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COLORADO DIVISION OF WATER RESOURCES

DEPARTMENT OF NATURAL RESOURCES

StreamLines

Quarterly Newsletter of the Office of the State Engineer

HEENEY LANDSLIDE

Alan Martellaro, Division Engineer, Division 5

Green Mountain Dam, part of the Bureau of Reclamation's Colorado-Big Thompson Project, is located on the Blue River south of Kremmling. It was constructed between 1938 and 1943. It is an earthfill structure that is 309 feet high, with a crest length of 1,150 feet and has a decreed capacity of 154,645 acre-feet. The small town of Heeney, along Green Mountain Reservoir's southwest shore, as the media has reported over the past year, is located on a landslide. The issue is not a new one, however, it is thousands of years old. The Heeney area was once part of an ocean, the floor made of cretaceous shale. The shale's geology is unstable and, if on a slope, tends to "creep." Several factors can contribute to the Heeney creep: seismic activity, excess draining or ponding water, physical changes in the hillside due to landscaping, and possibly reservoir water levels.

In late 1962, the Bureau drew the water level of Green Mountain Reservoir down in order to do maintenance on the dam. Two landslides occurred during this time, one along the northern shore and the other in the Heeney area. The slides were slow moving, with the Heeney slide creeping a number of feet over a period of three weeks, from December 1962 to January 1963. This resulted in some property damage. Seismic activity was recorded in the Denver area preceding the slide, and may have been a contributing factor. As a result of the slide, Bureau geologists and engineers re-evaluated draw-down operations for the reservoir. Draw-down rate limitations were recommended and followed. Until last year, Green Mountain had not seen extremely low water levels since the 1960s. For the last 40 years, slide activity has been minimal.

In 2002, Green Mountain did not fill. When drought demands pulled the reservoir to its lowest elevation in decades, concerns about possibly triggering a landslide were brought to the forefront. Consequently, Bureau geologists and engineers re-evaluated draw-down operations for the reservoir. The 1962-63 landslide occurred when reservoir water elevations dropped below a level of 7,847 feet. Referencing information from the 1962-63 slide, Bureau geologists last summer recommended limiting the reservoir level to an elevation of 7,850 feet.

When reservoir elevation levels hit the 7,880 feet mark, the Bureau stepped up its survey monitoring program and began following its slide recommendations. At elevation 7,870 feet, the Bureau's operations slowed to a release rate of no more than 1.5 feet per day of draw-down. The reservoir limita-

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Photo taken on October 8, 2002, looking south. Heeney and the potential slide area are highlighted. The Williams Fork range is on the left. At the time of the photo, the reservoir elevation was 7,879.21 feet; storage was 48,782 acre-feet. On September 3, 2002, Green Mountain hit its lowest elevation in 40 years at 7,875.08 feet (45,101 acre-feet).

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Heeney Landslide (cont.)

tion was only a temporary solution. Last summer, the Bureau began investigating whether there is any correlation between their operations of Green Mountain and the slide. In July and August, the Bureau extended the monitoring survey line installed in the 1980s and added four more, increasing the number of survey pins from five to twenty-nine.

This spring, the Bureau initiated a drilling program to install monitoring equipment and collect soil samples. From the data the equipment provides, they hope to discover a pattern in the hillside demonstrating if and how reservoir levels impact the slide zone. Preliminary results from instrumentation have shown the slide, while active, is creeping at a much slower rate than reported in the media, a maximum of 2.5 inches in the past year. The Bureau continues to monitor and study the slide. The work is ongoing and, due to its inherently complex nature, it will be some time before correlations, if any exist, can be made between reservoir operations and the landslide. To date, there is no evidence that operations are affecting the slide.

The Bureau of Reclamation will soon issue a report citing the most recently available geotechnical information, including revised operating recommendations. Because information is still very limited, the report will not be conclusive; rather, it will describe the geologic structure and past geologic events, and will recommend obtaining additional information through correlative reservoir operation regimes. For the 2003 release season, recommended draw-down rates for the reservoir based upon the report findings are:

- at 7,880 ft. (49,508 ac-ft), 1.5 ft. per day (690 cfs to 620 cfs)
- at 7,870 ft. (40,845 ac-ft), 1.0 ft. per day (405 cfs to 380 cfs)
- at 7,865 ft. (36,957 ac-ft), 0.5 ft. per day (187 cfs and below)

The Heeney slide stranded 20,000 acre-feet in the reservoir during 2002. Planned operations for 2003 will not strand any water due to the slide.

Because Green Mountain did not fill last year (according to a report issued by the Bureau, last year's drought conditions were the worst in 300 years), there was a shortage in the contracting pool. This was the first year since the reservoir contracting program was initiated in 1984 that the reservoir did not fill (either on paper or physically). Until long-term impacts of the landslide on reservoir operations may be determined, the USBR has suspended issuing any new Green Mountain water service contracts.

Due to the markedly improved hydrology conditions this year, Green Mountain Reservoir achieved a physical and paper fill on July 21, 2003. Given this situation, there are no anticipated shortages this year to contractors or other Green Mountain beneficiaries as a result of the Heeney Slide.

Geophysical Well Logs

George Van Slyke, Geotechnical Services Branch

What is a geophysical well log and why do I have to get one? If you work with wells in the Denver Basin, these are words that you hear a lot. All fee wells (non-exempt) constructed in the Denver Basin Bedrock aquifers and issued under the provisions of Section 37-90-137(4), CRS, are required by Rule 9 of the Statewide Nontributary Ground Water Rules (2 CCR 402-7) to obtain a geophysical well log. While this rule applies to all wells permitted to withdraw nontributary ground water that may be present in other areas of the state, it specifically references the bedrock aquifers present in the Denver Basin. The requirement was first added to well permits as the result of passage of what is commonly known as Senate Bill 5 in 1985.

