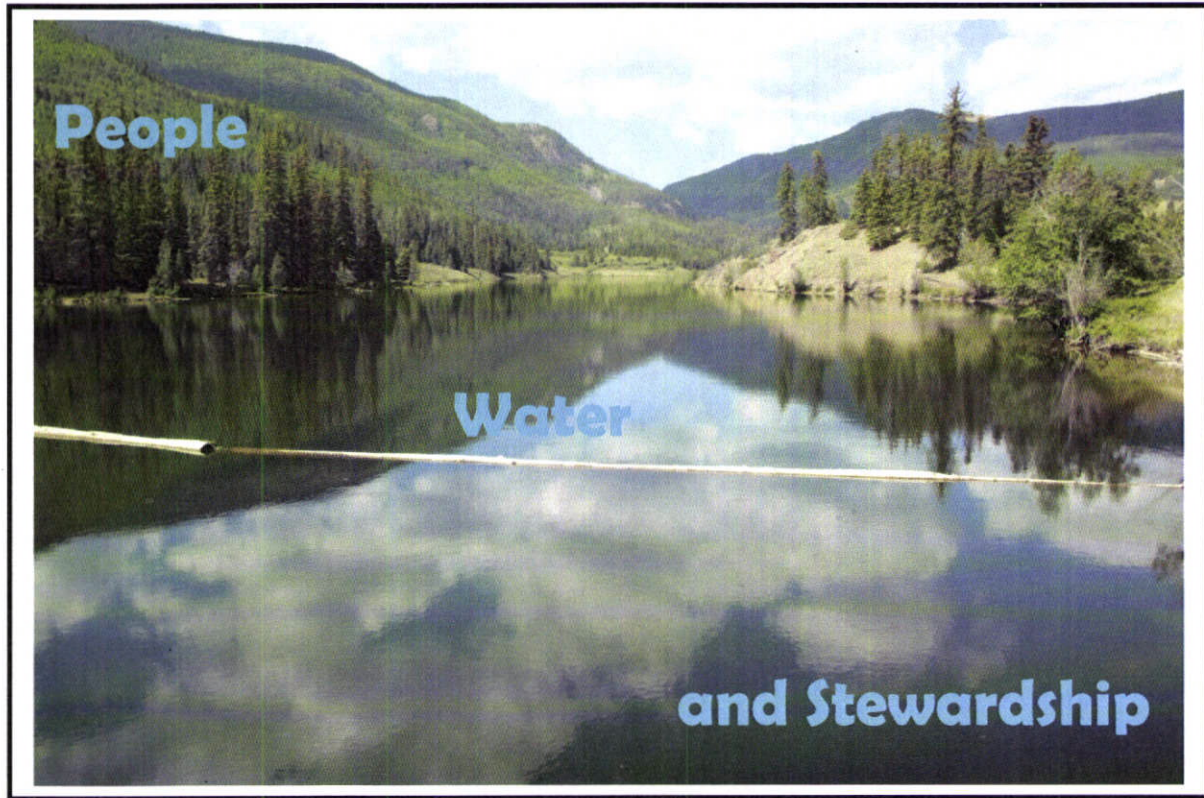


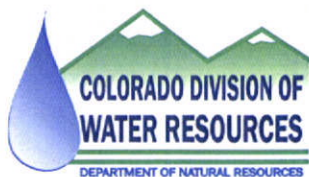
# ***STATE OF COLORADO***

***Division of Water Resources  
Office of the State Engineer***



## ***Water Supply, Engineering, and Investigations***

### ***2006 Annual Report***



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***April 2007***

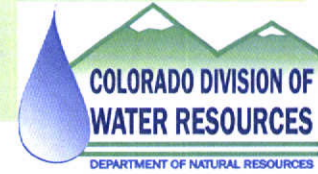


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## ***FORWARD***



The Water Supply, Engineering, and Investigations organization is comprised of a multidisciplined staff of engineers, geologists, hydrologists, technicians and support staff. We are an integral part of nearly every activity within the Division of Water Resources (DWR) spanning a broad spectrum of technical and engineering responsibilities.

The key resource and critical component necessary for the accomplishment of all that is discussed in the following is the highly skilled, dedicated and innovative staff. An organization chart and staffing are provided at the end of this report. Several staff participated in activities to foster teamwork in the accomplishment of DWR's mission.

I want to take this opportunity to personally thank each member of the staff for their support dedication and teamwork during 2006. With the many retirements several members of the staff in both in the Denver office and division offices have taken on additional workload with only my personal thanks, I am very proud to work with each of them.

The following report provides only the highlights of 2006, much of the day-to-day routine customer service and program accomplishment is too vast to include in the limited space of an annual report. Coordination with other local, state and federal agencies continues to be a key goal of our organization. In addition the staff is involved as leaders with many state and national professional organizations that reflect favorably on DWR. This annual report was compiled with tremendous assistance from the staff.



## DAM SAFETY BRANCH



### Introduction

The Colorado Division of Water Resources' Dam Safety Branch mission is to mitigate the loss of life and property damage and protect against the loss of water supplies due to the failure of dams in Colorado. The Dam Safety Program accomplishes that mission primarily through Safety Evaluations of Existing Dams (SEED) to determine the safe storage levels of reservoirs within the state. Additional program tools include a comprehensive set of rules and regulations, policies, and procedures for the design, construction, and maintenance of dams; the safe operation of reservoirs; and emergency action planning.



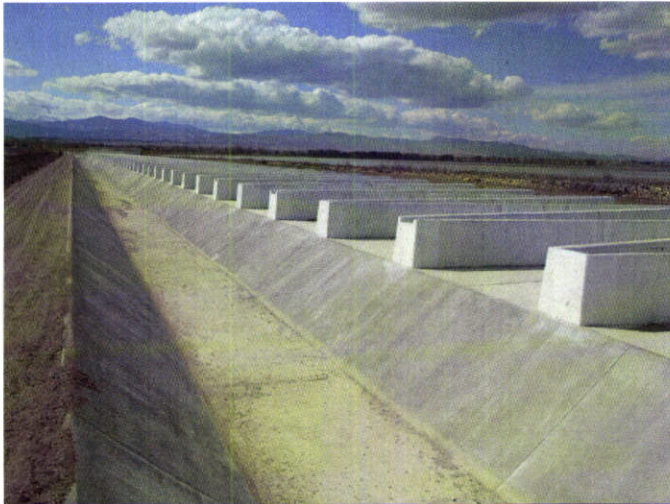
Humphreys Dam, Mineral County  
Division 3, High Hazard

The Dam Safety Program is managed by the State Engineer in accordance with Title 37, Article 87 of C.R.S. and the Livestock Water Tank Act, Title 35, Article 49 of C.R.S. The program is implemented by the State Engineer through the Dam Safety Branch and Water Division field offices. The Branch currently consists of a branch chief, eleven dam safety engineers, and one design review engineers. The Colorado Dam Safety Program oversees a total of about 2,900 dams with 1,928 dams of jurisdictional size. Of these, about 1,802 are non-federal dams. Of the non-federal dams, approximately 677 or about 38 percent of the total non-federal dams are classified as dams that, in the event of a failure, would be expected to cause loss of life and/or significant property damage within the flood plain areas below the dams.

For FY 05-06, the Dam Safety Program accomplished a number of the goals and objectives identified in the past annual report. Through the diligent field observations of dam safety engineers statewide, several near-failure incidents were acted upon in time to diffuse potentially dangerous situations and possible loss of life. As a direct result of these actions, no loss of life or significant property damage occurred in Colorado in the 2005-06 timeframe. This is attributed to the increased awareness and responsibility of the dam owners for their dams, including emergency action planning and to the enforcement of the regulations, policies, and procedures by the Division of Water Resources.



During FY 05-06, the State Engineer's Office approved five plans for new dams and 37 plans for alteration, modification, or enlargement of existing dams. Hydrology studies for four dams were also approved for determination of the inflow design flood for spillway design. The estimated cost of construction for the submitted plans was over \$60 million dollars.



Boyd Lake, Labyrinth Spillway  
Larimer County, Division 1, High Hazard

During FY 05-06, a total of 816 dam safety inspections and 146 construction inspections were conducted by Dam Safety Engineers for a total of 962 inspections. In addition, 115 follow-up inspections were performed. At the conclusion of the reporting period, there were 178 dams restricted from full storage due to various structural deficiencies such as significant leakage, cracking and sliding of embankments, and inadequate spillways. Total storage restricted was 117,510 acre-feet. The restrictions provide risk reduction

for the public and environment until the deficiencies identified are corrected. Although many dams were repaired and removed from the restricted list within the last year, a number of dams were also added to the list during the same time period. The change in the restriction from the same time last year resulted in a slight decrease in the number of dams on the restricted list and the volume of the restrictions decreased approximately 1,286 acre-feet. Approximately half of the dams on the Colorado Division of Water Resources restricted list have been on that list for ten years or longer.

The state has been able to acquire and maintain a full staff of experienced professional engineers, and has adequate statutes, regulations, policies, and procedures to implement and carry out the program.

This year, the Dam Safety Branch was successful in revising the *Rules and Regulations for Dam Safety and Dam Construction*, (Rules) and will be effective on January 1, 2007.

The key changes to the Rules as described in the public presentations include:

1. Elimination of the Intermediate dam size.
2. Revision and updating the nomenclature to be consistent with National Standards (i.e. hazard classification, Emergency action plans).
3. Revisions to the methodology for determining the Inflow Design Flood and spillway sizing.
4. Reduction of Probable Maximum Precipitation (PMP) due to elevation and location effects.



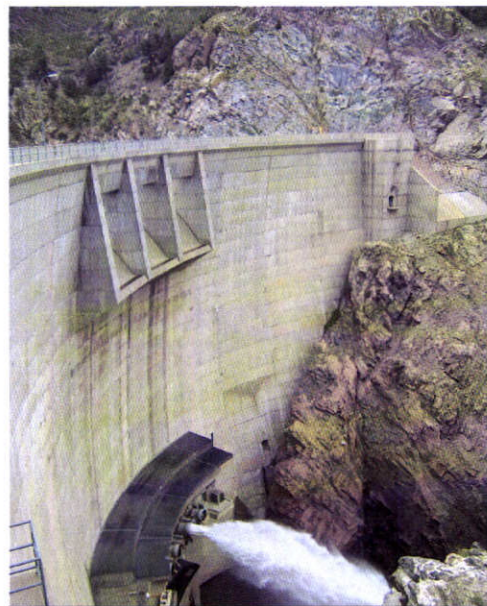
5. Modifications to the Embankment and Concrete Dam Design Requirements to bring the Rules in line with state-of-the-practice.

The Dam Safety Branch continues to use risk-based tools to help evaluate the jurisdictional dams in Colorado and prioritize the use program resources more efficiently and effectively. In addition, two major studies were completed to assist engineers and hydrologists develop consistent and reasonable PMP's and guidelines to estimate basin parameters for use in Inflow Design Flood (IDF) Studies. First, the beta version of the state-of-the-practice in Extreme Precipitation Analysis Tool (EPAT) for the West Slope was released. Initial use of EPAT has demonstrated that the tool emulates site-specific and Hydrometeorological Report (HMR) PMP events. The Branch is optimistic that this state-of-the-practice tool in hydrology and hydrometeorology in Colorado will be available east of the Continental Divide in 2007. Secondly, a draft of the Guidelines and Procedures for Estimating Basin Response Factors in Colorado was presented to the Branch in the fall. The final publication will be available for use in early 2007.

## Federal Dam Safety Coordination

Routine inspections of federal dams by Dam Safety Engineers have been curtailed in accordance with a legislative audit recommendation. The Branch, however, will participate in the evaluation of the safety of some federal dams for special issues and performance problem evaluations, in accordance with the procedure for obtaining approval to participate in these inspections. Less than about ten hours were spent this fiscal year participating in these safety inspections at a cost of less than \$450.

