



COLORADO WATER

*Newsletter of the Water Center
at Colorado State University*

INSIDE: *Salinity in the Lower Arkansas River Valley
Logan County Water Quality Test Project
Cheesman Lake Watershed Restoration
Perspective on TMDLs
and more...*

JUNE 2000

SUMMER WATER MEETINGS

**'Clean and Flowing Water'
COLORADO WATER WORKSHOP
July 26-28, 2000
Western State College
Gunnison, Colorado
See page 43**

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SUMMER CONVENTION
August 24-25, 2000
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EDITORIAL



DEMANDING UNDERSTANDING: AT WHAT COST?

Editorial by Robert C. Ward, Director

During the AWRA Colorado Section Annual Meeting on March 17, 2000, Tad Foster presented an overview of the Total Maximum Daily Load (TMDL) program's history, current status, and future issues. Given the growing concern about the TMDL program, *Colorado Water* asked Tad if we could publish his remarks as part of our coverage of the AWRA Colorado Section meeting. Tad's remarks are presented on page 21 of this issue of *Colorado Water*.

As Tad's paper notes, the concept of a TMDL, as one of the legal tools provided to management to achieve compliance with water quality standards, has been interpreted differently over the years. For many years the identification of streams and lakes that do not meet standards (one task associated with a TMDL program) was performed within the capabilities of limited monitoring and management resources. The ability to annually assess standard compliance of every water body in Colorado, with scientific rigor, simply was not feasible with the available funding. Likewise, where standards were not being met, the limited monitoring resources were again employed, along with professional judgment, to establish appropriate discharge limits in the case of point discharges and recommend best management practices in the case of non-point sources of pollution.

The recent TMDL lawsuits are forcing new interpretations of TMDL provisions in the Clean Water Act. Assessment of standard compliance is being demanded on a much larger spatial and temporal scale than that performed in the past. Such a demand comes with huge implications to the monitoring and assessment resources of a management agency. Likewise, when detailed modeling must be performed to allocate wasteloads among dischargers, even more monitoring and assessment resources are needed. In addition, the science that underpins our understanding of water quality conditions and processes in a watershed is stretched considerably.

Tad asks the question in his paper, "But did Congress really authorize EPA to do everything everyone wants through the TMDL program?" In a related manner, I ask the question, "Has science defined and quantified its ability to produce the information and understanding demanded by our nation's water quality laws?" Without a definition of the ability and resources needed to acquire water information, it will be difficult to ensure that we can obtain the understanding needed to support legal and management strategies, regardless of the strategies chosen. When we do not attempt, up front, to match management strategies with our ability to obtain supporting information, we encounter the high levels of frustration currently associated with trying to enforce a law, and its changing interpretations, without the necessary data and information.

Having said the above, it is obvious that many water quality management agencies have recognized the need to obtain all water quality data and information they can possibly find. This is leading to the creation of 'water quality monitoring councils' around the U.S. where sharing of data and information among agencies and the public is discussed and enhanced.

It is surprising, in many ways, that we are resorting at this late date to 'monitoring councils' in an effort to better coordinate the sharing of diverse sources of water data. The acquisition of water data and information has been highly fractured in our government for many years as each agency, charged to manage a particular use of water, collects the data and information it needs using its own methods. There is no one, integrated source of unbiased water quality information. Other dimensions of our society, for example, the economy, weather, and agricultural production, have strong government support for coordinated regional and national acquisition of data/information needed to make informed business decisions, predict weather, and guide agricultural policy. 'Water' has no one agency managing a recognized database employed to produce an unbiased, basic understanding about its character in which all elements of society have confidence.

It is understandable that some people oppose the acquisition of water data and information due to water's private property characteristics, particularly in the West. As noted above, with each agency/interest group collecting its own water information using its own methods, it is not surprising that those with a private property interest in a resource would be concerned. The owners can be involved in expensive lawsuits regarding the true conditions of the water and who is causing any detected/perceived problems. Rather than having a real problem identified that needs a solution, we often spend huge sums in lawsuits arguing over the true nature of a potential problem and who might be responsible.

Can science help our society obtain the water information it needs to effectively and efficiently manage the nation's water resources? I believe it can IF water scientists, as economists have, develop open (i.e., transparent) and peer-reviewed methods to obtain water information. Furthermore, monitoring cannot be designed and conducted independently, by one agency, one university, or one interest group if everyone is to have confidence in the resulting information. Rather it must be produced with input from all in a manner not unlike the way the unemployment statistics, the Dow Jones Index, and Consumer Price Index are produced.

When we move the reporting about water quality conditions in our country from the front pages of our newspapers to the back, among the basic data on our economy and weather, then we will know that agreement has been achieved regarding the measuring and reporting of water conditions. When such information is available, we may have the knowledge to support an information intensive management strategy such as the TMDL program. Can we afford such an integrated monitoring effort? Are agencies at all levels of government willing to work together to monitor water quality in a coordinated manner? Can we afford to not obtain a scientifically sound understanding of water quality conditions in our country? These are difficult questions that the current TMDL debate is forcing us to answer.



Editor's note: the Editorial in the last issue of Colorado Water (April 2000), which addressed evolving water infrastructures needs in the 'New West', invited letters to the editor in order to be more inclusive of the perspectives presented on this increasingly important topic to the State of Colorado. Below are the responses received. Colorado Water wants to thank those who took the time to share their views.

Dear Dr. Ward,

At the end of your editorial in the April 2000 issue of Colorado Water, you asked for comments on the future of water in the West. Here are mine:

As I have said publicly, Two Forks will someday be built. The alternative to not building it is the drying up of productive agricultural land in Weld County. Can we continue to afford the loss of this valuable food production area? With the uncontrollable worldwide population increase, the time of a food shortage may not be far off.

Two Forks would divert 50,000 acre-feet (plus/minus) from the Western slope, which it could well afford. Yes, the loss of that spectacular canyon area is irreplaceable, but we have to take care of people first and foremost. They are here and are coming.

Sincerely,

John R. Fetcher
Secretary, Upper Yampa Water Conservancy District
Steamboat Springs, Colorado

Dr. Ward, you stated "the 'New West' is demanding additional uses of water." Absolutely! Foremost is demand by growing urban areas across the state for consumptive use water. Senior water right holders are generally well-compensated when their water is purchased by cities or developers. This money can be used to reduce farm debt, purchase farmland away from busy highways, or to provide cash for retirement.

However, the sale of water rights has permanent effects on a region. Loss of open space, wildlife habitat, and farm income are serious problems for our state. Some would argue the open space and wildlife habitat can be replaced through conservation easements. The problem is always lack of money to acquire these properties. How important is farm income? If you work in the computer sector in metro Denver, agricultural production may not be high on your list of concerns. However, if you operate a farm implement store, loss of farm dollars is a very serious problem.

What can Colorado water managers do to encourage coexistence of irrigated agriculture in the midst of \$500,000 homes?

I'm afraid there's very little. Willing sellers will relinquish senior water rights to willing buyers. Conservation easements, right-to-farm laws, and education of new urban neighbors can provide a bit of relief, but, by and large, western water rights will shift from agriculture to urban uses. The landscape of Colorado will change once again.

Tom Cech, Executive Director
Central Colorado Water Conservancy District
Greeley, Colorado

Robert Ward, Director
Colorado Water Resources Research Institute
Via email: rcw@lamar.colostate.edu

Dear Robert,

I am writing in response to your editorial that was published in the April 2000 issue of Colorado Water. Sorry about the lateness! I should also note that I am writing on my own behalf, not as a representative of the Upper Gunnison River Water Conservancy District. While reading your editorial, several thoughts crossed my mind regarding Colorado's evolving values and infrastructure needs. From the perspective of the West Slope, and in particular the Gunnison River Basin, the subject of infrastructure is indeed one of interest.

Existing infrastructure in the Upper Basin is dominated by the Bureau of Reclamation's Taylor Reservoir (Uncompahgre Valley Project), Gunnison Tunnel, and Aspinall Unit storage projects. Operation of these facilities has been primarily "traditional" in nature, but there are numerous "new" uses that are being identified which will impact the existing irrigation/hydropower operational strategy. Local demands include meeting water needs for the Black Canyon of the Gunnison National Park and downstream endangered fish species. Strategies for meeting these demands are in turn affected by the operation of other western water infrastructure, i.e. changes in releases at Glen Canyon impact peaking power availability thereby putting more demand on the Aspinall Unit for hydropower production.

Proposed infrastructure components involving the diversion of water from the Gunnison basin to other basins is a matter of considerable concern. As currently proposed by the Union Park Water Authority, infrastructure would be constructed to

divert water from the headwaters of the Gunnison River to the Front Range for eventual use by municipalities in need of supplemental supplies. This type of transfer could be categorized as a “traditional” approach to meeting water needs on the Front Range, and has been met with considerable opposition from West Slope and other entities. Removal of water from the basin would impact existing water users, environmental values, the local economy, and other interests in the basin such as the National Park Service. Infrastructure proposals have also recently taken the form of legislative initiatives that would mandate state involvement in construction of a transbasin diversion project.

As you note in your editorial, values and demands are changing, and water management and infrastructure planning will continue to evolve to reflect these changes. What is not really addressed however is the role of water law and education in the evolution of water resources planning and management. Good science is certainly the foundation of good decision making, but it is not the only factor. The current legal structure provides the basis for decision makers working to address water needs, and education plays a key role in determining the political reality. For example, pursuit of additional Western Slope water as a means to address East Slope needs continues even though the need to use West Slope water to recover the endangered fish is documented scientifically. What is the role of research and science in terms of making decisions regarding addressing East Slope needs? Research shows that the groundwater resources of the Denver Basin Aquifer are sufficient to meet Front Range demands well into the future, yet there are continued strong political attempts to obtain West Slope surface water supplies to address growth-related demand. There appears to be a disconnect between the scientific findings and the political reality.

What is needed is a complete and objective analysis of all the impacts of our options for addressing water supply needs. Today’s laws allow for a somewhat fragmented review based on county land use authority and federal permitting. Existing infrastructure clearly plays a key role in the decision-making process, and the operation of existing facilities such as the Aspinall Unit is in transition due to numerous internal and external factors. Analysis of water infrastructure planning and development needs to incorporate numerous factors and concerns – and I’m not sure our existing legal system is set up for that. Decision-makers are trying to address sharp increases in demand, and they need good information. They need to understand the full impacts of their decisions. They need to be aware of the status of current research regarding water supply availability. Maybe we will end up at the same place either way, but the process would be improved if the facts were better integrated into the political reality. Thanks for the opportunity to comment on this subject.

Kathleen Klein

Letter to *Colorado Water*

The Editorial in the April 2000 edition of *Colorado Water* entitled “Western Water Infrastructure - Sustaining the Life Blood of the New West in the 21st Century” was thought provoking. Colorado is a fine example of how water infrastructure has and continues to evolve to meet changing societal needs.

In Colorado, the water infrastructure consists not only of the infrastructure’s more conventional structural components such as diversion structures, canals, pipelines, and dams that are used to divert, deliver, or store water, but also includes Colorado’s laws and water rights administration framework. Colorado’s water infrastructure system has proven itself to be stable, adaptive, and resilient throughout the 19th and 20th centuries. Colorado’s system has adapted to society’s “new” needs over time as witnessed by the fact that senior water rights have been and are being changed and new water rights are being developed to satisfy traditional values including irrigation, municipal, and industrial uses as well as “new” uses including in-stream flows, snow making, environmental needs, and recreational uses. Many of the structures built a century ago continue to provide water for human consumption, agriculture, wildlife, and recreation uses and are now providing water for environmental needs. In the future, new structures will be developed, and water management adjustments will be made in compliance with the diverse laws and regulations governing water use, both federal and state. The water supply needs for traditional and new purposes have been and can be satisfied within Colorado’s system as it continues to evolve in the future.

CWRRI’s efforts to work with Colorado water managers is welcome, needed, and essential in identifying and examining the many issues associated with the complex water infrastructure system now existing in the state. The integration of changing needs and values into the existing infrastructure can be better understood and accomplished with sound science. Technical understanding and definition are essential in making decisions. Important too are efforts to incorporate the knowledge and experience that have been gained and passed down by water administrators, water managers, and organizations which have played a role in successfully meeting the needs of water users and the environment over the past many decades.

Modification and adaptation of Colorado’s water infrastructure cannot fairly, equitably, or successfully be accomplished without considering the significant investments made by the water user community and their historic and continuing reliance upon those investments. While the future in Colorado will continue to bring about changing needs and values related to water, the foundation for appropriate modifications

to the existing water infrastructure remains within Colorado's existing and evolving system of laws and administrative framework. Solutions which will provide water for competing needs will be made better through collaborative efforts between water management entities based on sound science and technology developed through research, coupled with the incorporation of the experience and knowledge that has been gained over the decades of water management and administration.

Eric Wilkinson, Manager
Northern Colorado Water Conservancy District
Loveland, Colorado



Letter to *Colorado Water*

No matter how one characterizes the West: "New," "Old" or something in between, Coloradans will require water to quench their thirst, agricultural products to feed their families and power to heat their homes. While demand for wildlife, recreation and other uses increases, continued investment in water supplies and infrastructure becomes even more of a necessity.

While increasing demands from diverse sectors may seem incompatible, there are overriding common interests. For

example, irrigated agriculture provides a tremendous benefit to Colorado's environment, economy and quality of life. These irrigated lands help to sustain both our economy and our wildlife. In fact, over 90% of the habitat for endangered species exists on private lands. And on many of these lands, water is delivered in amounts, and at times, that would have been impossible without storage.

The prior appropriation doctrine and the sanctity of our state laws have guided policy within the state for more than one hundred years. They shall continue to do so. Meanwhile, common threats to Colorado water, such as unwarranted federal intrusions and increased demand from other states, serve to unite our interests. So too should the need to develop additional supplies.

The answers lie not with more government or more study, but with continued hard work to find common ground. Gone are the days where water supply projects are built with little regard for local needs or environmental concerns. In the future, successful projects will rest upon a foundation of cooperative efforts and common interests.

Greg Walcher, Executive Director
Colorado Department of Natural Resources
Denver, Colorado

ANNOUNCEMENT REGARDING THE FHL HISTORY PROJECT

A multi-year project to chronicle the history of the Farmers' High Line Canal and Reservoir Company on Clear Creek is now complete. Greg Silkensen, a graduate student in history at the University of Colorado-Boulder, has spent the last several years researching and writing a history of the company. The book, **THE FARMERS' HIGH LINE CANAL AND RESERVOIR COMPANY: A Century of Change on Clear Creek**, is a 5-chapter narrative of the company between 1885 and 2000. The work chronicles Farmers' High Line's transformation from a rural irrigation company in the late nineteenth century to a major water source for Denver's northwestern suburbs one hundred years later.

While the Farmers' High Line Canal was only one of many small irrigation ditches constructed on Clear Creek during the late nineteenth century, it became the largest ditch to divert water from the creek. Established in 1886, Farmers' High Line has operated continuously for more than 114 years. Major themes in the company's history include: Farmers' High Line's origins and its initial financial and legal difficulties; water scarcity and the company's persistent search for additional storage and supplies; chronic water quality problems associated with upstream mining operations on Clear Creek; and the effects of Denver's suburban population growth during the post-World War II era.

The book includes numerous maps, photographs, and an appendix listing each of the company's directors and officers between 1885 and 2000. Limited copies are available for \$15.00 per book at the company's office. Shipping and handling are an additional \$5.00 per book.

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MODELING AND ANALYSIS OF SALINE-HIGH-WATER-TABLE PROBLEMS IN THE LOWER ARKANSAS RIVER VALLEY, COLORADO

by *J. Philip Burkhalter, Timothy K. Gates and John W. Labadie*
Department of Civil Engineering, Colorado State University

The Threat of Salinization

Waterlogging and salinization are age-old nemeses of irrigated agriculture, and continue to plague irrigated regions around the world. In fact, about 20-25% of the world's irrigated lands, including 27% of those in the United States, are affected by saline high water tables (Ghassemi et al., 1995; National Research Council, 1996). The threat to global crop production is serious and losses, when measured in economic terms, are staggering (Postel, 1999). Ghassemi et al. (1995) estimated that worldwide productivity loss is valued at about \$10 billion per year. While losses to agricultural production are indeed high, any facilities provided for adequate management of the problems must be cost-effective. Concern is also strong regarding possible long-term damage to the environment from return flows to rivers, downward percolating saline waters, and disposal of saline drainage water.

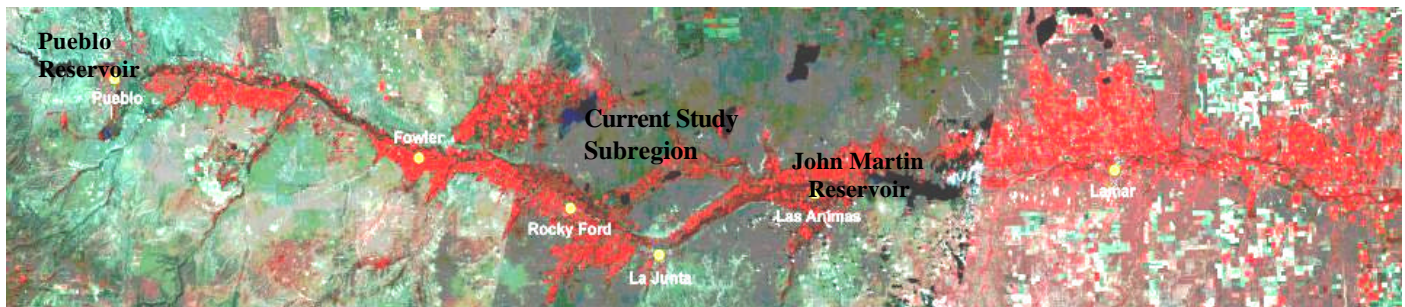


Figure 1. Composite Landsat TM satellite image of lower Arkansas River basin in Colorado

The research described herein focuses on one of the most salinity-affected irrigated regions in the U.S., the Lower Arkansas River Basin in Colorado (Figure 1). Irrigated since the 1870s, the lower Arkansas Valley began to develop saline high water tables in the early part of the twentieth century. Over the years, the problems have advanced and ebbed in response to sporadic human intervention and varying climatic conditions. Recently, however, due to a variety of interacting factors, conditions have progressively worsened. Construction of John Martin and Pueblo Reservoirs and subsequent modification of basin-wide system operations, such as the winter water storage program, have intensified problems of high water table elevations and salinity levels (Watts and Lindner-Lunsford, 1992). These problems have been further aggravated by decreased groundwater pumping in the Valley over the last decade, due in some measure to the Compact lawsuit between Kansas and Colorado.

According to Cain (1997), water tables in the study area rose from 0.3 to 1.3 meters during the period 1969 to 1994. Problems have intensified to the point where land is being taken out of production and significant yield losses are occurring (Valliant, 1997). In a recent survey, Frasier et al. (1999) found that about half of all respondents in Bent, Prowers, and Otero counties in the Arkansas Valley expressed significant concern about high concentrations of salinity. Figure 2 gives visual evidence of the problems of salinization and high water tables in the study area.



