate

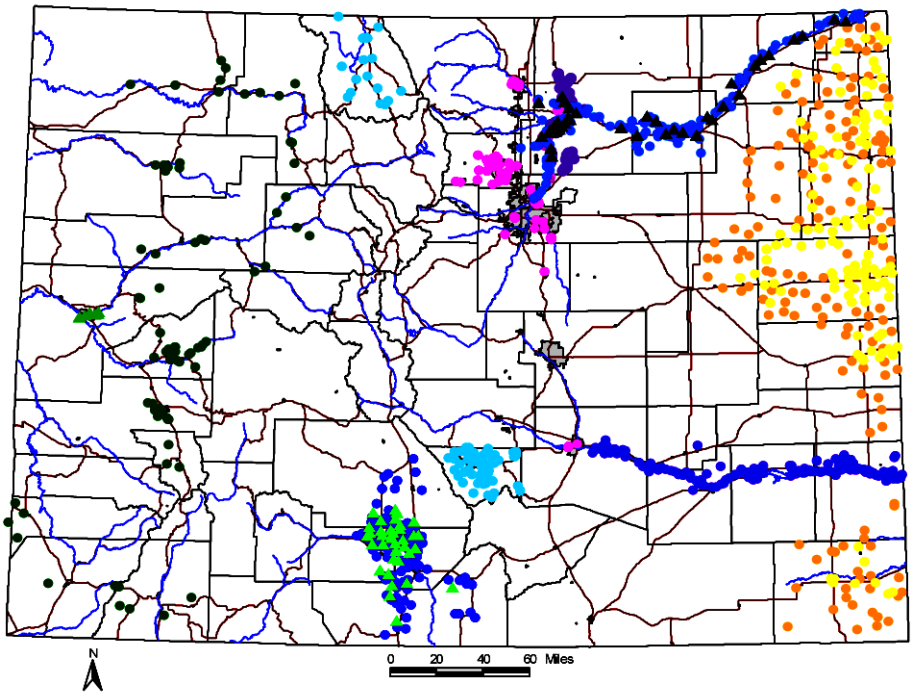

Figure 2. Monitoring locations of the Colorado GW Program, 1993-2003.
For color and higher resolution, see the PDF file on the web page at http://cwrri.colostate.edu.

where further research and education is needed. The GW Program agencies cooperate to inform the public and various stakeholders on the extent of ground water impacts and to obtain voluntary change in the use of agricultural chemicals in order to protect water resources. Monitoring information can be used by the CDA to trigger additional regulatory measures in the form of agricultural management areas if voluntary measures are ineffective.

The GW Program has been working with agricultural producers, the agricultural chemical industry and several state and federal agencies to prevent contamination of Colorado's groundwater resources from point and non-point source pollution for over a decade. This cooperation serves a good model for other programs working to protect Colorado's water for future generations. BMP adoption results and groundwater monitoring data indicate these efforts are working to protect groundwater quality in Colorado.

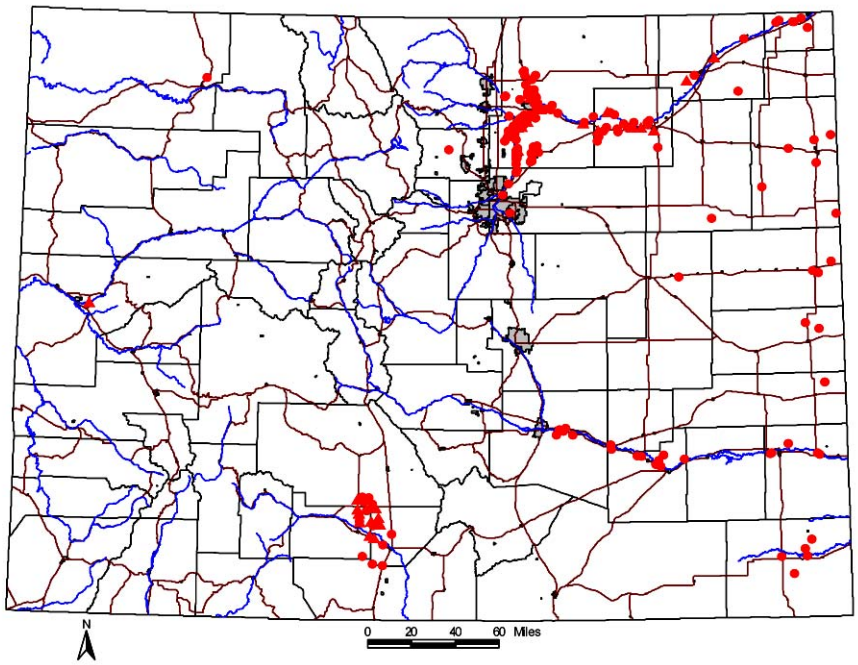

Figure 3. Location of wells with nitrate as nitrogen (NO_3-N) at a level of 10 mg/l or greater, sampled 1992 – 2003 For color and higher resolution, see the PDF file on the web page at http://cwrri.colostate.edu.

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Colorado State University Agricultural Experiment Station

MINIMIZING THE ENVIRONMENTAL IMPACT OF AGRICULTURAL ANTIBIOTIC USE AT THE WATERSHED SCALE

by Ken Carlson
Department of Civil Engineering
Colorado State University

Human and veterinary pharmaceutical compounds in the environment have received increased attention in recent years. These medicines are used for therapeutic treatment of infectious diseases in humans and for treating and protecting the health of animals. In addition, veterinary antibiotics are used to promote growth and feed efficiency in a range of animals. For example, Rumensin is a common feed additive for beef cattle that contains the antibiotic monensin. The tetracycline class of compounds is the most widely used animal antibiotic in this country although these drugs are also extensively used for treating human diseases. Currently, two of the ten approved antibiotic growth promoters are tetracyclines: chlortetracycline and oxytetracycline. Since only a fraction of these drugs are completely metabolized to inactive compounds in either human or animal applications, the ultimate fate of these compounds is an important environmental issue.

For the past two years, our research group has been collaborating with Dr. Jessica Davis in the Soil and Crop Science Department at CSU to study the occurrence, transport and fate of antibiotics in urban and agriculture-influenced environments. The objective of this research is to understand the extent of occurrence of these compounds in different areas of the Cache la Poudre watershed and then to determine the relative contributions from urban and agricultural sources. Additionally, we will attempt to identify best management practices at agricultural operations (e.g. waste handling) that will minimize the release of these compounds to the environment and contribute to sustainable agricultural practices in the future.

The presence of antibiotics in the aquatic environment has created two concerns. The immediate concern is the potential toxicity of these compounds to aquatic organisms and humans through drinking water. In addition, there is growing concern that release of antibiotics to the environment contributes to the emergence of strains of disease-causing bacteria that are resistant to even high doses of these drugs. Indications of increased bacterial resistance in waste effluent from hospitals and pharmaceutical plants have been reported raising

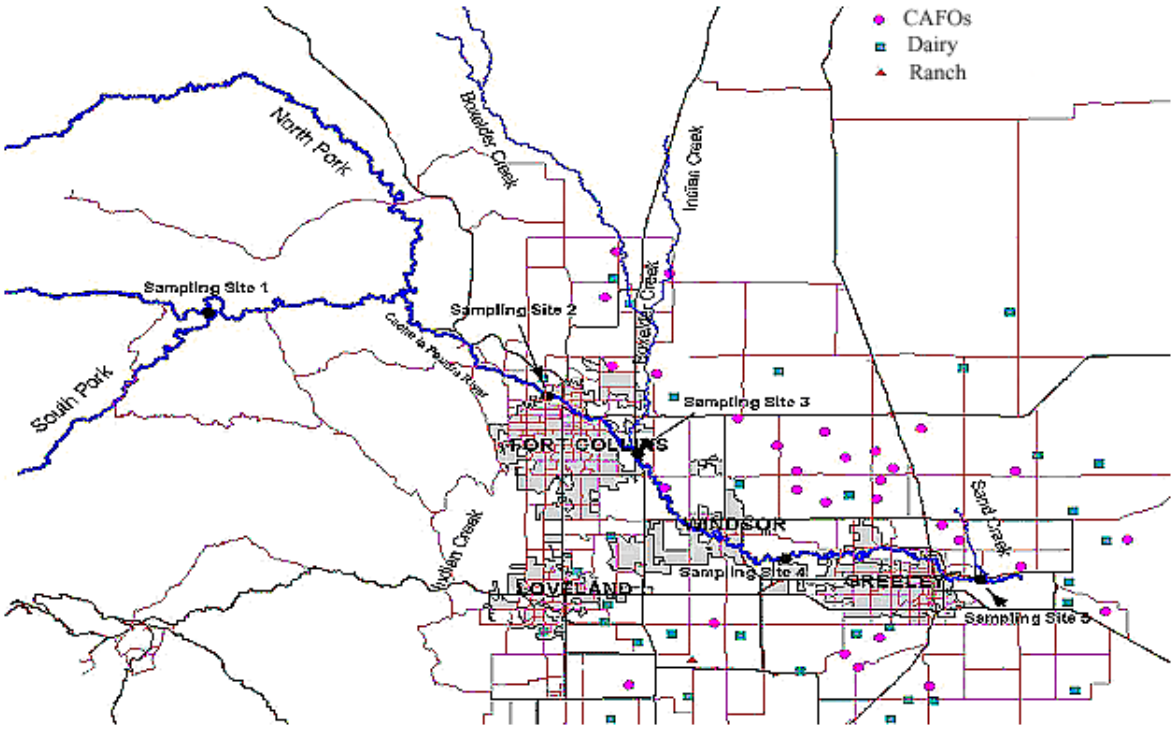


Figure 1. Sampling sites for water and sediment in the Cache la Poudre watershed.

potentially serious public health issues associated with the ultimate disposal of antibiotics.

The origin of antibiotic contamination in surface and ground waters is considered to be point and non-point source discharges of municipal and agricultural wastewater. Since few studies have been conducted on the occurrence, fate and transport of antibiotics in the environment, there are several questions that need to be answered on a regional and even watershed level. The most important question that needs to be addressed for a particular watershed relates to the occurrence and source (urban or agriculture) of these compounds. After these issues have been addressed and assuming that the goal is zero discharge of antibiotics to the environment, watershed stakeholders should identify approaches for minimizing release from both urban and agricultural sources.

A watershed-scale field study has been conducted on the Cache la Poudre (Poudre) River (Figure 1). The Poudre River originates near the continental divide in Rocky Mountain National Park flowing through steep mountainous terrain for approximately 43 miles before entering the Front Range city of Fort Collins. After traveling through Fort Collins, the river moves through approximately 45 miles of mostly agricultural landscape before it joins the South Platte River in Greeley, CO. Due partly to the semi-arid nature of the Front Range of Colorado, there are no significant tributaries to the Poudre River and therefore the inputs to the river are predominantly point sources in the urban landscape of Fort Collins and non-point sources in the agriculture areas outside of the City. These factors coupled with the source being snowmelt with minimal anthropogenic influences make this an ideal watershed to study the occurrence evolution of antibiotics through pristine, urban and agricultural landscapes.

Five tetracyclines (TCs) including tetracycline (TC), oxytetracycline (OTC), chlortetracycline (CTC), doxycycline (DXC), and democlocycline (DMC), and six sulfonamides including sulfathiazole (STZ), sulfamerazine (SMR), sulfamethazine (SMT), sulfachloropyridazine (SCP), sulfamethoxazole (SMX), and sulfadimethoxane (SDM) were analyzed and quantified. In addition, the concentrations of three ionophore antibiotics (monensin, salinomycin, naracin) were determined at each of the five sites. The ionophore antibiotics are of interest since they are used exclusively in agricultural applications.

