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COLORADO DIVISION OF WATER RESOURCES

DEPARTMENT OF NATURAL RESOURCES

StreamLines

Quarterly Newsletter of the Office of the State Engineer

Construction of Large Weighing Lysimeters in the Arkansas Valley

Dale Straw, P.E., Ground Water Modeling Branch

On October 4, 2004 the U.S. Supreme Court heard oral arguments on the Fourth Report of Special Master Arthur L. Littleworth in the ongoing litigation, Kansas v Colorado in the Arkansas River basin. One of the recommendations in the report, which the State of Colorado has been preparing to deal with for the past 10 months, is to use the ASCE standardized Penman-Monteith equation instead of the Blaney-Criddle formula to determine potential evapotranspiration of crops. Colorado's experts testified that, without proper adjustment for conditions in the Arkansas River basin, the ASCE Penman-Monteith method could overstate crop evapotranspiration (ET) and, therefore, cause the stream depletions caused by the pumping of post-compact wells to be over predicted.

In order to determine if adjustments to the Penman-Monteith method are needed, projects have been initiated by the Colorado Division of Water Resources:

- to design and construct two large weighing lysimeters in the Arkansas River valley,
- to upgrade and expand the network of Colorado Agriculture Meteorological (CoAgMet) weather stations located in the Arkansas River valley,
- and to conduct studies to determine the impacts of salinity and irrigation management practices on crop ET.

The background and development of these projects is discussed in greater detail in articles by Dennis Montgomery in the December 2003 issue of "Colorado Water" and by Dale Straw in the August 2004 issue of "Colorado Water" (PDF versions of both newsletters are available online at http://cwrri.colostate.edu). The purpose of this article is to provide a bit more detail concerning the design and construction concept of the two large weighing lysimeters that are to be built at the Colorado State University (CSU) Agricultural Experiment Station at Rocky Ford, Colorado. This design and construction concept is currently being reviewed by a peer panel of academic and agriculture experts coordinated by Robert C. Ward of the Colorado Water Resources Research Institute at CSU.

Figure 1

The first lysimeter to be constructed at Rocky Ford will be three meters by three meters by 2.4 meters deep and, when finished, will look like the large

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COLORADO DEPARTMENT OF NATURAL RESOURCES

Construction of Large Weighing Lysimeters in the Arkansas Valley (cont.)

lysimeters constructed by the U.S. Department of Agriculture (USDA) Agricultural Research Service (ARS) at Bushland, Texas (see Figures 1 and 2). The interior of the lysimeter shown in Figure 2 contains a steel tank that encloses the soil monolith, a scale system which supports the soil monolith tank and smaller tanks that collect the irrigation water that percolates to the bottom of the monolith, and the electronic equipment to collect data from the scale system and the environmental sensors located on a frame placed above the lysimeter during the growing season (the frame can be seen folded in Figure 1).

Figure 2

Figure 3

The strategy used to acquire the soil monolith and to construct the outer chamber that contains the monolith and the other equipment is illustrated using photographs provided by the USDA ARS at Bushland, Texas. These photographs show the construction of a smaller lysimeter using the same strategy to be used to construct the large lysimeter at Rocky Ford. This first step is to drill and construct four reinforced concrete piers below the level of the floor of the outer chamber shown in Figure 2. These piers serve two purposes. The first purpose is to anchor four steel columns which are used to pull the steel monolith tank into the ground using hydraulic jacks. Figures 3 and 4 show this pull down process. Once the soil monolith is fully enclosed by the steel tank, a temporary bottom plate is pushed under the steel tank and the soil monolith tank is lifted out of the ground (see Figure 5). A temporary top plate is then placed on the soil monolith tank and the tank is turned upside down. The temporary bottom plate is removed and the drainage system is installed in the bottom of the soil monolith tank.