Figure 2. Example of visible surface salt crusting on an irrigated field in the study area

Field Data Collection Program

A previous article in Colorado Water (Gates, 2000) described the intensive data collection effort associated with this research project that has been conducted over the past three years. Without this considerable data collection program, the assessment of salinity problems in the basin remain anecdotal in nature and ill-defined. Table 1 gives a summary of the

scope and extent of field data collection associated with this research. These data are valuable in their own right for describing the high water table and salinity problems existent within the basin, but also provide the foundation for modeling studies for prescribing cost-effective and environmentally sound solutions to these problems.

Table 1. Summary of field data collection program

Data Type	Spatial Resolution	Measurement Accuracy	Measurement Method	Measurement Frequency	Purpose
<i>Observation Wells</i> # Georeferenced Locations # Ground surface elevations	75 wells; approx. 1 well per 300 ha $10^2 - 10^3$ m $10^2 - 10^3$ m	10^{-2} m 10^{-2} m	GPS* GPS*	Once Once	Development of DEM for GMS model
<i>Water Table Depth</i>	$10^2 - 10^3$ m; depth to 3 m	10^{-3} to 10^{-2} m	Manually with tape measures	Irrigation Season-- Weekly/biweekly	Calibration of GMS model
<i>Soil Salinity</i> # EM probe # Soil samples	50 fields with observation wells** Depth up to 1.2m spheroid in root zone 3 sets of 4 samples with depth at 2 locations in field at EM-38 probe sites	50-60 measurements per field $10^{-2} - 10^{-1}$ m	Geonics™ EM-38 Probe Standard USDA procedure; Hach™ SIW-1 test	2 per season; May-June; Aug-Sept. 2 per season; May-June; Aug-Sept.	EC estimates EC of soil extract; Water content;
<i>Groundwater Salinity</i> # EC and temp. # Samples	In observation wells	$10^{-1} - 10^0$ m depth to 3 m 3 depths 3 depths	Conductivity meters	Irrigation Season-- Every 7 to 14 days	Obtain relation between EC values and TDS
<i>Aquifer Properties</i> # Soil texture # Hydraulic conductivity	Top 3 m; 73 wells $10^2 - 10^3$ m; depth to 3 m $10^2 - 10^3$ m; depth to 3 m		6 soil core samples per well Auger hole tests	Once Continuous—pressure transducer with data logger	Correlation of K_h values to soil texture using hydrometer analysis
<i>System Topology</i> # Streams # Canals # Drains	$10^2 - 10^3$ m $10^2 - 10^3$ m $10^2 - 10^3$ m	$10^0 - 10^1$ m $10^0 - 10^1$ m $10^0 - 10^1$ m	GPS+ GPS+ GPS+	Once Once Once	System topology for GMS model
<i>Hydrography</i> # Water surface elevations # Canal cross sections # Surface water salinity	$10^2 - 10^3$ m $10^1 - 10^2$ m $10^2 - 10^3$ m	10^{-1} m 10^{-1} m	GPS* Manual Conductivity meter	Once Once 2 per season	System hydrography for GMS model

* Trimble™ 4600 LS Surveyor

** 10 additional fields in Bent County

+ Magellan™ GPS Tracker

Some of the solutions being studied include improving irrigation efficiency, rehabilitating and modernizing aging water-delivery infrastructure, installing and maintaining subsurface drainage systems, conjunctively utilizing groundwater and surface water resources in the Valley, including vertical drainage for water table control; and adopting new and more salt-tolerant crop varieties. These site-



specific actions, however, cannot be adopted independently. The entire lower Valley is an interdependent web in which local changes ripple upstream and downstream via irrigation-stream-aquifer interactions and water rights issues. Basin-scale changes in river operations can either dampen or exacerbate the effects of localized actions. A variety of political and economic issues press for basin-scale changes through conservation, altered operations, and redistribution of water resources in the Valley. Also, cities along Colorado's front range are looking to agricultural water rights in the Valley to meet increasing urban demands, and it appears that new federal regulations will alter minimum in-stream flow requirements.

Preliminary Modeling

A study reach within Otero County was selected which extends for around 40 km from Manzanola to the Otero-Bent County line (Figure 1). This size is large enough to capture the variations of soil types, hydrogeology, irrigation and drainage infrastructure, and crops that are characteristic of the Valley upstream of John Martin dam, but small enough so that data collection is feasible. The Department of Defense Groundwater Modeling System (GMS) (Brigham Young University, 1997) was used to create a flow and salt transport model of the study reach using data collected as summarized in Table 1. Designed to serve as a comprehensive groundwater modeling environment, GMS acts as a graphical "GIS-style" interface for several different models. The GMS interface is divided into modules that allow the user to enter and analyze the various data types for the particular models being utilized. The two models within the GMS package employed in this investigation include: MODFLOW (McDonald and Harbaugh, 1988), a modular three-dimensional finite-difference groundwater flow model, and MT3D (Zheng and Wang, 1998), a modular three-dimensional contaminant transport model that uses MODFLOW results in its analysis.

Creation of background image. To aid in the construction of a conceptual model and interpretation of model output, Landsat Thematic Mapper (TM) data were obtained from the EROS Data Center and an image created using IDRISI GIS (Clark University, 1997) image processing functions. The resultant image can be seen in Figure 1 as the highlighted Current Study Subregion representing data collected on July 5, 1997. These data were chosen since they fall in a period of little precipitation within the irrigation season. Consequently, it can be reasonably assumed that areas indicating high soil moisture levels (i.e., red and dark red areas on the infrared image) are irrigated fields. Spatial resolution of the image is 28.5 meters, allowing major landmarks to be clearly visible for registration of the image. This image was imported into GMS using the import utilities within the *Map Module*.

Creation of conceptual model. The conceptual model is a simplified representation of the surface and groundwater system. Arcs, polygons, and points are used in GMS to represent features such as rivers, tributaries, canals, reservoirs, recharge zones, and wells. Attributes for each feature, such as bed elevation, channel dimensions, and pumping rates, are also entered and stored in the GMS database. GMS uses this database to create the input files for the imbedded numerical models (i.e., MODFLOW and MT3D for this study). To simplify data entry, GMS allows the user to enter each data type as a layer or theme. The following themes were entered to create the basic conceptual model of the study reach:

- # *Surface Water System* - System layout data were digitized from USGS quadrangle maps with adjustments made using the background Landsat image (Figure 3). River cross-section geometry was estimated based on data from Nadler (1978), with tributary and canal cross-section geometry obtained from field observations. Water surface elevations were measured during summer 1998 using a survey quality Trimble 4600LS GPS system. Additionally, USGS gauging station and map data were used to estimate water surface elevations in some areas.

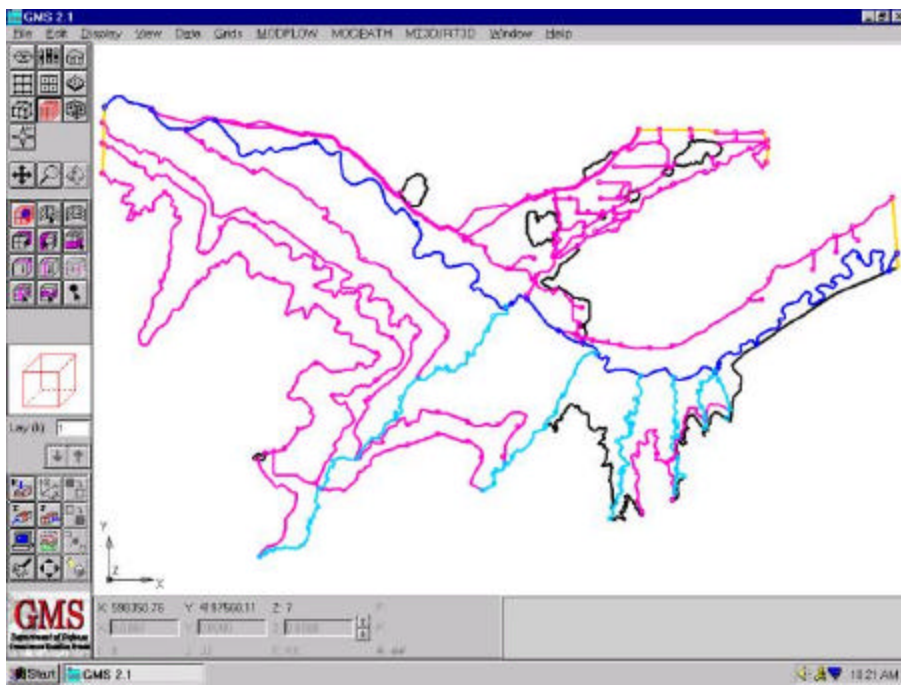


Figure 3. Surface water system theme

Conductance for estimating seepage in or out of surface water features was estimated for each system component based on values reported by Watts and Lindner-Lundsford (1991).

- # **Field Boundaries** - Field boundaries were digitized from aerial photographs and field maps provided by the Farm Service Agency (FSA) in Rocky Ford and imported into GMS within the Map Module. These field boundaries were used, along with crop type data and estimates of irrigation application efficiency, to estimate recharge due to irrigation.
- # **Pumping Wells** - Each existing pumping well within the study reach was entered as a point within a sink/source coverage. The coordinates of each well, as well as historic monthly pumping rates, were obtained from the State Engineer's Regional Office of the State Engineer in Pueblo. For the steady-state model, pumping rates entered reflect average rates from 1996 through 1998 for the modeled week (week 33).

Creation of the finite-difference grid. The finite-difference grid defines the cells in which MODFLOW and MT3D perform numerical calculations of groundwater flow and solute transport. The size of each grid cell greatly affects the accuracy of the results, since each cell represents average parameter values for the area it contains. For the study reach, grid cell size was selected based on analysis of field-size data obtained from the FSA. Average field size within the study area was calculated to be 6.27 ha (15.50 acres). Therefore, a square grid cell with a side dimension of 250 meters was selected for use within the model. For our study, this cell size translates to 104 rows and 174 columns, or 18,096 total cells, of which 6,314 cells overlay the modeled aquifer region and are used in model calculations (Figure 4).

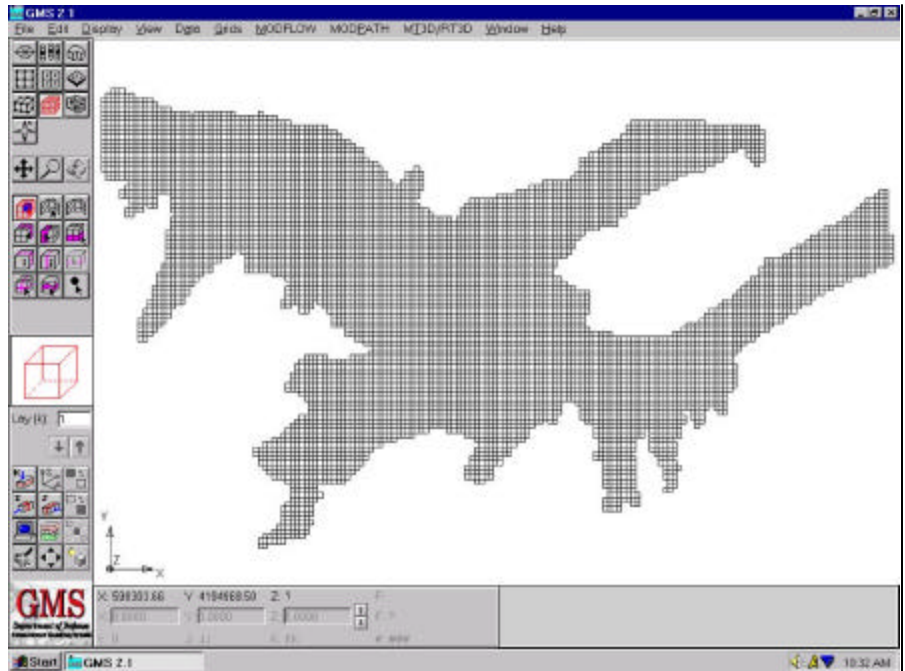


Figure 4. Finite-Difference grid theme

Additional input data sets. To complete the conceptual model of the system, additional data sets not defined in the Map Module of GMS must be input into the model.

- # **Ground Elevation** - Data points were taken from USGS quadrangle maps of the area and interpolated for importation into the MODFLOW Block-centered Flow (BCF) package.
- # **Hydraulic Conductivity** - Hydraulic conductivities were estimated from available transmissivity data (Wilson, 1965; Weist, 1962) based on estimated aquifer thicknesses. These data were interpolated and imported into the MODFLOW BCF package.
- # **Water Table Elevation** - Data on water table depth below ground surface were obtained from Weist (1962), representing late summer (July-September) readings from 1959. This data set was used in the preliminary modeling phase due to a lack of more recent water table depth data during the irrigation season. Recent data collected through this project indicate that water table depths are now much shallower over the study area.
- # **Bottom Elevation** - Bedrock depth data was obtained from Weist (1962), imported into GMS, and interpolated using the Linear method. The interpolated values were subtracted from the ground elevation data set and imported into the MODFLOW BCF package.

Estimation of recharge and evapotranspiration (ET). To arrive at estimates of recharge and ET, data were analyzed using an irrigation and fertilizer scheduling program called CropFlex98 (Broner and Lorenz, 1997). The steps in the analysis are as follows:

- # **Analysis of crop types** - Utilizing data acquired from the FSA, the average percentages of each crop type grown within the study area were calculated (based on data from 1992 through 1997).
- # **Assigning crop types to modeled fields** - Based on the calculated average percentages, crop types were randomly assigned to each modeled field.
- # **Estimation of crop water requirements, crop ET, and deep percolation** - Using meteorological data obtained from the CoAgMet on-line data center (Colorado Climate Center 1999) and crop coefficient data provided by Dr. Israel Broner (Colorado State Univer-

sity, personal communication), the soil moisture balance component of CropFlex98 was used to estimate irrigation requirements for each crop type for years 1993 through 1998. Crop ET and deep percolation due to precipitation were also calculated by CropFlex98. Calculated crop ET values were then input into each field polygon based on the assigned crop type. MODFLOW uses these values to estimate losses due to upflux.

- # **Calculation of recharge values** - Recharge values for each field were calculated based on CropFlex98 results and leaching fraction estimates generated based on a truncated normal distribution developed from field data collected for a region with similar irrigation practices in the South Platte River valley. Calculated crop requirements for each crop type were averaged over the data record for the modeled week (week 33) and used with the leaching fraction estimates to estimate recharge amounts. A unique value was calculated for each field polygon by applying the distribution of leaching fraction estimates and the appropriate crop requirement based on the assigned crop type.

Incorporation of salinity data. Regression equations developed by Cain (1987) and Ortiz et al. (1998) were used to relate measured EC and salinity (total dissolved solids, TDS) for all surface water and groundwater readings. Since the EC-to-salinity relationship varies with location, an inverse distance weighting interpolation routine was used to associate the regression equations at each measured data point. The data sets collected and incorporated into the model include:

- # **Surface Water EC** - An Orion™ Model 128 EC meter was used to measure 113 surface water points throughout the study area during the summer of 1998. These data were converted from EC into salinity concentration and entered into the conceptual model using the *Map Module*.

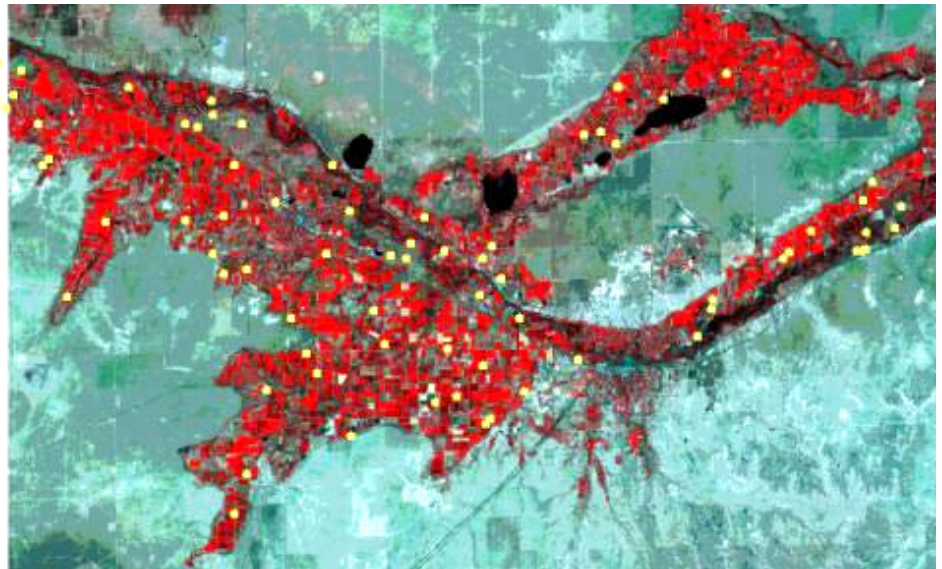


Figure 5. Observation well locations

- # **Groundwater EC** - Groundwater EC data were similarly collected at 75 observation wells which were installed and monitored over the summer of 1999 (Figure 5). These values were converted to salinity concentrations and imported into GMS in the Scatter Point module. The data were then distributed using inverse distance weighting interpolation and entered into the MT3D Basic Transport package as Starting Concentrations. It was assumed that groundwater salinity and salinity of the upflux (labeled as Evapotranspiration in the MT3D Source/Sink Mixing package) are equivalent.
- # **Soil bulk EC** - Geonics™ EM38 electromagnetic ground conductivity meters were used to find the soil bulk EC to a depth of about one meter over fields distributed approximately to locations shown in Figure 5. Regression equations from Sheets et al., (1994) and McNeill (1992) convert the EM38 soil bulk EC data into saturation extract EC based on soil type, which are used to estimate soil water EC based on soil moisture content. These EC values are then converted to salinity using the relationship developed by Cain (1987). These data are used in conjunction with the surface water salinity data to approximate the salinity of the recharge water for entry into the MT3D model under the Recharge option in the Source/Sink Mixing package.

Preliminary Modeling Results

The purpose of the preliminary modeling is to aid in directing the future course of data collection and provide a preliminary indication of the sensitivity of the stream-aquifer system to general widespread changes in groundwater extraction and recharge of excess irrigation water. The GMS interface was used to translate all of the conceptual model data sets into MODFLOW and MT3D input file formats. After a series of debugging procedures, the models were used to investigate the following scenarios:

- # **Scenario 1: Baseline Conditions** - simulate average conditions for the 33rd week of the year as a baseline for comparing subsequent model scenarios.
- # **Scenario 2: Increasing Pumping Rates by 20%** - impacts of increasing the average pumping rate of all pumps within the study area by 20% and routing additional pumped flow into nearby drains.
- # **Scenario 3: Increasing Pumping Rates by 30%**

- # Scenario 4: Reducing Recharge Rates by 20% - impacts of reducing average recharge rates over the entire study area by 20% by improving irrigation efficiency.
- # Scenario 5: Reduction of Recharge Rates by 30%
- # Scenario 6: Increasing of Pumping Rates by 20% and Reduction of Recharge Rates by 20%
- # Scenario 7: Increasing of Pumping Rates by 30% and Reduction of Recharge Rates by 30%

As expected, results from evaluation of the scenarios indicate that the effects of increased pumping are more localized, whereas impacts from reductions in recharge are more widespread. Table 2 summarizes the important information extracted from the preliminary modeling output.