The results of the occurrence survey are shown in Figures 2 through 4. Of the five sites along the Poudre River that were monitored, the only site at which no antibiotic was detected was the pristine site in the mountains before the river had encountered urban or agricultural landscapes. By the time the river had exited Fort Collins (Site 3), 6 of the 11 compounds that were monitored were found in the samples. At Site 5 in Greeley, CO where the river converges with the South Platte River, all five of the TCs monitored were present indicating both urban and agricultural influences. Although 3/6 SAs were detected in the river leaving Fort Collins, only 1/6 was found at Site 5. This result indicates that SAs were not originating from agricultural sources and that significant natural attenuation mechanisms were active in the river between sites 3 and 5.

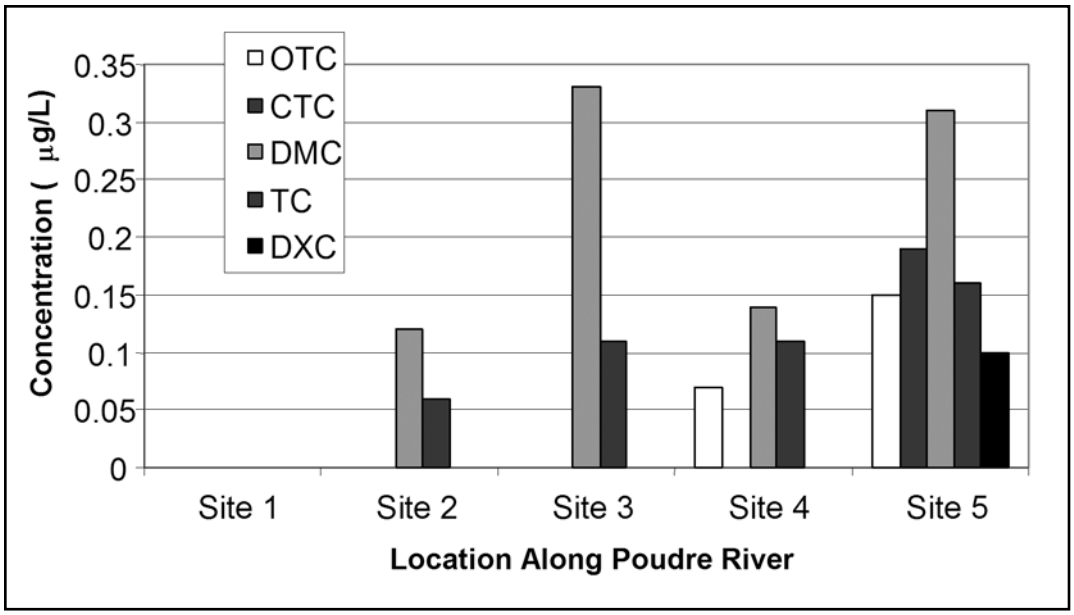


Figure 2. Occurence of tetracyclines in the Poudre River. (Site 1 is pristine, Site 2-3 are urban and Sites 4-5 are agricultural). Concentrations shown are the average of a minimum of three samples at each site.

The occurrence of ionophore antibiotics in the Cache la Poudre watershed is shown graphically in Figure 4. None of the antibiotics were observed at sample site 1 in either water or sediment verifying this part of the watershed as pristine. Monensin was only found at sample sites 4 and 5, the region of the watershed that is considered to agriculture-influenced. The highest detected concentration of monensin for water and sediment was

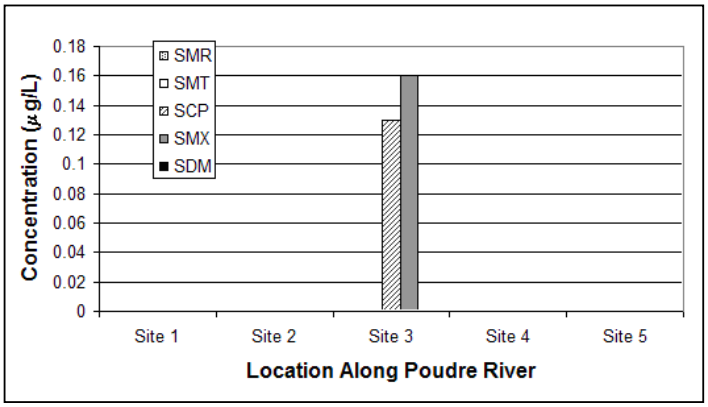
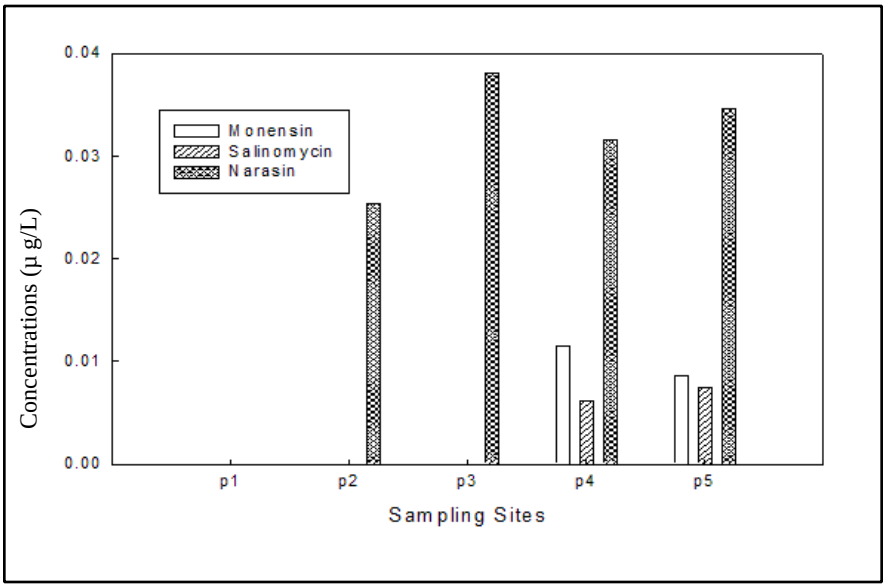
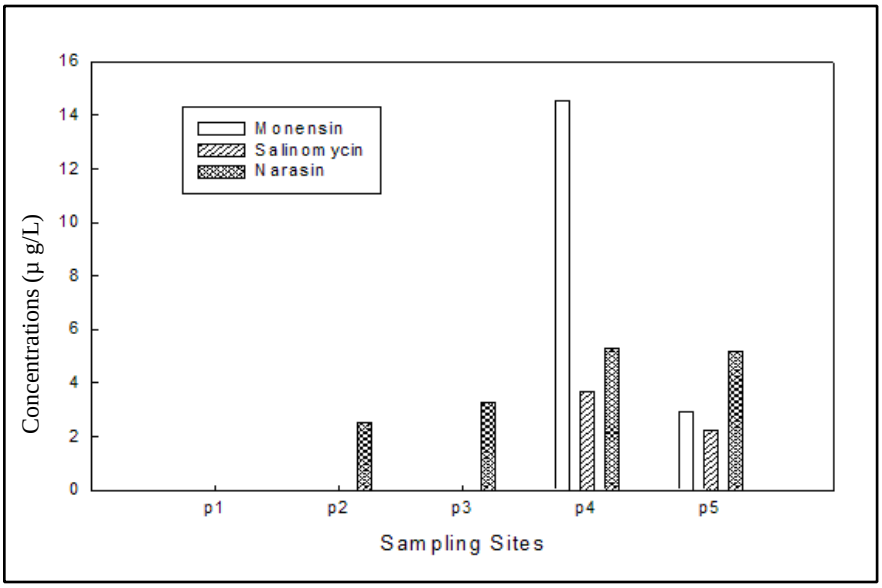


Figure 3. Occurrence of sulfonamides in the Poudre River (Site 1 is pristine, Site 2-3 are urban and Sites 4-5 are agricultural). Concentrations shown are the average of a minimum of three samples at each site



(a)



(b)

Figure 4. Occurance of ionophore antibiotics in (a) water and (b) sediment.

0.011 µg/L and 14.56 µg/kg at sampling site 4 respectively. Since this antibiotic is only used in animals and almost exclusively for growth promotion in cattle, it acts as a marker for contamination from agricultural sources. Therefore, it's not surprising that there is no monensin in the pristine and urban sampling sites (p1, p2, and p3). Monensin was detected at sample site 4, but the monensin concentration in the sediment decreased by about 80% at sample site 5. Since the aqueous concentrations are similar, a higher rate of natural attenuation (i.e. biodegradation, hydrolysis, or photo-degradation) must be present in the sediments at this location.

Another important finding of this study was the significantly greater concentration of the three ionophore antibiotics in the sediment compared to the overlying water matrix. For monensin, the concentration in the sediment is approximately three orders of magnitude greater than in the river at sample sites 4 and 5. Salinomycin was approximately 500 times greater in the sediment than the water column and narasin 100 times greater in sediment than water. These results indicate that antibiotics can significantly accumulate in the sediment potentially impacting the stream benthic biota. Therefore, when studying the occurrence of antibiotics in the environment, it is imperative to include the sediments in the analysis. To date, there has been little documented research of the occurrence of veterinary antibiotics in river sediments.

A significant number and concentration of human and animal antibiotics have been measured in the Poudre River in both urban and agriculture-influenced environments. The current phase of the study is focused on identifying and quantifying both urban and agricultural sources of antibiotics (e.g., wastewater treatment plants, animal waste lagoons, land application of wastewater and sludges). Future phases will study mechanisms for transport of these compounds from the farm to the stream and identify strategies for minimizing the release of these compounds to the environment.

FEATURE

ARS WATER MANAGEMENT UNIT DEVELOPS TECHNOLOGY TO REDUCE POLLUTION FROM IRRIGATED AGRICULTURE WHILE IMPROVING PROFITABILITY

By Dale Heerman
USDA ARS Water Management Research

A major problem being addressed by the ARS, nationally, is how to minimize adverse environmental impacts from crop production systems while producing a reliable and safe food supply. Agricultural crop production has been identified as a major nonpoint source of water quality degradation because of contamination from pesticides and nitrates in groundwater resulting from excessive application of water, chemicals, and fertilizers. The National priority to provide an adequate supply of safe drinking water requires efforts to reduce quality degradation by various major water users. Increasing competition for land and water resources and increasing pressure to curtail or more closely regulate agricultural operations because of environmental concerns are forcing producers to consider alternative crop production systems to remain sustainable. Irrigation is a critical component of American agriculture since about 40 percent of the nation's total crop value is produced on the 15 percent of the cropland that is irrigated. Precision agriculture is a management strategy that uses information technologies to bring data from multiple sources to bear on decisions associated with crop production. Small areas within a field are managed so only the needed amounts of fertilizer, chemicals, or water are applied in a timely manner rather than managing the entire field as a single unit, making uniform applications at the average or possibly maximum rate needed. Much of the commercial sector in Precision Farming (PF) is involved in developing equipment to collect large amounts of data, maps that visualize the data, and sophisticated equipment to variably apply crop production inputs.

The part of the major problem addressed by the Water Management Unit (WMU) in Fort Collins is development of integrated systems that can analyze these data to recommend scientifically based management strategies and deliver site-specific applications of water, fertilizers, and pesticides. Since more herbicide is applied than any other pesticide and nearly every acre of the major field crops is treated, the WMU is developing and evaluating sampling plans and bioeconomic weed management models. These tools will help growers determine whether weed control is economically justified and, if so, the most appropriate herbicide application for the weed population. PF includes the temporal management of inputs in addition to spatial management. Irrigation scheduling is a key tool integrated into the PF management systems.

