Did an Ice Plug Cause the Gold King Mine Spill?

by David F. Briggs

Gold King 7th Level Adit (Photo Provided by Fox 6 News)

On August 5, 2015, an Environmental Protection Agency (EPA) remediation project resulted in the release of three million gallons of polluted mine water into Cement Creek, a tributary of the Animas River, near Silverton Colorado. To date, the EPA has released very little information regarding the events that actually lead to the release of the toxic mine water from the Gold King 7th Level Adit.

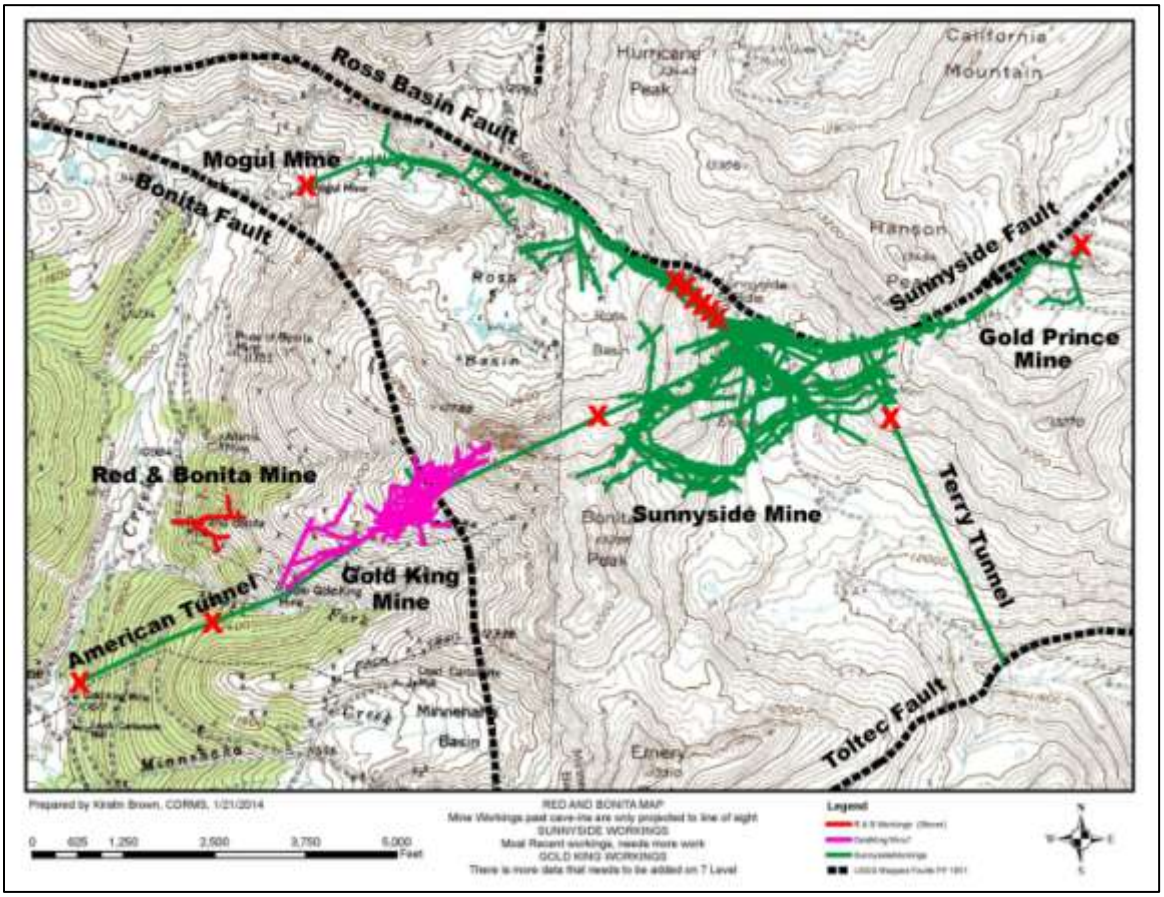
This article examines the sequence of events that lead up to the spill, which occurred at the Gold King mine on August 5th and analyzes the roles they played in this release. Conclusions reached in this article are based on information obtained from various media sources, historical accounts, and

geological, hydrological and engineering data that are a part of the public record.

The Red and Bonita mine was initially developed in 1897 and produced a small amount of ore before operations were suspended in 1900. It is a small mine with approximately 3,500 feet of mine workings located on a single level. Its portal is located at an elevation of 10,893 feet.