Table 2. Preliminary model output summary

Scenario No.	Maximum Reduction in Water Table Elev. (meters)	Ave. Reduction in Water Table Elevation (meters)	Standard Deviation (meters)	Percent Reduction in Salinity from Groundwater Upflux
1	-	baseline	scenario	-
2	0.482	0.012	0.032	0.6
3	0.749	0.017	0.045	0.9
4	0.410	0.045	0.063	1.9
5	0.632	0.068	0.093	2.9
6	0.954	0.058	0.081	2.6
7	1.562	0.086	0.125	3.8

Figure 6 shows the output of Scenario 7 in terms of water table drawdown. Results indicate that integration of strategies for increasing pumping rates and reducing recharge is important for producing significant basin-wide effects. Future modeling efforts will investigate other alternatives such as reducing seepage by canal lining, subsurface tile drainage systems, and lowering of river levels.

Coupled with the objective of lowering high water tables is the reduction of high salinity levels. The steady-state model yielded only limited information about decreasing salinity. Once a transient model has been established, the long-term effects of alternatives on salinity levels will become more evident. One interesting output result can, however, be extracted from this preliminary salinity model. The reduction of accumulated salinity deposited in the root zone, due to groundwater upflux, can be estimated from the MT3D output, as shown in Table 2. Ongoing studies are focusing on development of a transient model that can better estimate salinity that would be removed from the root zone by the increased leaching that might accompany the lowering of the water table.

Conclusions

The extensive field data collection program associated with this research confirms that extensive and severe saline-high-water-table problems exist in the Lower Arkansas Valley, resulting in diminished crop productivity (Gates, 1999). Although the saline high water table problem is serious, it seems recoverable through implementation of strategies developed by careful modeling. The preliminary groundwater flow and salinity modeling of the study region indicates that the effects of increased pumping are localized, whereas the

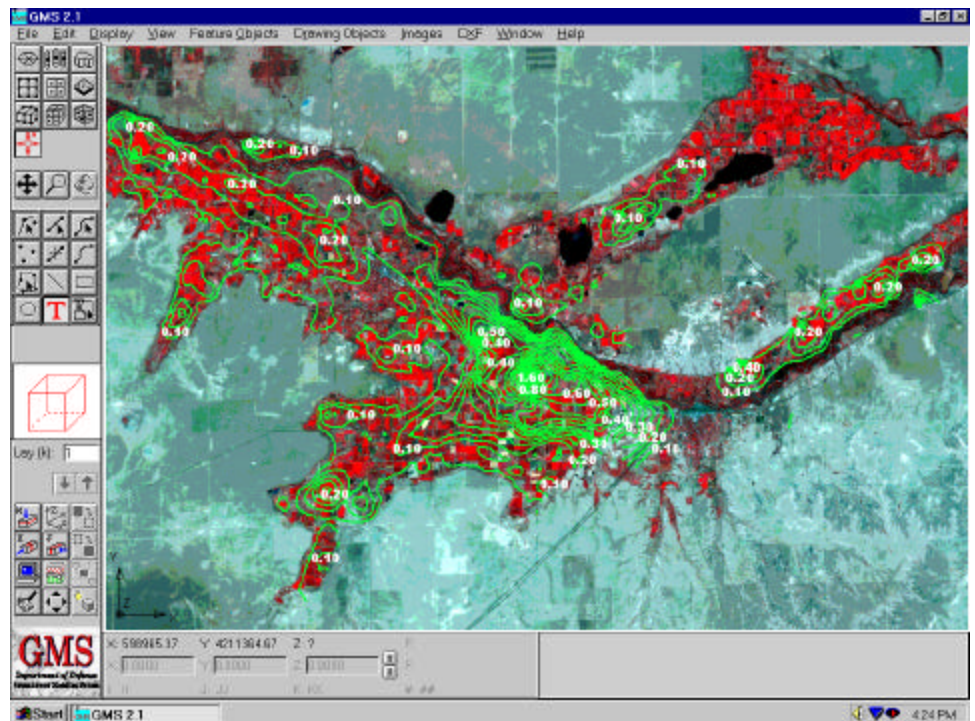


Figure 6. Scenario 7 - contours of estimated water table drawdown



potential effects of changing irrigation practices to reduce groundwater recharge can be widespread. However, solution alternatives incorporating multiple BMP's including seepage control and subsurface drainage systems, and alternatives investigating the reduction of river levels should be considered in future modeling efforts. Additionally, the current steady-state model should be expanded to consider time-varied (i.e. transient) changes to the system so that the long-term effects of alternatives can be evaluated. Critical to the development of transient models is the continuation and expansion of the described data collection activities.

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Acknowledgements. *This research is funded through grants obtained through the Colorado Agricultural Experiment Station, the U.S. Bureau of Reclamation, the Colorado Water Resources Research Institute, the U.S. Geological Survey, and the Colorado State Soil Conservation Board. The investigators are grateful for important help from many other cooperating agencies, including the USDA-NRCS Area Office in La Junta, the Southeastern Colorado Water Conservancy District, the Pueblo Subdistrict Office of the USGS, the Eastern Colorado Area Office of the USBR, the District II Office of the Colorado Division of Water Resources, the USDA Farm Services Agency, and the Bent County Soil Conservation Board. The important contributions of Jim Valliant, Colorado State University Cooperative Extension, are also gratefully acknowledged.*



LOGAN COUNTY WATER QUALITY TEST PROJECT

1990-91 Test Project

Water quality is identified as a state and national issue. To determine educational programs needed in Logan County, an ad hoc committee of the Colorado State University Cooperative Extension Logan County office advisory board designed a project to establish benchmark domestic well-water quality data. A local organization, Ag Search Inc., donated money that was coupled with user fees supplemented to the Colorado State Cooperative Extension Logan County office budget to pay for the project.

Participants in the project brought 358 water samples to clinics at seven sites in the county. Those samples were tested for lead, nitrates and bacteria. Of those tested, 101 were screened for lead, 149 for nitrates and 108 for bacteria.

Bacterial contamination of water supplies was found to be high; 36 percent of the samples were positive for coliform. Northeast Colorado Health Department (NCHD) officials cautioned that many of these samples could have been

contaminated by improper sampling techniques such as bacteria from a source other than the well.



Nitrate readings of more than 10 ppm were a problem in 24 of the 149 samples (16.2 percent).

Sodium was consistently found in high concentrations in the South Platte River Valley, reflecting the different geologies on either side of the river. More than 86 percent of all samples tested higher than the 20 ppm sodium recommended by the American Heart Association.

Only one out of 101 samples tested for lead was found to be above the .05 mg/l level of detection. Colorado State University's soil lab only could detect at the .05 mg/l level. Therefore, only when a water sample exceeded the maximum lead contaminant level then permitted by Environmental Protection Agency could lead be identified.

1996 Test Project

This project was funded by Colorado State University Cooperative Extension. Fifteen hundred dollars came from a US Department of Agriculture-funded water quality grant, \$750 came from initiative grant money, and the rest was supplied by the county budget and user fees. Two hundred and four citizens dropped water samples off at seven pick-up sites within the county. Of those participants, 124 (60.8 percent) had taken part in the 1990-91 testing. Nitrate samples did not increase and many showed a decrease.

Nitrate readings are more variable than was realized. Some wells remain consistent, while others can change up to 50 percent with a month's time. Changes can be attributed to

seasonal weather and the use of a more accurate nitrate-screening tool.

The 1996 bacteria testing showed encouraging results. Of the 124 wells tested for bacteria, 97 wells tested satisfactory for bacteria, while 27 (22 percent) tested positive for total coliform. None were positive for E.coli or fecal coliform bacteria. This compared to 27, or 36 percent, of the 1990 tests showing contamination. From the previously tested wells, 20 showed undesirable bacterial counts in the 1990 test; 15 of them were free of bacteria, a 75 percent improvement rate.

Conclusion and Future Plans

Overall, the tested domestic wells in Logan County met health standards. The water in Logan County does have some apparent problem sites for nitrates, salts and other minerals. Education for bacterial contamination of wells needs to continue since 22 percent of the tested wells had unacceptable bacterial growth. Also education for soft water wells is important because there are soft water wells

high in sodium and some of them are naturally soft.

Plans are underway to repeat the domestic well testing in 2001. Colorado State Cooperative Extension agents will cooperate with Northern Colorado Health Department and other local groups who have indicated interest in the program.





**CHEESMAN LAKE – A HISTORICAL PONDEROSA PINE
LANDSCAPE GUIDING RESTORATION IN THE
SOUTH PLATTE WATERSHED OF THE COLORADO FRONT RANGE**

*Merrill R. Kaufmann
USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO
and
David L. Hessel
Colorado State Forest Service, Fort Collins, CO*

An unlogged and ungrazed ponderosa pine/Douglas-fir landscape at Cheesman Lake in the South Platte watershed provides critical information for restoring surrounding forests influenced by more than a century of human impact. Cheesman Lake is a reservoir on the South Platte 40 miles southwest of Denver, owned by Denver Water and created by completion of a dam in 1905. Logging and grazing were prevented around the reservoir to protect the watershed.

The primary components of this 35-km² (13-mi²) landscape include openings, pure or nearly pure ponderosa pine stands, mixed ponderosa pine/Douglas-fir stands, and persistent old-growth stands having very old ponderosa pine or Douglas-fir trees. Estimates of the proportion of the historical landscape occupied by each of these patch types are shown in the top portion of Figure 1.

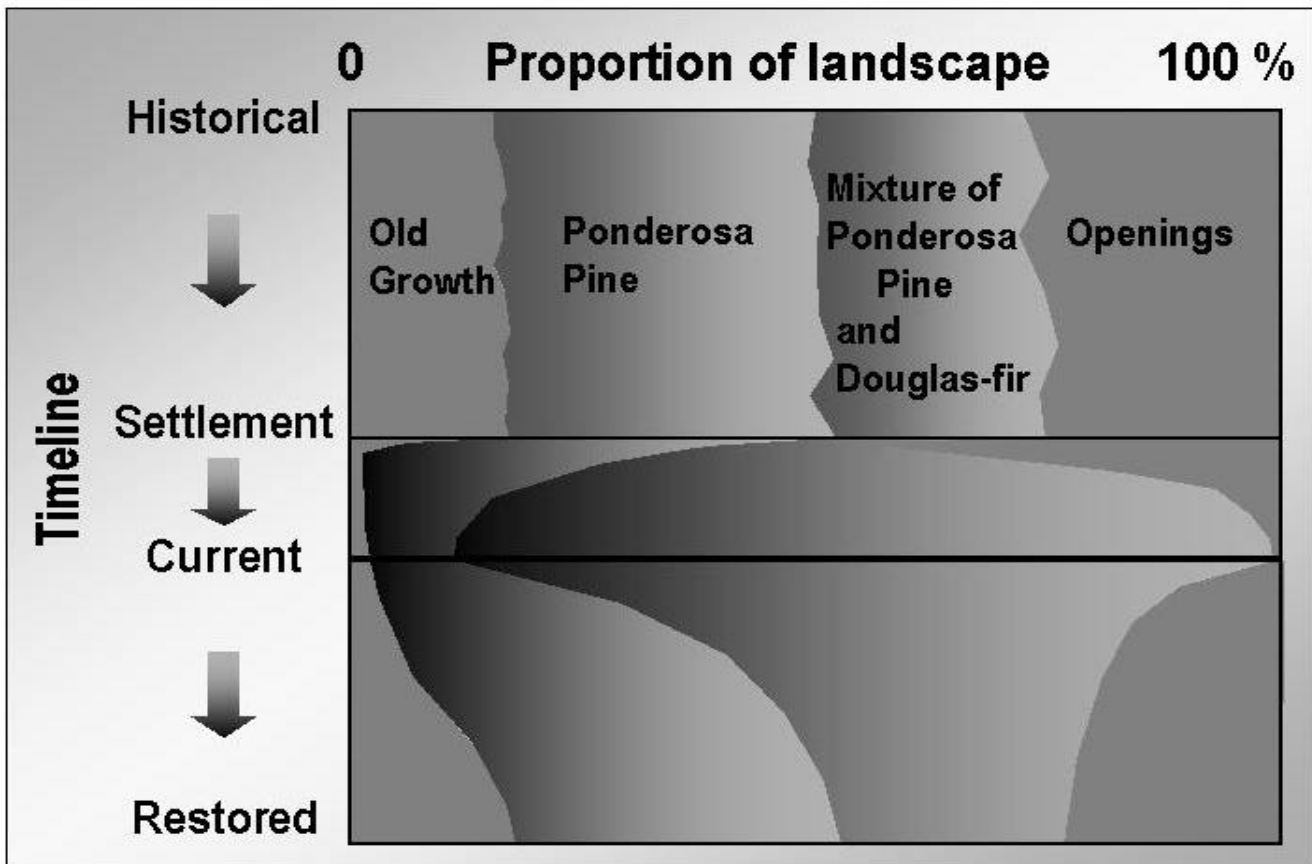


Figure 1. *Components of the ponderosa pine/Douglas-fir forest landscape in the South Platte watershed, for several centuries before settlement (upper), current conditions affected by more than a century of human activities (middle), and following potential forest restoration activities (lower). Darker shading reflects higher tree density.*



Research on fire history for the area covers an 800-year period, with the oldest fire scar dating to 1197. The oldest tree ring measured, from an old log on the ground, was dated to 991. The fire history, combined with extensive measurements of tree age where fires occurred, indicate that the historical landscape had a “mixed severity” fire regime, which is characterized by a combination of low-intensity surface fire and patchy crown fire. Tree establishment in openings created by fire was often delayed by climatic conditions, especially on south slopes. Tree establishment occurred in pulses, each about a decade long and with an average of two pulses per century, presumably because of more favorable climatic cycles. The larger fires also occurred about every 50 years and coincided with the periods of tree establishment, probably because of better understory production, which helped fire spread.

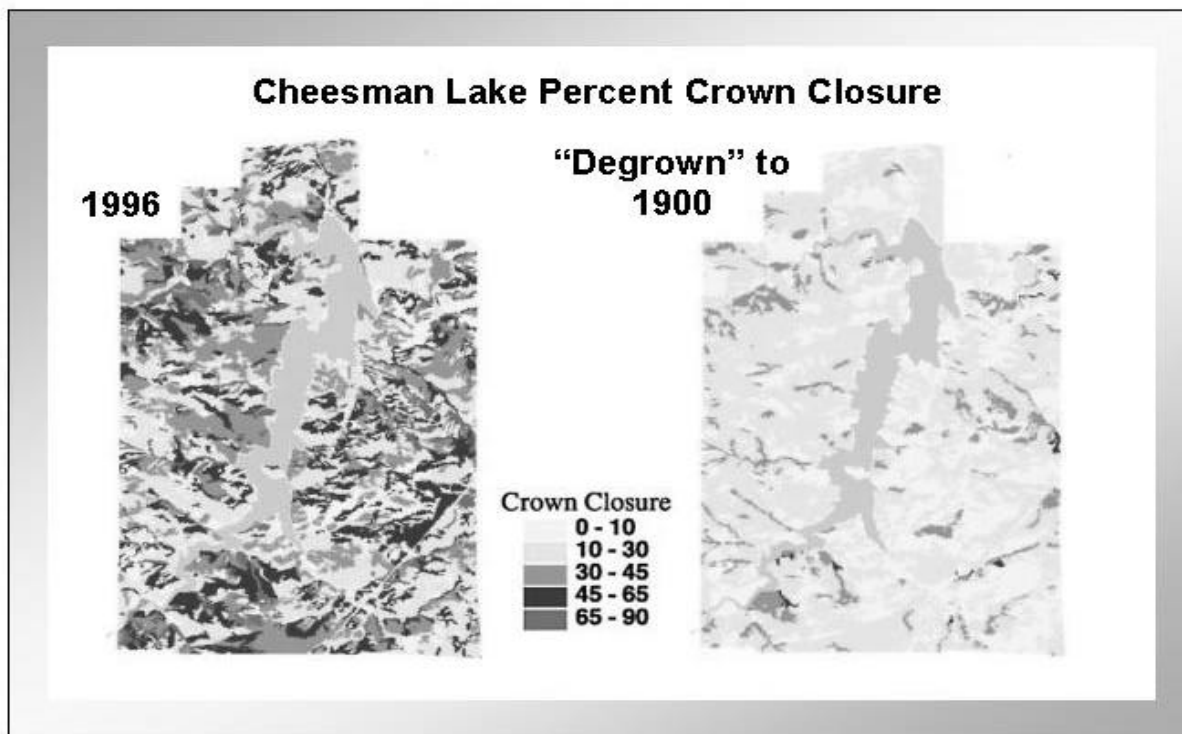


Figure 2. *Forest crown closure in 1996 (estimated from GIS mapping based on 1:6000 color infrared photographs) and in 1900 (estimated by “degrowing” the forest using the Forest Vegetation Simulator, a forest growth model)*

In combination, fire and tree establishment processes historically resulted in a very heterogeneous landscape structure with a low tree density. Currently, the Cheesman Lake landscape is becoming denser, because fire suppression has probably prevented at least two and maybe three major fires that would have thinned the forest and created new openings. Research shows that the historical landscape had fewer Douglas-fir trees and more old growth forest than presently found throughout much of the basin. Nearly one-third of forest patches sampled had trees over 400 years in age, and a few trees were over 600 years old.