Figure 4

While the drainage system is being installed in the bottom of the soil monolith tank, the hole created by the removal of the soil monolith is expanded. The second purpose of the four concrete piers constructed below the level of the floor of the outer chamber is to provide a foundation for the outer chamber floor which is constructed to support the outer chamber and the scale system supporting the soil monolith tank. Once the outer chamber is completed and the scale system has been constructed, the finished soil monolith tank is lowered onto the scale system (see Figure 6) and the electronic system installation is finished and tested.

Figure 5

The design of the various experiments that will be conducted on this lysimeter has not yet been completed. The current plan is to start the experiment program by growing alfalfa on the lysimeter for three to four years in order to compare the measured alfalfa ET with the alfalfa reference ET predicted using the ASCE Penman-Monteith equation. Once the second lysimeter is constructed at Rocky Ford and established as an alfalfa reference lysimeter, a series of other crops grown in the Arkansas River valley will be grown over a period of years on the first lysimeter in order to determine appropriate crop coefficients for use in predicting the ET of each crop using the ASCE Penman-Monteith equation.

Figure 6

Well Inspection Program

Joe Bender, Chief Well Inspector

The Well Inspection program, which was created under Senate Bill 2003-045 and signed into law by Governor Owens on May 14, 2003, is in operation. The inspection program provides geologic, geohydrologic, and engineering geologic expertise necessary to administer the ground waters of the state of Colorado within the legal framework of the Colorado Revised Statutes. The inspectors provide expertise and support to the Board of Examiners of Water Well Construction and Pump Installation Contractors in the enforcement of statutes, rules and court orders. Under the supervision of the Chief Well Inspector and/or the Division Engineer, the well inspectors research well construction problems, complaints against licensed and unlicensed well construction and pump installation contractors, document investigations, and conduct inspections for the Board of Examiners, courts, and other agencies regarding potential violations and compliance with statutes, rules, policies and industry standards.

Inspection of air rotary rig in Division 2

The inspection program began with the job position description and job qualification for the Chief Well Inspector. The Chief Well Inspector was hired in February of 2004 and the remaining inspectors were hired in July of 2004.

The well inspectors have in excess of 115 years of experience between them. They are:

Joseph T. Bender CWD/PI, Chief Well Inspector—Based in Denver

Joe is a licensed water well contractor, License #1240. He is a past President of the Colorado Water Well Contractors Association. He has owned and operated a well drilling and pump installation company for 20 years.

DWR Well Inspectors from left — Larry Hakes, Doug Pickering, Doug Stephenson, Tom Neefe, and Joe Bender

Larry Hakes - Based in Alamosa

Larry has been working in Division 2 for the past 6.5 years. He has 15 plus years operating drilling equipment and was a tool pusher (supervisor). Larry has a degree in Geohydrology from Montana State.

Douglas Stephenson - Based in Glenwood Springs

Doug is a licensed water well contactor, License # 1179, and has worked in all phases of drilling and well construction with over 30 years of experience. Doug has worked throughout the western United States.

Thomas Neefe - Based in Denver

Tom has a degree from Pennsylvania State University in Geological Science. He has over 15 years of field experience and has worked on such high profile jobs as the Exxon-Valdez oil spill as the public contact for Kodiak Island remediation. Tom has worked as a project manager for a national environmental cleanup firm with projects throughout the United States.

Douglas Pickering - Based in Durango

Doug has a degree from Mesa State College in Geology. He has over 20 years of field experience and has worked throughout the United States for Lockheed Martin Energy Research including the NRC Oak Ridge site. Doug has been a project manager working on environmental cleanup. He was also certified as a water well installer in Kentucky.

As of December 1, 2004, there has been approximately 700 well inspections and contacts made with contractors and well owners. An approximate breakdown of these inspections are as follows:

Division 1	86
Division 2	77
Division 3	245
Division 4	22
Division 5	66
Division 6	22
Division 7	192

Information on the Inspection program can be found on the web at www.state.co.us/boe (Well Inspection). As identified by the Board of Examiners as a high priority, the inspection program has identified and documented 24 unlicensed contractors working in the state of Colorado. Currently, the inspectors are averaging 150 inspections a month.