Models and remote sensing technology for applying the right amount of water and fertilizer are being developed and evaluated. The WMU is adapting sprinkler irrigation systems to apply chemicals such as fertilizers and pesticides when and where needed during the growing season. Producers can use this information to make and implement better management decisions that reduce water quality degradation and conserve soil and water resources while optimizing crop production. A multidisciplinary approach is necessary to get a better understanding of how various nutrient, water, pest, and climatic factors affect yield variability. The project includes additional disciplines through close cooperation with the Colorado State Experiment Station and Cooperative Extension to broaden the scope and transfer the technology. The WMU goal is to increase the scientific understanding of many of the interactions within the crop production system, so the appropriate data are analyzed correctly to make improved management decisions.

Crook aerial photo

The WMU approach is to study two commercial fields rather intensively over more than five years. A combination of direct measurements and values calculated from calibrated models is used to quantify and map various parameters affecting yield. Two years of data without variable rate application technology (VRT) are used to establish a baseline scenario. Several years of data collected after implementing PF practices will provide the PF scenario. Comparison of these two scenarios will provide the basis for assessing the environmental impact and economic feasibility of PF. The WMU is working with industry partners to develop and evaluate economical alternative data collection procedures to characterize soil and crop status as well as variable rate application technologies for water, fertilizers, and pesticides that are economically feasible for producers to use.

How serious is the problem? Why does it matter?
Nearly half of the irrigated area in the Northern Plains is planted to corn and is typically fertilized with nitrogen. Most producers of high value crops, which are nearly all irrigated, apply herbicides to minimize the risk of reduced crop yield and quality. Herbicides are also viewed as inexpensive insurance against future weed problems, although the environmental impacts of this use, which are difficult to quantify, may not be considered. Precision farming is currently being promoted

by agribusiness as a way of improving management. Harvesters with global positioning systems (GPS) and yield monitors collect data to generate yield maps using geographical information system (GIS) technology. Intensive soil sampling and variable rate application of fertilizers are heavily promoted. If producers are to benefit from adopting PF, they must make significant capital investments in equipment and data collection activities as well as obtain the analytical expertise to translate the voluminous data into improved management decisions. Generally, the science of interpreting and integrating the various kinds of PF data is not well understood and the environmental benefits that have been promised have not been well documented. Producers are not certain whether this new technology is technically or economically practical. Although preliminary PF research indicates herbicide use may be reduced 30-60 percent without affecting crop yield or quality, the economic feasibility should be carefully evaluated before producers make large capital investments for this and other PF management strategies. Water quality degradation and increase in water demand requires new knowledge and improved systems for using our water resources more efficiently to sustain production of high quality food and fiber.

Recent Water Management Unit Research Highlights

Previous research found strong relationships between yield and soil electrical conductivity (EC), but the WMU needed to explore the practical utility of EC mapping to characterize the soil productivity factors for site-specific management. Whole-field EC data from three commercial center pivot fields in Colorado were collected for the 1998-2003 period and analyzed by the WMU using GIS and statistical packages. Two significant results applicable to non-saline agricultural fields were found: 1) soil electrical conductivity maps are highly stable over time and do not require annual mapping, and 2) soil electrical conductivity correlates strongly with texture (clay content), organic matter and soil water. Field EC mapping provides a sound method of subdividing the field into yield response and soil management zones for the purpose of implementing variable-rate application of nutrients and pesticides to reduce input costs and enhance the environment.

Spatial and temporal variability of soil N supply in conjunction with temporal variability of plant N demand makes conventional N management difficult for site specific N applications. The WMU sampled soil in historically low and high yielding areas within a commercial center-pivot irrigated corn field in northeastern Colorado to determine NO_3-N levels before and after the growing season to evaluate effectiveness of in-season N management based on remotely sensed crop N assessment. The in-season management applied significantly less N than typical producer uniform management and reduced the residual NO_3-N in the crop root zone by 117 lb/ac in the high yielding area and remained at similar levels for the low yielding area. In-season N application was reduced based on crop "need" while not reducing grain yield, and crop root zone soil NO_3-N levels were reduced which minimizes potential N leaching and degradation of the environment.

The NRCS must approve improvements in irrigation systems for cost sharing as part of their EQIP program to encourage the conservation of limited water resources. The National Water Management Engineer, NRCS in conjunction with the Water Management Unit convened a meeting with center pivot and sprinkler manufacturers to critique the new NRCS sprinkler standard which led to the development of a version of CPED (center pivot evaluation and design program) for evaluating the adequacy of design of center pivot systems that would be eligible for cost sharing. CPEDlite is being used by the NRCS and manufacturers developed programs that would take the output from their design programs and input to CPEDlite; saving a significant amount of time for the NRCS and their technical service providers in approving and evaluating proposed designs. Water conservation in NRCS targeted areas will be greatly enhanced by ensuring quality designs of systems that are cost shared with producers to save water and reduce pollution.

Quadspray

Many high value crops are treated multiple times with fungicides applied either by air or chemigation in order to maintain disease control. A comparison of the efficiency of AccuPulse™ versus chemigation for applying chlorothalonil (a widely used fungicide) on potatoes showed that there was tenfold more residue of chlorothalonil on foliage treated with AccuPulse™ compared to chemigation, and the concentration of fungicide remaining on the leaves seven days after application was greater on plants treated with AccuPulse™ than on leaves one day after treatment with chemigation. These results suggest that farmers could reduce the number of applications of fungicides utilizing AccuPulse™ and still maintain efficacy.

Plot studies are underway to determine whether yields in historically low yielding areas could be substantially increased by more intensive water and nitrogen management. Potato yields were increased by 10 percent in the sandier low yielding areas by applying about 15 percent additional water to relieve water stress between farmer managed irrigations. Potato yields were not decreased when the farmer practice of applying 90 lbs/ac of nitrogen preplant was omitted indicating a savings of $20.00 /ac in reduced fertilizer costs.

The implementation of variable rate soi-herbicide application depends on finding a means to economically determine soil variability in the field and soil electrical conductivity (EC) could be such a method. The relationship between soil EC and herbicide binding of three different soil-applied herbicides was determined in three different fields. WMU found that it is possible to divide the fields into herbicidebinding zones based on soil EC , and subsequent sampling of areas of these fields that had not been previous sampled showed that it is possible to predict herbicide binding with good accuracy. These results indicate that this relationship between soil EC maps and herbicide behaviors could be utilized to develop a practical method for creating variable rate herbicide maps.

Variable rate application with the AccuPulse™ chemical application system requires the control sequence for implementation of the technology. The Water Management Unit used an ArcMap GIS model to develop the command sequence for variable rate application for AccuPulse™ chemical application system. Maps that are created showing where the application rate should be changed based on management zones can be input to the model and the variable rate technology can be implemented with span by span control of the AccuPulse™ system installed on a center pivot irrigation system.

Veris EC

Long-term Research Highlights

Water quality is often degraded when nitrogen is used inefficiently by applying nitrogen (N) fertilizer to irrigated corn without adequate knowledge of soil N supply and crop N requirements. The Water Management Unit made weekly assessments of crop N status during vegetative growth in historically high and low yielding areas within a commercial field in northeastern Colorado to determine when to apply N. Applications of N based on remote sensing were 109 lb/ac less than the adjacent producer practice in the low yield area and 180 lb/ac less in the high yield area, with essentially the same yields. Significant reductions in N applications amounting to $30.50/ac in the low yield area and $50.40/ac in the high yield area at 2001 prices are an environmental benefit, but the economic benefit to the producer will be less due to the cost of obtaining the data for determining the time to apply the fertilizer on a commercial farm.

Improved water management could be enhanced with an accurate, quick and low cost method to map water holding capacity. The Water Management Unit collected soil electrical conductivity (EC) data from three center pivot irrigated fields in northeastern Colorado for 1998-2002 which were analyzed using geographic information systems (GIS) and statistical packages to identify EC patterns. The patterns in soil EC maps are highly stable over time and soil EC correlates strongly with texture (clay content), organic matter, and soil water in non-saline agricultural fields that can be used to estimate the water holding capacity. Thus EC mapping to identify water management zones with various water holding capacities, can be done infrequently, resulting in better maps and significant savings in data collection costs for producers to improve their water conservation and environmental stewardship.

The efficient application of chemicals is a challenge for farmers to maintain an economical production system while being good environmental stewards. The Water Management Unit with partner Valmont Industry and a technology transfer/energy conservation study for the Department of Energy and the Colorado Corn Growers Association, have conducted comparison studies and measured uniformity of a seven tower AccuPulse™ system with water sensitive cards, made comparisons with conventional ground and aerial applicators, and tracked the pesticide residue at several levels in the crop canopy. The results demonstrate the comparability of the AccuPulse™ technology for producers to apply chemicals during the season with reduced wind drift potential.

Examples of Future Studies

Evaluate cost-effectiveness of variable rate herbicide application based on EC zones and farmers' experience. Determine impact of variable rate herbicide application on ground and surface water contamination based on models and field measurements.

Evaluate the performance of AccuPulse™ for variable rate application of pesticides. Use field data with physically based simulation models to estimate the environmental benefits of PF.

Implement remotely sensed water and nitrogen management on a commercial center-pivot irrigated corn field using high resolution satellite data. Evaluate robustness and reliability of a real-time active optical sensing system mounted on a sprinkler system for acquiring data to manage water and nitrogen applications.

Evaluate water management practices including flow measurement and irrigation scheduling practices.
For more information about the ARS Water Management Unit research programs, please contact Dale Heermann, 970-492-7410; Dale.Heermann@ars.usda.gov or visit the WMU home page at www.wmuinfo.usda.gov .

USDA AGRICULTURAL RESEARCH SERVICE DEDICATES NEW BUILDING IN FORT COLLINS

Over 350 people gathered on a windy April 20, 2004, to dedicate a new USDA Agricultural Research Service building on the grounds of Colorado State University's (CSU) Natural Resources Research Center. The new facility is home to three ARS research laboratories: the Soil-Plant-Nutrient Research Unit, the Water Management Research Unit and the Great Plains Systems Research Unit. ARS is the chief scientific research agency of the U.S. Department of Agriculture.

"This building will allow ARS scientists to work in state-of-the-art laboratories on campus with their CSU collaborators," said ARS Acting Administrator Edward B. Knipling.

Some 120 ARS employees will work in the new 100,000-square-foot building. The employees previously worked in separate buildings throughout Fort Collins. In addition to the research staff, the new building houses employees of ARS' Northern Plains Area Office and the agency's new National Software Support Center.

The building is one of four constructed by the General Services Administration on the CSU campus for use by USDA and U.S. Department of Interior agencies that deal with natural resources issues.

ARS projects explore the benefits of a variety of practices from using quad spray irrigation devices to precision farming.

Scientists in ARS' Soil-Plant-Nutrient Research Unit study ways to improve efficient use of plant nutrients in irrigation systems. They investigate how agricultural management practices affect nutrient cycling and plant nutrient uptake by crops, and they study agricultural systems to improve soil, water and air quality and protect the environment by lowering greenhouse gas emissions. This Unit is led by Ron Follett.

At the Water Management Unit, scientists study precision agriculture -- the technique of farming specific areas of a field based on soil and water characteristics and weather. Farmers who use precision agriculture are likely to save money by the more timely and reduced application of both water and chemicals, resulting in improved water conservation, water quality protection and weed control. Dale Heermann is the Research Leader of the Water Management Unit.

Scientists in the Great Plains Systems Research Unit have developed several computer models to help farmers and others make decisions about farming practices. Agricultural producers and researchers can enter information about their farm, and the model will estimate possible outcomes on a wide range of topics. For example, the system will recommend how much fertilizer should be used to obtain optimal yields, or whether tillage or no-tillage systems would be best for that farm. The Great Plains Systems Research Unit is led by Lajpat Ahuja.