Settlement brought logging, grazing, fire suppression, and tree planting to the South Platte basin. The results of these activities, shown from settlement to current times in Figure 1, are the loss of old-growth forests, loss of openings, and increased amounts of Douglas fir mixed in with ponderosa pine. Almost no trees 400 years old can be found, probably because they were logged. Current forests are homogeneous and far denser, and fire behavior has switched to a large crown fire regime. In addition, recent increases in human population have expanded the urban/wildland interface, putting lives and

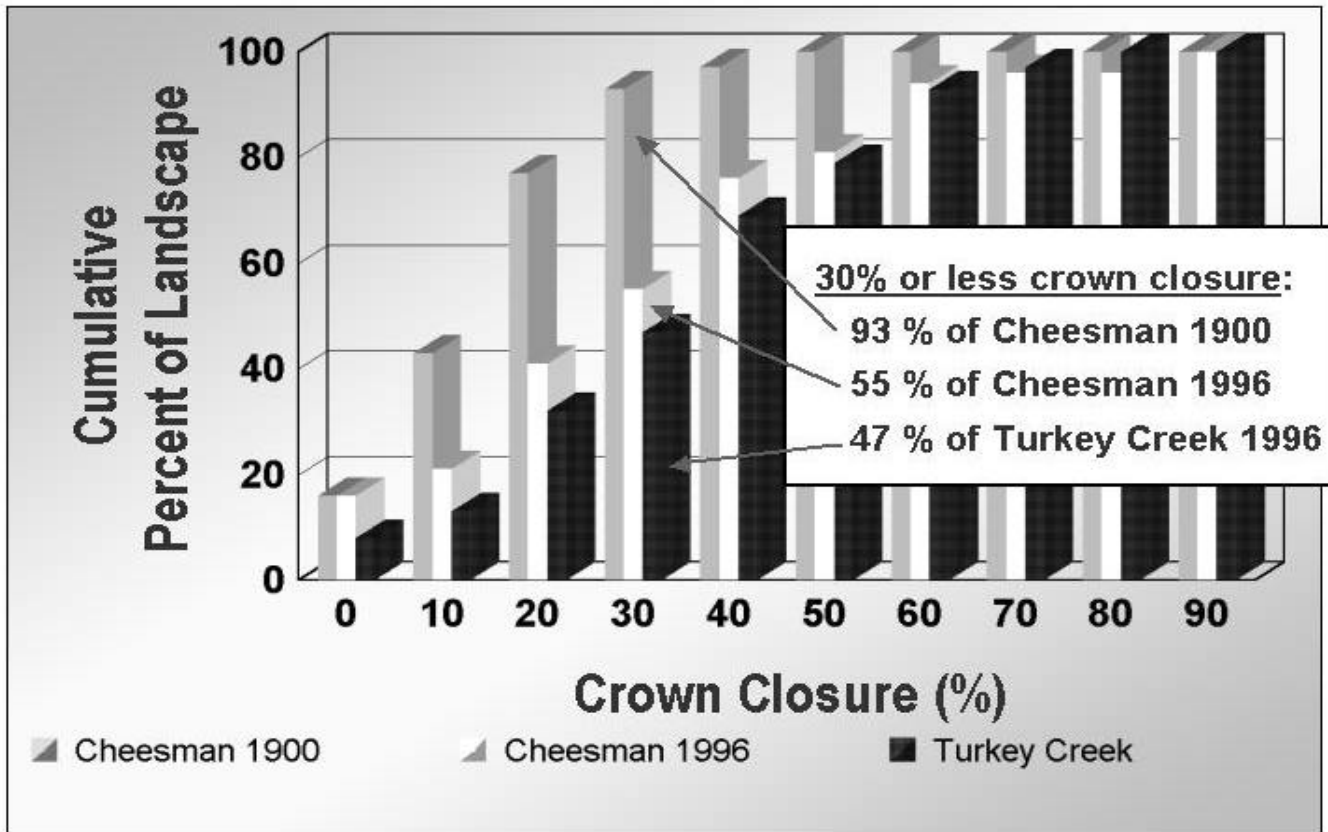


Figure 3 *Cumulative amount of the forest landscape covered by forest with increasing percent crown closure. For Turkey Creek, a logged and grazed area representative of the South Platte watershed, 47 percent of the landscape had a crown closure of 30 percent or less, compared with 55 percent for the 1996 Cheesman Lake landscape. However, estimates indicate that in 1900, over 90 percent of the landscape had crown closures of 30 percent or less.*

property at risk. The Buffalo Creek fire in 1996 burned 11,900 acres in a day, with intense crown fire creating a 7,500-acre opening in 4½ hours. This fire and severe post-fire erosion illustrated the level of risk in current forests. This scale and intensity of fire was not observed in the historical landscape and is considered to be ecologically unsustainable. When fires burn in dense forest, heat production is high, often killing understory vegetation and perhaps causing soils to be hydrophobic. Herbaceous and shrub vegetation recovery is slow, and soils are de-stabilized, resulting in excessive erosion and a generally undesirable watershed condition.



Research was done on crown closure (amount of ground area beneath tree canopies) for the Cheesman Lake landscape and the adjacent Turkey Creek landscape, which had been logged and grazed. Crown closure is a good indicator of tree density and wildfire risk. This research shows that about 55 percent of the historical landscape currently has a crown closure of 30 percent or less, compared with only 47 percent of the previously logged landscape (Figs. 2 and 3). However, because fires were suppressed during the last century even in the protected Cheesman Lake landscape, projections were made of forest density at the time of dam construction (1900). These calculations illustrate that a century ago over 90 percent of the historical landscape probably had a crown closure of 30 percent or less.

Restoring the landscape to the more open and heterogeneous structure found before the effects of settlement would address two important issues simultaneously. First, restored forests would be ecologically more sustainable, because catastrophic crown fires and insect epidemics occurring in recent decades would be unlikely at the much lower tree densities. Second, reduced tree densities would mitigate the risks that catastrophic fires and subsequent erosion pose to lives, property, and water quality. When fires burn in openings and low-density forests, they are fast-moving but with low heat production and residence time, and they are more readily controlled. These fires usually do not kill herbaceous vegetation, and soil stability after fire is protected by intact roots and rapid vegetation recovery. This provides a desirable watershed condition.

Landscape restoration treatments are most likely to require both mechanical treatment and prescribed burning to reverse the current “epidemic” of trees and reduce the amount of fuel presently creating a wildfire and erosion hazard. Research suggests that the following changes in landscape conditions would help address the issues of ecological sustainability and wildfire/erosion risk:

- ◆ Create openings over 15-25 percent of the treatment area;
- ◆ reduce tree density, especially through removal of small trees;
- ◆ reduce the amount of Douglas fir, particularly on east, south, and west slopes; and
- ◆ retain all the old trees (over 200 years of age).

A number of benefits are expected from restoring the forest landscape in the South Platte watershed. These include:

- ◆ Reduced forest density, which favors grass and shrub vegetation and rapid recovery after fire;
- ◆ Reduced risk of catastrophic crown fire;
- ◆ Reduced risk of post-fire erosion;
- ◆ Increased runoff water for riparian areas, especially in intermittent streams;
- ◆ Improved habitat for birds, deer, elk, the Pawnee montane skipper (a threatened species of butterfly), and other species benefiting from openings and open forests
- ◆ Restoration of old-growth forests

Continuing research is focused on increasing our understanding of historical landscape changes over space and time, and the development of effective and efficient strategies for sequencing treatments in restoration areas to maximize benefits.

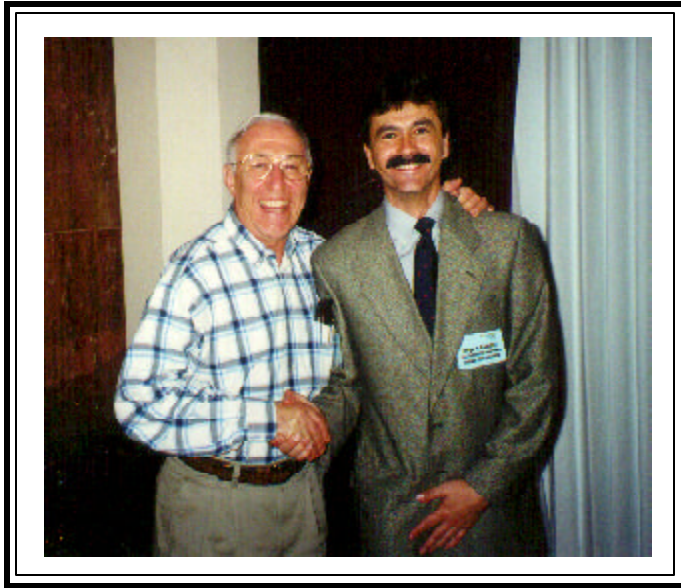
Paul Kugrens, CSU Department of Biology, will teach a one-day Algae Identification Workshop from 8:30 a.m. to 4:00 p.m. on August 10, 2000, Room E-203, Zoology Building, Colorado State University. Workshop participants should feel free to bring algae samples from their own lakes, reservoirs or ponds. Cost of the workshop is \$75, and lunch is included. Contact Dr. Kugrens at 970/491-7551 or at e-mail pkugrens@lamar.colostate.edu.



MEETING BRIEFS


**20TH ANNUAL HYDROLOGY DAYS DEDICATED
TO FOUNDER HUBERT MOREL-SEYTOUX**

The 20th Annual Hydrology Days was held at the Colorado State campus in Fort Collins April 3-6, 2000. The meeting was



dedicated to Professor Hubert Morel-Seytoux, Professor Emeritus of Civil Engineering at Colorado State, who founded Hydrology Days in 1981. The meeting has been held each year since on the campus of Colorado State University.

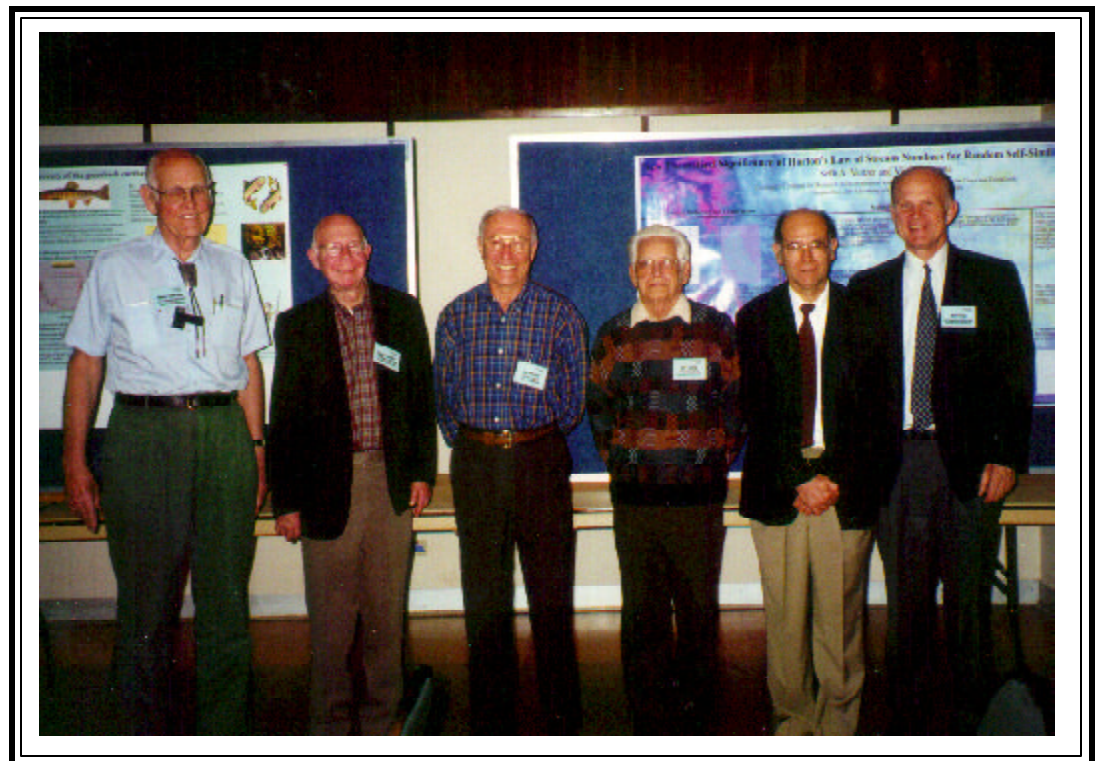
After 19 years of guidance by Professor Morel-Seytoux, this year's Hydrology Days was organized, coordinated, and very successfully executed by Dr. Jorge Ramirez, Associate Professor of Civil Engineering at Colorado State.

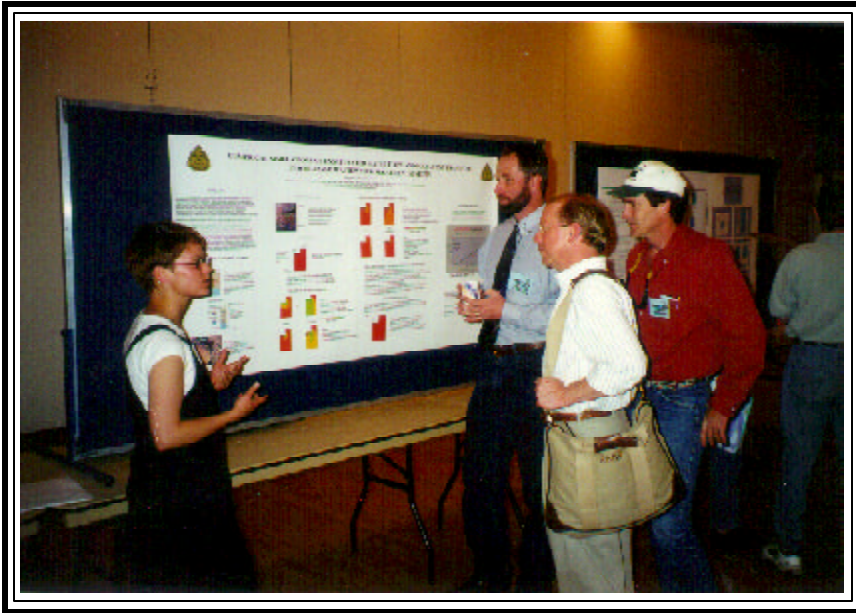
Hydrology Days provides an opportunity for students to present papers in a friendly, yet professional, atmosphere and have the opportunity to meet leading hydrologists and hydrology-related professionals. The four-day program includes contributed papers, invited papers, student papers and a poster session.

United States participants came from Colorado State University, the University of Colorado, the Colorado School of Mines, the University of California-Davis, Arizona State University, the University of Oklahoma, the U.S. Department of Agriculture's Great Plains Research Unit and Natural Resources Conservation Service, the U.S. Bureau of Reclamation, the U.S. Geological Survey's Midcontinent Ecological

PASSING THE TORCH! Hubert Morel-Seytoux congratulates Jorge Ramirez for his leadership in organizing the successful 20th Annual Hydrology Days.

From left: Maurice Albertson, Professor of Civil Engineering, CSU; David Woolhiser, Professor of Civil Engineering, CSU; Hubert Morel-Seytoux, Professor Emeritus of Civil Engineering, CSU, and founder and organizer of Hydrology Days; Art Corey, Professor Emeritus of Chemical and Bioresource Engineering, CSU; Jose Salas, Professor of Civil Engineering, CSU; and Neil Grigg, Professor and Department Head, Civil Engineering Department.



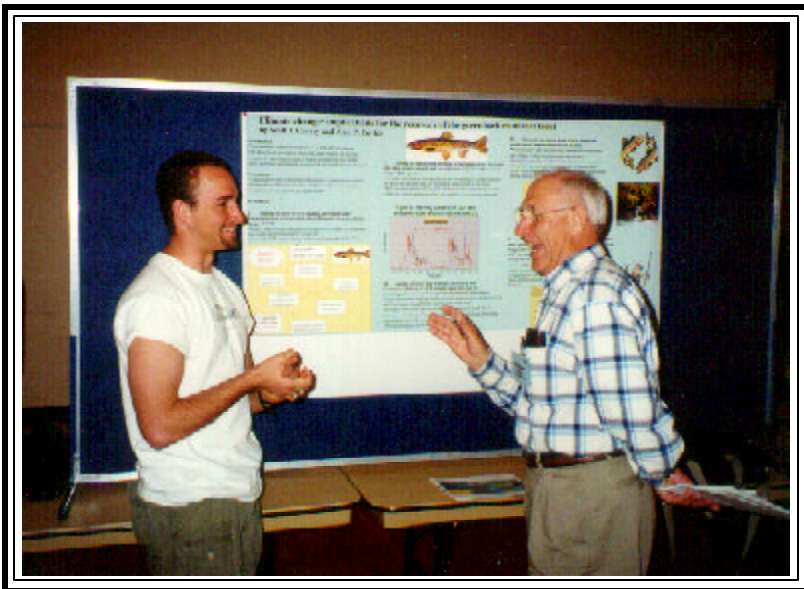


Left: Sheila Van Cuyk, Ph.D student at the Colorado School of Mines, discusses her poster with meeting participants

Below: Larry Roesner, Holder of the Harold Short Chair in Infrastructure Engineering at CSU, presents the luncheon address.



Science Center, Applied Weather Associates, Johnson Controls Inc. of Fort Collins, Colorado, Pacific Northwest National Lab, and Coastal Consulting of Huntington Beach, California.



Left: Scott Cooney, Department of Earth Resources, explains his poster to Hubert Morel-Seytoux.

International participants came to Hydrology Days from Weldwood of Canada Limited, Hinton, Alberta, Canada; the University of Genoa, Genoa, Italy; the Universidade Federal do Ceara, Ceara, Brazil; the University of Bonn, Bonn, Germany; the University of Genova, Savona, Italy; the University of Western Australia; the University of Ljubljana, the Mohammadia School of Engineers, Agdal-Rabat, Morocco, and from Consulting Eng. of Tehran, Iran; and PWITT, Tehran, Iran.



TMDLs AND FUTURE CLEAN WATER ACT AMENDMENTS: A PERSPECTIVE

*by Tad S. Foster, Esq.
Law Firm of Tad S. Foster*

*The following paper was presented during luncheon at the
American Water Resources Association, Colorado Section meeting
in Denver, Colorado, March 17, 2000.*

In the playoff football game between the Tennessee Titans and the Buffalo Bills, the win was based upon a disputed call. That dispute was simply a matter of perspective. Was it a forward pass or backward lateral? It depended upon the T.V. action cam one viewed. Only the television action cam from well above the play was the accurate perspective. Unfortunately, when it comes to

TMDLs, none of us have that overall perspective. There is no Goodyear Blimp available for that perfect overview. Rather, there are many perspectives on what constitutes Total Maximum Daily Loads (TMDLs), how to create them, and what to do with them.

For some, TMDLs are a roadmap to somewhere. For others, TMDLs are simply a numeric calculation and a numeric limit. For some, TMDLs are a segment specific study; for others, they are a watershed planning process. In reality, the TMDL process is becoming a gossamer social structure to do “what’s right”; for a few of us lawyers, TMDLs have little legal foundation for all that they are expected to do.

EPA’s emerging perspective on TMDLs is that they are the backbone of watershed planning. The proposed regulations appear to make TMDLs a prerequisite to all water quality standard-based permitting for point sources and the prerequisite for best management practices for all non-point sources. But the comments provided by many to EPA’s

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proposed TMDL regulations demonstrate many serious questions about the legal adequacy of the current Clean Water Act to authorize the many directions EPA hopes to create through the TMDL regulations. Litigation is likely if the final regulations resemble the proposal.

In this presentation, I hope to take a look through a number of action cams to gain a better perspective on where TMDLs have been and where they appear to be going. I hope to conclude with a number of proposals concerning changes to the Clean Water Act that better authorize where we ought to go. I encourage you to participate in this dialogue on where the Clean Water Act ought to be amended in order to achieve a greater vision for the coming decade.

What does the historical perspective action cam show us?

Section 303(d) was part of the Clean Water Act prior to the 1972 Water Pollution Control Amendments. Indeed, Section 303(d) was that part of the watershed approach that in fact was abandoned by at least the Senate as a failure when developing the new federal program under the 1972 Clean Water Act Amendments. The Senate’s alternative program was an emphasis on federal permitting of point sources. Categorical source limitations were placed upon major categorical industries in order to eventually

achieve the goal of zero discharge of pollutants. Non-point sources were to be addressed only through Section 208 planning. No permits were required for them. Best management practices were the means of control. The House Bill retained § 303(d) TMDLs and water quality standard based effluent limits as a minor role, as a safety net, in the event categorical limitations were inadequate. Consistent with this approach that 303(d) was an after-thought, EPA in 1978 finally complied with the first step required in Section 303(d) by announcing in the Federal Register that “all pollutants” were suitable for TMDLs. However, in that Federal Register preamble EPA also announced that TMDLs were not a “prerequisite” to the development and enforcement of water quality standards.