Discovered in 1887, the Gold King mine was operated from 1896 until the fall of 1922. It consists of numerous underground workings located on seven levels extending from an elevation of 11,440 feet to approximately 12,300 feet. The Gold King 7th Level Adit (elevation - 11,440 feet) is the location, where the August 5th spill occurred.

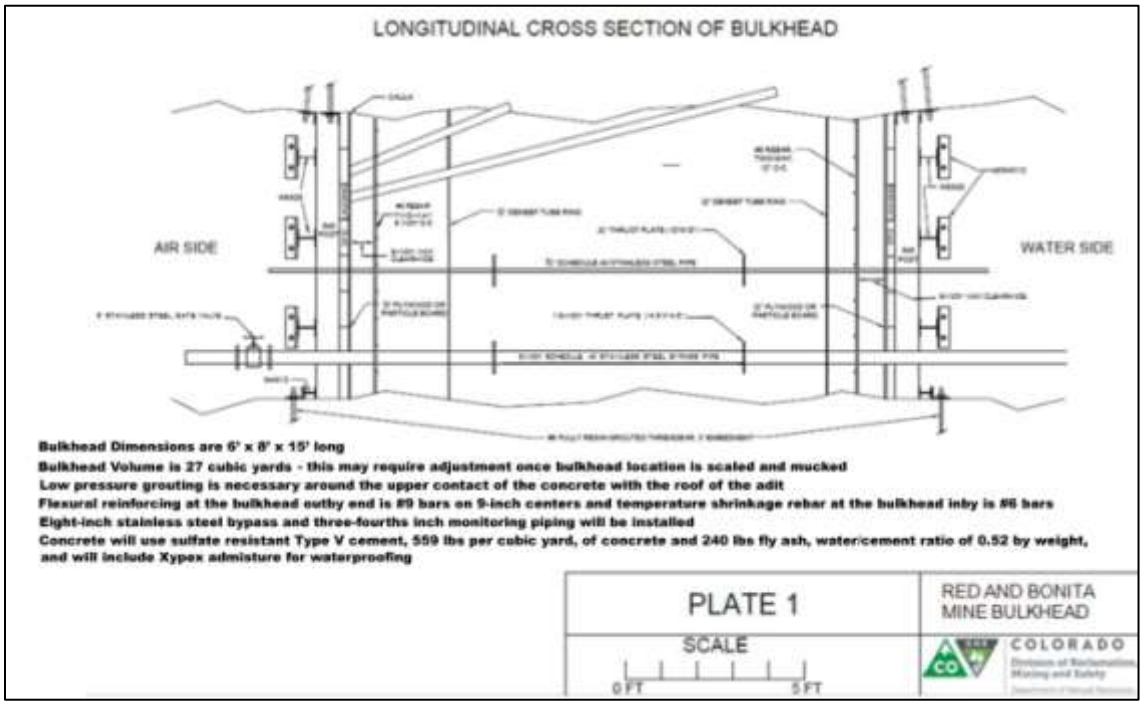
Initially discovered in 1873, the Sunnyside mine was the largest producer in the area. It was operated during two periods from 1875 until 1938 and 1959 until 1991. It was a very large mining operation with numerous underground workings extending from an elevation of approximately 10,660 feet to just over 13,000 feet. It has two haulage/drainage tunnels, the Terry Tunnel (portal elevation - 11,554 feet) and the American Tunnel (portal elevation - 10,589 feet).



Map Showing the Surface Projection of Underground Mine Workings, Major Fault Zones and the Locations of Bulkheads (Red X's).