This latest ARS facility, associated with CSU, is part of a long and rich collaboration to improve the science behind western irrigated agriculture. The story begins with the appointment of Elwood Mead as a professor, at what is now called CSU, in 1883. While at CSU, Prof. Mead studied the fundamental relationships associated with the efficient and effective use of water in irrigated agriculture. From 1899-1907, Prof. Mead served as Chief of the USDA Division of Irrigation and Drainage Investigations in Washington, D.C. In 1910, the USDA established an Irrigation Investigations Unit on the CSU campus, under the leadership of Victor Cone. Ralph Parshall joined the Unit in 1913 and developed his Parshall Flume while working for this forerunner of the ARS Water Management Unit. In 1912, Cone and Parshall designed and directed construction of the USDA Hydraulics Lab, which was located where the Lory Student Center is located today. This facility was used by the Bureau of Reclamation to design the Boulder Canyon Project (today's Hoover Dam). In 1953, the Agricultural Research Service was created and included what, today, is called the Water Management Unit. Dale Heermann, who received his PhD from CSU in 1968, assumed leadership of the WMU in 1981. The WMU, more recently, has been housed at the Engineering Research Center and the Agricultural Engineering Research Center, both on CSU's Foothills Campus. The move to the NRCC represents a return to the main campus and excellent new facilities.

An ARS news release by David Elstein was a source for the above article.

HELPING YOU HELP US: DONATING MATERIALS TO THE WATER ARCHIVE

By Patricia J. Rettig
Head Archivist for Water and Agriculture Archives
Colorado State University Libraries

The Water Resources Archive was brought into existence three years ago at Colorado State University to document the state's water heritage. The Archive began by bringing together collections of historical water documents that existed in various locations on campus to make them easily accessible to researchers. Other collections have come from off-campus donors, and the Archive depends on such donations to fulfill its mission. The water community at large, being so historically minded, has been quite generous toward this end. Further information on why, what and how to donate is presented here to keep that spirit of generosity flowing.

Why donate

Two years ago, files containing twenty years of groundwater data nearly ended up in a dumpster. The data existed nowhere else, and were it not for someone stepping in to save it, it would be lost to history. The files, however, were saved and donated to the Water Resources Archive, and now researchers have perpetual access to that unique data, along with the associated reports, photographs and maps.

Situations like this often do not have such a happy ending. People clean out their offices, throwing away one-of-a-kind materials instead of considering their historical importance. Another common situation occurs when people do realize the importance of their materials and save them, but store them in out-of-the-way locations such as garages, basements, attics or barns. The environmental conditions of these places are less than optimal and the potential dirt, pests and temperature extremes actively deteriorate what is being "saved."

The Water Resources Archive can solve these problems by providing materials with secure, environmentally sound storage, lengthening their lifespan. In addition to simply saving important historical documents, the Archive makes them available to any person who has interest in seeing them. The materials of the past then inform the future. The Archive does this by organizing the materials and creating a finding aid--a standard archival tool describing a collection of materials, which includes information on the collection creator as well as a folder-level inventory of each box. The finding aids are made available to researchers over the Internet, along with digitized items from collections as deemed appropriate, enabling universal access beyond the walls of the Archive.

What to donate

The materials the Water Resources Archive is collecting are not the books, published reports and government documents that widely exist in libraries, but rather the primary materials that were used to create such items. Think of materials that get stored in filing cabinets: bylaws, correspondence, data, financial and legal documents, meeting minutes, newsletters and reports. Or in family treasure chests: letters, diaries, memoirs, photographs, films and scrapbooks.

The Archive seeks materials such as these that are related to the study and development of water resources in Colorado. Materials need not be organized or "old" or related to a prominent individual or event in order to be historically significant. The Archive prefers acquiring related groups of materials rather than individual items. Because the research value of records may be diminished if items are removed or rearranged, donors are encouraged to contact the Archive before discarding or reorganizing materials.

The Water Resources Archive always welcomes the chance to review material to determine if it fulfills our particular mission. If it is not appropriate for CSU, there may be another repository to which it could be referred. Some material, though, may be of more sentimental than historical value and should be kept by the individual or family.

The Archive accepts materials of both individuals and organizations. Records of the latter should be inactive--that is, no longer regularly used for routine business. If an organization is an ongoing enterprise, it is best to donate records periodically. To assure regular contact, an organization might add the periodic transfer of inactive records to the duties of one of its officers.

How to donate

If you have a collection to donate, contact the Water Resources Archive with as much information as possible. This would include the subject matter and material types in the collection, along with its overall condition and volume. Once the conversation begins, the archivist will inevitably have more questions, and, if needed, a visit to review the collection can be arranged. Once accepted as a donation, the Archive can provide boxes and packing assistance. The collection can be delivered by the donor, picked up by the Archive, or, if at a distance, shipped by a reliable company.

The Archive accepts only permanent donations of materials. Donors are asked to sign a donation agreement, called a Deed of Gift, which formally signifies that the materials become the property of the Archive.

Once materials are donated, researchers and other users will be able to access them by visiting the Archive. Materials are used on location and under supervision, in order to ensure security and long-term preservation. Prospective donors should become familiar with Archive policies on access and use and discuss any special needs or concerns with the archivist before completing the donation agreement.

Sensitive items that may exist in the collection should not be removed by the donor. Instead, discuss with the archivist the possibility of restricting part of the collection to address privacy concerns, trade secrets or similar matters. While the Water Resources Archive desires to make all materials accessible to users, it can agree to reasonable restrictions for limited periods of time.

The Archive requests that copyrights be donated along with materials. Assignment of copyright is often complex, and donors should work with Archive staff to clarify issues of copyright ownership prior to completing a donation agreement. Generally, copyright belongs to the creator of writings and other original materials (such as photos and music) but can be legally transferred to heirs or others. Moreover, ownership of copyright is separable from ownership of the physical item (the letter or photo). The Water Resources Archive asks donors to donate not only the physical materials but also any copyright in them that the donor might own. This facilitates researcher use of quotations from the materials and digitization of the materials.

An incentive for some donors is the possibility of a tax deduction. Donors are encouraged to speak with their tax accountants or attorneys about this. Archivists cannot give tax advice, nor are they permitted to appraise the monetary value of a collection. The Archive can provide donors with a list of local appraisers who can (for a fee) make monetary appraisals. It is a donor's responsibility to arrange for and bear the cost of appraisal.

Perhaps the biggest incentive for making a donation though is the one that has no price. Upon making a gift of historic materials that will be cared for and accessible to all future generations, many donors gain feelings of satisfaction, pride and honor, knowing that the Archive cares as much about their family member or organization as they do. Recently, those feelings were evident in members of the Carpenter family when they donated their grandfather's papers .

Final thoughts

The Water Resources Archive is committed to identifying and making accessible the documents of Colorado's water heritage. Fulfilling that commitment by preparing the documents for use—which often means inspecting them page by page—is an expensive task. Although monetary grants are never a prerequisite for the acceptance of a collection, donors who are able to assist the Water Resources Archive by making grants toward the arrangement, cataloging and preservation of their donations are always encouraged to do so.

Letters, diaries, photos and other materials created over the years give vital and unique information regarding Colorado's water heritage. When historical materials are donated to the Water Resources Archive that history becomes a part of Colorado's collective memory. Please contact the author if you would like to discuss making a donation (970-491-1939, prettig@manta.colostate.edu).

AAWA NAMES MACILWAINE NEW DEPUTY EXECUTIVE DIRECTOR

The American Water Works Association (AWWA) named Paula MacIlwaine, the association's current director of Convention, Education and Section Services, as its next deputy executive director .

"Paula MacIlwaine has learned the respect of the water community and AWWA's volunteers over the past 18 years, and we're pleased she has accepted this new leadership role," said Jack Hoffbuhr, AWWA executive director. "AWWA is committed to providing the very best services and products for the water community. Paula will make certain we continue to do that."

With more than 19 years experience in leading staff and volunteers, MacIlwaine has hands-on experience managing programs that provide current technical, regulatory and management information.

"AWWA is fortunate to have association staff, hundreds of volunteers and thousands of members that are dedicated to public health through the provision of safe drinking water," MacIlwaine said. "I am grateful to those who have mentored me, education me or guided me throughout the last 18 years. It has been my privilege to further AWWA's mission, and I am excited about the opportunity to support the association in a new capacity."

MacIlwaine is an alumnus of the University of Northern Colorado with a Bachelor's degree in Psychology. She's been with AWWA since 1986. She replaces Robert Renner, who will leave AWWA in June to become the executive director of the Instrumentation, Systems and Automation Society (ISA) in North Carolina.

FACULTY PROFILE

AUNG HLA ENCOURAGES ADOPTION OF SELENIUM BEST MANAGEMENT PRACTICES IN TRI-RIVER AREA

by Marian Flanagan

Aung Kyaw Hla joined Colorado State University Cooperative Extension in July 2003. A relative newcomer to Colorado, Aung is based in Montrose, Colorado as an Irrigation and Water Extension Specialist for the Tri River Area. The Tri River area is comprised of the Gunnison River, the Uncompahgre and the mainstem of the Colorado River. Aung held a similar area extension position with North Dakota State University from 1998 to 2003.

Born in Bangladesh, Aung grew up in an agricultural environment. In 1973, he obtained his BS in Agricultural Engineering from Bangladesh Agricultural University. Aung began his career as an irrigation engineer to develop surface and groundwater based irrigation infrastructure. In 1993, he came to the United States. Aung earned an MS in Agricultural and Biosystems Engineering with a minor in Soil and Environmental Sciences from The University of Arizona in 1996.

Aung K. Hla, Irrigation and Water Extension specialist for Cooperative Extension Tri-River Area for Tri

Salts and selenium have always been an integral part of the unique "irrigation ecosystems" in the Tri-River area since the ecosystems were altered in the early 1900s. However, selenium became important subject matter in 1997 when the Colorado Water Quality Control Commission (WQCC) adopted new numeric standards. Several stream segments, including the lower Gunnison River, and lower Uncompahgre River were placed on a list of impaired waters. In April 2004, additional segments, including the mainstem Colorado River and many tributaries in the lower Gunnison Basin, were added to the impaired list. Aung anticipates that this round of regulations may prompt stakeholders to aggressively seek a better understanding of Selenium movement and seriously look for practical ways to control the movement.

With funding from EPA and 319 grants, Aung wears several hats. He serves as a Best Management Practices (BMP) coordinator and also as an extension educator. He works with the Selenium Task Forces in the Gunnison River Basin and the Grand Valley to build synergy. Aung seeks to encourage the adoption of selenium reduction strategies with specific focus on improving the efficiency of water use. To date, the two Selenium Task Forces have implemented several projects and localized studies.

Aung looks for opportunities to provide "hands on education" about irrigation management and water conservation. He is developing practice guidelines for water users in residential settings, small acreages, golf courses, pond, and individual septic leach field systems. He hopes that the "implementation" of these guidelines will encourage "targeted" irrigation and the adoption of water conserving practices in the Tri River area. When tailoring his message to irrigators and landowners Aung's preferred method is "one-on-one". He believes that the ongoing demographic trend that tends to create smaller, more manageable acreages could drive the adoption of better water efficient practices for stakeholders in the Tri-River Area.

Aung's wife, Hnan Nyan Sein is a pediatrician. Aung and Hnan have two sons; Win is a graduate student and Min is a junior at the North Dakota State University. Aung Kyaw Hla can be reached by phone at (970)249-3935 or email: Aung.Hla@colostate.edu.

U.S. COMMITTEE ON IRRIGATION AND DRAINAGE ORGANIZES UPCOMING WORKSHOPS AND CONFERENCES

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

Third International Conference on Irrigation and Drainage, March 30-April 2, 2005, San Diego, CA.
The theme of this conference is Water District Management and Governance.
A Call for Papers will be posted on the uscid website soon: **www.uscid.org/05call.html**.