As early as 1979, some of us were raising the question of whether TMDLs had to be established prior to water quality standard-based effluent limits being developed and imposed in NPDES permits. We also asked whether the Section 305(b) Report under the Clean Water Act was a necessary precursor to the listing and prioritization process of § 303(d). The Report is an assessment by the state of those waters in non-attainment as well as an estimate of their environmental impact, the economic and social costs necessary to achieve the objectives of the Act, and the economic and social benefits of such achievement. Our argument was that the § 305(b) Report laid that groundwork necessary to do the prioritization under the 303(d) process.

Furthermore, Colorado looked to the Section 305(b) Report to legitimize its consideration of “economic reasonableness” in permitting POTWs with water quality-based permits beyond secondary treatment. In 1981 Colorado adopted Senate Bill 10 to require consideration of economics in permitting. The NRDC petitioned EPA to remove Colorado’s permitting program as a result. Subsequently, Colorado, for the most part, conceded to NRDC.

Prior to such concession, numerous discussions with EPA

and NRDC were conducted. This included a seminar to the Water Quality Control Commission by Dave Sabock, head of EPA’s Water Quality Standards Program. It is my recollection, as a member of that Commission, that Sabock and others believed that TMDLs were not a prerequisite for water quality standard-based permitting. Indeed, EPA was distancing itself from TMDLs and Section 305(b) and 302. Rather, EPA looked to Clean Water Act Section 301(b)(1)(C) as it’s only necessary authority to require water quality standard-based effluent limits. There was no prerequisite for 303(d)-based TMDLs.

During the 1980s, Colorado continued to issue permits with water quality standard-based effluent limits for ammonia particularly and the metals without any formal

TMDL process. Such water quality based-permits were issued where there was a “reasonable potential” of water quality standards not being attained, but without any § 303(d) determination that those segments were not in attainment. Apparently, these permits were considered by the state and EPA to be waste-load allocations (WLAs), but no real opportunity for allocating any loading clearly occurred. There were,

however, a few informal allocations among point sources. These WLAs were not forwarded to EPA for approval. The draft permits were sent to EPA for any objection, but not for approval.

In 1984, Colorado adopted the Dillon Reservoir Control Regulation as the TMDLs for Dillon Reservoir. A control regulation is an overarching regulation of the Water Quality Control Commission. For Dillon Reservoir that control regulation included specific pound limitations for phosphorous for the various point-source dischargers, the amount generally available for non-point sources, and general allocations for some general sources. NPDES permits are issued consistent with the pound allocations for each point source. That control regulation also included non-point

The Dillon Reservoir Control Regulation was the culmination of a long process over several years involving the Denver Water Board and Summit County communities, including the Regional Council of Governments. The control regulation was to protect Dillon Reservoir from eutrophication and its potential impacts, not only upon Denver’s water supply quality, but also the recreational uses of the reservoir.

source control provisions. This included a one-pound POTW discharge credit for each two pounds of phosphorous controlled through non-point source controls. It also included certain assumptions that Summit County and the local governments would adopt regulations that required best management practices for phosphorous for all new non-point sources.

The Dillon Reservoir Control Regulation was the culmination of a long process over several years involving the Denver Water Board and Summit County communities, including the Regional Council of Governments. The control regulation was to protect Dillon Reservoir from eutrophication and its potential impacts, not only upon Denver's water supply quality, but also the recreational uses of the reservoir.

In 1985, the Cherry Creek Reservoir TMDL-based control regulation allocated point-source loading and non-point source responsibilities. Like the Dillon Reservoir process, it was a difficult process over many years, and remains so.

The Clean Water Act Amendments of 1987 shifted all of the states' focus to toxics control as required under the new Section 304(L). Examining the language of this new section, one discovers that in essence it required a quick TMDL process. It identified the impaired streams, the point sources, and the control measures necessary to achieve water quality standards, taking into consideration the existing controls on point and non-point sources of pollution. Attainment was to be achieved within three years of the development of the "individual control strategy."

For Colorado, compliance with Section 304(L) was mostly a paper exercise. This was because the water quality standard-based effluent limits in permits already issued were attaining the toxic standards requirements.

The important perspective is that Section 304(L) did not require doing TMDLs as a prerequisite to permit limits for non-attaining segments. This is despite the fact that the 1987 amendments also added Section 303(d), paragraph 4.

It is the only statutory authorization for the concept of "allocating" the total maximum daily load reductions. Congress was clearly thinking about TMDLs in 1987, but did not require them for toxic water quality standard-based effluent limits. Consistently, EPA's regulations did not require waste load allocations as a prerequisite to such 304(L) based limits. See 40 CFR 123.46.

In response to the 304(L) requirements, EPA promulgated 40 CFR 122.44(d) to define the criteria for water quality standard-based effluent limits in permits. Those lengthy regulations do not require TMDLs as a prerequisite to the writing of such water quality limited permits. Only in the closing paragraph of these regulations does EPA state that when developing water quality based effluent limits, the permitting authority is to assure that the effluent limits on point sources comply with all applicable water quality standards and the requirements of "any available waste-load allocation for the discharge prepared by the state and

approved by EPA under the TMDL regulations at 40 CFR 130.7." Subsequently, Colorado adopted the same criteria for issuing new water quality standard-based effluent limited permits. TMDLs were not a prerequisite for such permits. TMDLs are to be used when available.

Why are we now . . . looking at TMDLs as a prerequisite to water quality standard-based effluent limits for point source discharges to streams, without the use of any kind of control regulations, and also for controlling non-point sources on non-point source only streams?

During Colorado's implementation of its § 304(L) responsibilities, Colorado returned to control regulations for TMDLs for phosphorous. In 1989 and 1992 it adopted control regulations for Chatfield and Bear Creek Reservoirs after extensive effort.

Clearly, from Colorado's experience, TMDLs are appropriate for lakes. They work well for addressing complicated problems. They address coordinated limitations among numerous permits as well as non-point source controls. TMDLs have never been prerequisites for all point sources. Yet, the 1998 303(d) lists for most Region VIII states now include all segments with any expiring water quality limited permits. Therefore, TMDLs are a prerequisite for permit renewal.

So why are we now, as the new way of doing business, looking at TMDLs as a prerequisite to water quality stan-

standard-based effluent limits for point source discharges to streams, without the use of any kind of control regulations, and also for controlling non-point sources on non-point source only streams?

It might be simply because TMDLs have to be approved by EPA and that is the best way to get to other issues that EPA or the states have failed to adequately address. For example, these issues of inadequate water quality protection include:

- ◆ Whether the permits for textile mills in Georgia could be inadequate, because they had no limitations for blue dye, when the discharge was causing turtles in the rivers to turn blue?
- ◆ Whether logging on Forest Service lands could be better controlled, where sediment runoff clogged the streambeds and smothered spawning areas for salmon.
- ◆ Whether better non-point source best management practices could be required as a condition of federal subsidies where agriculture adversely impacts streams. While the Clean Water Act prohibits NPDES permits on agricultural return flows, under § 208 best management practices can be required under other regulations and statutes affecting the Department of Agriculture.
- ◆ Whether urban runoff could be subjected to water quality standard-based effluent limits under the TMDL program, despite the Clean Water Act's current requirement of only BMPs in urban runoff/storm-water permits.
- ◆ Whether water quality-based effluent limited permits could be inadequate to protect downstream water quality standards, where no cumulative impact analysis was considered as a part of the permitting process for persistent pollutants.
- ◆ Whether Endangered Species consultation could be tied to state-issued NPDES permits through TMDLs, since the TMDLs have to be approved by EPA, but EPA can only object to the state permits.

There are other issues that may be developed and tied to EPA's requirement to approve TMDLs or issue its own TMDLs. There is legal leverage here in EPA's approval/disapproval power to be explored and perhaps expanded. Environmentalists, dischargers, states and EPA see TMDLs from many different perspectives and for many different purposes.

If the watershed approach under Section 303(d) failed prior to the 1972 Clean Water Act Amendments, why do we expect that approach to be anything better now?

Are we ignoring that the Clean Water Act may not be adequate to do what we would like it to do for watershed planning and control?

But did Congress really authorize EPA to do everything everyone wants through the TMDL program?

As I mentioned earlier, EPA's proposed TMDL rulemaking is well beyond the bounds of the authority of the current Clean Water Act. A few of the issues are as follows:

- ◆ How can Section 303(d) authorize a comprehensive information gathering and planning process, when it requires solely a numerical computation?
- ◆ How can Section 303(d) be a comprehensive accounting consisting of four separate lists, when Section 305(b) of the Clean Water Act authorizes that assessment?
- ◆ How can Section 303(d) address segments with only non-point sources when Section 303(d)(1) is really limited to point-source impacted segments?
- ◆ How can Section 303(d) require an implementation plan as part of a TMDL, when an implementation plan is only authorized under Section 303(e) as a state responsibility?

◆How can EPA approve an implementation plan under Section 303(d), when only the states are authorized to do the implementation plan after EPA approves the calculated loading under 303(d)?

◆How can 303(d) really authorize allocations among point and non-point sources, when 303(d)(4) only refers to point source allocations? Indeed, the current TMDL regulation which refers to point and non-point source allocations was adopted in 1985, but only in the later 1987 amendments to the Clean Water Act is there authorization for any allocation of loads. And that allocation is only among point sources. There is no authority for allocation between point and non-point sources. The current regulations are without authority to require allocations with non-point sources.

◆Even if the 1987 CWA amendments through Section 303(d)(4) enable allocation, did this amendment authorize EPA to approve those allocations? I don't think so.

These are but a small portion of the many legal interpretation issues rampant through the proposed regulations. Lawsuits will likely ensue should EPA promulgate regulations similar to those proposed.

However, EPA is already backing off its proposal insofar as the so-called offset provision, the implementation plan and other provisions.

In the meantime, bills to restrict EPA's proposal are being introduced in Congress. For example, S2041 and H.R. 3625 would clearly deny EPA's permitting power over agricultural storm-water discharges or silvacultural/forestry operation discharges.

The EPA TMDL proposal should be galvanizing all of us to rethink the Clean Water Act reauthorization. That reauthori-

zation failed in 1992. Lack of consensus has precluded any reauthorization since then. Accordingly, the dialogue must continue to build a national consensus. Watershed planning was the essential focus of the House-proposed bill that failed in 1992. That bill needs to be revisited.

It is appropriate for all of us to step back and get a vision on where the Clean Water Act should go from here,

and how we can amend the Act to do it.

I have some current concepts, although I am not wedded to them and may easily back away from them in the future, but I suggest them as a point of beginning for our dialogue to the future.

It is appropriate for all of us to step back and get a vision on where the Clean Water Act should go from here, and how we can amend the Act to do it.

◆I suggest deleting Section 303(d) as currently drafted as obsolete and out of date. In lieu thereof, I recommend replacing it with other provisions.

◆Amend Section 402 concerning the NPDES permitting program to require reopening or amending the delegation to the states of the EPA permitting programs. EPA would be authorized to allow states to issue NPDES permits upon the states' demonstrating an adequate permitting program that has the following elements added to it:

◆An adequate statewide water quality monitoring program to identify point and non-point sources and stream water quality. (The lack of an adequate monitoring program has precluded an effective 303(d) program.)

◆An updated Section 208 water quality management planning program on a defined watershed scale, which is renewed every five years. Such plans should identify allowable loading or concentration limitations and the allocations among point and non-point sources and their necessary implementation plans.

◆These 208 plans should reflect the county, municipal, and federal land management agency land use plans

which are to include best management practices, local ordinances and regulations necessary to implement the non-point best management practices so as to assure non-point source reductions.

- ◆The 208 plan is to include an implementation plan subject only to state approval. State regulation defining the minimum requirements for that implementation plan would be submitted to EPA for its approval.
- ◆The point source permits must be consistent with the 208 plan.
- ◆Federal consistency reviews, such as federal funding for agricultural programs, including Section 319 grants for specific non-point source control projects, must be consistent with the 208 plans.
- ◆Limit the allocation of loading or concentration reductions to no greater than a proportional share for point sources, so long as there is an updated 208 plan adopted by the state. In addition, authorized point sources, in the absence of a 208 approved plan, to recover from other point and non-point sources certain up-fronted costs by the point sources for the clean up; those costs will reflect that share which is greater than the proportional reduction attributable to the point sources up-fronting the remediation costs. This follows the CERCLA model.
- ◆Enable the 208 plans to define a schedule for phased and iterative improvements that can include physical habitat improvements prior to chemical reduction improvements. Allow for trading among all physical, biological, and chemical parameters, so as to restore or enhance the physical habitat or biological condition before chemical quality improvements are made where more bang-for-the-buck justifies it.
- ◆Enable the 208 plans to schedule the implementation of watershed plans so that it is a set of five-year rolling increments, rather than a 15-year maximum term. A 15-year maximum period is unrealistic for completing the TMDL program.
- ◆Enable the 208 plan to be submitted as a habitat conservation plan under Section 10 of the ESA. The 208 plan would apply only where endangered species habitat is directly related to water quality — the chemical, physical, or biological integrity of the riparian and aquatic system.

Finally, EPA must reinstate and significantly improve state funding to reenergize the 208 watershed planning process. It is erroneous to say that even the current Clean Water Act has failed under Section 208 in light of the significant cutback by EPA of federal funding for the 208 planning process since the 1972 funding levels.

The overall intent of the above proposal is to do as directly as possible what the proposed regulations are doing indirectly; that is, watershed planning has to be local, phased, and with incentives for group participation. The state and federal governments must fund it. Federal grants and loans to non-point sources must be increased to levels similar to the grants to point sources in the past, before it can be said that the non-point source program has failed.

Clearly, there are many perspectives to bring to bear on watershed planning processes. I encourage your participation in this dialogue. I look forward to your suggestions on what is a realistic perspective of the whole game, from the Goodyear Blimp. Thank you for your kind attention.





DAVID HOLM HEADS ASSOCIATION OF STATE AND INTERSTATE WATER POLLUTION CONTROL ADMINISTRATORS (ASIWPCA)

David Holm, Director of the Colorado Water Quality Control Division, is this year's President of the State and Interstate Water Pollution Control Administrators, an independent, nonpartisan organization of state water program managers. ASIWPCA members represent the state professionals who, on a daily basis, implement surface and groundwater quality management programs. ASIWPCA's Washington office was established in January of 1979 to provide a continuing communication link between ASIWPCA members, state government executives and agencies, the Congress, the Administration, public organizations and the national press.

As water programs have expanded to address emerging pollution control and environmental protection issues, ASIWPCA has broadened its focus. In addition to providing the states with a forum for the exchange of information, ASIWPCA is also involved in program issues that affect water. It also performs an expanded public education function including youth education programs, technical assistance to state executives, members of Congress, and Administration officials.

Association positions are initiated by state regulators through issue-specific task forces. Each position is reviewed by the board of directors, and if approved, considered by the full membership. ASIWPCA task forces include:

- ◆ Point Source Management
- ◆ Groundwater/Sourcewater Protection
- ◆ Watershed Management
- ◆ Standards and Monitoring
- ◆ Strategic Management
- ◆ Information Management

Holm participated in a roundtable discussion focusing on "Western Issues regarding Development and Implementation of TMDLs" at the Western Governors' Association meeting in February. He said there is substantial evidence that growth will result in a redistribution of discharge allocations, possibly affecting water rights use where effluents are discharged to streams that serve as drinking water sources. Another issue in Colorado is the treatment of whirling disease in fish as a pollutant, with introduction of infected hatchery fish treated as a discharge. Holm also expressed a need for a "Good Samaritan" provision in the Clean Water Act to facilitate acid mine cleanups.

Also in February Holm testified before the House Transportation and Infrastructure's Subcommittee on Water Resources and the Environment, which conducted Clean Water Act oversight hearings. Holm testified, "Congress gave the States the lead role in the development and implementation of the water quality program...and we believe the establishment of TMDLs is one of many important mechanisms to be used to achieve cleaner water." He noted the states have been in a "continuing dialogue" with EPA through a series of conference calls and TMDL workshops.

Holm identified three fundamental obstacles to be addressed to make TMDLs a meaningful component of state water quality management programs: the significant lack of funding and authority to address non-point source and other water quality problems under the current program; major gaps in available data, research and monitoring; and insufficient attention to multi-media and multi-jurisdictional water problems. He listed five guiding principles needed to move forward and improve the TMDL program:

- ◆ The states' lead role in the Nation's clean water program must be maintained.
- ◆ TMDL requirements need to be flexible and consistent with existing statutory authority, available resources and state water quality agency jurisdiction.
- ◆ Existing initiatives should be used, wherever possible, to achieve water quality objectives.
- ◆ Expectations need to be clearly focused on desired environmental outcomes.
- ◆ The iterative approach is crucial to success, particularly for non-point sources.

With respect to EPA's proposed TMDL regulations, Holm felt:

- ◆ They broadly expand the federal role and seriously undermine EPA's relationship with state government.
- ◆ The role of Section 303(d) is greatly enlarged, beyond what the Clean Water Act envisioned.
- ◆ The proposal is too prescriptive.
- ◆ It adds burdensome new administrative layers.
- ◆ It restricts states' ability to use adaptive management approaches to TMDL development and implementation where NPS are of significant concern.
- ◆ It mandates TMDL development and implementation plans for problems beyond the jurisdiction of state water quality programs, including interstate and

◆ It mandates TMDL development and implementation plans for problems beyond the jurisdiction of state water quality programs, including interstate and international waters, and air deposition problems.

◆ EPA does not acknowledge the significant funding increases that are needed.

Holm warned that unless the proposed rules are refined the likely outcome would be litigation and delay, and less, not more, environmental progress. He suggested the proposal is a significant rulemaking subject to the Unfunded Mandates Reform Act and its requirements to keep costs to a minimum and seek offsetting funding from Congress.

On March 15, 2000 the Western States Water Council, Interstate Council on Water Policy (ICWP), Association of

State and Interstate Water Pollution Control Administrators (ASWIPCA), and Association of State Drinking Water Administrators (ASDWA) jointly cosponsored the “2000 State and Interstate Water Policy Roundtable: Intergovernmental Cooperation,” in Arlington, Virginia. Holm participated in the first Roundtable panel that addressed issues related to the Clean Water Act’s (CWA) Total Maximum Daily Loads (TMDLs). Panel members included the Executive Director of the Delaware River Basin Commission, the Director, Water Quality Division, Oklahoma Department of Environmental Quality, J. Dale Givens of the Louisiana Department of Environmental Quality, Diane Shea of the National Governors’ Association, Gary Ingman, Bureau Chief, Montana Department of Environmental Quality, and Don Brady, Branch Chief, EPA Office of Wetlands, Oceans and Watersheds.

Sources: ASIWPCA website at <http://www.asiwpca.org>; *Western States Water* 2/25/2000, 3/24/2000



WATER SUPPLY

As warmer temperatures and below-average precipitation pervaded this April, the statewide average snowpack decreased from 90 percent of normal to 69 percent of normal during April. Water supplies are at near normal to above normal levels in the South Platte, the Arkansas, and the Colorado river basins due to maintained or increased storage and snowpack. The Yampa/White Basin joined the Rio Grande, Gunnison, and San Juan/Dolores basins in their below normal water supplies, primarily attributable to low snowpack. Streamflows statewide appear to be peaking earlier than usual. Fortunately, reservoir storage is average to above average in most of the reservoirs across the state.