Rules for New Appropriations from the Confined Aquifer in Division 3

Mike Sullivan, Assistant Division Engineer

In 1998, under HB-1011, the State Engineer was directed to develop rules and regulations for new appropriations from the confined aquifer in the San Luis Valley. The legislation also directed the development of the Rio Grande Decision Support System (RGDSS), which was to be used to support the rules.

After six years of hard work, the RGDSS was sufficiently completed to allow for the promulgation of the rules. The modeling effort included the talents of the DWR and Colorado Water Conservation Board modeling staff and contractors including HRS, Hydrosphere, Leonard Rice and Associates, HDR, Agro Engineering, Principia Mathematica, Helton & Williamson, and Davis Engineering. This group of experts developed a GIS centered model, which looks at surface and ground water supplies, hydrology, acreage, crop demand, irrigation type, return flows, climate, priority, recharge, precipitation, and compact demands.

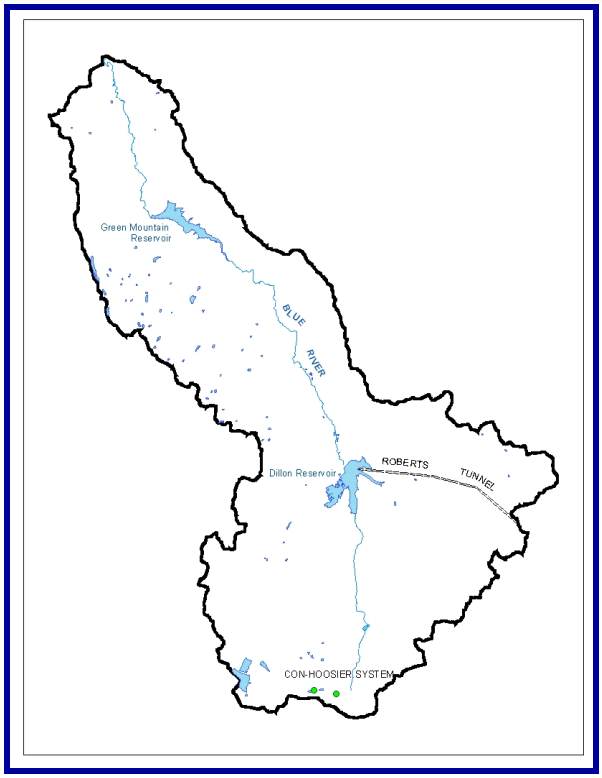
At the end of June 2004, the State Engineer delivered the *"Rules covering new withdrawals of ground water in Water Division 3 affecting the rate of direction of movement of water in the confined aquifer system"* to the Secretary of State. The new rules were also delivered to the Division 3 Water Court for publication in the Water Court resume.

A copy of the rules is available on the DWR website.

Green Mountain Reservoir Fill Accounting

Alan Martellaro, Division Engineer, Division 5

Green Mountain Reservoir was constructed by the United States Bureau of Reclamation as part of the Colorado Big Thompson Project as a compensatory reservoir the west slope to offset depletions caused by east slope diversions. Green Mountain Reservoir is located on the Blue River downstream from the City of Denver's Dillon Reservoir/Roberts Tunnel and the City of Colorado Spring's Continental Hoosier Diversion. Green Mountain Reservoir has a storage right and a power right that is senior to Denver's and Colorado Springs' transmountain diversions on the Blue River. The water rights are extremely important to both the west slope and to the east slope because of the location of Green Mountain and the impact of these water rights on many water users in the state of Colorado.