RESEARCH AWARDS

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

COLORADO STATE UNIVERSITY, FORT COLLINS, COLORADO
Awards for March 26, 2004 to May 25, 2004

PI	Dept	Sponsor	Title
Myrick, Christopher	**FWB**	**CDWL**	**Measuring & Mitigating the Impacts of Instream Drop-structures on Fishes from Colorado's Eastern Plains**
Bestgen, Kevin	**FWB**	**CDWL**	**Inventory of Stream Fishes in Colorado**
Fausch, Kurt	**FWB**	**CDWL**	**Effect of Agricultural Water Use & Drought on Groundwater that Sustains Critical Habitats for State-Listed Fish**
Vonderhaar, Thomas	(CIRA)	NOAA	CIRA Activities & Participation in the GOES I-M Product Assurance Plan
Hicke, Jeffrey	NREL	USGS	Western Mountain Initiative: Response of Western Mountain Ecosystems to Climatic Variability & Change
Cooper, David	**FRWS**	**NPS**	**Data Gathering for Ecological Restoration of Flooded Campgrounds, Yosemite Valley, Yosemite National Park, ...**
Thompson, David	Atmos Sci	NASA	Understanding the Impacts of Large-scale Climate Variability on the Global Carbon Cycle
Rutledge, Steven	**Atmos Sci**	**NASA**	**Physically-based Observational Studies for Tropical Rainfall Measuring Mission & Concept Development for …**
Randall, David	Atmos Sci	NASA	Analysis of Precipitation Variability as Observed by Emerging Satellite Systems
Niemann, Jeffrey	**Civil Engr**	**ARMY**	**Scaling Properties & Spatial Interpolation of Soil Moisture**
Wilkins-Wells, John	Sociology	USBR	Management Practice Study II - County Land Use Impacts on Irrigation Districts
Gray, William	Atmos Sci	NSF	Studies in Empirical Climate Prediction & Understanding
Rutledge, Steven	Atmos Sci	NSF	The Colorado State University - CHILL Radar Facility
Venkatachalam, C	ECE	UMASS	ERC: The Center for Collaborative Adapative Sensing of the Atmosphere

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

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

OTHER SPONSORS: ADEC-American Distance Education Consortium.

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

PI	Dept	Sponsor	Title
Maciel, Gary	Chemistry	DOE	Multinuclear Magnetic Resonance Study of the Interactions of Pollutants with Major Soil...
Labadie, John	Civil Engr	USBR	MODSIM Enhancement and Maintenance
Simmons, Carol	**NREL**	**USGS**	**BRD Global Change Data Management & Program Support**
Garcia, Luis	**Civil Engr**	**SE CO Resource Conser & Dev**	**Technical Assistance for Field-Scale Assessment of Improved Irrigation Practice Impacts on Drainage Water Dissolved ...**
Rathburn, Sara	**Geosci**	**City of Fort Collins**	**SEDIMENT BUDGET FOR HALLIGAN RESERVOIR, NORTH FORK CACHE LA POUDRE RIVER**
Ward, Robert	CWRRI	Various Sponsors	Developing a Decision Support System for the South Platte Basin
Roesner, Larry	**Civil Engr**	**Water Env Research Fdn.**	**Protocols for Studying Wet Weather Impacts & Urbanization Patterns**
Gates, Timothy	Civil Engr	Waterstone Env. Hydrology Engr., Inc.	Planning & Consultation for Design of Weighing Lysimeters for Measurement of Evapotranspiration
Christensen, Dana	HLA	Golf Assoc/U.S. Green Section	Development of Stress Tolerant, Turf-Type Saltgrass Varieties
Cifelli, Robert	Atmos Sci	Various Sponsors	CoCoRaHS Charter Members Cost Share
Fausch, Kurt	**FWB**	**USFS**	**Tradeoffs Between Native Fish Passage and Nonnative Fish Invasions**
Wohl, Ellen	**Geosci**	**USFS**	**Assessing Snow-Making Impacts to Stream Channels**
Lefsky, Michael	FRWS	USFS	Lidar Remote Sensing for Precision Forest Management
Macdonald, Lee	FRWS	USFS	Measurement & Predictions of Cumulative Effects on the Eldorado National Forest

UNIVERSITY OF COLORADO, BOULDER, COLORADO
Awards for January 1, 2004 to March 25, 2004

PI	Dept	Sponsor	Title
Syvitski, James	IAAR	NAVY	Modeling the Effect of Climatic and Human Impacts on Margin Sedimentation
Smyth, Joseph	**Geological Sciences**	**NSF**	**Water in the Mantle: Effects of Hydration on Physical Properties of Mantle Minerals**
Amy, Gary	**CEAE**	**Metro Water Dist. So. California**	**Contribution of Wastewater to DBP Formation**
Williams, Mark	IAAR	CO Mtn. College	Isotope Tracing Analysis for Leadville Mine Drainage Tunnel, California Gulch Superfund Site and Affected Areas
Rajaram, Harihar	CEAE	DOE	Two-Phase Immiscible Fluid Flow in Fractured Rock: The Physics of Two-Phase Flow Process in Single Fractures
Ryan, Joe	CEAE	DOE	Influences of Flow Transients and Porous Medium Heterogeneity on Celloid Associated Contaminant Transport in the Vadose Zone
Zagona, Edith	CADSWES	USBR	Upper Colorado Riverware Support
Veblen, Thomas	Geography	NSF	Climate Variation and Disturbance Interactions in Subalpine Rocky Mountain Forests
Scambos, Theodore	CIRES	Univ. of New Hampshire	Field Study and Technical Support for Antarctic Glaciological Research
Steffen, Konrad	CIRES	NASA	Variability and Forcing of Climatic Parameters on the Greenland Ice Sheet: Greenland Climate Network
Wahr, John	**CIRES**	**NASA**	**Hydrological and Oceanographic Applications of GRACE**
Voemel, Holger	PAOS	NASA	Balloon-Borne Soundings for the Validation of Upper Tropospheric Humidity and Temperature
Miller, Gifford	IAAR	NSF	Laurentide Ice Sheet Dynamics: Applying Cosmogenic Exposure to Constrain Chronology and Glacial Style in the Eastern Canadian Arctic

PI	Dept	Sponsor	Title
McKnight, Diane	**IAAR**	**NSF**	**Biogeochemistry of dissolved organic matter in Pony Lake**
Randall, Cora	LASP	Hampton Univ.	Aeronomy of Ice in the Mesosphere
Williams, Mark	**IAAR**	**Geography**	**New Tools for Evaluating Alpine Sensitivity and Water Quality in the Upper Animas Watershed, San Juan County, CO**
Brandemuehl, Michael	**CEAE**	**Natl. Renewable Energy Lab**	**Analysis of Economic Impacts of Varying Technical and Resource Parameters in Renewable and Hybrid Power System Design**
Stroeve, Julienne	**CIRES**	**Oregon State Univ.**	**Validation Studies and Sensitivity Analyses for Retrievals of Snow Albedo and Snow-Covered Areas…**

CWRRI University Water News

Western State College water news

THE NATURAL HISTORY OF THE GUNNSION RIVER
WESTERN STATE COLLEGE
JULY 24-27, 2004

Explore the natural history of the Gunnison River from the pristine headwates to desert canyons. Class includes an overnight raft trip from Delta to Whitewater in he spectacular Dominquez canyon area. Topics covered include stream ecology, ecosystem functions and landscape patterns, river processes, and human impacts on the river system. Credit at WSC is available

NOTE: The class is scheduled just prior to the Colorado Water Wokship (July 28-30) at WSC in Gusnnison. You can register for credit for atttending and participating in the Water Workshop as well.

Instructors: Prof. Patrick Magee, Biologist (pmagee@western.edu) and Prof. Gigi Richard, Geologist (grichard@mesastate.edu, 970-248-1689).

CSU water news

CE580 WATER ENGINEERING FOR INTERNATIONAL DEVELOPMENT

Many rural areas in developing countries do not have water systems that meet basic needs of their populations. Development of such systems is heavily constrained by funding limitations and technical considerations. In addition, appropriate designs must consider local customs and cultural values. This course provides training in the design of small-scale, low-cost systems for drinking water supply, crop irrigation, and wastewater disposal.

Topics include gravity diversions, wells, storage tanks, water distribution systems, irrigation demands, water quality testing, septic tanks, leach fields, and oxidation ponds. The course emphasizes on-site data collection methods and practical issues of design. Guest lecturers, case studies, systems design, homework and exams No textbook required, various resources used.

Fall, 2004, MWF 11 to 11:50 a.m., course ID 324765. Prerequisites: Basic hydrology, hydraulic engineering, pollution control or equivalents. Instructor: Jeffrey D. Niemann, Dept. of Civil Engineering, jniemann@engr.colostate.edu. More information: www.engr.colostate.edu/~jniemann/ce580.htm

CWRRI University Water News

Colorado School of Mines

International Ground Water Modeling Center
Colorado School of Mines
Golden, Colorado, 80401-1887, USA
Telephone: (303) 273-3103 / Fax: (303) 384-2037
Email: igwmc@mines.edu / URL: http://typhoon.mines.edu/

2004 SHORT COURSE SCHEDULE

Less than Obvious: Statistical Methods for Data below Detection Limits, August 18-19
by Dennis Helsel

This two-day short course presents statistical methods for interpreting data below detection limits. The course examines up-to-date methods which are more appropriate for interpreting data than deleting less-thans, or substituting arbitrary values. Example problems are worked in class, so students can confidently take these methods back to their office. The course assumes a knowledge of basic statistics, including some familiarity with t-tests, linear regression, and simple nonparametric tests like the rank-sum test. The fee for the short course is $895 before August 5 and thereafter $995.

MODFLOW: Introduction to Numerical Modeling, November 4-6
by Eileen Poeter

This course is designed for the hydrogeologist and environmental engineer familiar with ground-water flow concepts, but who have limited or no experience with ground-water flow modeling. Basic modeling concepts: conceptual model development, definition of boundary and initial conditions, parameter specification, finite-differencing, gridding, time stepping, solution control, and calibration are presented using MODFLOW-2000. Basic modules of MODFLOW are explained and concepts are reinforced with hands-on exercises. The fee for the short course is $995 before October 21 and thereafter $1195.

Polishing Your Ground-Water Modeling Skills, November 4-6
by Peter Andersen and Robert Greenwald

This course is designed to provide significant detail on practical ground-water flow modeling concepts and techniques. It will explore development of conceptual models for complex sites or regions, how to convert these conceptual models to appropriate ground-water flow models, and how to apply supplemental MODFLOW modules to effectively solve such problems. This course takes the user beyond topics covered in introductory modeling courses and beyond courses that teach the mechanics of applying various pre- and post-processing software. The fee for the short course is $995 before October 21 and thereafter $1195.

Modeling Water Flow & Contaminant Transport in Soils and Groundwater
Using the HYDRUS Computer Software Packages, November 5-6
by Rien van Genuchten and Jirka Simunek

This course begins with a detailed conceptual and mathematical description of water flow and solute transport processes in the vadose zone, followed by an brief overview of the use of finite element techniques for solving the governing flow and transport equations. “Hands-on” computer sessions will provide participants an opportunity to become familiar with the Windows-based RETC, STANMOD, HYDRUS-1D and HYDRUS-2D software packages. The fee for the short course is $495 before October 21 and thereafter $595.