The surface Water Supply Index (SWSI) developed by this 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 snowpack, 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, 2000, and reflect conditions during the month of April.

Basin	5/1/00 SWSI Value	Change from the Previous Month	Change from the Previous Year
South Platte	+1.5	-0.5	-0.9
Arkansas	-0.9	-0.6	-2.0
Rio Grande	-2.4	-1.0	-3.6
Gunnison	-2.1	-1.8	-3.2
Colorado	-0.5	-0.2	-1.5
Yampa/White	-2.2	-1.6	-1.9
San Juan/Dolores	-2.1	-0.7	-2.5

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



AWARDS



HAL SIMPSON RECEIVES CSU COLLEGE OF ENGINEERING HONOR ALUMNUS AWARD



Robert Ward, Director, Colorado Water Resources Research Institute and the CSU Water Center, with Hal Simpson and his wife Carol

Hal Simpson, Director of Colorado's Division of Water Resources and Colorado State Engineer, received Colorado State's College of Engineering Honor Alumnus Award at CSU's Distinguished Awards Program on April 7, 2000.

A second-generation Colorado native from northern Colorado, Hal graduated from Colorado State University in the late 1960s and went on to a distinguished career in water resource management.

He has served as Deputy State Engineer, advisor to the State Engineer on interstate compacts, and director of litigation activities for the Colorado Division of Water Resources. He also was in charge of the Engineering Section of the division, where he was responsible for six programs including the Water Management Branch, the Water Supply Branch, the Geo-Technical Support Branch, the Dam Safety Branch, the Hydrographic Branch, and the Satellite-Linked Water Resources Monitoring Program. Hal is a registered professional engineer in Colorado.

After a 20-year career in state service, Hal was appointed State Engineer in 1992. He has been actively involved with Colorado State's water pro-

grams and has provided opportunities for faculty, students, and researchers to participate in programs of the Colorado Division of Water Resources. He has utilized his leadership and vast knowledge to work with water users, attorneys, and engineers to recommend changes in legislation resulting in streamlined water processes and better and more efficient water management and administration in Colorado.

Hal's ability as a mediator was demonstrated in negotiating with Arkansas River Basin farmers during the lawsuit brought by the State of Kansas against Colorado. He successfully developed rules and supporting plans for the replacement of junior well depletions to the State of Kansas and Colorado senior surface water rights. This included defense of the state's position in the U.S. Supreme Court.

Hal's community interests include his church and serving on the Board of Directors of Long Scraggy Camp located near Buffalo Creek, a non-profit mountain camp for retreats and meetings. He speaks to high school and college students about Colorado water law and water resources, and also has coached youth league soccer and basketball teams.



From left: Derek Swierenga (son-in-law), Holly Swierenga (daughter), Kelly Waanders (daughter), Mark Simpson (son), Carol Simpson (wife) and Hal Simpson. Hal, Carol, and their three children all graduated from Colorado State.



**FIRST ANNUAL PROVOST'S LECTURE SERIES AND AWARD
FOR INTERDISCIPLINARY ENVIRONMENTAL ACHIEVEMENT
HELD AT COLORADO STATE**

by Emile Hall

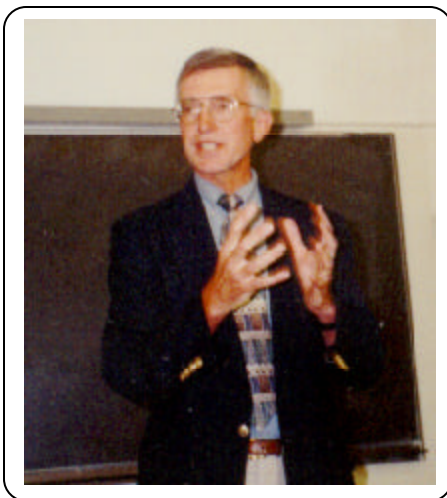
On April 27, 2000, Patricia Nelson Limerick, a leading historian of the American West who teaches at the University of Colorado at Boulder spoke at Colorado State's first annual Provost's Lecture Series. Her lecture, entitled "Speaking Western: Promoting Conversations Between the Sciences and the Humanities in the New West" discussed the benefits of removing the barriers between the diverse academic disciplines. The moral: those in the humanities and those in the sciences have much to learn and gain from collaboration with one another.

Following the lecture, Provost Loren Crabtree presented Dr. Robert Ward with the first Provost's Award for Interdisciplinary Environmental Achievement for his work as the director of the Water Center, which brings specialists representing 25 different Colorado State University departments together around water issues.

In his comments following presentation of the award, Robert Ward reflected on the value of interdisciplinary activities in his career, particularly during his graduate studies.

He noted a number of successful interdisciplinary water research and education efforts at CSU and hoped more can be supported in the future.

Right: Robert Ward receives first Provost's Award for Interdisciplinary Environmental Achievement for his work as the director of the Water Center. Provost Loren Crabtree (left) presented the award.



Sponsors of the event were the Provost's Office, the Center for Teaching and Learning, College of Liberal Arts, the English Department, the Environmental Studies Coalition: Environmental Affairs, Conservation Biology, Interdisciplinary Studies in Education and Human Resource Services, the Institute for the Built Environment, and the College of Natural Resources.



Colorado Water
Resources Research Institute

CU Water News



GILBERT F. WHITE RECEIVES NATIONAL ACADEMY OF SCIENCES HIGHEST HONOR

The National Academy of Sciences (NAS) selected Gilbert F. White for its most prestigious award, the Public Welfare Medal. White was chosen for his enduring fundamental contributions to the study of environmental issues and for his positive impact on the welfare of society. Established in 1914, the Public Welfare Medal is presented annually to honor extraordinary use of science for the public good. Previous recipients include Arnold Beckman, C. Everett Koop, and Carl Sagan.

“By applying science and wisdom to the ways we think about how water is used throughout the world, he has taught us how to recognize the scope of our impact on the environment,” said R. Stephen Berry, NAS home secretary and chair of the selection committee. NAS President Bruce Algers said, “For more than 60 years, Gil White has worked with great energy and skill to improve both domestic and international hazard management in many different areas. To give but two examples, he has led major efforts in this country to significantly improve the effectiveness of federal flood-control efforts, and internationally he has tenaciously pursued efforts to improve the water supplies in Africa and the Middle East.”

Early in his career, White went to Washington, D.C. to help a federal committee prepare a comprehensive public works plan for the Mississippi valley. He became skeptical that flood damages could be curbed exclusively by prevailing technologies of dam, levee, and channel construction, and began to study how to reduce flood hazards. Instead of managing the river, for example, it made sense to stop building homes and businesses in flood-plain areas and focus efforts on protecting those already there. Years later, while professor of geography at the University of Chicago, White launched a 15-year research effort to apply these principles. White first presented his flood-management approach in 1942 in his groundbreaking study, *Human Adjustment to Floods*. His work led to development of the field of flood-plain management, a profession that has saved countless lives and dollars. To help implement this strategy, he served with numerous committees and bureaus in a variety of roles, including vice chair of the President’s Water Policy Commission in 1950 and consultant to the White House Floodplain

Management Review Committee in 1994.

White later turned his attention to dealing with other hazards such as wildfires, earthquakes, tornadoes, and hurricanes. He sponsored annual workshops where, along with other experts, he examined various ways to reduce human suffering caused by natural disasters. And he founded the University of Colorado’s Natural Hazards Research and Applications Information Center, which soon became the nation’s leading agency for providing natural hazard information.

White also has made a major mark internationally. Since 1952 he has chaired several gatherings of diplomats to discuss controversial issues. During 1969 he was involved in assembling an international scientific committee on environmental problems. His landmark study on domestic water supply in East Africa, *Drawers of Water*, led to several policy changes, including public support of rural water schemes in developing countries. White has chaired international reviews of water problems in the Lower Mekong and Aral Sea Basins, and more recently headed a committee of the National Research Council in a multinational study examining water management issues in the West Bank and Gaza Strip, Israel, and Jordan.

White was educated at the University of Chicago, where he received his B.S. degree in 1932, his S.M. in 1933, and his Ph.D. in 1942. Among his many citations for achievement are the Daly Medal of the American Geographical Society, the Icko Iben Award of the American Water Resources Association, and the Outstanding Achievement Award of the Association of American Geographers. He holds honorary doctorates from Hamilton, Swarthmore, Earlham, Augustana, and Haverford Colleges and from Michigan State University. He is a member of the American Academy of Arts and Sciences, the American Philosophical Society, and the National Academy of Sciences.

The NAS Public Welfare Medal, consisting of a bronze medal and an illuminated scroll, was presented to White during the Academy’s annual meeting in April 2000.

The National Academy of Sciences is a private, nonprofit institution that provides science advice under a congressional charter.

CSU Water News



NEW FEDERAL NATURAL RESOURCES RESEARCH CAMPUS DEDICATED

Top federal, state and local officials dedicated the campus of the Natural Resources Research Center (NRRC) on April 28, 2000. The campus, which eventually will consist of five buildings and house 1,000 employees, will offer what federal officials term “one-stop shopping” for



agency clients. Scheduled to be completed in 2005, the \$65 million campus will consolidate in the Fort Collins area U.S. Department of Agriculture and U.S. Department of the Interior agencies scattered locally and throughout the Rocky Mountain West. Eight government agencies eventually will occupy space in the new NRRC buildings, including the Agricultural Research Service, Animal and Plant Health Inspection Service, Farm Service Agency, Forest Service, Office of the Chief Information Officer/National Information Technology Center and Office of the Inspector General, all under the auspices of the USDA and the USDI's Geological Survey. The campus will pay for itself through savings gained from consolidated operations and efficiencies. By assembling federal agencies that deal with natural resource issues, the NRRC – which won a Hammer Award for government reinvention – will be able to use economic and

physical resources more efficiently, enhance teamwork among agencies and scientists, and improve technology transfer.

Built on land leased from Colorado State, the campus' construction will be overseen by the General Services Administration. Speakers at the ceremony included Assistant Agriculture Secretary Richard Rominger, U.S. Geological Survey Central Region Director Thomas Casadevall, Rep. Bob Schaffer, Sen. Wayne Allard, Colorado State University President Albert Yates, Everitt/Keenan Associates II President John S. Hill, Deputy General Services Administrator Thurman Davis, and Fort Collins City Manager John Fischbach.

Source: *CSU Comment*



WATER WORKSHOPS FOR TEACHERS

Dear Educators,

Study the many facets of the Poudre Watershed. This series of workshops is designed to provide teachers a chance to explore different aspects of the biology, geology, physics, and land use of the Poudre River System and sponsored by the Colorado Division of Wildlife and the Poudre Learning Center. Graduate credit available through CSU.

June 12-13 **Urban Impact on the Poudre Watershed**, UNC Lab School and Poudre Valley. Larry Rogstad, CDOW. \$104 (scholarships available to first 20 registrants).

June 16-17 **Physics of Sailing**, Poudre Learning Center Lake, Weld Cty Rd. 62 and 83rd Ave. Bernie Kendal and Courtney Willis. \$104 (scholarships available to first 20 registrants).

June 22-30 **Poudre River System**, UNC Lab School and Poudre watershed with overnight at Rocky Mountain National Park. \$152 (scholarships available to first 20 registrants).

Contact: Gerry Saunders at (970) 351-2210; or gwsaund@unco.edu for more information.



SHORT COURSES

Course Title	Instructors	Start Date/No. Days	End Date/Times	Fee
Applied Environmental Statistics	Dennis Helsel Ed Gilroy	August 7 4.5 days	August 11 8am-5pm	\$1495

To register, contact:
 Office of Special Programs and Continuing Education
 Colorado School of Mines, Golden, CO 80401
 Phone: 303/273-3321 FAX: 303/273-3314 Email: space@mines.edu

For more information, contact:
 International Groundwater Modeling Center
 Phone 303/273-3103 FAX: 303/384-2037 Email: igwmc@mines.edu



Colorado Water
Resources Research Institute

CU-Denver Water News



FLOODPLAIN DELINEATION USING HEC-RAS

NCES 8320 This hands-on three-day course is designed to provide engineers, planners and other professionals involved in major drainage ways, floodplain delineation and other flood problems with a practical working knowledge of the latest version of the HEC River Analysis System (HEC-RAS). HEC-RAS is a Windows®-based PC program that computes steady-flow water surface profiles for subcritical, supercritical and mixed-flow regimes.

The program was designed to replace HEC-2, and future editions will provide unsteady flow and sediment transport capabilities based on a single definition of river-reach data. This course will present Version 2.2 of the program, and cover river modeling, bridge and culvert hydraulics, GIS, HEC-2 data import, and floodway analysis.

Each participant will receive a training certificate, a copy of the software, plus the User's and Hydraulics Reference Manuals.

Dates: August 16 - 19, 2000 (Wednesday - Friday)
Time: 8 a.m. - 4:30 p.m. (Wednesday & Thursday)
8 a.m. - 3:30 p.m. (Friday)

Location: Lowry Higher Education Center
Cost \$895
CEUs: 2.0 Continuing Education Units



WESTERN WATER RIGHTS AND WATER ENGINEERING

NCES 8380. This six week, 16-hour course is designed for people who are interested in water resources. This course will emphasize Colorado water rights, but examples from other western states will be included. You will acquire valuable information in: development of the water rights doctrine; water institutions in Colorado; water rights changes, transfers, administration, and plans for augmentation; and, the implications of the above factors for water resource management. The course will be taught from a professional engineering point of view not a legalistic perspective.

Dates: September 26 - October 31, 2000; 6 Tuesday evenings
Time: 5:30 p.m. to 8:10 pm
Location: Auraria Campus, downtown Denver
Cost: \$495
CEUs: 1.6 Continuing Education Units

Colleen Anderson, Marketing/Program Coordinator
Continuing Engineering Education Program
Campus Box 104, P.O. Box 173364
Denver, Colorado 80217-3364
Voice: 303-556-6216
Fax: 303-556-6688
E-Mail csanders@carbon.cudenver.edu

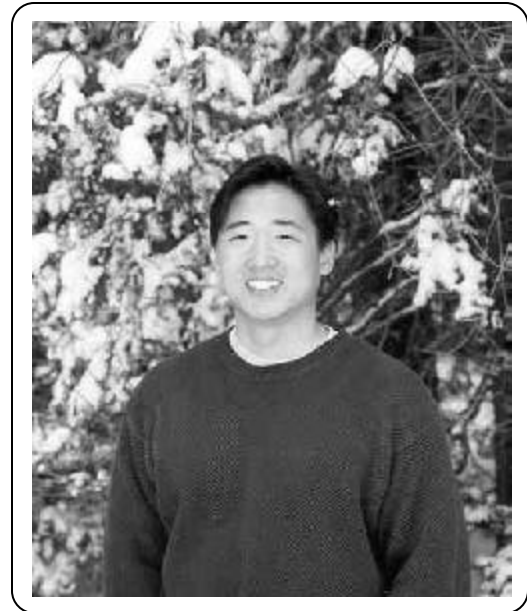
CU-Boulder is home to the Western world's most powerful centrifuge, a machine with an 800,000-pound swinging arm that can spin two tons of earthen material at 200 times the force of gravity. The huge machine is used for geotechnical modeling research of projects involving dam safety, earthquakes, foundations and highway bridge abutments.



FACULTY PROFILES *by Emile Hall*

“Just as a watershed connects the myriad biophysical features of a landscape towards a single outlet, so it connects the myriad people who work towards sustaining its productivity and health.”

Dr. Tony Cheng
Forestry and Natural Resource Policy
Department of Forest Science



In January 2000, Dr. Tony Cheng assumed the Forestry and Natural Resource Policy faculty position in the Department of Forest Science, the first position of its kind. Dr. Cheng specializes in the examination of the sociological and group dynamic aspects of natural resource management. While earning his doctoral degree at Oregon State University, Dr. Cheng studied the development and operation of watershed councils in Oregon. “My primary interests lie in the areas of conflict and collaboration in landscape-scale natural resource decision processes. I have been drawn into the world of water resources by virtue of the emergence of the watershed as a central landscape unit in scientific research, land use and natural resource planning, and a growing number of federal and state policy initiatives.”

Organization around a common sense of place, most recently the watershed, creates the potential for both collaboration and conflict. “Since virtually all watersheds encompass a mix of land uses, natural resource issues, and ownerships, watershed-based planning and management decisions invariably produce conflict – who gets what at what cost to others. Yet, a watershed-based approach also contains innumerable opportunities for collaboration among individuals and groups who normally would not work together towards common objectives.” Conflict management to foster creative, viable solutions around place-based natural resource management issues is the ultimate goal.

Dr. Cheng recognizes a connection between forestry and water resources issues. He is interested in working with federal land agencies on generating collaborative solutions to some of the current instream flow conflicts. “As I continue to examine the sociological and political dimensions of landscape-scale decision processes the need to build bridges across disciplines and organizations is apparent. I look forward to meeting and hopefully working with the diverse individuals who make up Colorado State’s broader water resources community, whatever their disciplines.”

Along with research and evaluation of the sociology of group organization around place in Colorado, Dr. Cheng is teaching Natural Resource Policy (NR320) and Sustainability of Renewable Resources (NR 425). He is also developing several courses: one on conflict and negotiation skills and another utilizing GIS mapping on community scales to better define and evaluate place.

Dr. Myrick hopes to conduct the research required to revitalize native, non-game fish while their populations are still relatively healthy.

Dr. Chris Myrick
Department of Fishery and Wildlife Biology
Colorado State University

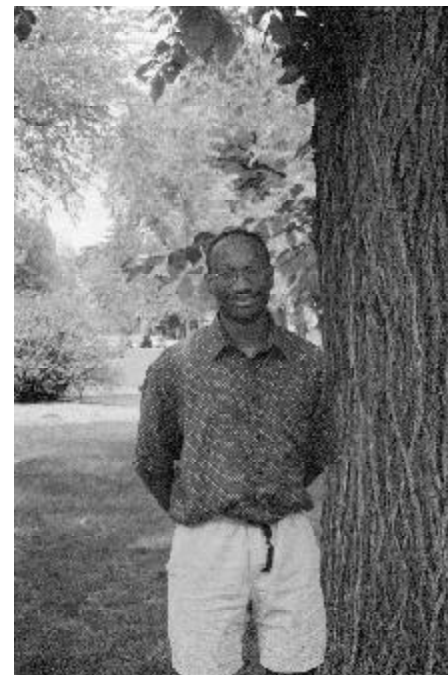
In January, Dr. Chris Myrick left the University of California at Davis to accept an assistant professorship in CSU's Department of Fishery and Wildlife Biology. Dr. Myrick is all about fish. In fact, he is a self-proclaimed "pathologic fisherman." While earning his master's and doctoral degrees at UC-Davis he still averaged about 100 fishing excursions a year. When not casting a line for fun and possibly dinner, Dr. Myrick conducted research on fish physiology.