Memorandums of Understanding (MOU) have been executed with the U.S. Bureau of Reclamation (USBR), the U.S. Bureau of Land Management, and the Air Force Academy (AFA) relating to dam safety activities in Colorado. An MOU is also in development for the Fort Carson Army installation. The MOUs provide for the exchange of safety-related information of dams under each agency's jurisdiction. An MOU is also being updated with the U.S. Forest Service, Rocky Mountain Region, to provide coordination of mutual responsibilities for dam safety and their Travel Management Plan for the National Forests. This is necessary to provide access to private dams located within the forests. MOUs are being pursued with the other federal agencies such as the U.S. Army Corps of Engineers (USCOE) and the Federal Energy Regulatory Commission (FERC) to assure that the dams under their jurisdiction are being maintained in a safe condition and to coordinate activities and exchange of information and data.



Strontia Springs Dam,  
Douglas County, Division 1  
High Hazard



In the past, the Branch has performed safety inspections of dams that are also regulated by FERC. In accordance with an agreement (since a formal MOU was not completed) with them, they were to furnish copies of their reports for branch records. More recently, the branch had curtailed participation in FERC regulated dams in accordance with a 1998 State of Colorado internal audit. However, during a recent review of the agreement and procedures for administration of FERC regulated dams, the need for a change in the current policy was identified. It was determined that the Dam Safety Branch does not regularly receive copies of FERC safety inspection reports. Further, it was clarified that unlike USBR and USCOE dams, the FERC does not own the dams they regulate and, in most cases, the dams are owned by Colorado based entities. To ensure the safety of the citizens of Colorado, it was determined that Dam Safety Branch engineers would resume performing dam safety inspection of FERC regulated dams in Colorado. Policy Memorandum No. 06-02 modifies recommendation #3 of the 1998 legislative audit resuming inspections on non-federal dams that are regulated by FERC.

## Revisions to Rules and Regulations



Elkhead Dam Outlet Works Tower  
Moffat County, Division 6, High Hazard

This year, a serious effort was been made toward the revision and updating of the *Rules and Regulations for Dam Safety and Dam Construction*, (Rules) which were last revised in 1988. The Dam Safety Branch was successful in revising the Rules, which will become effective on January 1, 2007. Major steps were taken in the revision process and the proposed revisions were presented to all the dam safety engineers for review and comment. Following several months of vigorous review and discussion within the Dam Safety Branch, the proposed rules

were posted on the Dam Safety Branch web site for public comment. Several presentations were made to the engineering communities on the Front Range and the western slope to describe the proposed Rule revisions and elicit comments. Many comments were received, with most of them being positive.



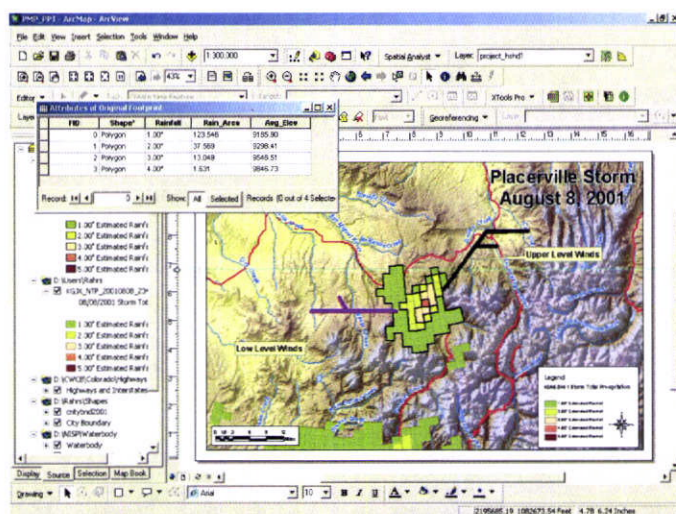
The key changes to the Rules as described in the public presentations include:

1. Elimination of the Intermediate dam size.
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3. Revisions to the methodology for determining the Inflow Design Flood and spillway sizing.
4. Reduction of Probable Maximum Precipitation (PMP) due to elevation and location effects.
5. Modifications to the Embankment and Concrete Dam Design Requirements to bring the Rules in line with state-of-the-practice.

Based on comments from consulting engineers on the Front Range, several consultant-lead committees were formed to take a closer look at updating specific sections of the rules. Committees for Geotechnical Engineering, Concrete Dam Engineering and Engineering Geology were formed to address specific areas of the Rules. The committees provided their comments to the Dam Safety Branch for consideration and possible inclusion into the new Rules. This process of open review and comment has resulted in positive communication between the dam owners, their engineers and the State Dam Safety Regulators. This communication has allowed all to agree that the safety of general public is of paramount concern when discussing the operation and regulation of dams in Colorado. This process of open review and comment proved to be beneficial and, as a result, nobody contested the Rules at the hearing held in November.

## Extreme Precipitation Study

The hydrologic evaluation of spillways on dams located above elevation 7,500 feet has been on hold for a number of years. The hold status is predicated by uncertainties in the existing tools and methodologies available to determine the Probable Maximum Precipitation (PMP) in high altitude watersheds in the state. Although long considered a factor, the real effects of terrain and 14,000-foot mountains on the tools used to predict and quantify extreme precipitation events has not been wholly understood or accounted for by the commonly available



Typical screen from an ArcView based GIS analysis of an Extreme Precipitation event.



tools or methods, most of which are nearly 40 years old. It is believed that a more accurate estimate of the probable maximum precipitation in the mountainous area could save millions of dollars in the construction of spillways for dams.

In the summer of 2005, discussions began between the Dam Safety Branch and consulting hydrometeorologists regarding the use of Geographic Information System (GIS) technology to solve the long-standing extreme precipitation dilemma. Based upon those discussions, in the fall of 2005, a proposal was developed to provide an Extreme Precipitation Analysis Tool (EPAT) for use in dam safety and rehabilitation studies within specific regions of the state. Funded by the Dam Safety Branch's National Dam Safety Program (NDSP) grant and the CWCB, a beta version of the EPAT) for the West



Ritschard Dam, Grand County  
Division 5, High Hazard

of the Continental Divide was released for use within the Dam Safety Branch in the Spring of 2006. The tool was initially developed for the western slope with drainage basins of less than 500 square miles.

EPAT is an objective GIS-based analysis tool that utilizes existing National Weather Service storm databases as well as the Colorado extreme weather database developed by Colorado State University and modern meteorological techniques to analyze extreme precipitation events. EPAT provides dam

owners an alternative to costly site-specific studies. The Branch will provide training sessions to the public on how to effectively use EPAT. The initial use of EPAT has shown that the tool emulates site-specific Probable Maximum Precipitation (PMP) and Hydrometeorological Report (HMR) PMP events. The Branch is optimistic that this state-of-the-practice tool in hydrology and hydrometeorology in Colorado will be available for the east of the Continental Divide in 2007.

## Hydrologic Basin Response Study

The determination of spillway adequacy is based upon the development of an Inflow Design Flood (IDF) for the watershed above a given dam. The analysis of spillway adequacy for dams within much of the state has been on hold for some time due to questions regarding estimates of extreme precipitation. A second part of the development of an IDF has to do with how the watershed reacts to the extreme precipitation event. Many "Basin Response Factors" can effect how much precipitation (water) from a given magnitude event actually "runs off" and needs to be safely handled by the spillway and passed through the reservoir to prevent overtopping the dam. As with the methodologies used for estimating extreme precipitation, the methods of estimating basin response



factors used in determining the IDF are based on past research and have not been updated in over 40 years. Additionally, in many cases the empirically based response factors are based on studies performed in other states, making their application within Colorado questionable.

The problems associated with choosing appropriate basin response factors for Colorado watersheds have long been known within the Dam Safety Branch. There are large cost implications associated with spillways in Colorado as a direct result of estimating basin response factors.

During the spring of 2005, the Dam Safety Branch embarked on the development of a hydrologic basin response study. The goals of the study were developed by the Dam Safety Branch and generally include investigation and documentation of the use of data and information available to estimate watershed parameters for use in IDF studies. The scope of the study also includes the development of guidelines and procedures that when used by engineers and hydrologists with appropriate training and relevant experience, will produce consistent and reasonable IDF hydrographs throughout the state.

Through the efforts of a nationally recognized consulting hydrologist and a select group of dam safety engineers with an expertise in hydrology, a draft of the Guidelines and Procedures for Estimating Basin Response Factors in Colorado was presented to the Branch in the fall. Comments were provided and the final publication will be available for use in early 2007.



Genesee Dam No. 2, Foundation Inspection  
Jefferson County, Division 1, High Hazard

## **National Dam Safety Program Assistance Grants**

With the passage of the National Dam Safety Program Act (NDSP), PL 104-303, and its subsequent funding, Colorado has applied for and received assistance grants each year since 1998. An additional grant was approved for 2006. These funds were used to provide advanced training to the Dam Safety Branch personnel in the fields of dam safety and risk analysis. Additional training is provided under the technical seminar provisions of the Act. The grant funds are also used to acquire emergency communication equipment, upgrade computers, and purchase engineering computer software programs and other equipment. Future grants may be available each year under the Act, subject to appropriations.



A critical element in the Dam Safety Program is the continued training of our personnel to maintain a high level of technical competency, to keep up with changing technology, to develop additional management and communication skills, and to keep abreast of changes in the development of dam safety programs across the country. The following training opportunities were achieved this fiscal year:

- ✦ HEC-HMS Training Emmittsburg, MD (attended by 2 dam safety engineers);
- ✦ FEMA Workshop on HEC-RAS Unsteady Flow, Emmittsburg, MD (attended by 1 dam safety engineer);
- ✦ ASCE HEC-RAS Steady Flow Analysis, Denver, CO (attended by 1 dam safety engineer);
- ✦ ASDSO Hydraulics of Spillways Technical Seminar Las Vegas, NV (attended by 2 dam safety engineers);
- ✦ ASDSO Annual Conference, Boston, MA (attended by 4 dam safety engineers);
- ✦ USBR Dam Tender Training, Grand Junction, CO (attended by 2 dam safety engineers);
- ✦ USSD Annual Conference, San Antonio, TX (attended by 2 dam safety engineers);
- ✦ Extreme Precipitation Analysis Tool (EPAT) Training, Denver, CO (attended by the Dam Safety Branch);
- ✦ Pressurized Concrete Cylinder Pipe and Concrete Repair Technical Seminar, (attended by two Dam Safety Engineers).

## **Integration of Risk Assessment**

Colorado has relied on an inspection / standards based program for over 20 years to assure the safety of dams in the state. While inspection activities are necessary and provide a basis for dam inventories, evaluation of hazard classifications and site conditions at dams, too many serious incidents and even failures of dams in Colorado are still occurring. After attending an ASDSO workshop in 1999 on risk assessment, dam safety engineers decided to explore ways to include risk assessment in the Dam Safety Program as a tool for identifying potential failure modes at existing dam and to focus resources at the dams having the greatest risk of failure and significant consequences.

The Dam Safety Branch has embarked on a program to utilize Risk-Based methods to rank dams according to potential failure modes and consequences. An Intergovernmental Agreement between the Bureau of Reclamation (USBR) and the Dam Safety Branch was issued to allow the USBR to revise their Risk-Based Profiling System (RBPS) to meet the needs of the Colorado Dam Safety program. The goal of the Colorado RBPS program was to develop a relatively simple (to the user) software tool to quickly rank the relative condition of Class 1 (High Hazard) and Class 2 (Moderate Hazard) dams in the state. The rankings would then be used to more efficiently allocate resources to those dams determined to present the greatest risk to public safety.



After several iterations of evaluating prototype software, in the summer of 2005, a RPBS software tool suitable for use by the Dam Safety Branch was delivered. Since the software was delivered at a time when safety evaluations of existing dam field inspections were at their peak, the tool was temporarily shelved. This winter, the RBPS program enabled the dam safety engineers to rank all High (Class 1) and Significant (Class 2) Hazard dams in their areas of responsibility by March. Those rankings will be an important tool for the dam safety engineers as they develop schedules and priorities for the



J.O. Hill Dam Emergency Spillway  
Douglas County, Division 1,  
Significant Hazard

2007 inspection season. These rankings will also be used to more efficiently allocate resources to those dams determined to present the greatest risk to public safety.

As the dam safety engineers become more familiar with the RPBS program, additional application of the Risk-Based methodologies, including increased implementation of Failure Modes and Consequence Evaluations (FMCE), will be pursued.