UCODE: Universal Inversion Code for Automated Calibration, November 11-12
by Eileen Poeter

If you have a working knowledge of ground-water flow modeling and some knowledge of basic statistics, you will benefit the most from this short course. This course introduces ground-water professionals to inverse modeling concepts and their use via UCODE, relying heavily on hands-on exercises for automatic calibration of ground-water models to promote understanding of UCODE and avoid “black-boxing”. If you would like to spend more time being a hydrologist and less time as a “number tweaker”, please join us in the ucode course. The fee for the short course is $795 before October 28 and thereafter $995.

PUBLICATIONS

ADMINISTRATION UPDATE/WATER RESOURCES

U.S. Geological Survey/Water Use

The U.S. Geological Survey (USGS) has released a report, "Estimated Water Use in the United States in 2000" (USGS Circular 1268, March 2004). The report presents consistent and current water-use estimates by source and by state. The USGS has compiled similar national estimates every five years since 1950. This series of water-use reports serves as one of the few sources of information about regional or national trends in water withdrawals. The report provides information on eight categories of water use – public supply, domestic, irrigation, livestock, aquaculture, industrial, mining, and thermoelectric power. It contains a section on total water use for 2000, followed by more detailed discussions for each category. The final section presents a discussion on trends in water use from 1950 to 2000. Despite growing population and increasing electricity production, water use in the United States remains fairly stable, according to the new report.

The USGS report states that in 2000, Americans used 408 billion gallons of water per day, a number that has remained fairly stable since 1985, which may be a sign that conservation is working. In the report, USGS researchers found that the chief water users for the Nation are power generation, agriculture and public water supply. The report also finds that the personal use of water is rising, but not faster than population change. "It's pretty good news for the nation that despite the increasing need for water, we have been able to maintain our consumption at fairly stable levels for the past 15 years," says USGS Chief Hydrologist Robert Hirsch. "It shows that advances in technology in irrigation and power generation allow us to do more with less water." Power generators make up 48 percent of the usage (withdrawals). Irrigation is 34 percent of the total and public supply (that delivers water to homes, businesses, and industries) accounts for 11 percent of daily water usage. Self-supplied industrial users, livestock, mining, aquaculture and domestic wells, taken together, account for seven percent.

The total quantity of water withdrawn for thermoelectric power for 2000 was an estimated 195,000 Mgal/d, or 219 million acre-feet per year (Maf/yr), with surface sources supplying over 99% of the water. Nearly one-third of that surface water was saline. Thermoelectric-power withdrawals accounted for 48 percent of total water use, 39 percent of total freshwater withdrawals, and 52 percent of fresh surface-water withdrawals. For 2000, public-supply withdrawals were an estimated 43,300 Mgal/d, or 48.5M af/yr, about 13 percent of total freshwater withdrawals. Some 240 million people depended on public water suppliers, with 63 percent from surface sources.

Irrigation withdrawals for 2000 were estimated to be 137,000 Mgal/d, or 153 million af/yr, accounting for some 40 percent of total freshwater withdrawals and 65 percent of total freshwater withdrawals for all categories excluding thermoelectric power. About 61.9M acres were irrigated in 2000 – 29.4M acres with surface flood systems; 28.3M acres with sprinkler systems; and 4.18M acres with micro-irrigation systems. Application rates were calculated by dividing total withdrawals by irrigated acres. The average application rate was 2.48 af/acre. The majority of withdrawals (86 percent) and irrigated acres (75 percent) were in the seventeen Western States. Surface water accounted for 58 percent of withdrawals, and is the primary source in the arid West and the Mountain States. Ground water was the primary source in the Central States. California, Idaho, Colorado and Nebraska combined accounted for one-half of the total irrigation withdrawals. California and Idaho accounted for 40 percent of surface irrigation withdrawals, and California and Nebraska, 33 percent of ground water withdrawals.

California, Nebraska, Texas, Arkansas, and Idaho accounted for 53 percent of total irrigated acreage. In Arizona, Montana, and Idaho, application rated exceeded five af/acre. States that utilize the High Plains Aquifer (Nebraska, Texas, Kansas, and Oklahoma) for irrigation relied mostly on ground water and had application rated ranging between 1 and 2 af/acre. Estimates of total irrigation withdrawals were about 2% more than 1995. Surface-water withdrawals were about five percent less, but ground-water withdrawals are up 16 percent.

"Sound planning for water depends on a sound understanding of the Nation's water resources and a sound understanding of how people will use water in the future," Hirsch said. "This study will help the public, decision makers, engineers and scientists better understand water use, aid in the development of long-term national water policy and ensure that information is available to take proper steps now to ensure water availability for future generations of Americans."

The report is available at http://pubs.water.usgs.gov/circ1268 and http://water.usgs.gov/pubs/circ/2004/circ1268. Additional waste use information is available at: http://water.usgs.gov/watuse/
Source: *Western States Water /U.S. Geological Survey/ Special Report #1557 / March 19, 2004*

MEETING BRIEFS

COLORADO SECTION OF AWRA DISCUSSES INTERSTATE COMPACTS -- THEN AND NOW

Over 125 people gathered at the Arvada Center on April 30, 2004, to examine the 'then and now' of Colorado's river compacts. The Colorado Section of AWRA annual meeting program included an examination of how compacts were made, how they are administered today, and the role of compacts in the Colorado's future management of its limited water resources. In addition, the impact of endangered species and water quality legislation upon compacts was discussed.

David Robbins, with Hill and Robbins, P.C., in his luncheon address, noted that compacts are contracts between states. If the conditions of a contract are met, there is no opportunity to successfully contest its contents. A similar situation exists with compacts. As long as Colorado complies with compact conditions, the compacts can be maintained whole over time. The Endangered Species Act and Clean Water Act regulate certain water-related activities. Until the conditions of these acts are complied with, Colorado may not be able to use all the water it is allocated under a compact. In the long run, however, as conditions of the ESA and CWA are met, water use restrictions will be removed and Colorado will be able to use the water it is entitled to under the compacts. David concluded his remarks with the observation that Colorado needs to maintain a long-term, strategic, view of its use of water resources. He cautioned the audience not to let mythology operate water resource planning in Colorado, but rather know that the compacts (contracts) have real provisions that must be met in order to protect Colorado's future water supplies.

Brad Wind (Northern Colorado Water Conservancy District) speaks with Reagan Waskom.

Ken Knox (State Engineer's Office) receives his autographed book from author Dan Tyler.

In an afternoon session, Dan Luecke, hydrologist and environmental scientist, noted that there is nothing that cannot be done under a compact EXCEPT over use an allocation. As Alan Berryman, Northern Colorado Water Conservancy District, noted, however, it is not easy melding the water needs of the ESA into a compact. Alan serves as the Colorado Water Users Representative on the Platte River Recovery Program Governance Committee where Colorado is negotiating with Wyoming, Nebraska and the federal government to find ways to comply with the ESA within the constraints of the South Platte Compact. Alan notes that solutions are limited and not always the most efficient, nor are they obvious. However, the negotiation process appears preferable to other options that may be available.

Discussions at the Colorado Section AWRA meeting pointed out, to higher education researchers in Colorado, a need to better understand the provisions of Colorado's river compacts and the relationship of these provisions to the science that underpins efforts to incorporate ESA and CWA provisions into compact administration. Colorado's water management system is capable of adjusting to new knowledge (e.g. incorporation of ground water in the 1960s and instream flows in the 1970s into Colorado's prior appropriation system) as well as new human uses. A challenge is given to today's water managers and scientists to, jointly, develop a better understanding of how ESA and CWA provisions can be met within the constraints of Colorado's water compacts. It is not an easy challenge, but it is doable with careful science and ongoing dialogue and negotiation.

The proceeds of the Colorado Section AWRA annual meeting go to the Section's long standing scholarship program for college students preparing for careers in water resources. See article on 2004 scholarship recipients on page 12.

WATER NEWS DIGEST

by Marian Flanagan

Administration

Water conservation district would serve Front Range
Senate Bill 232 written by the same interests that brought forth Referendum A last year, would create the Front Range Water Conservation District, a new water conservation district that would include some of Colorado's most populated and thirstiest counties. The bill was approved, 5-2, by the Senate State Affairs Committee on Monday and now will be considered by the entire Senate. Opponents argued that the state's three current conservation districts — all located on the West Slope — all operate with mitigation laws. The bill received strong support from county commissioners and water providers that would be included in the new district (unincorporated areas of Douglas, Arapahoe, Jefferson and northern El Paso counties). As a water conservation district, the counties could raise and borrow money to build dams and reservoirs and acquire water rights. "This is an opportunity for us who are the have-nots to have an opportunity to coalesce and to create a power base from a political standpoint and the ability to put financing together to build projects," said Frank Jaegar, district manager for Parker Water.

The Daily Sentinel / April 20, 2004

Conservation

The cost of conservation
Ten of the largest water utilities on the Front Range will spend an average of $2.50 per customer - the cost of a small latte - on water conservation programs this year, according to a survey by the Rocky Mountain News. As the state enters its fifth year of drought, Colorado Springs will spend the most - $6.25 per customer, or about 1.26 percent of the overall budget of the state's second-largest water utility, the survey found. Pueblo will spend the least, 59 cents, or about one-third of 1 percent of its water budget. Denver Water, the state's largest water utility, will spend about $3.72 million on conservation, 1.7 percent of its budget or about $3.10 per customer. Denver's conservation spending pales in comparison to the budget in Las Vegas, which is attacking one of highest rates of water use in the West. Las Vegas will spend about $15.50 per customer, on conservation according to Tracy Bower, spokeswoman for the Southern Nevada Water Authority. Experts say communities must aim higher in conservation to ensure that new residents and wildlife have enough water. Denver's long-range water plans call for reducing demand through conservation programs by 29,000 acre feet by 2050 - that's about 14 percent of current water use. In addition, Denver's new recycling plant will save another 17,000 acre-feet during that time, freeing up enough water for up to 35,000 families. One thing almost everyone agrees on is the need to permanently reduce outdoor water use.

Rocky Mountain News / April 17, 2004

Officials hope to make conservation a long-term habit
Many Front Range residents facing their third summer of drought have learned to do with a little less water. The City of Aurora says its customers have reduced water use by about 30 percent since 2002 and Denver's use is down about 13 percent. "We're hoping we can encourage these behaviors over the long term," said Denver planner John Loughry. Builders in parts of Arapahoe County now routinely lay dual pipe water systems, one to carry treated drinking water and a second for recycled water that can be used for lawns. Recycled water isn't available there yet, but Gary Atkin, manager of Arapahoe County Water and Wastewater District, promises it will be by 2007. Some communities are looking for ways to create less water-dependent lawns. Carl Wilson, a horticulturist with the Colorado State University Cooperative Extension, said Coloradans are slowly shifting their mindset to accommodate the state's naturally semi-arid climate.

Rocky Mountain News / April 17, 2004

Drought

Board imposes water restrictions
Denver Water, which serves 1.2 million metro-area customers, is the third major water supplier to announce restrictions this year that include two-days-per-week lawn watering and tough fines for those who don't play by the rules. Aurora approved similar rules Monday and Colorado Springs ordered mandatory watering limits earlier. Marc Waage, a water resource engineer at Denver Water said, "The March dryness put us too far behind in the game to come out of the drought this year." Along with two-day-per-week watering, the Denver Water Board also approved a 20 percent surcharge on new home taps. Forty-percent of the utility's 1.2 million customers paid surcharges last summer. Fees from the tap and consumption surcharges will fund another round of appliance rebates this summer, board members said.