The years 2000-04 produced below average runoff in the Colorado River Basin, and included the driest year on record. The drought, combined with increased demand from both the east and west slopes, has made each administrative decision and interpretation of state and federal court decrees more critical. The drought years have focused the various opposing parties on the interaction of the Green Mountain Storage and Power Right. The separate rights have equal priorities and how the USBR "calls" for their water as either storage in the reservoir or to generate power, can impact both upstream and downstream water users.

From 2000 through 2002, the fill accounting at Green Mountain Reservoir was debated each year at the very moment DWR was attempting to make the decision. To avoid continued disagreement and prior to the mainstem river call in July 2003, staff from the Division 5 office convened a meeting of 40 to 50 attorneys, engineers, and water managers. The meeting resulted in a one-time agreement to get through that year that was not binding on the future with a commitment to work on a permanent resolution of the issue. Division 5 staff began a series of meetings in the fall of 2003 through the spring of 2004. At that time, the State Engineer and the Attorney General's

Green Mountain Reservoir Fill Accounting (cont.)

Office were brought into the discussion. In a race to resolve the dispute before the end of fill, a series of meetings was held individually with each of the major interests, several were held twice. Denver Water, the Colorado River Water Conservation District, and the Grand Valley Entities each submitted position papers. The culmination of this effort was a meeting on July 7, 2004 where all the interested parties were brought together to review a proposed policy, which became the SEO Interim Policy 2004-4, dated July 8, 2004, "Administration of Green Mountain Reservoir."

The central issue involves the determination of a reservoir paper fill. Is the Green Mountain Reservoir storage right satisfied with upstream out-of-priority junior storage in Dillon and Upper Blue Reservoirs? Green Mountain Reservoir (GMR) has a 1935 storage and power right, while upstream is the Continental Hoosier System with a 1948 right and Dillon Reservoir with a 1946 right. Both upstream junior rights are allowed to store and divert prior to the filling of GMR to the extent that water is on hand for the lesser of replacing diversions or filling GMR. The Blue River Decrees (BRD) were originally adjudicated in federal court, affirmed in state court, prior to the upstream storage statute, but operate in a similar manner. The issue arises when a call downstream of GMR causes administration of these rights.

The policy guided the administration for 2004 and initiated a committee, whose first meeting was on August 30, 2004. At this initial meeting, the USBR presented the details of its proposed Active Management Plan for the filling of Green Mountain Reservoir and Power Production. Under the Active Management Plan the USBR assesses the runoff forecast and determines the amount of that forecast needed for storage and the amount needed for power. As the runoff forecast changes, and storage targets change, the amounts of Blue River runoff allocated to storage and power changes. Any water intercepted by Denver and Colorado Springs that is part of the USBR storage allocation (or any other storage the cities have on hand) must be available for later release should GMR not fill. However, any water the USBR has allocated to power—at the time of each forecast—intercepted by the cities may be kept by the cities. Should GMR not fill, the USBR is at risk and this water does not need to be released. The BRD does state the Secretary of Interior shall offer a plan and that plan can change from time to time. A complete list of issues was developed at this initial meeting.

A second meeting was convened on October 6, 2004 where the USBR's active management plan was reviewed with new details, relevance of historic operations was discussed, and a few positions on the issues argued in front of the whole group.

The third meeting was held on November 8, 2004. This meeting was focused on what each party expected from continuing with this process, and what is necessary to permanently resolve the issues. A general consensus emerged where permanent resolution would only be reached through moving the federal court to recognize a stipulation in the BRD that provides resolution to the fill accounting and on any outstanding issues the group can reach agreement. Prior to the next meeting of the group, the USBR will circulate a proposal/written explanation. Each party will submit a response to the USBR, and the USBR will attempt to incorporate these responses. This document will then be the starting point for negotiating a stipulation to be offered to the court.