## Personnel

- ✘ Mark Haynes was appointed Chief of the Dam Safety Branch in January.
- ✘ John Redding joined the Denver office in March as PE I, Dam Safety Engineer. The PE I position was created in the Dam Safety Branch as a training position. John transferred from the Water Supply Branch with no real Dam Safety experience.
- ✘ John Batka joined the Division 1 office in Greeley in June as a PE II, Dam Safety Engineer. John transferred over from the Division 1 Water Supply Team.
- ✘ Paul Perri joined Denver office in October as a PE II, Design Review and Construction Inspection Engineer. Paul joined DWR from the private sector and has nearly 10 years of dam design and dam construction experience.



### Introduction

The protection of Colorado's water resources is a complex and vital challenge to the employees that serve in the Division of Water Resources. Recognizing the importance and value of our responsibilities, the following highlights some of the activities and accomplishments achieved by the staff during 2006. The administrative and functional responsibilities performed include:

- ◆ Analysis and approval of pending Substitute Water Supply Plans (SWSP's).
- ◆ Subdivision review, analysis, and comment to Colorado counties for proposed housing developments in regard to water supply adequacy.
- ◆ Perform all functions of groundwater well analysis and permitting.
- ◆ Conduct engineering analyses and groundwater well permitting functions for the designated groundwater basins. Also serve as technical staff for the Colorado Groundwater Commission.
- ◆ Perform litigation management for our involvement within the judicial and water court processes and expert witness testimony. Coordinate activities with the seven Water Divisions, the seven Water Courts, and legal counsel provided through the Colorado Attorney General's Office.
- ◆ Conduct engineering and technical analyses into all facets of water resource engineering, planning, and administration.
- ◆ Provide water resources training and education to attorneys, consulting engineers, federal/state/county officials, school children and water users through a variety of formal and informal presentations.



Suzanne Sellars obtaining a low flow measurement at Woodmen Hills.



## Substitute Water Supply Plans

The authority to evaluate and issue substitute water supply plans (SWSPs) is vested exclusively to the State Engineer's Office. During 2006, this office reviewed and acted upon 249 general SWSPs (including emergencies) and 63 SWSPs related to gravel pits. This includes 13 Rule 14 replacement plans approved in Water Division 2 pursuant to the Arkansas Use Rules.

## Subdivision Review

Subdivision water supply plan reviews must be conducted within 21 days to meet statutory time restrictions. We often satisfy this requirement in substantially less than 21 days. During 2006, a total of 435 subdivision referrals were received and acted upon by this office. This function requires perpetual information sharing and communication with all Colorado counties.

## Designated Groundwater Basins and Colorado Groundwater Commission



Kevin Rein observing flow conditions on Box Elder Creek.

In performance of their duties, the Designated Basins staff issued 144 final permits, 536 small capacity well permits, 304 large capacity permits/ Determination of Water Rights, 76 change application approvals, and was involved in 47 enforcement actions.

Staff conducted a multi-day field trip to the Southern High Plains that facilitated the collection of several hundred Statements of Beneficial Use in the basin for final permitting. Staff continued evaluation of Final Permits in the Kiowa Bijou and Southern High Plains Basins. Staff

also participated in 8 Ground Water Commission administrative hearings and/or court cases. Staff conducted 2 day-long sessions in the Kiowa Bijou Basin to assist well owners in submitting Statements of Beneficial Use and for gathering information for final permitting.

Staff worked with the Hearing Officer and the Ground Water Commission to complete and approve new Rules of Procedure for All Hearings before the Colorado Ground Water Commission. Staff also participated in one variance hearing and one appeal hearing in front of the Ground Water Commission. Staff worked on migrating some of our Denver Basin Aquifer permitting information into digital format using GIS.



Staff evaluated a petition to create a new Box Elder Creek Designated Basin. The hearing on this matter is set for January 2007.

The staff continues to be active participants in designated basin groundwater management through consultation with the Groundwater Management District and the Republican River Water Conservation District.

## **Groundwater Well Permitting**

The groundwater evaluation staff received and acted upon 7,112 applications for well permits in 2006. Of this total, 405 were emergency applications for replacement wells. The well permitting staff continues to process and analyze well permit applications, Monitoring-Hole Notices (670), Changes in Ownership/Address (5,976), Well Construction and Test Reports (5,692), and Pump Installation Reports (3,626).

## **Other Referrals**

The Division of Water Resources is a referral agency for other State and Federal agencies including the Colorado Division of Reclamation, Mining, and Safety, the Army Corps of Engineers, and the Colorado Department of Public Health and Environment and miscellaneous Federal agencies regarding environmental assessments and environmental impact statements. Staff acted on 153 referrals from these agencies.

## **Water Quality Activity**

Staff received one consultation request from the Water Quality Control Commission during 2006. Several parties to WQCC's Rulemaking Hearing for Consideration of Potential Revisions to Current Provisions Regarding Water Temperature Criteria and Standards, scheduled for January 8, 2007, had expressed concerns about possible water rights impacts attributable to proposed revisions to temperature standards. The proposed changes were located in WQCC's Basic Standards and Methodologies for Surface Water (Regulation #31), and the consultation request was intended to address the concerns of those parties. With the assistance of the Attorney General's Office, a letter from the SEO and CWCB was prepared in late December and presented to WQCC during the January hearing.

## **Special Projects**

- ◆ Authored Chapter 14 – *Water Administration: State Engineer's Office* of the Colorado Water Law Bench Book.
- ◆ Participated in the Internship Fair at Colorado State University.
- ◆ Surface Water Supply Index Report to Water Availability Task Force.
- ◆ Staffed booth at the Colorado Farm Show in Greeley.
- ◆ Staffed booth and repaired water model at the Colorado State Fair in Pueblo.
- ◆ Support to Water Quality Control Commission.



## Special Projects (Continued)

- ◆ Adjunct presenter for Aims Continuing Education Center.
- ◆ Table Hosts for *Water Tables*, a benefit banquet for Colorado State University Libraries' Water Resources Archive.
- ◆ Presentations for real estate appraisers and realtors for continuing education credit.
- ◆ Presenter at Colorado Agricultural Trade Show in Greeley.
- ◆ Presentations for the Colorado Water Congress Water Law Seminar.
- ◆ Presentation for the American Society of Civil Engineering.
- ◆ Presentation for the American Council of Engineering Companies.
- ◆ SEO Forum.
- ◆ Presenter at the Water Conservation Workshop in Alamosa.
- ◆ Presenters at the CSU Cooperative Extension Service Conferences.
- ◆ Presenter at the International Ground Source Heat Pump Association.
- ◆ Presentations to local groups regarding water matters, administration, water issues and drought.
- ◆ Presentations regarding Water Rights and Beneficial Use of Produced Water from Oil and Gas Wells in Colorado.
- ◆ Initiated Coalbed Methane Stream Depletion Assessment Studies in the Raton Basin and Piceance Basin.
- ◆ Technical Advisors to the roundtables for SWSI and the IBCC.
- ◆ Presentations and dialogue with county planners, county commissioners, and/or county attorneys, including the following.
- ◆ Staff traveled to Castle Rock to meet with Douglas County planning staff, a county commissioner, and county attorneys to discuss subdivision water supply.
- ◆ Staff traveled to Sterling to meet with the Logan County Planning Department regarding the SEO's review of subdivisions and cluster developments.
- ◆ Staff traveled to Golden to meet with the Jefferson County Planning Department regarding the SEO's review of subdivisions and general well permit questions and issues.
- ◆ Staff traveled to Colorado Springs to meet with the El Paso County Planning Department regarding the SEO's review of subdivisions, and general well permit questions and issues within the Denver Basin and designated basins.



Dick Wolfe and Kevin Rein explaining DWR engineering opportunities at the Colorado State University internship fair.



## Special Projects (Continued)

- ◆ Staff worked with Aqua Net Team in the development and upgrades for the AUG 3 model, the Aqua Map tool, and State CU.
- ◆ Presentation given to the Jefferson County Horse Council on wells, water rights, and water administration.
- ◆ Presentation in Westminster on the Geothermal Rules to participants of the GeoExchange IGSPHA Installer Accreditation Course.
- ◆ Administered the Geothermal Rules certification exam in Westminster.



DWR personnel touring the Parker Water and sanitation District's Rueter-Hess Reservoir construction site.

- ◆ Monthly preparation and presentation of the SWSI report for the Water Supply Task Force.
- ◆ Developed a new Division 7 critical area map.
- ◆ We have participated in several meetings regarding state permitting for demonstration projects involving new technologies for the extraction of oil from oil shale reserves located in the Piceance and Yellow Creek drainage basins, which are tributary to the White River. DRMS is the lead agency for oil shale production permits.

## Litigation and Hearings

Litigation continues to consume a significant amount of time, effort, and expense for the Division of Water Resources. In particular, we continue to be actively involved in the adjudication of many large augmentation plans involving wells in Water Divisions 1 and 2. However, the State Engineer stipulated to all of the cases in which he was a party.

Water Supply staff were involved in three hearings before the Hearing Office regarding such matters as revocation of permits and 600-foot spacing for nonexempt permits.

## **Personnel Changes**

- ◆ Keith Vander Horst appointed new team leader for the Designated Basins Branch in March 2006.
- ◆ Sandy Johnson was promoted to Eng/Phy Sci Tech II in May 2006.
- ◆ Chris Grimes was promoted to Eng/Phy Sci Tech II in July 2006.
- ◆ David Keeler was hired in March 2006 and put under Designated Basin's supervision in October.
- ◆ Arlene Boone moved from Team 1-A to Team 1-B in August as the primary permit evaluator for exempt wells.
- ◆ Professional Engineer Mark Vanarelli started work for Team 456 as in September 2006.



## GEOTECHNICAL SERVICES BRANCH



The Geotechnical Services Branch provides expertise in the disciplines of geology, hydrogeology, engineering geology, geophysics, well construction and satellite assisted surveying. The branch primarily responds to requests by internal or external customers, assisting in general investigations, ground water litigation, ground water data collection and reporting and technical assistance to the Board of Examiners and Groundwater Commission.

The Branch is currently fully staffed and consists of three geologists/hydrogeologist, five well inspectors, and a part-time data entry person. Dave McElhaney is Chief of the Branch, Michael Schaub is the Branch senior geologist, and Elizabeth Pottorff is staff hydrogeologist. Jessie Dunbar assists the Geotechnical Services Branch and supports the Board of Examiners by reviewing and inputting data from more than 10,000 reports submitted annually for pump installation, well construction and well abandonment.

Enactment of Senate Bill 03-045 established a requirement for a well inspection program under the direction of the State Engineer. Because the program is developed primarily to support the enforcement efforts of the Board of Examiners and is closely associated with the support activities of the Geotechnical Services Branch, the Well Inspection Group has been assigned to the Branch. The association continues to work very well.

Table 1 provides a summary of work done by the Geotechnical Services Branch in 2006.

**Table 1**  
**Geotechnical Services Branch**  
**2006 Summary of Work**

Well construction variance requests reviewed	210
Geophysical logs evaluated	93
Geophysical log waivers reviewed	250
Oil and Gas injection and cathodic protection well proposals reviewed	30
Well permit evaluation consultations	350
Designated Basins Final Permit aquifer evaluations	800
Well abandonment consultations	20
Water levels measured	1,200
Phone contacts and general evaluations	1,000

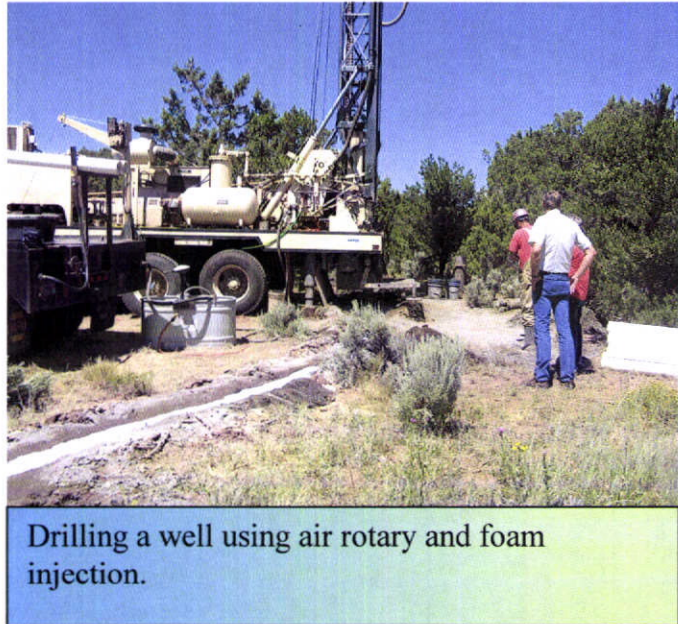
In addition to the above, the Branch verified the location and elevation for approximately 2480 oil and gas wells included in the geophysical log database. The work was accomplished primarily by Patrick Tyler working as an intern for the Branch.