Rocky Mountain News / April 15, 2004

Man in charge of drought forecasts ready for rain
In 2004, the "Four Corner" states of Utah, New Mexico, Nevada and Arizona experienced their warmest March in 120 years. Douglas Le Comte works in Boulder's "World Weather Building," and wishes his computer would show him that the Western drought is coming to an end. But Le Comte's computer model portends a summer of drought. Since the National Weather Service started a monthly "drought outlook" in 2000, Le Comte, a 58-year-old senior meteorologist, has been its principal author. But Le Comte doesn't work alone. Thousands of reporting stations from various government agencies feed measures of temperature, river stages, soil moisture and snowpack into the computer models, which sometimes disagree. "You're looking at a whole bunch of different models, but it's the human that has to put them all together and decide which one to emphasize and which one to de-emphasize based on his experience," Le Comte explained. "Droughts seem to occur every 22 years, so the Southwest should be coming out of it," he added. But research also shows that the decades before the drought were "exceptionally wet" in the West. Le Comte said that what happened in the prior 30 years may not really be representative of the climate.

Scripps Howard News Service / Boulder Daily Camera / April 18, 2004

Drought lingers in region
Restrictions have been imposed on hundreds of thousands of water users in Denver, Aurora, Colorado Springs and other Front Range cities, but not Fort Collins and Loveland. Fort Collins attributes its plentiful water supply this year to a 7,000-acre-foot water savings amid restrictions last year. "The new water pricing structure motivates people to save water," said City Manager John Fischbach. The Loveland City Council last month also decided against watering restrictions. Statewide snowpack at the start of May was 68 percent of average, according to the federal Natural Resources Conservation Service. But by late this week, state-

wide snowpack was 39 percent of average. Similarly, snowpack in the South Platte River Basin, which supplies reservoirs used by Fort Collins, Denver and other cities and towns, dropped from 65 percent on May 1 to 40 percent Friday. "Snowpack came off pretty fast in lower elevations, so that is obviously going to mean a higher fire danger," said Tony Tolsdorf, a hydrologist with the conservation service. Climatologist Roger Pielke warned it could take Colorado several years to recover from the drought because the reservoirs and the seven river basins that replenish them remain depleted after seven consecutive years of spotty, sparse precipitation. "The prudent thing is to plan for continued drought this year and continued drought in 2005," Pielke advised.

Coloradoan / May 24, 2004

Endangered Species

Fish denied extra water for 5th year
Ongoing drought will prevent Western Slope reservoirs from releasing extra water for endangered fish in the Colorado River this year. The additional flows, when available, help scour out new habitat for the fish in a crucial 15-mile stretch of river near Grand Junction. But this is the fifth year the fish will miss out on the surplus water, according to George Smith with the Endangered Fish Recovery Program. When available, the voluntary water releases benefit two of the four federally protected fish in the Upper Colorado Basin - the razorback sucker and the Colorado pikeminnow.

Rocky Mountain News / May 24, 2004

Flood Prediction

Flood study more detailed / South Boulder residents still express concerns
A city-funded flood study of South Boulder Creek has come up with the most sophisticated computer model of a creek watershed done in the Denver-Boulder area according to researchers from HDR Engineering. By fall the computer model will be able to predict flooding along the South Boulder Creek drainage, which runs from Gross Reservoir and along Boulder's south and eastern edge. The model uses more types of historic, geologic and hydraulic information than a previous study completed in 2001. John Henz, a climatologist for the new study, looked at various documented storms since 1860 in the area and concluded that South Boulder Creek is vulnerable to drenching storms The team will model a variety of theoretical storms to see what kinds of rainfall will trigger floods, what severity of flooding could be expected and where the water would go.

Boulder Daily Camera / April 23, 2004

Groundwater

Arsenal clean-up succeeds
Last week marked an important milestone--Interior Secretary Gale Norton (a Colorado native) announced formal transfer of 5,000 acres to the U.S. Fish and Wildlife Service. Eventually, the agency will manage 15,000 acres for native animals and birds and some human recreation. Overall, though, great progress has been made on a complicated job. The arsenal will still have some contamination - there's no known technology to safely and completely remove all the materials. The EPA and the Army will keep control of 2,000 acres and systems that protect groundwater. Most of the site, though, has been cleaned adequately or was never contaminated.

Denver Post / April 19, 2004

Salinity

Lower Water Conservancy District supports CSU study
The Lower Arkansas Valley Water Conservancy approved a motion by board member Loretta Kennedy to support and cooperate with the next phase in a Colorado State University study of irrigation practices and their impact in the Arkansas Valley. Dr. Tim Gates of the Colorado State University Department of Civil Engineering made a presentation to the district's board of directors yesterday on the progress of his studies on salinity and water logging as a result of irrigation in the valley. Gates has been collecting data for about six years in hopes of helping the valley make better decisions to manage water and to help improve efficiency of irrigated agriculture.

***Lamar Daily News** / April 16, 2004*

Water Quality

Funding shortfall may cut efforts to keep rivers clean / State-specific selenium study needed, district says
The National Irrigation Water Quality Program (NIWQP) has had its funding reduced to zero for fiscal year 2005. The NIWQP was developed to look for areas the western United States where selenium leaching was a problem and how that leaching affected wildlife. Area efforts to reduce selenium loading in the Gunnison and Colorado rivers may be hampered unless additional funding can be obtained. The Gunnison Basin Selenium Task Force and Grand Valley Selenium Task Force both lean on the program heavily and rely on it for much of their technical support to get local rivers into EPA compliance. The task forces have $750,000 in congressional write-ins for fiscal year 2003 and fiscal year 2004, but funding for fiscal year 2004 has yet to be approved . "The scientific study of selenium issues in Colorado is critical," River District General Manager Eric Kuhn wrote to Sen. Ben Nighthorse Campbell. Kuhn asked Campbell for help securing funding in 2005 appropriations for such a study. The River District and other Colorado water agencies want to know: whether Colorado's unique environment should be held to the same standards as other places across the country; how much selenium comes naturally from the geology of the area and how much is contributed by human activities; and whether the selenium concentrations could be lowered to national standards, given Colorado's unique environment.

Montrose Daily Press / April 11, 2004
The Grand Junction Daily Sentinel / April 22, 2004

EnCana reveals plan to deal with gas seeps
On March 30, a resident found natural gas bubbling up in West Divide Creek near gas wells recently drilled by EnCana Oil and Gas (USA) Inc. More seeps were soon found downstream for a half mile. The gas drilling company has begun work to protect residents and wildlife from possible effects of the seeps, as required by the Colorado Oil and Gas Conservation Commission (COGCC), the state agency that regulates gas drilling activity. EnCana started surveying the soil for more gas seeps by using infrared gas detection devices. Walter Lowry, EnCana's director of community and industry relations said the company will install gas monitoring devices in the ground at nearby homes. EnCana installed an aeration system in West Divide Creek, just downstream from the largest gas seep, where benzene, a cancer causing substance, was detected in water samples. Benzene, toluene and methyl phenol xylene, all poisonous

chemicals associated with natural gas, were found in the water, but only benzene was found in quantities over acceptable standards. The company has also placed porous tubes filled with activated charcoal, across the stream at several points downstream from the seeps, to absorb benzene and other toxic chemicals from the water. The company is supplying water to residents within one mile of the known seeps on West Divide Creek, residents' wells are being tested every day. EnCana has stopped work on all its wells within two miles of the seeps until the issue is resolved.

Glenwood Springs Post Independent / April 15, 2004

Water Rights

Water groups focus on future / River 'call' would cut Front Range supply

The state's top water users will be sitting down this year to plan for what was once unthinkable: a federal demand that Colorado shut down its water users to provide more water for California. Colorado will also have to re-evaluate its intent to begin a huge dam-building program to create more water storage if the drought continues, said Scott Balcom, the state's representative to the seven-state Colorado River Commission. Balcom told the legislature's Joint Agriculture Committee that water users and state officials need to develop a unified position to help in any future negotiations about how to manage the river during a long-term drought. One big question for examination is how to keep water flowing to Front Range cities if Colorado is forced to release water from its reservoirs for use by California, Nevada and Arizona. Most water delivery across the Continental Divide to the Front Range was developed after the 1922 Colorado River Compact and would be vulnerable to a compact call. Under the compact, Colorado, Wyoming, Utah and New Mexico are required to allow an average of 7.5 million acre-feet per year to flow past a river gauge below Lake Powell for use by California, Arizona and Nevada. The four upper-basin states have met their compact obligations during the five-year drought by releasing water from Lake Powell in Utah and Arizona. But the lake is expected to fall below its current 42 percent of capacity by year's end. And federal Bureau of Reclamation officials say the lake could drain completely if the drought continues for two or three more years. Members of the panel expected to address a range of issues will include most of the state's biggest water utilities and conservation districts, including the Denver Water Board, the Northern Colorado Water Conservancy District and the Colorado River Water Conservancy District. Colorado officials contend the state is legally able to develop another 600,000 acre-feet from the Colorado River, but some hydrologists have questioned whether that water is really there. "We're definitely going to have to reassess the amount of water available to us in the upper basin," Balcom said. Some legislators believe Colorado got shortchanged by the 1922 compact and suggest reopening negotiations on the agreement. "If this drought lasts much longer, it's going to change the rules by which we evaluate new storage projects," Balcom replied. "If there's ever a (compact) call, any new reservoir storage would be junior to the compact, and, bingo, we wouldn't be able to fill new reservoirs," he said.

Denver Post / April 25, 2004

Water Supply and Development

Up a creek / Supply-demand deficit looms for river basin

The Arkansas River basin faces a gap of 32,800 acre-feet between projected supply and projected demand by the year 2030. According to preliminary figures from a Colorado Water Conservation Board statewide study, the gap could be three times that if currently planned water projects don't come to pass. The third of four planned "basin roundtable technical meetings" was held Thursday in Pueblo, drawing together representatives of municipal, agricultural, recreation and environmental interests. Kelly DiNatale, one of the consultants working on the study, said the preliminary figures show demand in the total basin growing by 94,400 acre-feet by 2030, and three-quarters of the growth will be in El Paso and Pueblo Counties. But the study projects that 61,600 acre-feet of new "yield" will offset a portion of the increased need. The bulk of the new water is in El Paso and Pueblo Counties, and the projection depends almost entirely on plans to change the operation and possibly enlarge reservoirs of the Fryingpan-Arkansas Project. The study is supposed to be completed by November.

The Pueblo Chieftain / April 18, 2004

Future growth feeds water needs

Loveland water officials have been working on expanding Green Ridge Glade Reservoir since it was built in 1978. Its expansion should give the city a firm water supply of 22,500 acre-feet or 7.3 billion gallons per year — enough water for the 102,000 residents expected to live here by 2027. But city planners predict Loveland will eventually grow beyond that — to a city of 150,000 or more. So, as Green Ridge expansion is nearing completion, water officials are looking at a number of strategies to build the city's water supply to serve the city past 2027. Loveland Senior Water Engineer Larry Howard said the city must look at all its options in securing future water supplies. He said water officials will look at future population and water demand, as well as strategies for making growth pay its way, before deciding whether a new reservoir is needed. Fred Anderson, chairman of the Loveland Utilities Commission, is more certain that one is needed and he wants to start planning now for Loveland's next reservoir. Loveland's recent water study shows the city could get more out of the water it owns if it could store more during dry years. "A new reservoir also could secure Northern Colorado water rights and stave off water raids from thirsty Denver suburbs," Anderson said. "Loveland has relied too long on the water pioneers who secured the city's current water supply," he said, adding, "It's time for this generation to pioneer the water supply for the next generation of Lovelanders."

Loveland Reporter-Herald / April 26, 2004

Officials move to limit water-supply damage

The Picnic Rock fire torched 8,900 acres northwest of Fort Collins, including land surrounding Milton Seaman Reservoir and the North Fork of the Poudre River, both of which supply water to Greeley. "Greeley's highest priority needs to be reseeding burned areas," said William Lewis, a limnologist from the University of Colorado-Boulder. If new grasses take hold, it will help prevent erosion of ashy sediment. "The big problem, the one we would all groan about, is a massive transport of clay and sediment. You could get tons and tons of sediment going into the reservoir," said Lewis. Select areas will be aerially mulched with straw and blanketed with grass seed, according to a damage-control plan crafted by Greeley, the state and the federal government. Greeley expects to act on the $346,000 revegetation plan as early as next week.