In his eight years of research experience at UC-Davis he focused on the effects of environmental factors such as water temperature, on physiological characteristics of chinook salmon, rainbow trout, and golden trout, to name a few. Some of his research on salmonid temperature responses has been used to create models to extrapolate optimum streamflows in California.

In reflecting on his research experience in California, Dr. Myrick recounts the difficulties of working with threatened or endangered species. Since fish populations are already limited and protected under federal and state laws, it becomes more difficult to conduct the research required to revitalize the populations. He hopes to circumvent this problem in the future by studying the physiology and biology of native, non-game fish while their populations are still relatively healthy. He points out that not only is it easier to study healthy fish populations, but it is usually less expensive and may offer solutions for fish populations before they reach critical levels.

Dr. Myrick is interested in conducting research on the environmental tolerance of non-game fish native to Colorado, such as the brassy minnow. The brassy minnow often lives in intermittent streams and can be found in isolated populations on Colorado's eastern plains. Due to its natural habitat, often pools of water on the plains, the brassy minnow is expected to be able to tolerate high temperatures and low dissolved oxygen concentrations, but there is little information on the physiology of the brassy minnow and that hypothesis remains to be tested. Along with fish biology and physiology, Dr. Myrick is interested in examining how to raise non-game fish in captivity, or fish culture. He hopes to work closely with the rare and endangered fishes hatchery located in the San Luis Valley to help restore rare and endangered Colorado fish species.

While Dr. Myrick enjoys research, he is also enthusiastic about teaching. In fact, the teaching component of his job was one factor that brought him to CSU. This past spring semester he team-taught Ichthyology (FW 300) with Dr. Kurt Fausch to over 100 students. He will also be teaching Introduction to Fishery Biology (FW 204) and Fish Culture (FW 402).



RESEARCH AWARDS AT COLORADO UNIVERSITIES

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

Title1	PI	Dept	Sponsor
Natural Heritage Investigations	Pague, Christopher A	FWB	Nature Conservancy
Integrated Modeling & Assessment for Balancing Food Security, Conservation, & Ecosystem Integrity	Coughenour, Michael B	NREL	Univ. CA-Davis
Ecological Systems Viability Specifications for the Southern Rocky Mountain Ecoregion	Rondeau, Renee	FWB	Nature Conservancy
National Parks Vital Sign Project	Binkley, Daniel E	NREL	Nat'l Parks & Cons. Assn.
Survey of National Park Managers to Identify Geologic Resource Management Issues of Concern	Wallace, George N	NRRT	DOI-NPS
Cooperative Agreement for Hydrologic Model Development & Maintenance	Labadie, John W	Civil Engr.	USBR
Cooperative Agreement for Technical Assistance in Water Resource Investigations	Julien, Pierre Y	Civil Engr.	USBR
Management Practice Study II - County Land Use Impacts on Irrigation Districts	Wilkins-Wells, John R	Sociology	USBR
Air-Sea Interaction Remote Sensing Processes	Vonderhaar, Thomas H	CIRA	NOAA
CIRA Activities & Participation in the GOES I-M Product Assurance Plan	Vonderhaar, Thomas H	CIRA	NOAA
Colorado River Salinity Control Program	Gray, Mary Mephail	Coop. Ext.	USDA-NRCS
Development of Theory & Application of the Trapping Web for Estimating Density of Biological Populations	Anderson, David R	Coop Fish & WL Research	USGS
Wildlife Habitat Management Institute	Flickinger, Stephen A	FWB	USDA-NRCS
Agricultural Research	Sommers, Lee E	Agric. Exp.Sta.	USDA-CSRS
Biological Resources Division Global Change Data Management & Program Support	Simmons, Carol L	NREL	USGS
Training & Education for Agricultural Chemicals	Waskom, Reagan M	Soil & Crop Sci.	CDA
Stream Water Quality Modeling Technology Development	Garcia, Luis	CBE	USBR
USFS NFWF EO Specifications	Wunder, Michael B	FWB	Nature Conservancy

FEDERAL SPONSORS: BLM-Bureau of Land Management, COE-Corps of Engineers, DOA-Department of the Army, DOE-Department of Energy, DON-Department of the Navy, DOT-Department 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, , USBR-US Bureau of Reclamation, USDA/ARS-Department of Agriculture, Agricultural Research Service, USDA/NRS-Department 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 Department of Natural Resources, CDPHE-Colorado Department 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.

UNIVERSITY DEPARTMENTS, INSTITUTES AND CENTERS: Colorado State: BSPM-Bioagricultural Sciences & Pest Management, CBE-Chemical & Bioresource Engr., CIRA-Cooperative Inst. for Research in the Atmosphere, DARE-Dept. of Agric. & Resource Economics, FWB-Fishery & Wildlife Biology, HLA-Horticulture & Landscape Architecture, NREL-Natural Resource Ecology Lab, NRRT-Nat. Resources Recreation & Tourism, RES-Rangeland Ecosystem Science. University of Colorado: AOI-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, 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.

Title1	PI	Dept	Sponsor
IID/SDCWA Water Transfer EIR/EIS -Conservation Modeling	Labadie, John W	Civil Engr.	CH2M Hill
Preferences & Willingness to Pay Related to Natural Resource Management	Loomis, John B	DARE	USDA-USFS-RMRS
Levee Removal & Floodplain Connectivity Evaluation in the Green River, Utah	Bestgen, Kevin R	FWB	USBR
CloudSat	Stephens, Graeme L	Atmos. Sci.	NASA
Coupling Atmospheric, Ecologic, & Hydrologic Processes in a Regional Climate Model	Pielke, Roger A	Atmos. Sci.	NASA
Net Carbon & Energy Balance of Savanna Ecosystems at Earth Observing System (EOS) Validation Sites in Southern Africa	Hanan, Niall P	NREL	NASA
Identification & Mitigation of NPS Water Quality Impacts	Stednick, John D	Earth Res.	Univ. WY

**UNIVERSITY OF COLORADO
BOULDER, COLORADO 80309**

Title1	PI	Dept	Sponsor
Reservoir Stratigraphy and its Controls on Reservoir Architecture and Performance...	Pulham, Andrew	Geological Sci.	Various Oil Co.
Evaluation of Oceanic Cool-Skin and Warm-Layer Models Using Long-Term Measurements	Wick, Gary	CIRES	U. of Washington
Developing a Program for Climate Change and Climate Variability Scenarios for the Nigec Regional Climate Impact Analysis Projects	Strzepek, Kenneth	CEAE	U. of CA-Davis
Refinement and Verification of a Climatological Forecast Model of the Loop Current and Associated Eddies	Kantha, Lakshmi	ACCAR	Marathon Oil Co.
Investigation of Photochemical Transformations Within Snow and Their Effects on Snow and Atmospheric Composition	Steffen, Konrad	CIRES	NSF
Evaluation of Snow Simulation in the Second Phase of the Atmospheric Model Intercomparison Project	Frei, Allan	CIRES	NSF
Applications of Aerosondes to Long-Term Measurements of the Atmosphere and Sea Ice Surface in the Beaufort/Chukchi Sector of the Arctic Ocean	Curry, Judith	AOI	NSF
Global and Regional Impacts of Mesoscale Variability in Air-Sea Fluxes	Webster, Peter	CIRES	NASA
Characterizing the Siple Coast Ice Stream Using Satellite Images, Improved Topography, and Integrated Aerogeophysical Measurements	Scambox, Theodore	CIRES	NASA
Use of Satellite Gravimetry to Develop and Test a Land-Water and Energy-Balance Model	Wahr, John	CIRES	NASA
Land and Land-Use Change in the Climate-Sensitive High Plains: An Automated Approach with Landsat	Goetz, Alexander	CIRES	NASA
USBR Mid-Pacific Region Cooperative Agreement: Proposed Scopes and Budgets for Riverware	Zagona, Edith	CADSWES	USBR
Atmospheric Impacts of Global Agriculture: of Remote Sensing and Biogeochemical Models for Trace Gas Assessments in Iowa	Emery, William	ACCAR	U. of New Hampshire
Seasonal Differences in Air-Snow Chemical Relationships at Summit, Greenland	Steig, Eric	IAAR	NSF

Title1	PI	Dept	Sponsor
Undergraduate Research...Focused on Protection and Treatment of Water Supplies	Silverstein, Joann	CEAE	NSF
Radarsat Antarctic Mapping Project	Scambos, Theodore	CIRES	NASA
Climatology of Arctic Canada	Steffen, Konrad	CIRES	NASA
Upper Colorado Research, Development, and Support for Riverware	Zagona, Edith	CADSWES	DOI
International Research Workshop on Integrating GIS and Environmental Modeling: Problems, Prospects, and Research Needs	Parks, Bradley	CIRES	DOI
Interdisciplinary Graduate Education and Research Program in Hydrology	Gupta, V.K.	CIRES	NSF
A Study of the Spatial and Temporal Transitions of Climate and Ecosystems in the Circumpolar Arctic	Lynch, Amanda	CIRES	NSF
Feedback Coupling Between Flow and Reactions in Heterogeneous Porous and Fractured Media...	Rajaram, Harihar	CEAE	NSF
Application of LES to Understanding and Parameterizing the Arctic Cloudy Boundary Layer	Curry, Judith	PAOS	NASA
Theoretical Investigations of Clouds and Aerosols in the Stratosphere and Upper Troposphere	Toon, Owen B.	PAOS	NASA
Climate Sensitivity of Thaw Lake Systems on the Alaskan North Slope	Zhang, Tingjun	CIRES	NASA
Arctic Regional Sea-Ice Anomalies: A Diagnosis of the Atmosphere Ocean Interactions and Linkages to Large-Scale Climate	Lynch, Amanda	CIRES	NASA



WATER NEWS DIGEST

by Emile Hall



INSTREAM FLOWS/WATER RIGHTS

USBR to take less Ruedi water — At a meeting to discuss flow augmentation from the Ruedi Reservoir the Bureau of Reclamation announced that the total amount of water taken from the reservoir to help with the Endangered Fish Recovery Program may be cut in half. While this was somewhat encouraging to fishermen, the main problem they have with the releases is the manner in which they're let out from the reservoir and down the Fryingspan. For optimum fishing conditions on this popular fly-fishing river, anglers say levels should run below 250 cubic feet per second. Concerned parties are seeking minimum and maximum flows, an economic assessment of increased flows, a biological assessment of the river and that the contract for water releases be renewed yearly rather than implementing a long-term contract. USBR representatives, while acknowledging the desire for optimum flows for fishers, would not commit to them. The main question was whether the bureau should enter into an agreement that allows up to 10,825 acre feet of water and 5,412.5 acre feet of contracted, but unused, water to be released from Ruedi Reservoir each fall to help in the recovery of endangered fish. More water has been needed during late summer and early August when irrigation depletes the Colorado River to levels that are dangerously low to these fish. In the new alternative offered by the bureau, Ruedi could supply 10,825 acre-feet of water each year from mid-August through late October. This is about half of an earlier proposal that had Ruedi supplying more than 20,000 acre-feet of water to the program each fall. This decrease is the result of other reservoirs, including Wolford Mountain Reservoir and Williams Fork Reservoir, pitching in more water for the recovery effort.

Aspen Daily News, 5/11/00

Salazar criticizes White River flow plan — Colorado Attorney General Ken Salazar was among thousands filing comments on the White River National Forest management plan. Salazar's objection was to the USFS effort to claim 10 percent of flows on the nine rivers that pass through the White River National Forest. These efforts to protect fish, wildlife, aquatic plants and habitat would hamper future dams and diversions, Salazar said. Salazar helped settle lawsuits stemming from similar federal claims on 302 streams in the Rio Grande National Forest. The 10-percent flow requirements could constitute a taking, because the water is owned by another user. He said state requirements for maintaining minimum flows year-round may satisfy the USFS request, and emphasized that working with the state is better than through the forest plan. Specifically, Salazar said the 10 percent set-aside would stop

Colorado water users from fully tapping their rights to Colorado River water. He noted that in past cases challenging USFS flow claims, the U.S. Supreme Court has sided with the water users.

Denver Rocky Mountain News, 5/10/00, and *Grand Junction Sentinel*, 5/11/00

Subordination signed for Upper Gunnison Basin water - as promised— The Upper Gunnison River Water Conservancy District President and board secretary signed the Aspinall subordination agreement in May, 2000, joining the Colorado River Water Conservation District. The agreement awaits the signatures of U.S. Bureau of Reclamation officials, which should not be a problem because USBR helped draft the Aspinall subordination. The Aspinall subordination sets aside 60,000 acre-feet of water with the same appropriation date as the Aspinall Unit's to protect Upper Gunnison Basin water users with rights equal or junior to 1957. Conceived in 1957, the subordination agreement was offered to Gunnison County residents by USBR, which sought local acceptance of the dams and reservoirs of the Aspinall Unit: Blue Mesa, Morrow Point and Crystal. Under the terms of the agreement, 60,000 acre feet of the Aspinall's storage capacity were reserved - or subordinated - for eventual use in the Upper Gunnison Basin. The subordination was created to allay fears that Aspinall's huge hydropower rights could flush the basin dry and preclude future development. Once signed, the subordination ensures the 60,000 acre-feet for uses in the Upper Gunnison Basin.

Gunnison County Times, 5/11/00



LITIGATION

Colorado unwilling to pay debt with water— Colorado no longer will offer to use water to repay Kansas for damages Kansas will collect in its lawsuit against Colorado over the Arkansas River. Dave Robbins, part of the legal team defending Colorado against Kansas, said an earlier offer by Colorado to repay in water whatever damages are decided by a special court official was a "legal strategy" that is no longer needed. The portion of the case that will decide how much Colorado owes Kansas is still being heard by a special federal court official, who will issue his decision this fall, Robbins said. Kansas officials always have said that their state wants to be repaid in money, originally demanding more than \$100 million. Now, after 15 years of litigation, Kansas' claim has been reduced to \$65 million. However, Colorado attorneys say the state owes Kansas only about \$4 million. Colorado has worked hard to whittle down Kansas' estimate of how much it was damaged. Colorado attorneys initially attacked the computer model Kansas used to estimate how much water it lost to Colorado wells. More recently, Robbins and other Colorado attorneys have argued that much of the damage Kansas is claiming is "highly speculative" and include estimates of commerce lost by businesses that might have had more trade from farmers who might have made more money from their crops if Colorado hadn't improperly used the extra water. Robbins also said the court official overseeing the case has never decreed that Colorado now is obeying the 1949 compact. That also will be decided soon. Colorado instituted new well-use rules a few years ago that require the owners of most high-capacity wells to replace water their wells keep from reaching the Kansas border. Colorado officials think the new rules and other water-management changes are enough to comply with the compact, but only the court official can say for sure.

Pueblo Chieftain, 5/17/00



WATER QUALITY

Initiative to ban new cyanide leaching permits survives Supreme Court review — The Colorado Supreme Court affirmed most of a title for a proposed initiative to ban the use of cyanide to leach gold and silver in open mining. The Court changed one sentence in the initiative, proposed by the Alliance for Responsible Mining, to clearly state that active mines could continue to use cyanide under current permits. The ballot measure was inspired by the Summitville Consolidated gold mine's cyanide heap-leach affect on the Alamosa River. Summitville is now an EPA superfund site and is expected to cost taxpayers \$130 million to clean up. The grassroots effort to bring the issue to public vote on November 7 is requesting donations totaling \$100,000 to pay signature gatherers.

Pueblo Chieftain 5/3/00

Department of Ag offers incentives — The USDA will reimburse landowners who install conservation buffers along streams, wetlands and other environmentally-sensitive areas. Incentives include up to \$350 million in signing bonuses and more money for installing and maintaining conservation practices, enhancements in the U.S. Department of Agriculture's (USDA) new sign-up period for the Conservation Reserve Program (CRP). The program is designed to protect more environmentally-sensitive land. The incentives include:

- ◆ An up-front signing bonus incentive of \$10 per acre for every full year the contract covers. This amounts to \$100 to \$150 per acre at the start of the contract. The money is used to help defray up-front installation costs for filter strips, riparian buffers, grassed waterways, field windbreaks, shelterbelts and living snowfences.
- ◆ A payment incentive equal to 40 percent of the installation cost of all continuous CRP practices. This is in addition to the 50 percent cost-share paid by USDA for establishing certain approved practices.
- ◆ Increases in maintenance rate incentives for certain practices involving tree-planting, fencing or water development. Marginal pasture land rental rates have been updated nationwide to better reflect the market value of these lands. In most cases, rental rates in Colorado increased slightly.

- ◆ An increase of 20 percent on the average widths of filter strips and riparian buffers to allow farmers to square off field and buffer boundaries for more efficient farming.
- ◆ Conservation buffers protect streams and rivers by keeping sediment and nutrients from entering the water, provide cleaner drinking water, enhance recreation and improve wildlife habitat.

The sign-up period continues through Sept. 30.

Craig Daily Press, 5/17/00

Summitville drama could play out in federal court - Colorado's biggest environmental case could go before a federal judge in the next few months. The federal government is trying to recoup more than \$150 million from international financier Robert M. Friedland that it spent cleaning up the failed Summitville Mine, 25 miles southwest of Del Norte. Friedland founded Galactic Resources Ltd., the Canadian company that owned the mine. Federal and state lawyers say the case is an important test of whether mine operators can be held responsible for the consequences of their actions. Friedland, a U.S. and Canadian citizen who lives in Australia but maintains his business headquarters in Singapore, denies responsibility. He argues in court documents and interviews that his role at Galactic extended only to selling stock, even though he held the titles of president and chairman of the board at various times. He says others handled the operation of the mine. However, key executives who ran the mine reported to him, he participated and even chaired meetings of those executives, and he represented himself as the person in charge at Galactic when the company was called before state mine regulators. In addition, Friedland negotiated for the mineral rights at Summitville and signed the bank loan that got the project under way. It appears that the government will argue that an executive doesn't have to be at the mine site or even be the sole decision-maker in a company to be held responsible for pollution.

Rocky Mountain News, 5/8/00

Power plant sees rise in water minerals — Pawnee Power Plant has been monitoring a rise in mineral levels in groundwater at a monitoring well northeast of the plant. Test results have shown higher levels than usual of sodium, calcium, magnesium and chloride and the levels have been rising throughout 1999 with some fluctuations. The readings for higher groundwater concentrations of minerals were only in one monitoring well near a water recycling pond northeast of the plant. Another well near the one reporting higher levels showed no change in levels. Six additional monitoring wells were installed near the pond to investigate the elevated levels. This pond, like others, is lined to prevent leakage. There is no danger at this point, since levels are not large, but the company is trying to be a good neighbor and has notified those in the area. Pawnee Power Plant has also put together an action plan to identify the source of the rising mineral levels. The biggest rise has been in chloride, which has gone from 100 parts per million to 300 parts per million. Pawnee will perform weekly sampling of the new wells and three existing wells over at least eight weeks to determine calcium, magnesium, sulfate and dissolved solids in the groundwater. This will be compared to historical data and evaluate the data to determine the source of the additional minerals. At that point a decision will be made if further testing or wells need to be done. In addition, pond liners will be tested for integrity for any ponds identified as a potential source of the minerals.