## General Investigations

The Branch is involved in a variety of geologic, geohydrologic and geotechnical studies and projects. The following provides a brief description of the key activities in 2006.

- 7 Coal Bed Methane (CBM) – Dave McElhaney has assumed responsibility as the lead geologist in questions related to methane and the aquifer/CBM relationship. A study of the potential effects of ground water pumping by CBM wells in the Raton and Piceance Basins was commissioned by CGS in 2006, in cooperation with DWR and COGCC. S.S. Papadopoulos and Associates, Inc. is the states consultant for the projects. The Branch provides technical review and comment of reports developed from the CBM projects.



- 7 SPDSS - The Branch has provided water level data and geophysical log information to the state's ground water consultant, Camp, Dresser, and McKee, Inc., in their data collection efforts. The Branch has again provided technical review of a series of maps produced from the data and associated reports to insure that geologic and hydrogeologic issues have been addressed.
- 7 U.S.G.S. Modeling - The Branch provided geophysical log information and data to the U.S. Geological Survey for its effort to produce a new Modflow ground water model for the Denver Basin. The Branch worked with the USGS to resolve data issues and to verify data values. It is anticipated that the Branch will provide some technical review of the model and its results.
- 7 Colorado Geological Survey Cross-Section Construction - The CGS continues its interest and effort in describing the rocks of the Denver Basin that comprise the Denver Basin aquifers. The Geotechnical Services Branch has provided technical review of the products of the mapping efforts and continues to provide geophysical data for the effort to construct geologic cross-sections extending from the west basin margin into the central basin.

## Ground Water Commission



The Branch continues to assist the Groundwater Commission through the monitoring of groundwater levels and technical support to the Commission and staff. A few of the activities that warrant highlight are presented below.

- 7 Monitoring of water levels in over 1200 wells covering almost 3/4 of the state are done annually and published by the branch in a series of 10 annual reports. Many of these water level measurements are obtained from wells located in the designated basins.
- 7 The staff provided technical support to the well permitting staff. Michael Schaub and Elizabeth Pottorff evaluated well construction to determine aquifer intervals for approximately 800 final permits and determinations in the Designated Ground Water Basins.

## Denver Basin



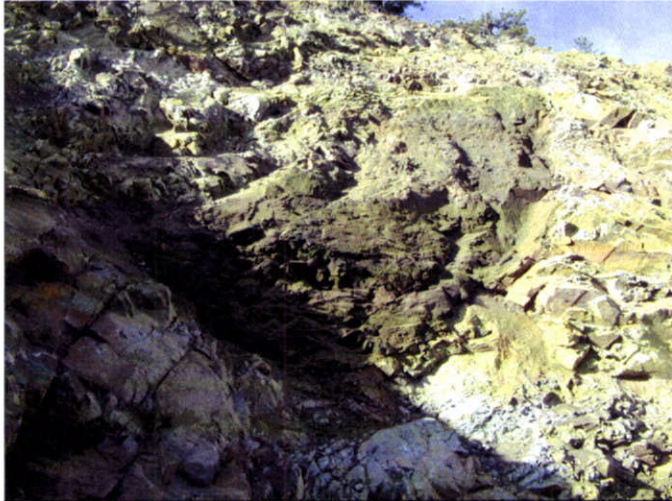
A unique old spudder drill rig drilling a well in the San Luis Valley.

- 7 The Branch provided geophysical and water level information for modeling efforts for the Denver Basin bedrock aquifers. Ground water modeling is currently being conducted by the USGS and subsurface mapping of the Denver Basin aquifers was performed by CDM in the South Platte DSS project.
- 7 The Branch is compiling information for the amount of ground water currently permitted for withdrawal from the bedrock aquifers of the Denver Basin.

- 7 The Branch provided technical input and review for publications concerning the Denver Basin aquifers drafted as a result of the SPDSS project and for a Citizen's Guide to the Denver Basin Aquifers initiated by the Colorado Foundation for Water Education. The Branch also provided review and comment to CGS publications regarding the Denver Basin aquifers.

## Division Support

- 7 Court actions were addressed through general review of findings and performing geophysical log evaluations to provide site specific information for water court applications seeking water rights. In support of the Permitting Section and in preparation for a hearing, a visit to Cressman's Gulch near Golden, CO was performed to evaluate the relationship of a well and nearby pond that was contested by the owner of the existing well.
- 7 Well Permitting and Subdivision Review Assistance - work continues on a daily basis with these activities. The Geotechnical Services Branch routinely assists the permitting staff by reviewing the geology along the margins of the Denver Basin to determine aquifer boundaries and to identify aquifer intervals at other locations throughout the state.
- 7 The Branch reviewed technical reports for the Genesee Dam no. 2 project and visited the dam site to assess geologic information provided in the reports.
- 7 Elizabeth Pottorff provided review and comment on two special projects brought to the Division for action by the State Engineer; an evaluation of La Plata River Basin wells and a proposal to form a geothermal district at Glenwood Springs.
- 7 Michael Schaub provided ground water hydrology expertise for the Well Tester Certification training in Division 3 and presented information regarding the State Engineer's Geothermal Rules at certification training sponsored by the International Ground Source Heat Pump Association (IGSHPA).
- 7 Michael Schaub and Elizabeth Pottorff continue to be the Division's representatives to the Colorado Ground Water Protection Council.
- 7 The Branch evaluated several requests for nontributary ground water during the past year and expects to see even more effort by persons seeking ground water supplies to identify nontributary sources.



View of the right abutment rock foundation at Genesee Dam No. 2 in Jefferson County.



## Board of Examiners (BOE)

- 7 Complaint Investigations for Rules Enforcement - Dave McElhaney continued to spend much of his time working with the Well Inspection Group that is now receiving complaints and performing investigations to resolve complaints before the BOE. Dave also participates at Technical Action Committee (TAC) meetings held bi-monthly with representatives of the Colorado Water Well Contractors Association (CWWCA), the Colorado Ground Water Association (CGWA) and various consultants. Nolan Lloyd is the primary contact and handles most of the day-to-day activities related to well construction, pump installation and unlicensed contractor complaints. Nolan processed 90 formal complaints filed with the BOE in 2006 and continues to conduct follow-up on those cases not resolved during the year.
- 7 Variances – The Branch (primarily Michael Schaub) processed more than 200 requests for variance from the well construction rules during the year. In addition, the Branch performed several evaluations for proper well abandonment.
- 7 Complaint Database – Elizabeth Pottorff completed re-design and enhancement of the complaint database utilized and maintained by Nolan Lloyd to track complaints submitted to the BOE.

## Well Inspection Program

The well inspection program was instituted for the protection of groundwater resources and public health through enforcement of the *Rules and Regulations for Water Well Construction, Pump Installation, Cistern Installation, and Monitoring and Observation Hole/Well Construction, 2 CCR 402-2*. Specific duties include inspection of water well construction and pump installation; monitoring/observation hole/well construction; well and hole plugging and abandonment; and to conduct complaint investigations; provide education and outreach; and general support of the State Engineer and Board of Examiners.



Drilling a domestic well in the Fox Hills formation near Keensburg, CO.

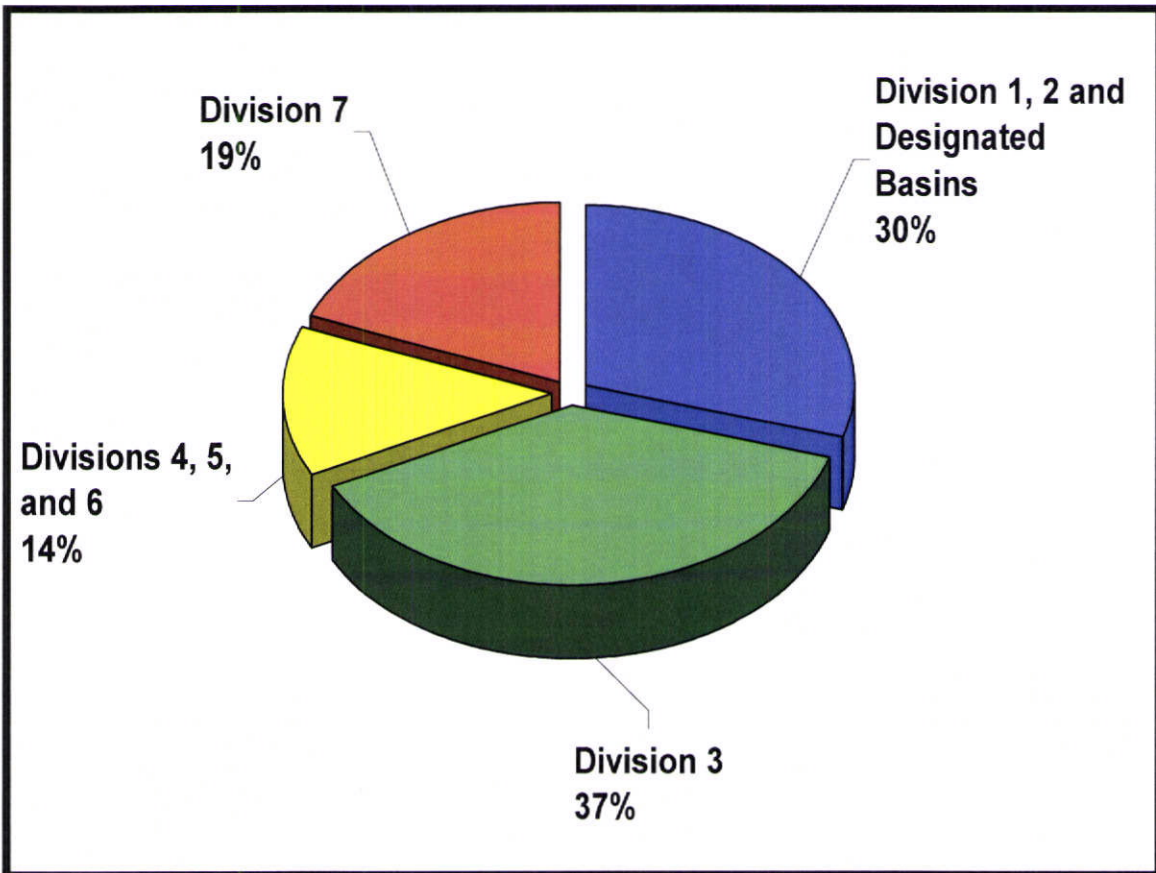
Nolan Lloyd assumed the responsibilities of Chief Well Inspector in late November 2005 and rapidly became an integral part of the inspection and enforcement team. Nolan supervises the activities of the well inspectors located in Division 1-Denver (Tom Neefe),

Division 3 (Larry Hakes), Division 5 (Doug Stevenson), and Division 7 (Doug Pickering). The well inspectors currently assigned to the field began their tenure with the Division in June 2004 and have become an irreplaceable asset to supporting the enforcement efforts of the BOE.

A key focus of the well inspectors and the inspection program is to locate and initiate action against unlicensed contractors working illegally in the state. With regard to licensed contractors, the most frequent violation continues to be contractors drilling outside the distance limits allowed by the permit (usually 200 ft). However, non-compliance with grouting requirements has become a prominent concern as well.