Greeley Tribune / April 22, 2004

CALLS FOR PAPERS

INTERNATIONAL SALINITY FORUM
April 25-27th (Conference) and 28th (Coachella Valley Tour), 2005
Riverside Convention Center, Riverside, California
CALL FOR PAPERS AND POSTERS

INTERNATIONAL SALINITY FORUM
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Deadline for abstracts: December 31, 2004

Sessions Topics:

- Social and Economic Costs
- Assessing and Mapping Salinity
- Seawater Intrusion and Saltwater Encroachment
- Wildlife Impacts (Estuaries, Wetlands, and Riparian)
- Regional Watershed/Basin Management Strategies
- Rangeland Salinity
- Waste Water (Sewage) Re-use
- Plant Salt Tolerance and Breeding
- Environmental Impacts and Mitigation
- Understanding Salinization (Processes)
- Desalinization Technologies for Watersheds
- Salton Sea and Other Closed Basins
- Irrigation Drainage and Return Flow in Saline Environments
- Dryland Salinity
- Brackish and Saline Waters – Use and Disposal
- Reclamation of Saline/Sodic Soils
- Plant Crop Responses to Salinity

Abstract template and information available at this website: **http://www.waterresources.ucr.edu** Click on: News/Events

- For more information on Call For Papers and Posters contact:
  - Heidi Hadley – phone: 801/524-3886, email: hhadley@uc.usbr.gov
  - Donald Suarez – phone: 909/369-4815, email: dsuarez@ussl.ars.usda.gov

MEETINGS

Dam Safety 2004
Association of State Dam Safety Officials
Phoenix, Arizona, Sunday, September 26, 2004

One of the leading conferences in the United States dedicated to dam safety engineering and technology transfer.

ASDSO invites all those interested in the latest policy and technical information on dam safety in the US to attend Dam Safety 2004. Twenty-one technical sessions, two workshops, two field trips, an abundance of networking opportunities and a world-class resort location will make this one of the best conferences of the year. For more information, go to **http://www.damsafety.org**/

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Aquifer Storage Artificial Recharge

Solutions to Colorado water shortage?

Focus on ASR and Denver Basin Aquifer

A two-day Information-Exchange Forum

(Aquifer Storage Recovery, Artificial Recharge, Conjunctive Use, MAR, Water Banking etc.)

Denver Marriott Southeast, Denver, Colorado – July 12-13, 2004

Science & Technology program – Monday, July 12, **Management & Policy program,** Tuesday – July 13
Field trip – Sunday afternoon, July 11 - **One-day or two-day registration - Top presenters - CEU credit available** -
Discount registration for full-time students

Details and registration online at www.agwt.org (click on workshops and conferences)
American Ground Water Trust, 16 Centre Street, Concord, NH 03301
Telephone: (603) 228 5444 **Web: www.agwt.org**

COLORADO WATER CONGRESS
Meeting Notices & Agendas

COLORADO WATER CONGRESS WORKSHOP SCHEDULE

The Colorado Water Congress prepares a series of six-ten workshops each year for the purpose of increasing and updating water knowledge both for the actively involved water community and general public knowledge. Workshops will all be held in the Colorado Water Congress Conference Room, 1580 Logan Street, Suite 400, Denver, Colorado. CLE credits are typically given for these workshops.

Colorado Water Law Seminar – September 20-21, 2004

2004 Summer Convention, August 26-27, 2004
Silver Tree Resort in Snowmass Village, Aspen, Colorado

For programs and registration forms in Word and PDF see the website at **http://www.cowatercongress.org**
or email macravey@cowatercongress.org

47th CWC Annual Convention, January 27-28, 2005
DIA Hotel and John Q. Hammonds Convention Center
15500 East 40th Ave., Denver, Colorado

Meeting Schedule -- Open to the Public Rocky Mountain AWWA Water Conservation Committee Colorado Water Wise Council				
Date	**Time**	**Location**	**Speaker(s)**	**Topic**
Thurs., Sept. 9	11:30 a.m.-2:00 p.m.	Aurora Municipal Bldg., 15151 E. Alameda Pkwy., Aspen Conference Room (2nd floor)	Natalie Brower-Kirton, City of Aurora	City of Aurora's Xeriscape Demonstration Garden
Thurs., Nov. 4	11:30 a.m.-2:00 p.m.	Denver Water Board Room (3rd Floor)	Larry Keesen, Keesen Irrigation	New Irrigation Technology: Benefits and Challenges (sursurface irrigation, ET-Controllers, soil moisture sensors)
For information contact: Laurie D'Audney at ldaudney@fcgov.com				

2004 Annual Conference

"Planning for the Future"

September 9th & 10th

Hotel Colorado
Glenwood Springs

Please complete this registration form and
return it with payment to the Conference Registration address below. The Registration fee of $75.00 includes admission to all plenary and concurrent sessions, entry to exhibits, Thursday and Friday breakfasts, Thursday luncheon, refreshment breaks, Thursday's Barbecue Picnic Dinner and a conference folder. Registration after August 30th or at the door will not guarantee conference meals or discounted hotel prices.

Name: _____ Position/Title: _____
Affiliation: _____
Office (or home) address: _____
Day Phone: _____ Fax: _____
Email: _____
___ I would like a vegetarian meal ___ I would like information on receiving a Scholarship
___Yes! I am interested in having booth space available for my organization at the Conference

SEND THIS REGISTRATION & MEMBERSHIP FORM ALONG WITH PAYMENT TO:
Colorado Watershed Assembly, 633 Remington Street, Fort Collins, CO 80524
$____ Registration for 2004 Annual Conference $75
$____ First Year Membership in the Colorado Watershed Assembly* (Select category below)
_____Watershed Group -- $50** _____Individual -- $25
_____Business/Consulting -- $50 _____Agency -- Contribution
$____ Total Enclosed – Please make checks payable to the Colorado Watershed Assembly
*After first year, membership fees are based on a sliding scale based on your total water program budget:
Under $75,000 - $ 50 $100,000-149,999 - $100 $250,000 and up - $250
$75,000-$99,999 - $ 75 $150000-$249,000 - $200
** Watershed groups approved by CWA Board will become members of the Steering Committee. Serving on the CWA Steering Committee requires attending (in person or teleconference) meetings every other month, and participation in CWA organizational activities and committees.

This year's CWA Conference is being held in conjunction with the NPS Forum 2004, at the Hotel Colorado in Glenwood Springs on September 8. "Watershed Planning: Blueprint for Action!" is their theme. Their pre-registration is $30 by August 27, $35 at the door. Go to www.npscolorado.com for more information.

Committee Membership – We need volunteers for the following committees:
YES! – I would like more information about becoming a member of the following committee(s).
___ Outreach ___ Annual Conference ___ Funding ___ Watershed Assessment
*All Steering Committee members are expected to be on at least one of the above committees

REMINDER: Rooms at Hotel Colorado will only be held until July 22st!!
Make your reservations NOW!!

QUESTIONS? – Need more information??
See www.coloradowater.org or call Chuck at (970) 259-3583 or Sarah at (970) 513-8340 x 221 Please call during regular business hours, and NOT after 9/2/04.

Hotel Colorado Info: phone: 1-800-544-3998, fax: (970) 945-7841, 526 Pine Street, Glenwood Springs, CO 81601
www.hotelcolorado.com Please use our conference code for room reservations, which is "COW".

CALENDAR

July 12-13	AQUIFER STORAGE ARTIFICAL RECHARGE: Solutions To Colorado Water Shortage? Focus On Asr And Denver Basi Quifer, Denver Marriott Southeast. Details And Registration Online At Www.agwt.org (Select Workshops And Conferences.) Phone 603/228-5444
Jul. 28-30	29TH COLORADO WATER WORKSHOP, Western State College of Colorado, Gunnison, CO. Go to www.western.edu.water for conference program, registration information, exhibitor information, and other information.
July 20-22	UCOWR/NIWR 2004 ANNUAL CONFERENCE, Portland, OR. Contact: Gary Johnson, Idaho Water Resources Research Institute, Phone 208/282-7985, E-mail johnson@if.uidaho.edu; or Ari Michelsen, Texas A&M, phone 915/859-9111 or E-mail a-michelsen@tamu.edu. Web-site: **www.uwin.siu.edu/ucowr**.
July 28-30	29th COLORADO WATER WORKSHOP, Western State College, Gunnison, CO. See the website at **www.western.edu/water/**.
Aug. 26-27	COLORADO WATER CONGRESS 2004 SUMMER CONVENTION, Aspen, CO. See the website at **www.cowatercongress.org**, phone 303/837-0812, email macravey@cowatercongress.org.
Sept. 9	CITY OF AURORA'S XERISCAPE DEMONSTRATION GARDEN, Aurora Municipal Bldg., Aurora, CO. Contact: Contact: Laurie D'Audney at ldaudney@fcgov.com.
Sept. 20-21	COLORADO WATER LAW SEMINAR, Denver, CO. See the website at **www.cowatercongress.org**, phone 303/837-0812, email macravey @cowatercongress.org.
Sept. 26-29	DAM SAFETY 2004, Phoenix, AZ. Contact: Assn. of State Dam Safety Officials, Phone 859/257-5140, FAX 859/323-1958, Email info@damsafety.org, website **www.damsafety.org**.
Oct. 10-13	CONFERENCE ON TAILINGS AND MINE WASTE '04, Fort Collin, CO. Contact: Linda Hinshaw, Dept. of Civil Engr., CSU, Phone 970/ 491-6081, FAX 970/491-3584, email lhinshaw@engr.colostate.edu.
Oct. 13	WORKSHOP ON WATER QUALITY, Denver, CO. See the website at www.cowatercongress.org, phone 303/837-0812, email macravey@co watercongress.org
Oct. 13-16	WATER RIGHTS & RELATED WATER SUPPLY ISSUES, Salt Lake City, UT. See the USCID website at **www.uscid.org/oridcall.html**.
Oct. 14	WORKSHOP ON ENDANGERED SPECIES, Denver, CO. See the website at **www.cowatercongress.org**, phone 303/837-0812, email macravey@cowatercongress.org.
Oct. 20	WORKSHOP ON A REVIEW OF FEDERAL ENVIRONMENTAL LAWS, Denver, CO. See the website at **www.cowatercongress.org**, phone 303/837-0812, email macravey@cowatercongress.org.
Oct. 27	WORSKHOP ON THE INITIATIVE PROCESS, Denver, CO. See the website at **www.cowatercongress.org**, phone 303/837-0812, email macravey@cowatercongress.org.
Nov. 1	WORKSHIP ON THE LEGISLATIVE PROCESS, Denver, CO. See the website at **www.cowatercongress.org**, phone 303/837-0812, email macravey@cowatercongress.org.
Nov. 3	WORKSHOP ON ETHICS, Denver, CO. See the website at **www.cowatercongress.org**, phone 303/837-0812, email macravey@cowatercongress.org.
Nov. 4	NEW IRRIGATION TECHNOLOGY: Benefits and Challenges, Denver Water Board Room, Denver, CO. Contact: Laurie D'Audney at ldaudney@fcgov.com.
Nov. 10	WORKSHOP ON THE NINE INTERSTATE COMPACTS, Denver, CO. See the website at **www.cowatercongress.org**, phone 303/837-0812, email macravey@cowatercongress.org.

Colorado State University
Colorado Water Resources Research Institute
Colorado State University

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