Tumbleweeds Choke an Irrigation Canal on the Arkansas River

Joe Flory, River Operations Coordinator, Division 2

Whether they are considered noxious weeds or obnoxious weeds, tumbleweeds blowing into canals wreaked havoc with late-season deliveries of water to shareholders in the Arkansas Valley during October and early November of 2004. The weeds blew into the canals in such quantities that headgates were closed. Despite round-the-clock efforts by canal personnel removing tumbleweeds with heavy equipment and burning them where possible, headgates remained closed for much of October and early November. No sooner would the crews get a section of ditch cleared before the winds would fill them back in again. The effects of this inability to divert water were far-reaching and proved to have consequences that may last through the winter water storage period. Not only were valley farmers deprived of water to finish late-season crops or to build soil moisture for germinating winter wheat, but the effects were also felt as far away as Aurora.

Tumbleweeds Choke an Irrigation Canal on the Arkansas River (cont.)

Aurora's diversions under their temporary lease and diversions of Rocky Ford Highline were curtailed during the periods when the Highline Canal was not able to divert because the historical regimen of administration must be followed or mimicked in water rights changes to protect the rights of junior appropriators downstream. When a ditch is unable to divert for irrigation, the presumption is that the water would have historically been available to downstream junior rights, including not only junior Colorado ditches, but the Arkansas River compact with Kansas as well. Curtailments of Aurora's Highline Canal lease diversions may have cost the city more than 300 acre-feet of yield. Operation of the winter water program was also affected by the inability of the ditches to divert because the pre-program baseline flow into John Martin Reservoir is established during the period November 1 through November 14. This baseline flow is the basis for establishing the "split" of water between compact storage and winter water storage in John Martin Reservoir. The higher flow during the first part of November will result in a higher percentage of the flows recorded at the Las Animas gage being booked into compact storage, which is divided between Colorado and Kansas, with 60 percent going to Colorado's District 67 ditches and 40 percent to Kansas.

The worst may be yet to come. According to some ranchers and farmers, the tumbleweeds causing the problems this year are actually from the previous year's crop, grown in 2003 during a much dryer season. With a much wetter 2004 growing season, some predict an even greater problem will be blowing in the wind next fall when the 2004 crop of tumbleweeds dries out enough to break loose and start the process all over again.

Human Resources

New Employees

Patrick Alexander was hired as a permanent part-time employee in the Division 1 office on November 1, 2004 as the new Deputy Water Commissioner for Water Districts 8, 9 and 80 (Cherry, Plum, Bear and Turkey Creeks as well as the North Fork of the South Platte and part of the South Platte main-stem). He started in this position as a temporary employee during this past spring and summer. Patrick also has previous experience working as a computer technician, which will be invaluable to the water commissioners in Districts 8, 9 and 80.

Linda Plate started as the Deputy Water Commissioner/Hydrographer for Water District 64 (lower end of the South Platte) on November 10, 2004. She worked for the U.S. Geological Survey for a number of years. Linda has previous experience monitoring and sampling wells, maintaining and calibrating water meters and measuring streams. She has a Bachelor of Science degree in Geography and is currently pursuing a Master's degree.

Brenda Hoisington started on November 29, 2004 as primary receptionist in the Denver office. Her prior work experience history in the private sector includes placement by temporary agencies for long and short-term assignments providing general office assistance and customer service. Brenda has a B.A. in Environmental Analysis and Policy from Boston University and is fluent in Swedish. Brenda is a welcome addition to the Denver office.

Angelica "Angie" Cohen began her new job as Records Technician I in the Denver office on November 29, 2004. Her duties will include imaging and maintenance of DWR records, as well as assisting the public in accessing and researching various water-related records. Angie has a strong background in using Geographic Information Software (GIS) to create state park, water utility and thematic maps, as well as in developing applications in Microsoft Access using Visual Basic

Human Resources (cont.)

programming language. Angie is bilingual (English and Spanish,) and has a Bachelor of Science degree in Sociology; her minor fields of study were Urban Studies and Geography.