The Well Inspectors conducted more than 2800 inspections during 2006. As in 2005, nearly half of the inspections were conducted in Division 3 (1083 inspections) which is fitting as the legislation that established funding and authority for the inspection program stemmed from the concerns of an individual who resides in the San Luis Valley. Well inspections were distributed across the state generally as follows:

### Summary of Well Inspections By Division





## **Geotechnical Branch -Where We Are Going**

- 7** The Branch will continue cooperation with the CGS in support of its mapping and cross-section construction of parts of the Denver Basin. The Branch will also provide information pertinent to the Denver Basin bedrock aquifers in support of the ground water modeling effort by the USGS and will provide technical review of publications regarding the Denver Basin drafted for the SPDSS project and Citizen's Guide.
- 7** Michael Schaub's will continue management responsibility of the water level monitoring programs and will continue modifying the programs as needed to replace monitoring sites that have been discontinued and to add new sites to provide better coverage.
- 7** The Branch will continue to review and compile permitted appropriations from the Denver Basin aquifers. The Branch's efforts to verify surface elevations and well locations in the geophysical log database are on-going.
- 7** The Branch will begin a review of Denver Basin aquifer geophysical logs to compare actual saturated sand thicknesses indicated by the logs to the estimated sand thicknesses of the associated well permits and court decrees.

## ***HYDROGRAPHIC AND SATELLITE MONITORING BRANCH***



### **Introduction**

The Hydrographic and Satellite Monitoring Branch provides accurate, high quality ‘real time’ stream flow data to support water rights administration. The Branch also develops historic streamflow records in coordination with other State and federal entities and the water user community. Hydrographers around the State operate and maintain a system of gaging stations on rivers, streams, canals, and reservoirs; perform streamflow measurements to maintain stage-discharge relationships at gaging stations; and maintain satellite monitoring equipment with goals of improving the quantity and quality of data used to manage and administer water throughout the State of Colorado.

The satellite-linked monitoring system (SMS) provides the Division of Water Resources, other State and federal entities, and the water user community with access to real-time streamflow data from gaging stations across the State of Colorado. These data and software systems provide for more effective and efficient water rights administration, water resource management, computerized hydrologic record development, and flood warning. The SMS allow the Division of Water Resources to collect, process, store, and distribute any kind of environmental data transmitted from remote locations. The data set of interest to the Division is the water level at rivers, streams, diversion structures, and reservoirs. The SMS converts these raw water level values into several “products” of use to various “clients.” The “products” range from raw data passed on to other computer systems to the official Hydrographic Records of mean daily streamflows. “Users” include Division of Water Resources personnel and other water users wanting real-time flow data for water rights administration, computer systems performing other analyses, and the varied user community of State and federal agencies, municipalities, canal companies, attorneys, recreationists, and consulting engineers needing access to real-time stream flow data.

### **Staffing**

Hydrographic staff are located in each of the 7 Division offices and in Denver. Denver staff include Tom Ley, Chief Hydrographer; Jana Ash, PE I, who provides Statewide hydrographic program support as well as operates and prepares streamflow records at several gages in Division 1; Patrick Tyler, EPST II, who procures hydrographic equipment and supplies, repairs and maintains hydrographic equipment, helps compile the annual hydrographic streamflow record publication, and assists gaging station measurements and operation in the Denver area; and David Hutchens, Electronics Specialist III, who specifies and procures all electronic equipment for the satellite monitoring system, installs satellite monitoring equipment at gages, troubleshoots and diagnoses equipment problems, and performs electronic equipment repair (data collection



platforms (DCP), transducers, shaft encoders, etc.) and maintenance. Hutchens provides technical support for the hydrographic staff, and conducts training on new and existing equipment. Ten percent of his time is spent providing technical support to the USGS Lakewood field office, including training staff on new and existing equipment; bench repair of USGS-owned DCPs, shaft encoders, and water quality equipment; and troubleshooting problems at USGS streamgaging stations. This year he upgraded 4 USGS gages to high data rate DCPs, and installed new satellite telemetry in 5 USGS gages which previously were equipped with non-satellite recorders.

### **Division 1**

Division 1 experienced considerable hydrographic staff changes in 2006. George Sievers and Merlin Friedrichsen retired in 2006, and Merlin passed away to cancer a short time after he left. We lost a lot of knowledge and dedication with Merlin and George. In addition, Garver Brown took the Water Commissioner position in South Park. Merlin's job as hydrographer for the CBT Project was filled by Russell Stroud. Steve Barrett then moved into hydro work full time by filling Russell's old position. George's and Garver's positions are currently vacant. George's old position will be announced as a PSRS I to meet increased demands for spreadsheet skills in water accounting for the CBT system, municipal gage diversions, and records work. Garver's old job will likely remain at the Tech II level to minimize hiring time.

Currently Division one is staffed with 6 FTE:

∅	Lead PE II	Bob Cooper
∅	PE I	Lee Cuning
∅	EPST II	Russell Stroud
∅	EPST I	Steve Barrett
∅	EPST II	Vacant (To be announced as PSRS I)
∅	EPST II	Vacant (South Park, ½ FTE)
∅	EPST I	Bob Erosky (Sterling, ½ FTE)

Our part-time hydrographers actually perform about 90% hydro work, but most of it involves administrative measurements done for non-record gages and ditch ratings. The two positions receive technical supervision from the lead hydro, and personnel supervision from their lead water commissioner. In addition to our regular staff, Division One has received assistance from the following individuals: Mark Simpson, deputy WC in District 3, has taken on some hydrographic responsibilities with the district 3 transmountain gages; Jana Ash from the Denver Office has been operating South Platte River gages involved with municipal water supply; Patrick Tyler from the Denver Office has been cross training by assisting Jana and also operating 3 gages near the Denver Area.

## **Division 2**

Division 2 is lead by Assistant Division Engineer, Bill Tyner, PE III. He was supported by Lead Hydrographer, Brian Boughton, PE I; Hydrographic Engineer, Lou Schultz, EIT; and Hydrographic Technicians, Anthony Gutierrez, EPST II, and Adam Adame, EPST II. Brian Boughton was promoted to a PE II position in Division 7 and left Division 2 on 7 August, 2006. The Lead Hydrographer position remained vacant for the remainder of the water year. Mark Perry became the Division 2 Lead Hydrographer on December 11, 2006.

## **Division 3**

Division 3 is staffed with four hydrographers. Long-time Lead Hydrographer Craig Cotton was promoted to Assistant Division Engineer in this division. Scott Veneman, a Hydrographic Technician has taken on the Lead Hydrographer duties while continuing to manage the satellite monitoring system for this division. The three other Division 3 hydrographers perform hydro duties as well as manage portions of the hydrographic program. Stan Ditmars, also a Hydrographic Technician, is the Division 3 construction manager, and Lee Conner, EIT, is in charge of repair and maintenance of Division 3 hydrographic and construction equipment. Matt Hardesty, PE I, was hired in September and is taking charge of construction design.

## **Division 4**

The Division 4 hydrographic program is managed by Jerry Thrush, EPST II. Several water commissioners in Division 4 are equipped with measuring equipment and make administrative measurements in their Districts. Water commissioners Steve Tuck and Doug Wist perform measurements and provide record development support.

## **Division 5**

When fully staffed, Division 5 has a full-time hydrographer and a part-time hydrographer who also serves as the augmentation plan coordinator. The full-time position is currently vacant due to the retirement of George Wear early in 2007. James Kellogg is the hydrographer/augmentation plan coordinator, and started in Division Five in December 2006. Since becoming vacant, the full-time hydrographer position was changed from PE1 to EIT level. The hydrographer/augmentation plan coordinator remains a PE1 level position with supervisory duties over the full-time hydrographer position. It is expected that a new full-time hydrographer will be hired by the end of June 2007. In the meantime, James Kellogg is performing full-time hydro duties. Water Commissioners help with various satellite monitoring and gaging station maintenance duties. District 72 Supervisor, Steve Pope, also assists by working one published streamflow record. Commissioners and other staff members occasionally assist with stream flow measurements.



## **Division 6**

The Division 6 hydrographic program consists of one part-time Hydrographer whose other duty is Water Resources Engineer, providing engineering support to the Division Engineer. Three water commissioners have hydrographic equipment, however, this equipment is seldom used and these water commissioners and the other five water commissioners in the division often request that the Hydrographer make measurements for them. In July 2006, the Division 6 Hydrographer, Erin Light, PE I, was promoted to Division Engineer and a new Hydrographer/Water Resources Engineer, Jean Ray, PE I, started in August 2006.

## **Division 7**

Division 7 Assistant Division Engineer, Scott Brinton, PE III, provided overall program leadership of the Division Hydrographic Program during 2006. He was supported by Hydrographic Engineer, Cheston Hart, EIT. Scott Brinton was appointed Assistant Division Engineer on May 19 2006. He continued to act as Division 7 lead hydrographer until August 7 2006 when Brian Boughton was appointed to that position. Cheston Hart provided most of the stream gauging support for Division 7 while Scott Brinton transitioned to Assistant Division Engineer and Brian Boughton transitioned into the Lead Hydrographer positions. Routine work includes responsibility for regular streamflow measurements, gaging station operation and maintenance, satellite monitoring equipment operation and maintenance, support water commissioners with flow measurements on ditches and the complete development and computation of streamflow records.

# **Gaging Station and Hydrographic Operations**

## **Division 1**

There are a total of 217 satellite monitoring gaging stations monitored by Division 1 hydrographic staff. DWR owns and operates the satellite and gaging equipment and maintains the stream gage at 128 of the sites. Division 1 staff operate and maintain gages and DCPs at 33 sites where the DCP is owned by a cooperator. This makes for a subtotal of 161 sites where Division 1 staff are responsible for measurements, rating maintenance and streamflow data. Division 1 staff perform monitoring only at 56 of the 217 total SMS sites.

## **Division 2**

There are a total of 176 satellite monitoring gaging stations monitored by Division 2 hydrographic staff. Of these, 97 sites are gaging stations where Division 2 hydrographic staff have operation and maintenance responsibility. Of the 97, streamflow records are prepared at 48 sites. The remaining sites operated and maintained by other agencies, primarily the USGS, where the Division 2 staff perform monitoring only, but are sites where, as needs arise, check measurements are performed.

### **Division 3**

In Division 3, 77 gages with satellite telemetry are maintained, which includes 53 stream-gage record stations. An additional stream-gage record station is tied into the satellite telemetry network via a line of site radio-bridge to a station with satellite telemetry. There are currently only 3 stream-gage record stations with no satellite telemetry link. They are trans-mountain diversion stations owned by other entities. Other stations with satellite telemetry include 6 stream-gage administrative stations, 11 stream-gage diversion stations, and 7 reservoir stations. One of the reservoir stations also transmits outflow data for 1 additional stream-gage administrative station. Of the 77 gages with satellite telemetry, 2 of them also have phone line telemetry. An additional stream-gage administrative station that doesn't use satellite telemetry, but is equipped with phone line telemetry is maintained. DWR owns the data logger / transmitter equipment at 66 of these stations.

### **Division 4**

Division 4 has 21 satellite gages. Streamflow records are prepared at 7 of these locations. Division 4 is closely associated and cooperates with the USGS at four additional gages. They have historically owned and maintained several DCPs in USGS gages. These have been taking less and less attention directly proportional to their administrative importance. Division 4 cooperates with the US BOR at three sites including two gages and one reservoir.

### **Division 5**

Division 5 operated and maintained 45 DWR satellite monitoring stations. Streamflow records are being prepared for publication for 12 of the stations for WY2006. Twelve gages were used for to develop diversion records. Ten stations were for administration with no published record. Nine of the stations are reservoir gages. In addition, there was active monitoring of many of the 70 satellite monitoring stations that are operated by other entities in Division 5.

### **Division 6**

Division 6 operates 12 active stream gage sites in the Yampa, White, and North Platte River basins. Of the twelve, ten are equipped with satellite monitoring. Of these, two transmit reservoir water surface elevation, six transmit stream flow gage height, and two transmit both parameters. The remaining two gages are equipped with chart recorders and/or a data collection platform (DCP) to record gage heights.