The Fort Morgan Times 5/9/00

Settlement reached over mine pollution — Battle Mountain Gold Co. agreed to pay about \$100,000 to settle state complaints over seepage from a backfilled pit that leaked pollutants into a southern Colorado creek. The settlement between the Houston-based company and the state Water Quality Control Division (CWQCD) includes a \$71,700 civil penalty and calls for Battle Mountain to pay for a \$30,000 supplemental environmental project for improvements to the Costilla County Water and Sanitation District's treatment plant near San Pablo. Battle Mountain operated the gold mine four miles northeast of San Luis from Jan. 1990 through Oct. 1996. Pollutants from one of the mine's two pits were found to be flowing into the Rio Seco Creek in mid-1998. State officials believe the seepage started in October 1997 and may have continued through this winter. A CWQCD official said an examination didn't show any damage to the environment or human health. The discharges were mostly dissolved solids, manganese and sulfate.

Pueblo Chieftain, 5/10/00

EPA lists mine firms as polluters - The Environmental Protection Agency has listed mining companies and electric power generators as Colorado's major sources of toxic chemical releases. Industry leaders charge the EPA report is based on a new definition of toxic release that counts chemicals that remain on a company's property, such as metals contained in waste rock from mining. "This is not pollution," said Stuart Sanderson, the director of the Colorado Mining Association. "This is rock...that's simply put back into the ground (when the site is reclaimed). It's managed on-site." The rocks contain metals that occur naturally in Colorado, Sanderson said. But environmentalists said disturbing the rock exposes it to air and water, which can turn acidic and carry the metals into groundwater and streams. Also listed was Public Service Co. because coal ash contains a variety of metals. Jim Witt, PSC's environmental coordinator, said citizens rarely come in contact with the ash. Some goes to a landfill. It also has been used to build a railroad embankment at the Cherokee Plant in Adams County, Witt said. Joyel Dhieux of the EPA's Denver office said whether the waste rock is harmful depends on whether the mining company is careful to keep it away from water, which can carry the metals to area streams.

Rocky Mountain News, 5/13/00



Urban Runoff causing new strain of algae in Greeley? — It looks like toilet paper, feels like toilet paper, and that's what workers at Greeley's Bellvue Water Treatment Plant thought it was before they took a closer look. It turned out to be gomphonema, a type of algae that even the most experienced workers at the plant had never seen before. Officials believe the algae may be from urban runoff, which many say is the biggest threat to pristine drinking water facing Greeley and northern Colorado. Agricultural pollution from feedlots and fertilizers used to be the biggest threat, but city water officials are discovering that the habits of city residents are just as dangerous. Urban residents dump fertilizer, herbicides and pesticides on their lawns. Their cars leak oils onto city streets. They leave pet waste on the ground. They dump old paint and other hazardous chemicals directly down storm drains. All that goes into Greeley's two main water supplies, the Poudre and Big Thompson rivers. This has prompted more intensive studies of the Poudre and Big Thompson rivers. The initial findings from the Big Thompson are a bit troubling, said Nancy Koch, water resource manager for Greeley. "It basically told us that all the pieces of the puzzle were there for more algae blooms in the future," Koch said. Because Greeley's water is from the Big Thompson and Poudre rivers, the sources of contamination may be cities upstream. At the same time the city has called on residents to pay more attention to what they dump and may even install signs near stormwater drains to remind people that the water often goes directly to the rivers without treatment.

Greeley Tribune, 5/14/00



WATER RECREATION

DOW stocking plan modified due to whirling disease; economic implications upset locals — Lake County businesses that rely on tourism are concerned that the decision not to stock lakes at higher elevations because of the potential of wild trout stocks contracting the disease will put them out of business. A DOW press release said that the decision to bring more trout to lower-elevation waters, and to stock higher elevations with scant amounts if any at all, is due to fish with WD possibly affecting populations of wild trout downstream. Lower-elevation lakes and reservoirs already infected with the parasite can continue to be stocked because they do not drain into trout waters. According to Colorado Fish Health Board Chairman Greg Brunjak, "There has been no threat in the last 12 years of whirling disease expanding. The DOW has been stocking us since 1988 and we've had some of our highest populations in the last couple of years." At the same time Brunjak said that the decision not to stock Turquoise Lake is well founded because the disease has not yet been detected there.

Leadville Herald Democrat, 4/20/00

John Martin Reservoir considered for state park designation — John Martin Reservoir, a dam and recreation area between Las Animas and Lamar on the Arkansas River, could become the first state park in southeastern Colorado. State officials are negotiating with the U.S. Army Corps of Engineers, which built and manages the reservoir and surrounding area, to lease 13,000 surface acres of Lake Hasty below the dam and 16,000 acres of land. The state would put in about \$10 million of improvements to enhance the existing facilities. When full, John Martin Reservoir is the second-largest in the state after Blue Mesa Reservoir on the Western Slope. It was built in the 1940s as a flood-control project on the Arkansas River and is named after Colorado's late congressman. Martin served two terms in the U.S. Congress and was instrumental in getting the dam and reservoir built.

Lamar Daily News, 5/15/00

County presses for river access answer — As the boating season begins, Gunnison County is again attempting to create a local solution to the dispute over waterway rights. For a decade, the question of river access rights has caused unrest between boaters and private landowners in Gunnison County. In 1978, the attorney general ruled that once a kayaker or rafter touched the banks or beds of a waterway adjacent by private property, then it was trespassing. There is also a Colorado state statute that prohibits the blocking of a waterway. In the last year, both the Gunnison County Sheriff and District Attorney have expressed concern over the laws regarding the rights over waterways. They are hoping people will voluntarily avoid conflict and solve access concerns on a case by case basis. A community forum on recreational use of waterways/private property has been scheduled that will allow landowners and recreational users to identify current cross-ways and waterways used in the county.

Crested Butte Chronicle-Pilot, 5/5/00



WATER SUPPLY/TRANSFERS

Lots of ideas, no solutions offered at water meeting — Water and how to keep it in the Lower Arkansas Valley was the focus of a meeting Gov. Bill Owens held with area community leaders and water managers. Local officials don't want any more of the region's farming water sold to Front Range cities, but stopping those sales without trampling private-property rights has been impossible. Bob Bauserman, Otero County commissioner and member of a local group exploring the issue, told the governor that conservation easements might be the solution. Farmers would be paid to sign away their right to sell their water rights, tying the water to the region and solving the cash-flow crisis that has led farmers to sell in the first place. Who would pay for the easements? Bauserman said he hoped Owens could help with that. Greg Walcher, director of the Colorado Department of Natural Resources, said the idea makes sense because society should help pay for what ultimately is a societal benefit - the future of irrigated agriculture in the Lower Arkansas Valley. Bauserman said other sale-stopping measures such as leasing water to Front Range cities don't work as well because the water still leaves the area. A Rocky Ford implement dealer said measures such as creating interruptible supplies, in which farmers and cities share water, would help. Conservation also was mentioned by a farmer/rancher and Bent County representative of the Southeastern Colorado Water Conservancy District. Owens called for the state to become more aggressive about storing water. If dams are politically unpalatable, Owens said underground storage such as that used at Highlands Ranch could be the future alternative.

The Pueblo Chieftain, 5/9/00



MISCELLANEOUS

New hope for Monument Lake — There's new hope for saving Monument Lake, which for more than a century has provided water for irrigation and firefighting, trout for fishermen and flood control. Over the years, roots of willow and pine trees growing along the dam weakened it and caused it to leak. In 1997 the state engineer declared the dam unsafe and warned city officials it threatened the 20 or so homes below the 50-acre lake. Then rain water from last year's spring floods pushed large rocks over the top of the spillway, damaging the dam. But fixing the problem isn't as simple as breaching the dam and draining the water. To do so could harm an extensive wetland that has developed over the years and is home to the endangered Preble's meadow jumping mouse. More than 15 beavers and a half-dozen beaver dams, and even an elk and its young calf, also live in the wetland. Monument officials have been struggling with questions of whether to fix the dam, what exactly needs to be done and even who owns the dam and is responsible for paying. Two Springs-area lawmakers - Rep. Lynn Hefley and Sen. Doug Lamborn - believe they have resolved the ownership question so the search can begin for the \$1.8 million needed to make repairs. Monument's town council created a preservation committee charged with rescuing Monument Lake. The committee could go before the Water Conservation Board as early as December to ask for loans and state grants to fund the project. After the state built Monument Lake in 1891 and gave El Paso County ownership of the lake in 1899, it didn't give any money for maintenance or repairs.

Colorado Springs Gazette, 5/13/00

PUBLICATIONS



From Reclamation to Sustainability: Water, Agriculture, and the Environment in the American West, by Lawrence J. MacDonnell, former director of the University of Colorado's Natural Resources Law Center. Produced in cooperation with the Center and published by University Press of Colorado. This is the story of the essential role water and irrigation played in the settlement and development of the West, particularly in the Arkansas Valley and Grand Valley in Colorado, the Truckee-Carson River Basins of Nevada, and the Yakima River Basin in the State of Washington. In the epilogue, MacDonnell writes, "The West, I suspect, is not doomed to eternal damnation just because of its twentieth-century embrace of large-scale water development... At the heart of the reclamation movement was an understandable desire for human betterment... Human betterment turned into human greed and folly... This is hardly a golden age for irrigated agriculture, and many...find themselves largely on the defensive, trying to hold on to what they have against seeming attacks from all directions... In some places, ...irrigated agriculture remains a vital economic activity with a bright future. In other places,...it may not be economically sustainable in its present form... The transition from traditional irrigation to irrigation in the twenty-first century promises to be painfully difficult...[H]owever, irrigated agriculture has been remarkably resilient over the past hundred years..."

He continues, "Growth in the West no longer is linked directly to the use of water... [I]t is linked to quality of life... It is still possible to meet direct human needs, today and in the foreseeable future, with far less water than we are using today...It is still possible to restore parts of the water-based West that were readily sacrificed in this century to 'development.' It is possible to reclaim at least portions of western waterways for the rivers they once were...It is possible to remove dams...and to make those that we need operate in ways that better support essential river functions... This is not a book preaching the existence of a 'water crisis' and offering a path to salvation. Rather, it is intended to be a book that says the choices we make about water matter...". The approaches suggested are directions,...for the twenty-first century...not quick fixes... If we are to have in the West, as Wallace Stegner has urged, a 'society to match its scenery,' we must use our rivers, our aquifers and their water wisely.

For copies, contact Gary Bryner, Director, Natural Resources Law Center, 303/492-1286 or FAX 303/492-1297.

Source: *Western States Water*, 4/28/2000

WATER AND WASTEWATER ASSISTANCE IN COLORADO

The Colorado Division of Local Government, Department of Local Affairs, has available two lists that are used to coordinate financial and technical assistance to local governments: **Colorado Sewer Needs List** and **Colorado Water Needs List**. The lists represent the DLG's tracking water and wastewater system needs of local governments for over 15 years. The two eligibility lists are updated by the Colorado Water Quality Control Division annually, and a project must be listed on them to receive funding through the Water Pollution Control Revolving Fund loan or Drinking Water Revolving Fund. For copies of the list or for more information contact Barry Cress, Division of Local Governments, at 303/866-2352.

CALLS FOR PAPERS

Money Flowing Through the South Platte Basin: The Business of Water
11TH ANNUAL SOUTH PLATTE FORUM
October 24-25, 2000 -- Raintree Plaza Conference Center, Longmont, Colorado
CALL FOR POSTERS

What really drives the cost of water? Join us for the 11th Annual South Platte Forum to further investigate the driving forces behind the business of water. We will examine a variety of perspectives, including urban, agricultural, environmental, and municipal. The 2000 forum will include the following sessions:

- ◆ Changing Conditions in the South Platte: Can We Supply the Demand?--*An overview of the current state of the South Platte Basin*
- ◆ The Skyrocketing Price of Water: Are We Getting Soaked?--*An in-depth session on what is happening in South Platte Basin water market*
- ◆ How Much Green to Keep it Clean?--*Investigating the value and cost of maintaining water quality and preserving habitat*
- ◆ Growing Crops or Growing Houses: Rural v. Urban Water Competition--*An exploration of how urban water needs affect rural water users*

You are invited to submit a one-page abstract to the organizing committee for a planned poster presentation. The posters will be displayed during breaks and an informal cocktail hour on Oct. 24. **Poster abstracts are due by August 1, 2000.** To submit abstracts or request information about the conference please call or write:

Jennifer Brown
 Colorado Water Resources Research Institute
 410N University Services Center
 Fort Collins, CO 80523-2018
 Phone: 970/587-4778 or 970/491-6308 FAX: 970/491-2293

CONFERENCE ON TRANSBASIN WATER TRANSFERS
June 27-30, 2001 -- Denver, Colorado

Conference will feature five half-day Technical Sessions, a Poster Session, and a one-day study tour to see two major Colorado transbasin water projects. Contact: Larry D. Stephens, Phone 303/628-5430, FAX 303/628-5431, E-mail stephens@uscid.org. See the USCID web page at www.uscid.org/~uscid. Conference sponsored by U.S. Committee on Irrigation and Drainage. Co-Sponsors are the Bureau of Reclamation, Garrison Diversion Conservancy District and Northern Colorado Water Conservancy District. Deadline for submitting abstracts is August 1, 2000.

MEETINGS

Celebrating Our 25th Anniversary! — **Colorado Water Workshop**
Western State College, Gunnison, Colorado
 July 26-28, 2000 — **"Clean and Flowing Water"**

The Colorado Constitution guarantees that the right to divert shall never be denied, but recent developments in water quality, instream uses, and federal flow requirements are making new demands on our water resources. How do these demands fit into Colorado's prior appropriation system? What impacts can we expect for water users and suppliers?

David Holm and Mark Pifher will provide an update on new TMDL rules and discuss the impacts of other upcoming water quality issues. Speakers from around the West, including Wyoming's Jeff Fassett, will report on quality/quantity concerns in other states. Topics will also include demands for snowmaking, flows for water quality protection, and the growing popularity of whitewater parks. Carol Angel of the state attorney general's office, Bruce Bernard of the US Department of Justice, and other speakers will discuss efforts to secure flows for federal lands. Colorado Supreme Court Justice Greg Hobbs will offer his analysis of the challenges facing Colorado's prior appropriation system. In the keynote presentation, former governor Richard Lamm and former state senator Fred Anderson will debate the future of Colorado and its implications for water resource planning.

For more information contact Lucy High, Director 970-641-8766, 1-5PM, M-F; E-mail: water@western.edu Or check the conference web page for complete conference agenda and registration form: www.waterinfo.org/workshop.html. Scholarships are available for students.

CALENDAR



June 20-24	COLORADO STATE UNIVERSITY ALUMNI/AE & FRIENDS, Fort Collins, CO. Contact: Marilee Rowe, Civil Engr. Dept., FAX 970/491-7727, e-mail mrowe@engr.colostate.edu, or see webpage at http://www.engr.colostate.edu/depts/ce/conferences/index.html .
June 20-24	INTERNATIONAL CONFERENCE ON THE CHALLENGES FACING IRRIGATION AND DRAINAGE IN THE NEW MILLENNIUM, Fort Collins, CO. Contact: Larry Stephens at e-mail stephens@uscid.org, Phone 303/628-5430, FAX 303/628-5431, or see webpage at http://www.uscid.org/~uscid .
June 21-24	WATERSHED MANAGEMENT 2000 CONFERENCE, Science and Engineering Technology for the New Millenium, Fort Collins, CO. Contact Marshall Flug at Phone 970/226-9391, FAX 970/226-9230, e-mail marshall_flug@usgs.gov, or see ASCE website: http://www.asce.org .
July 10-14	USCOLD 20TH ANNUAL MEETING AND LECTURE, DAM O&M ISSUES - THE CHALLENGE OF THE 21ST CENTURY, Seattle, WA. Contact: Larry Stephens, Phone 303/628-5430, FAX 303/628-5431, e-mail stephens@uscold.org, or see webpage at http://www.uscold.org/~uscold .
15-Jul	UNDERSTANDING STREAM SYSTEM DYNAMICS, Loveland, CO. Contact: Chuck Wanner, at phone 970/484-0810 or email cwanner@poudriver.org; or Rob Buirgy at phone 970/613-7951 or email rbuirgy@btwatershed.org.
July 26-28	CELEBRATING OUR 25TH ANNIVERSARY! COLORADO WATER WORKSHOP, Gunnison, CO. Contact: Lucy High at 970/641-8766 or E-mail water@western.edu.
July 27-28	HIGH ALTITUDE REVEGETATION TOUR. Contact: Bryce Romig at 719/486-2150 x723 or Gary L. Thor at 970/491-7296. See the HAR website at www.highaltitudereveg.com .
Aug. 1-4	UNIVERSITIES COUNCIL ON WATER RESOURCES, LIVING DOWNSTREAM IN THE NEXT MILLENNIUM: RECONCILING WATERSHED CONCERNS WITH BASIN MANAGEMENT, New Orleans, LA. Contact: UCOWR office, phone 618/536-7571; FAX 453-2671 or e-mail ucowr@win.siu.edu.
Aug. 24-25	SUMMER CONVENTION, COLORADO WATER CONGRESS, Vail, CO. Contact: Dick MacRavey at phone 303/837-0812, FAX 303/837-1607, email macravey@cowatercongress.org, or see website http://www.cowatercongress.org .
Aug. 28-31	INTERNATIONAL CONFERENCE ON RIPARIAN ECOLOGY AND MANAGEMENT IN MULTI-LAND USE WATERSHEDS, Portland, OR. See AWRA webpage http://www.awra.org/meetings/Portland/Portland.html .
Sept. 24-27	2000 ANNUAL FORUM, Ground Water, Source Water and Underground Injection Forum and Technical Exchange Exposition, Ft. Walton Beach, FL. See online conference information at http://gwpc.site.net/meetings.htm .
Oct. 24-25	11TH ANNUAL SOUTH PLATTE FORUM, Longmont, CO. Contact: Jennifer Brown, CWRRI, at Phone 970/491-1141, FAX 970/491-2293.
Nov. 8-10	NORTH AMERICAN LAKE MANAGEMENT SOCIETY 20TH INTERNATIONAL SYMPOSIUM, Miami, FL. Phone 727/464-4425, FAX 727/464-4420, E-mail pleasure@pinllas.fl.us, or see the NALMS webpage at http://www.nalms.org/ .
Nov. 13-15	ASKING THE RIGHT QUESTIONS: EVALUATING THE IMPACT OF GROUNDWATER EDUCATION, Nebraska City, NE. Phone 1-800-858-4844, 402-434-2740, Fax 402/434-2742, or E-mail cindy@groundwater.org.
Dec. 13-14	GROUND WATER: A TRANSBOUNDARY, STRATEGIC AND GEOPOLITICAL RESOURCE, Assoc. of Ground Water Scientists and Engineers Annual Meeting, Las Vegas, NV. See the webpage http://www.ngwa.org/education/agwse2.html .
Jan. 25-26	SYMPOSIUM ON SPATIAL METHODS FOR SOLUTION OF ENVIRONMENTAL AND HYDROLOGIC PROBLEMS: Science, Policy and Standardization -- Implications for Environmental Decisions, Reno, NV. For information contact A. Ivan Johnson, 7474 Upham Court, Arvada, CO 80003-2758, Phone 303/425-5610, Fax 303/425-5655.

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