Senate Bill 5 required the State Engineer to promulgate rules for the extraction of nontributary ground water in the Denver Basin and to determine areas where nontributary ground water existed. In order to accomplish this, the Division of Water Resources (DWR) had to accurately map the location and extent of the bedrock aquifers in the basin. While there was some information available at the time, it was limited and consisted of some mapping of the areal extent of the aquifers, some limited structural mapping of the aquifers and a rather limited set of subsurface information consisting of geophysical logs in the basin obtained mainly from oil and gas drilling. At that time, a total of around 1,000 geophysical logs were available for the 6,700 square mile area of the Denver Basin.

Utilizing these data, the DWR's geologists were able to construct structural maps of the Dawson, Denver, Arapahoe and Laramie-Fox Hills aquifers to use in the development of a finite difference model of the basin for the determination of areas of tributary and nontributary ground water. Needless to say, a

Geophysical Well Logs (cont.)

data density of less than one data point per six square miles left a lot to the ability of the geologist to interpret what was in the subsurface. This was especially true when you look at the data and discover that for large areas of the basin, data density of one point for an entire township (36 square miles) was all that was available. The produced maps and model work well in the areas of high data point density, but lose accuracy near the aquifer outcrop and in areas where the data density is low. For this reason, the provisions were added to the rules requiring additional data when there is no acceptable geophysical log within a quarter mile of the proposed well location.

These additional data points allow the DWR's geologists to look at the subsurface and determine the actual top, bottom and sand thickness for the aquifer at the location of the well. In addition, it allows the designer of the well to accurately place screened intervals in the well bore and to determine the actual amount of water available for appropriation. Thanks to this provision, the DWR now has a database of over 4,200 geophysical well logs and is capable of predicting the location of the aquifers to within 25 feet throughout most of the basin. However, since these aquifers were deposited by meandering streams, surprises do occur, and it is still necessary to collect data whenever possible. The collection of these data not only assists the DWR in the well permitting process but also is highly valuable to the well owner and to water supply planners.

This basically explains the ***why***, so what ***is*** a geophysical log? In short, it is a recording of electrical and geophysical characteristics of the material penetrated by the well. Generally, the log is run after drilling the well and prior to casing and developing the well. To obtain a geophysical log, a probe is lowered into the well. The probe or tool consists of a number of sensors and detectors that transmit data to a recorder on the surface. The most common arrangement allows for the recording of the spontaneous potential (SP) or electrical current generated in the materials penetrated, the resistivity of the material to the flow of current (Resistivity) and a measure of the natural radiation emitted by minerals in the material (Gamma Ray). These logs are recorded as a series of lines that allow a trained interpreter to determine the location of the aquifer and some information as to the type of material and the amount of ground water that might be contained within the aquifer. With a number of these logs in hand, the interpreter can compare each of the logs and determine the characteristics and location of the aquifer over large areas.

Although the DWR requires only an SP and Resistivity log, many other types of geophysical logs are available that can be of use to the person drilling the well or consultants and administrators. These include density, caliper, porosity and acoustic logs. All have specific applications that can possibly be of use for aquifer determinations. The DWR limited the types required to SP and Resistivity because they are the most common and can be readily obtained at minimal costs to the well owner. A typical SP and Resistivity log will cost around $1,500 for the first 1,000 feet logged.

In areas where sufficient logs are available or in areas where ***only*** the upper most aquifer is penetrated, the logging requirement may be waived. To request a waiver, the well owner should contact the Geotechnical Services Branch of the Division of Water Resources at 303.866.3581.

Human Resources

New Employees — **Larry Gepfert** returned to the DWR in June as a Water Commissioner in Water District 38 after a two-year stint as a pilot for the Division of Wildlife. **Michael Craig** started in May as a Water Commissioner in District 45 and will also be doing well permitting. Michael previously managed the family ranch in the Woody Creek area, worked for Pitkin County and the City of Boulder. **Stephanie LeMasters** began full-time permanent employment on August 10 as Program Assistant in the Durango office. Stephanie has attended a business school in North Carolina and worked in the private sector prior to taking this job. **Jeff Titus** accepted the position as full-time Water Commissioner on the Animas River later in August. Prior to transferring in this position, he worked as deputy on the Animas River and on the Pine River. He is assuming the duties as field commissioner as well as doing the primary well permitting .

Retirement — **Tim Lovato**, Well Commissioner in Division 3, is retiring in September 2003 after over 27 years with the Division of Water Resources. He started April 20, 1976 as Water Commissioner on Saguache Creek (District 26) and was the Water Commissioner there for 24 years. Tim transferred to the Well Permitting position in the Alamosa office over three years ago. He plans on spending his time on his ranch tending to his cattle.

CALENDAR OF EVENTS

September 22-23	Colorado Water Conservation Board Meeting, Grand Junction, Colorado; for more information, contact Catherine Gonzales at 303-866-3441
October 7	Colorado Board of Examiners of Water Well Construction and Pump Installation Contractors Meeting, Denver, Colorado; for more information, contact Gina DeArcos at 303-866-3581
November 21	Colorado Ground Water Commission Meeting, Denver, Colorado; for more information, contact Marta Ahrens at 303-866-3581
November 19-21	Colorado Water Conservation Board Meeting, Denver, Colorado; for more information, contact Catherine Gonzales at 303-866-3441
December 2	Colorado Board of Examiners of Water Well Construction and Pump Installation Contractors Meeting, Denver, Colorado; for more information, contact Gina DeArcos at 303-866-3581

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