### **Division 7**

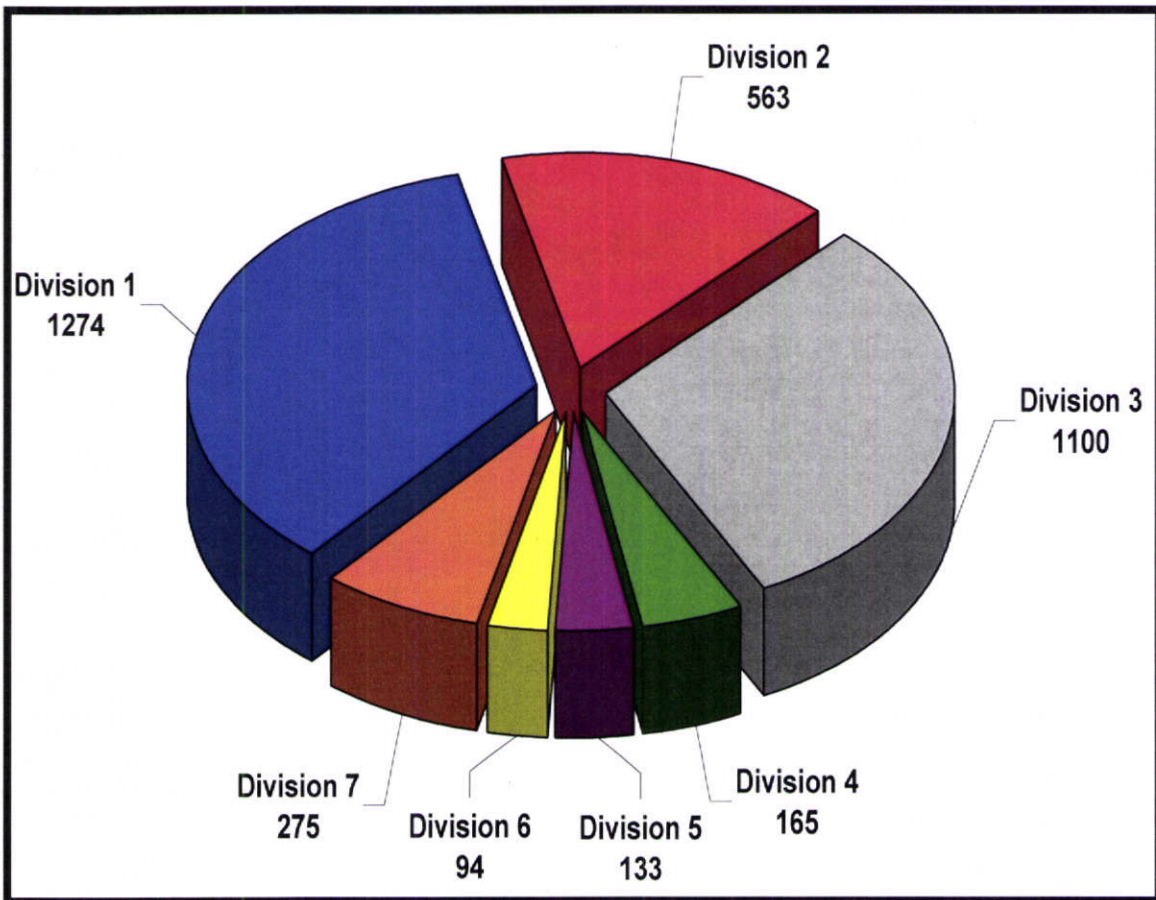
Division 7 operates and maintains 40 satellite gages, 28 of which have been upgraded to high data rate (hourly) transmissions. Streamflow records are prepared at 23 of these sites.



## Streamflow Measurements

Hydrographers, water commissioner/hydrographers and water commissioners across the State made over 3600 measurements in 2006 in streams, rivers, canals and ditches (Figure 1) These measurements were used to check and update stage-discharge relationships at gaging stations and in canals and ditches in support of real-time water administration decision-making and in support of historic streamflow record development.

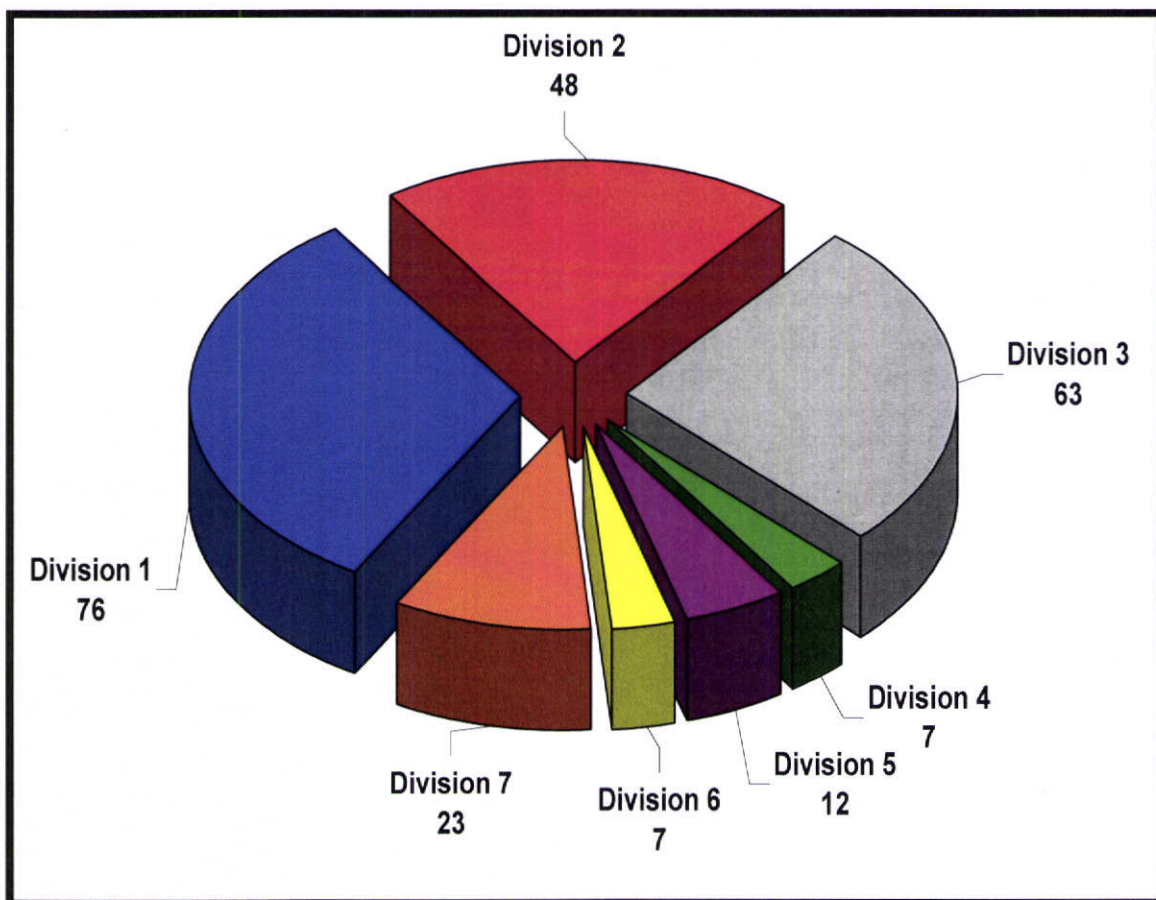
**Figure 1**  
**2006 Streamflow Measurements**



## Streamflow Records

A total of 236 streamflow records are being prepared for publication in WY2006 (Figure 2). Of these, 34 records will be published by the USGS Colorado Water Science Center in their annual streamflow data report for WY06, and the New Mexico office of the USGS will publish four. Division 4, 5, 6 and 7 record checking and review is now conducted among those Division offices, under the leadership and final signoff authority of Brian Boughton, PE II, Division 7.

**Figure 2**  
**WY2005 Streamflow Records**





## **New Gaging Stations**

Several new gaging stations were added to the satellite monitoring system in 2006. Typically new gages are added as the result of the identification of a critical water administration need. Existing gaging stations, not previously on the SMS, are also often candidates for adding satellite equipment where water administration needs have increased. Gage cooperators pay the capital costs associated with these new or upgraded stations. Annual maintenance agreements with cooperators on these gages are also developed.

### **Division 1**

Division 1 established new gages at the following sites and for the purposes indicated:

- ∞ Weldon Valley Return Ditch—radio link to South Platte River near Weldona; to support water administration in District 1.
- ∞ Town of Julesburg Return Ditch-Compact administration.
- ∞ Cherry Creek below Cherry Creek Reservoir- gage and low data rate DCP were turned over to DWR from the Army Corps of Engineers.

### **Division 2**

Division 2 added the following new gages:

- ∞ Abobe Reservoir: Gage installed at dam in May 2006 and brought on to Satellite Monitoring System. Gage was relocated in November 2006 so that dead pool storage could be monitored. Approximately 2000-ft orifice line was laid.
- ∞ Adobe Creek Outflow: Installed satellite equipment and brought on to Satellite Monitoring System in February 2006. An improved rating was developed for the existing concrete control.
- ∞ Cascade Creek: Satellite equipment installed and DCP replaced. Gage brought on-line in Satellite Monitoring System in November 2006. Satellite equipment was pulled and reinstalled at another location in May 2006.
- ∞ Fort Bent Aug Station: Flume, stilling well, shaft encoder and satellite equipment installed. Gage was brought on to Satellite Monitoring System in September 2006.
- ∞ Gageby Creek: New gage installed to measure discharge from Fort Lyon Canal into Gageby Creek. Sheetpile weir, stilling well, shaft encoder and satellite equipment were installed in April 2006.
- ∞ Holbrook Aug Station: A Parshall flume and measuring equipment were installed around April 2006.
- ∞ Minnequa Canal: Satellite monitoring equipment installed in September 2006, and gage brought on to Satellite Monitoring System in October 2006.

- ⌘ Rule Creek: New gage installed in April 2006 with Division of Wildlife as cooperator. Gage consists of Sutron Accububbler with Satlink radio. Gage was brought on to Satellite Monitoring System in June 2006.
- ⌘ Skaguay Reservoir: New gage installed in December 2005. New water level monitoring equipment, satellite equipment and shelter were installed to monitor reservoir stage. Gage was brought on to the Satellite Monitoring System on or around February 2006.

### **Division 3**

New gaging stations added to the satellite monitoring system in Division 3 in 2006 include:

- ⌘ Gaging station shelters were installed on existing stilling wells at Big Spring Creek above Los Ojos Diversion at Medano Ranch and Little Spring Creek at Medano Ranch near Mosca in order to move electronic equipment above ground level. A HDR data logger / transmitter system was installed at the Big Spring Creek station with an SDI-12 radio bridge to retrieve and transmit gage-height data from the Little Spring Creek station.

### **Division 4**

There were no new gaging stations added to the satellite monitoring system in Division 4 in 2006, however, work plans have been developed and are partially completed to add gages at: Cow Creek, Leroux Creek, Razor Creek, and Buckeye Reservoir.

A 600 KHz, broad band, Acoustic Doppler Velocity Meter (ADVM) was installed at the Redlands Canal in cooperation with the US Bureau of Reclamation in the spring of 2006 (Figures 1 and 2). This collaborative effort greatly enhances a forebay situation that has been plagued with an unstable to non-existent

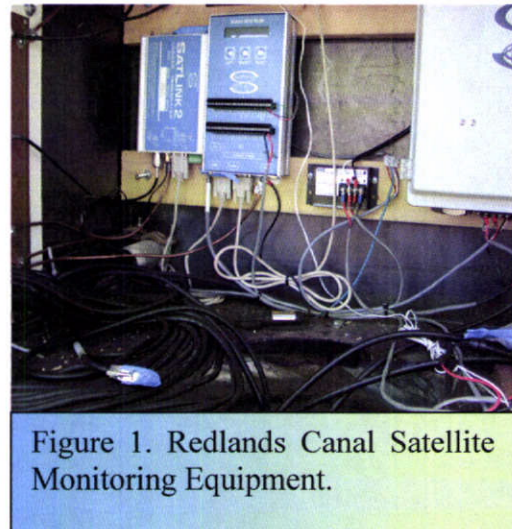


Figure 1. Redlands Canal Satellite Monitoring Equipment.

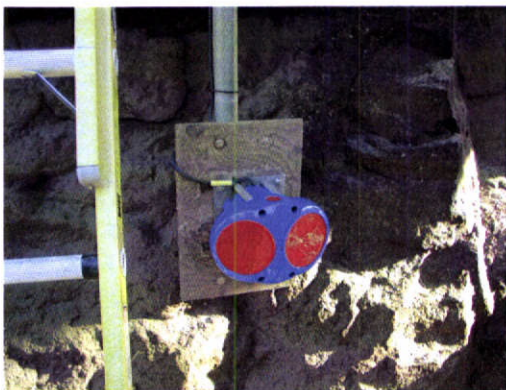


Figure 2. Redlands Canal ADVM.

stage-discharge relationship. The instrument was mounted and cross sectional survey was conducted during the routine spring shut down March 23 and 24, 2006. The ADVM was hooked up to new equipment on April 19 and 20, 2006. There were problems with equipment, power, and set up. This complex system still seems to be really touchy, but the result of on-site, near real-time measurement and calculation of discharge is a real benefit.