John Read began working for the Division of Water Resources on November 29, 2004. His position is Engineering Physical Science Technician on the Denver Basin Team in the Denver Office. John holds a Bachelors and Masters Degree in Geology and has extensive experience in the mining industry. His primarily duty will involve exempt well permitting in the Denver Basin. John is easy to work with and will be a great addition to the Denver Basin Team.

John Van Oort joined the Division 2 office in Pueblo on December 13, 2004, as Water Commissioner in Water Districts 14 and 15. John previously worked for the Colorado City Metro District where he was Utilities Superintendent and Water Treatment Plant Operator, setting the call on Greenhorn Creek and is well versed in administration of the extremely complex Colorado City change decree. While at Colorado City, John converted their complicated pencil and paper accounting system to an Excel spreadsheet system, automating and improving many of the functions along the way. John comes from a farming/ranching background and has lived in the Colorado City area for more than ten years and so knows many of the water users in the area.

Chunming Yu began working for the Modeling Branch in the Denver office on December 1, 2004. She filled a newly created position as the RGDSS Applications Specialist. Chunming has a B.S in Hydrogeology from Lanzhou University in Gansu, China. She also has a M.S. and Ph.D. in Hydrogeology from the University of Arizona. She comes to us from a local environmental firm where she modeled all phases of ground water flow using finite difference and finite element methods. Chunming is a welcome addition to our agency and we are pleased to have her on board.

Clayton Kimmi began working for the Division of Water Resources on December 13, 2004. His position is Engineering Physical Science Technician on Team 237 in the Denver Office. Clay holds a Bachelor of Arts Degree in Geology and a Bachelor of Science Degree in Watershed Science and has extensive experience in the mining industry. He will be doing primarily exempt well permitting in the Team. Clay is easy to work with and will be an great addition to the DWR.

Victor Abad became a Records Technician I with the Denver office on December 13, 2004, where he will be imaging and maintaining various water-related records, as well as assisting the public in accessing and researching these records. Victor has a strong customer-assistance background, as well as years of experience in Microsoft Access database creation, technical support, IBM computer equipment repair, computer network configuration and installation, and Kofax Records Archive Scanning Software. Victor graduated from Red Rocks Community College, where he studied to become a microcomputer specialist and LAN administrator.

Retired Employees

John Lochhead retired on October 31, 2004 after 25+ years of service to the Division of Water Resources. John retired as an Assistant Division Engineer for Division 1 in Greeley. In this position, he provided overall direction for the administration of the upper South Platte in Water Districts 8, 9, 23 and 80. He was also the lead engineer for insuring the operations of Chatfield, Cherry Creek and Bear Creek Reservoirs were in accordance with reservoir policies. John started his career as a Hydrographer out of the Fort Logan office in 1979. From there, he moved to the Greeley office in 1990, and then back to the Denver office as the upper South Platte Assistant Division Engineer in 1991.

Jim Norfleet is officially retiring on January 1, 2005, after 23 years with the Division. In 1981, he left the U.S. Bureau of Reclamation and began working in the Dam Safety Branch in Denver. Jim was closely involved in the forensic investigation of the Lawn Lake Dam failure in 1982. He was the first engineer to take part in the decentralization of Colorado's Dam Safety program, moving to the Division 4 office in Montrose in 1987. Jim has been a valuable technical resource for his fellow engineers, both within DWR and in private practice. He has hosted numerous dam safety workshops for the public and has presented a number of technical papers at dam safety conferences. Jim plans to stay in the Montrose area where he plans to devote more time to woodworking, gardening and fly-fishing.

CALENDAR OF EVENTS

January 25-26	Colorado Water Conservation Board Meeting, Denver, Colorado; for more information, contact Catherine Gonzales at 303-866-3441
February 1	Colorado Board of Examiners of Water Well Construction and Pump Installation Contractors Meeting, Denver, Colorado; for more information, contact Gina DeArcos at 303-866-3581
February 25	Colorado Ground Water Commission Meeting, Denver, Colorado, Colorado; for more information, contact Marta Ahrens at 303-866-3581

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