The ADVM calculates velocity, temperature, water depth and correlates these with the cross



sectional area to compute a total flow from an index velocity rating that calibrates velocity measured by the instrument (in a sonic cone) to the total flow.

In 2006, Division 5 began operating the West Divide Creek near Raven station, formerly operated by the USGS. Additionally, the division installed new satellite monitoring stations on the Crystal River at the DOW fish hatchery (CRYDOWCO) and on the Roaring Fork River above the Fryingpan River near Basalt (ROAFRYCO) for the CWCB.

### **Divisions 6 and 7**

There were no new gaging stations added to the satellite monitoring system in Divisions 6 and 7 in water year 2006.

## **Gage Refurbishment Projects**

The Hydrographic Branch continues to refurbish and maintain our existing gaging sites that are not designated as critical flood sites, but are extremely important for our primary purpose of water administration. Gage refurbishment funds amounting to \$55,000 were received from CWCB for this purpose. These funds along with a portion of our General Fund appropriations were used to carry out several refurbishment projects.

### **Division 1**

- § A shelf, DCP, and chart recorder were installed at the Fulton Ditch near Thornton gage.
- § At the South Platte River Below Chatfield Reservoir gage, the remote data line to USACOE DCP on the Reservoir was discontinued and a DWR DCP was installed. The shelf in the shelter was rebuilt shelf. The ladder chain from the chart recorder to the encoder was removed and holes in 13" concrete floor were drilled to put the encoder on its own float.

### **Division 2**

- § Amity Canal: New shelter was installed to replace a dilapidated old shelter in April 2006.
- § Arkansas River at Catlin Canal: Cableway A-frames were painted and new platforms were installed in May 2006.
- § Arkansas River at La Junta: New orifice line was run to replace failed EMT line in March/April 2006. New line is pipe conduit with expansion joints and has performed well since then.
- § Arkansas River below Pueblo Dam: Did major repair work to satellite equipment, including replacing solar panel, antenna, wiring and battery.
- § Highline Canal: New satellite equipment and shelter installed on or around March/April 2006.

- ☒ Homestake Tunnel: Colorado Springs Utilities installed a new footbridge around October/November 2006.
- ☒ Muddy Creek near Toonerville: Gage was installed and brought on-line in WY2005. In WY2006 (Feb. 2006), an embankment was constructed (by others) downstream of DWR gage, which affected the flow regime at our gage. Hydro staff coordinated to have the dam removed.
- ☒ Purgatoire River at Nine Mile Canal: Installed a new orifice line and muffler in July 2006.
- ☒ Rain gages, paid for by National Weather Service, were installed at numerous DWR stream gages.
- ☒ Lake Creek Above Twin Lakes: Metal stairs and railing, and installation of a wire weight gage were completed.

### **Division 3**

- ☒ New rock weir controls were installed at Cotton Creek near Mineral Hot Springs and San Isabel Creek near Crestone.
- ☒ New inlets and a concrete well were installed at North Branch Conejos River near Conejos Colorado.
- ☒ The four foot Parshall flume at Big Spring Creek above Los Ojos Diversion at Medano Ranch was modified with a ramped insert in the throat of the flume to alleviate submergence problems and allow flume to pass the heavy sediment load.
- ☒ The cableway cable was replaced at the North Channel Conejos River near La Sauses gage.
- ☒ The cableway cable and turnbuckle were replaced at the South Fork of the Rio Grande at South Fork gage.

### **Division 4**

- ☒ Gaging station maintenance saw three supplemental solar panels installed and a hundred amp hour battery installed in stations that were having power problems. These were all accomplished before the short days of winter and appear to have been successful. A directional antenna and setting additional retries in the SDI-12 radio link between the South Canal and the AB Lateral Canal has helped that data quality and reliability.

### **Division 5**

- ☒ The West Divide Creek near Raven station had to be reconstructed at a new location due to construction of a bridge just upstream. Chart recorders were replaced with stage-discharge recorders at the four upper stations that Division 5 operates on the Fry-Ark Project.



### **Division 6:**

- ∞ conducted inspection, maintenance, and refurbishment activities at several sites. In August 2006, the Accubar bubbler at the Williams Fork gage station was realigned to prevent sediment clogging of the orifice. The bubbler had been covered by a tree, which had been carried downstream during spring runoff, causing buildup of sediment over the bubbler. A muffler is planned to be installed in 2007.
- ∞ In October 2006, the Pearl Lake, Steamboat Lake, Willow Creek, Illinois River at Rand, Michigan River near Meadow Creek Reservoir, and Michigan River at Walden sites were inspected. A photovoltaic battery regulator was installed at the Pearl Lake site and a new solar panel was installed at the Steamboat Lake site. A new solar panel, high data rate DCP, and upgraded encoder were installed at the Michigan River near Meadow Creek Reservoir site. Plans to upgrade the Illinois River near Rand site were deferred until 2007.
- ∞ Replacement of the existing 12-inch stilling well on Willow Creek below Steamboat Lake was initiated in late October 2006. The existing well is hydraulically connected to the stream channel via a pea gravel layer extending from the well to the channel. The new well is larger in size to better accommodate equipment (shaft encoder) and has an intake pipe extending from the well to the channel. Some damage to the new well and pipe, however, occurred during backfill and additional settling is anticipated to occur during the winter snowfall and spring snowmelt months. This station is scheduled to be inspected, re-constructed, and completed in 2007.

### **Division 7**

- ∞ Florida River below Florida Farmers Ditch near Durango: Replaced instrument shelf and upgraded the site to high data rate DCP.
- ∞ Florida River above Lemon Reservoir: Removed the existing cableway and cart and began installation of a bank operated cableway. The project will be completed in WY 2007

## **High Data Rate Data Collection Platform Upgrade Project**

The high data rate (HDR) data collection platform upgrade project continued this year. CWCB funding in the amount of \$248,000 was received in support of this ongoing activity. Included in this funding is the cost of the replacement data collection platforms plus upgraded shaft encoders and grounding systems. Often, gage power supply equipment (batteries, solar panels, charging regulators) and antennas also need upgrading along with the new DCP.

A total of 21 State of Colorado DWR-owned data collection platforms were upgraded in 2006 from satellite transmissions once every 4 hours at 100 bps to hourly satellite transmissions at 300 bps. Currently nearly 70 percent of the State of Colorado DWR data

collection platforms have been upgraded to high data rate. This activity was less than in previous years due to the fact that our Satellite Telemetry and Electronics Specialist, David Hutchens, was without a reliable State vehicle for nearly 11 months. David Hutchens also upgraded 4 USGS gages to HDR and installed new satellite telemetry in 5 USGS gages that only had non-satellite recorders.

## **Flood Hardening Projects**

Flood hardening of gaging stations, which may involve moving gages to higher ground, installing redundant gage height sensors, bank stabilization and protection, rating extensions, improved high flow measurement capability, or some other means of fortifying gage stations to enhance data collection and processing during flood events, continues to be one of our top priorities. The CWCB provided \$50,000.00 funding this year for the continuation of flood hardening projects. Four bank-operated cableway units were purchased with a part of the funds. These were delivered to Divisions 1, 2, 3 and 7.

In 2006, Division 1 completed the installation of a bank-operated cableway at the South Platte River at Waterton gage.

In Division 2, new shelters were purchased for installation at the Arkansas River near Portland and Arkansas River at Canon City gages. Other flood hardening work at these gages, including the installation of the new shelters is currently underway.

Division 4 is scheduled to install a bank-operated cableway at Surface Creek nr. Cedaredge as the final phase of the flood-hardening project, but access to the site during low flow periods has been problematic. The cableway apparatus has been purchased. Installation will include repair to the bridge abutment upstream of the gage due to high flows in 2005. The bank-operated cableway will be relocated upstream from the original planned location.

Divisions 3, 5, 6, and 7 were not involved in any flood hardening projects in 2006.

## **Alert System**

The DWR Flow Alert System was upgraded in 2005. The system compares measured data (gage height, discharge, or any other parameter) from remote gaging sites against the alert criteria (threshold values) set up by DWR/CWCB users. Alert criteria choices include high flow alarm, low flow alarm, or rate of change alarm. The system then contacts the users of a current alarm via e-mail, phone, or pager.



Upgrades that were added and have been in working order are:

- ☒ Allow handling of data from any source (DWR, USGS, NCWCD, and others).
- ☒ Allow use of self-timed or random data transmissions for alarm setup.
- ☒ Remove the need to program the DCP's in the field unless desired.
- ☒ Allow alarm for any station parameter (gage height, discharge, etc.).
- ☒ Provides automatic change of threshold values based on the time of the year (primarily for low flow alerts).
- ☒ Allows setting of threshold values using flow in addition to gage height.
- ☒ As before, provides accurate data in near real time.

The DWR Flow Alert System has been running smoothly with the new upgrades for over a year. There are 36 users, 407 alerts, and people are satisfied with the system and the new functionalities.

## **Training**

Nineteen DWR Hydrographers and Water Commissioners participated in a one-day Swiftwater First Responder training course on May 24, 2006 at the Arkansas Headwaters Recreation Area (AHRA) Visitor Center in Salida CO. The Swiftwater First Responder training course uses a curriculum developed by Rescue 3 International, a world leader in water and flood rescue. Rescue 3 International certified instructors for the course were Stew Pappenfort, AHRA Senior River Ranger, and Kevin Bird, Colorado Springs Fire Dept. This one-day class was designed to familiarize participants with the dangerous conditions that can exist while measuring streamflow, and the steps to be taken to keep oneself safe. The course was broken into two half-day sessions: the first four hours were spent in a classroom setting, while the second half was spent enjoying the 45-50 °F, 1520 cfs flow of the Arkansas River in downtown Salida.

The Annual Hydro Fall Training Meeting was held at the Holiday Inn Express in Gunnison, October 3-6, 2006. Thirty DWR staff attended. Topics included: accuracy and precision in discharge measurements, tips and techniques in making discharge measurements (both wading and cabling), cableway safety pre-use inspection, Parshall flume inspection and assessment, update on new hydro tools being developed by the IT staff, a review of the 2005 records QA/QC reviews and where improvements are needed.

All State hydro staff were introduced to and provided training on the use of new stilling well air quality monitors. A large number of stilling wells were tested in 2006 for oxygen, carbon monoxide, methane, and volatile gas levels. No hazardous levels have been found in any testing to date.

Jerry Thrush participated in four one-hour classes via computer covering various subjects concerning hydroacoustics methods, software and equipment. WebEx was the format for these live, interactive sessions.

## **Miscellaneous Activities**

### **Streamgaging cost study**

The Hydrographic Branch continued participation in a streamgaging cost study and comparison with the USGS Colorado Water Science Center. The average cost to operate and maintain DWR gaging stations was determined by dividing DWR total funding for the Hydro Branch by the number of gages and by use of a detailed cost spreadsheet developed by the USGS. The USGS has prepared a summary report of this activity, after much review and suggested revision by CO DWR staff. The report has not yet been published by the USGS.

### **Snow Surveys**

DWR is continuing its support of NRCS (Natural Resource Conservation Service) by conducting snow survey's throughout the State. The sites are surveyed the last day of each month from January through April and the data are collected and disseminated by NRCS and published on their website for water users. We are currently measuring 7 sites across the State.

### **Division 1**

The USBR is nearing a decision on whether to transfer operation of the CBT project over to NCWCD. The transfer would place a greater burden on data collection and water accounting on our hydrographer, Russell Stroud. Some extra work has already occurred as the USBR has begun removing and switching USBR-owned SMS equipment in order to facilitate the transition.

DWR took over maintenance for 5 USACOE DCP's this year, when the USACOE cut funding to the USGS. The Corps transferred the equipment to DWR. The DCP below Cherry Creek Reservoir was replaced by DWR with a high data rate unit, and the other 4 gages were placed on our upgrade list.

Two training sessions were conducted on water measurement. The first was done in Sterling for contractors who install flumes and weirs. At that seminar, emphasis was placed on correct installation and the points of inspection that will be made by state hydrographers. The second training was in-house, for all new staff hired within the last few years. This training emphasized on common mistakes encountered in the operation of ditch and stream gages and included an afternoon tour of functional and dysfunctional flumes in District 2.

Russell Stroud assisted Denver personnel by beta-testing CDWR's new HydroApp3 and Records spreadsheet programs and the new Surface Water Conditions website.



## **Division 2:**

On July 5-6 2006, a major rainfall-runoff event on the Arkansas River above Pueblo Dam swamped the shaft encoder and chart recorder at the Portland gage (Figure 3). Estimated peak discharge was 15,900 cfs. Division 2 Hydro staff cleaned-up debris, replaced the shaft encoder and chart recorder, ran levels, etc. The flood peak was estimated to occur at 00:00 on July 6. Hydro staff had the gage back on-line by 13:30 the same day. After the flood, Division 2 and Denver Hydro staff did channel surveys and a HEC-RAS analysis to model the event and extend the rating curve.



Figure 3. Arkansas River at Portland July 5-6 flood debris.

A set of measurements were performed by Division 2 Hydro staff to verify the rating at Highline Canal's 15-ft Parshall flume. As a result of extensive analysis by Division 2, a private consultant, and the Bureau of Reclamation, a shifted rating was developed for the flume by Division Hydro staff.

Division 2 hydro staff continued routine coordination of stream and reservoir gaging activities with the USGS Pueblo Subdistrict office, the US Bureau of Reclamation, and the US Army Corps of Engineers and other State and federal agencies during WY2006.

Division 2 hydro staff participated in lysimeter construction work at the CSU Rocky Ford Experiment station, and assisted with maintenance of 11 CoAgMet weather stations in the Arkansas Valley.

Anthony Gutierrez assisted Denver personnel by beta-testing CDWR's new HydroApp3 and Records spreadsheet programs and the new Surface Water Conditions website.

## **Division 3**

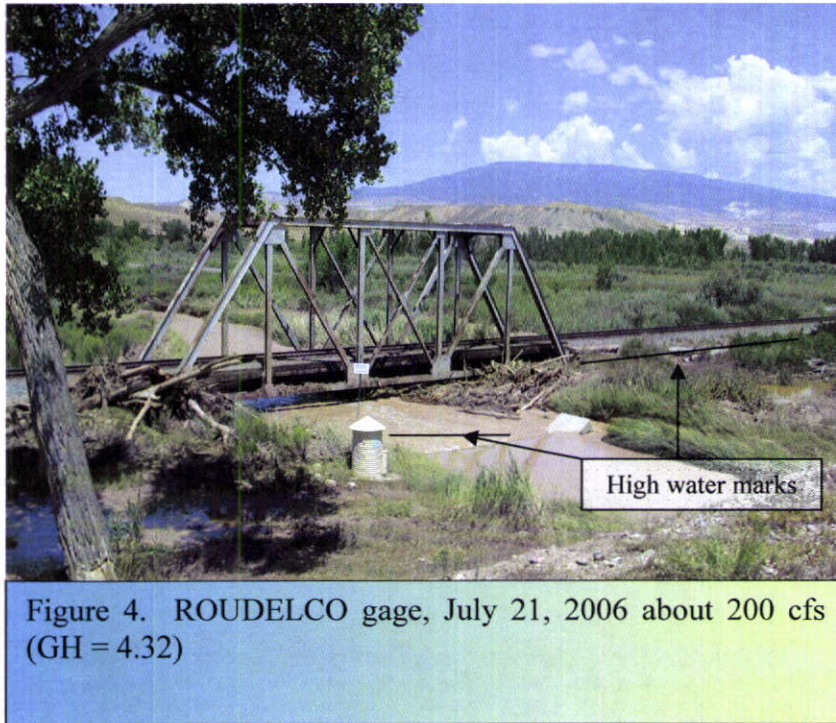
The Hydrographic Branch in Division 3 is charged with fulfilling the terms and conditions of a contract between the State of Colorado and the USBR. This contract provides for streamflow measurement and data collection on the Closed Basin Project. It is the responsibility of the Hydrographic Branch to measure, record, and disseminate flow information to the USBR and to other public entities. In addition, the Hydrographers are consulted on certain areas of concern regarding streamflow and measurement within the Project. Specifically, the Division of Water Resources is responsible for the operation of the gaging station on the Closed Basin Canal, and the development of monthly and yearly



streamflow records for this location. In addition, there are at least nine other locations on the Closed Basin Project area that are to be measured when the need arises. The current 5-year contract agreement between the State of Colorado and the USBR regarding the Closed Basin Project went into effect in February of 2005.

#### **Division 4**

There were two serious rain/flood events during 2006. The Roubideau Creek gage saw water above the instrument shelf and sustained damage to the ramp flume (Figure 4).



The water was less than two feet from going over the railroad grade. The float for the recorder and shaft encoder stopped at the instrument shelf. The high water mark was 0.32 ft. above the RP on the instrument shelf (9.84 ft. total). Flow can't be determined by this because of the backwater from the railroad bridge. Note a lot of flow going around the right side of the right wing wall.

The next high water event was the South Canal. The canal over topped and there was damage sustained. Quick action by shutting down the Gunnison Tunnel averted more severe erosion. The circa 1909 concrete lining just below the west portal was badly damaged.

#### **Division 5**

Operating and maintenance costs were developed for CRYDOWCO and ROAFRYCO stations so that user agreements can be made with station cooperators.

#### **Division 7**

Surveyed channel cross-sections (in cooperation with Jana Ash from the Denver office) at Navajo River below OSO Diversion Dam near Chromo and Rio Blanco below Blanco Diversion Dam near Pagosa. The data will be input into a HecRAS model to determine high-flow rating extensions at both sites.





## **Introduction**

In Article 91 of Title 37, the Colorado legislature created the State Board of Examiners of Water Well Construction and Pump Installation Contractors under the Division of Water Resources in the Department of Natural Resources. The Board consists of five members, one of which is the State Engineer who has historically provided staff to support the activities of the Board and to assist the Board in the efficient and effective discharge of its duties and responsibilities. In 2003, the legislature passed Senate Bill 03-45 authorizing an increase in well permit fees and authorizing the creation of a well inspectors program (section 37-91-113, C.R.S.). During 2004, the State Engineer hired a Chief Well Inspector and four Well Inspectors to monitor compliance with applicable statutes and the Water Well Construction Rules adopted by the Board. In addition to the Well Inspectors, several DWR employees in Denver, as well as Water Commissioners and Division office staff, contribute to supporting the activities of the Board.

Entry of data from well construction reports, pump installation reports, and well abandonment reports required by the Board continues to be accomplished by Jessie Dunbar who also shares his time supporting the permitting section. Data entry of well construction, pump installation, and well abandonment information continues to be kept current by Mr. Dunbar's efforts. Mr. Dunbar also identifies potential well construction and/or pump installation deficiencies and forwards the information to Nolan Lloyd, Chief Well Inspector, for further investigation.

## **General Support**

Activities of the support staff are focused in three general areas: complaint/enforcement actions, variances from the requirements of the Water Well Construction Rules, and licensing of well construction and pump installation contractors. In addition to these functions, the Staff provides technical and professional assistance to the Board in the development of its administration rules, construction rules and associated Board policies. The Staff also reviews and presents to the Board new technology developed in the well construction industry, coordinates the activities of the Board with the objectives and requirements of the Division of Water Resources and other agencies, disseminates information to contractors, and provides education and general information concerning the Board's activities in a variety of public forums.

License renewal for 2007 included a requirement that each contractor licensed by the Board of Examiners submit a Certificate of Completion listing the accredited continuing education (CE) courses or programs attended by the contractor between January 2006 and January 2007. The staff is active in reviewing and recommending accreditation of

proposed CE courses for contractor's compliance with section 37-91-105(7), C.R.S. Criteria for accreditation were determined in conjunction with the Colorado Water Well Contractors Association (CWWCA). The Board established an accreditation committee composed of staff, a CWWCA representative, and a Board member to ensure the timely review of applications for course accreditation. Thirty-seven courses or functions were accepted for a total of 181½ accredited hours of continuing education during the 2006 CE period.

## Complaints and Enforcement Actions

The State Engineer's Well Inspectors and Staff supporting the Board of Examiners are responsible for the investigation of complaints that allege well construction or pump installation that violates the provisions of Article 91 of Title 37, C.R.S., and/or the Water Well Construction Rules. The investigations often result in bringing the issues before the Board of Examiners for resolution, while staff actions authorized by the Board resolves other issues. The well inspectors and staff also conduct "follow-up" actions to ensure that contractors and well owners are complying with Orders of the Board, including pursuing judicial enforcement if necessary. The staff works closely with the Attorney General's Office to accomplish these tasks. Credit for successful judicial resolution of complaint issues during 2006 primarily goes to Beth VanVurst of the Attorney General's office. Beth has worked extremely hard and diligently to represent the Staff and the Board in its legal matters and has been a great addition to the team.

The following is a summary of complaint/enforcement actions brought before the Board or resolved by the Board or support staff during calendar year 2006.

### 2006 Board Complaint/Enforcement Summary

<b><i>New Complaints Investigated</i></b>			<b>87</b>
	Construction Violation	28	
	Permit Violation	35	
	Unlicensed Contractor	16	
	Order to Fix or Plug	8	
<b><i>Complaints Resolved</i></b>			<b>103</b>
	2004/2005 Complaints Resolved in 2006	29	
	2006 Complaints Resolved	74	
<b><i>Resolution/Action</i></b>	Dismissed, withdrawn, discontinued, or resolved	29	
	Complied with Order	12	
	Fines	51	
	Letter of admonition/reprimand/fine	5	
	Suspension or revocation	0	



In addition, the staff reviewed and processed 210 requests for variance from the Water Well Construction Rules and plans for the construction of gallery-type wells. The staff (Jessie Dunbar) also reviewed and entered data into the Well Database from 5726 completion reports, 3623 pump installation reports and 1526 well abandonment reports.

## **Licensing**

The Board licensed a total of 276 contractors in 2006, including 14 new contractors. Gina DeArcos coordinates the licensing activity of the Board by scheduling and administering written examinations, assembling test scores, and scheduling oral examinations before the Board. Gina also provides licensing information to persons interested in obtaining a contractors license. The license renewal process requires that Gina assemble, mail and subsequently process more than 300 packets of information annually for renewal of contractor licenses.

License renewal for 2006 marks the second year that each contractor is required to obtain a minimum of eight hours of continuing education (CE) for license renewal. Gina has been instrumental in tracking and providing information concerning the CE programs accredited by the Board and available to the contractors for meeting the CE requirement.

## **Education and Outreach**

The staff continues to work with the Colorado Water Well Contractors Association (CWWCA) to provide information to the licensed contractors. This is accomplished by individual outreach through mailings, CWWCA newsletter articles and examination preparation workshops. Staff participates at the annual conference of the CWWCA and is available for discussion and instruction on permitting issues and construction standards at the conference.

A Technical Action Committee (TAC) was formed during 2006 to discuss various topics of concern to the contractors association, the Colorado Ground Water Association, and area consultants. Jack Byers and Dave McElhaney attend the bi-monthly meetings of the committee to represent the BOE, Well Inspection Program, and DWR.

## **Well Inspection Program**

Nolan Lloyd, Chief Well Inspector, is based in Denver along with Tom Neefe, Well Inspector, who covers well inspections in Divisions 1 and 2. Well Inspectors are located in Alamosa (Larry Hakes), covering the south central and portions of the southeast; Glenwood Springs (Doug Stephenson) , covering the northwest; and Durango (Doug Pickering), covering the southwest. The well inspection program has proved to be a tremendous asset to the Board of Examiners' enforcement efforts. The well inspectors are doing an outstanding job as is described in the Geotechnical Services Branch section of this report.

As was anticipated, as the well inspection program continues to develop, the proportion of violations discovered as a result of inspections appear to be decreasing. Since inception of the inspection program, it is evident that many licensed contractors are refining their well location and construction practices to ensure full compliance with the Board's Rules.