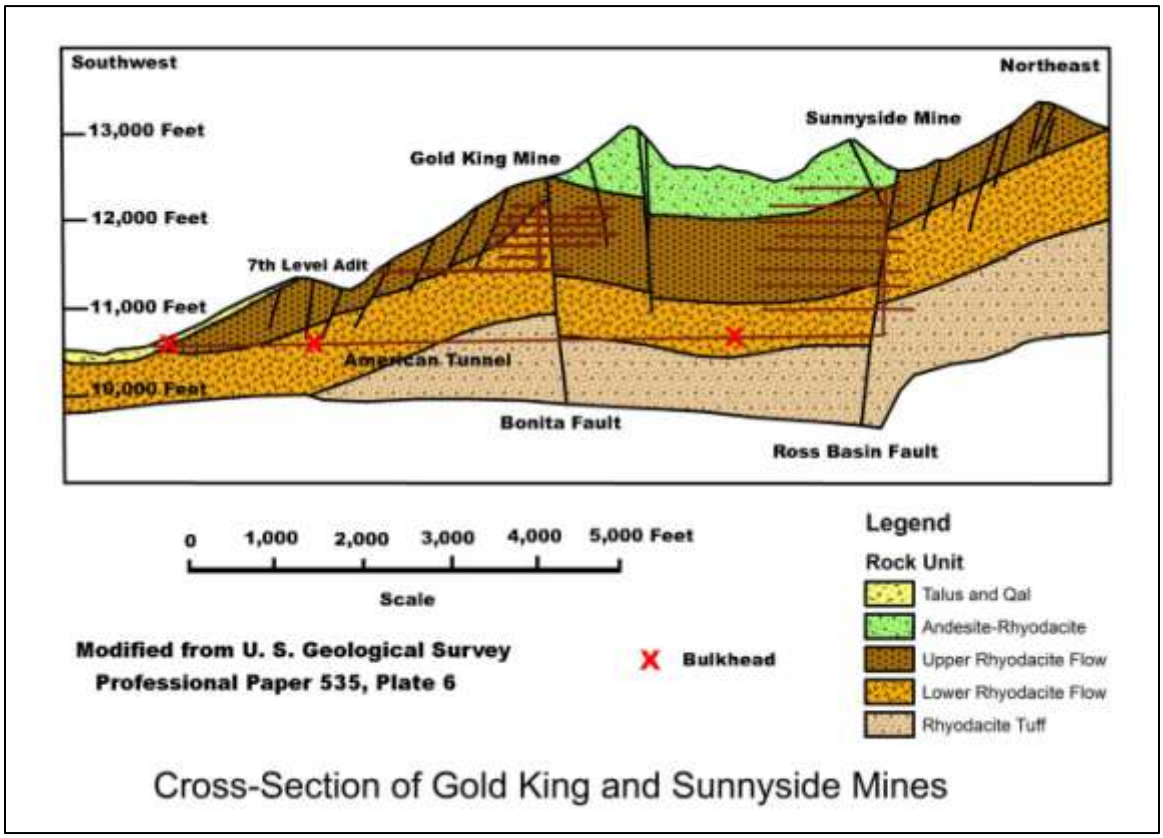
The Terry and American drainage tunnels were very effective in dewatering adjacent rock units over a very large region above the level of these tunnels. This method of dewatering underground mine workings was commonly used by historical operations including the Sutro Tunnel at the Comstock Lode in Nevada, the Ontario Tunnel at Park City, Utah and the Yak Tunnel at Leadville, Colorado. Current domestic environmental regulations discourage the use of this risky mining practice at new mining projects, because it results in unacceptable levels of acid mine drainage, is prone to accidents and complicates reclamation efforts.

Following the closure of the Sunnyside mine in 1991, twelve bulkheads (see map) were installed as a part of its decommissioning and reclamation effort. Bulkheads are engineered dams placed within underground passageways, which are designed to contain acid mine water in the mine as the regional groundwater table returns to its natural, pre-mining level.



In theory, once the underground workings are submerged by groundwater, the inundated portions of the mine will be denied oxygen. This halts the oxidation process, which produces acid mine water that contains high levels of dissolved metals. As the regional water table is restored to relatively stable, pre-mining levels, the water will be diluted as it moves through fractured rock along pre-mining groundwater pathways. This reduction in acidity results in the precipitation of much of its heavy metal content prior to being discharged at springs or into streams. However, this approach requires all adits that intersected the pre-mining water table to be plugged. Otherwise, the water will rise to the level of the portal and discharge acid mine drainage into the environment.

Although no mine workings connect the American Tunnel with the overlying Gold King or Red and Bonita mines, the water table in the vicinity of these underground workings was lowered as a result of drainage into the American Tunnel through natural fault and fracture zones that cut the rocks where the underground workings are located. While the Sunnyside mine was in operation, there was very little if any drainage from either the Gold King 7th Level Adit (7 gallons per minute in 2003) or the Red and Bonita mine (5 gallons per minute) because the water that would have otherwise accumulated within these workings was drained by the American Tunnel. However, not long after the three bulkheads were installed in the American Tunnel (1996-2002), drainage from the Red and Bonita mine (pH 5.5 to 6) and the Gold King 7th Level Adit (pH 2.5 to 5) increased to 200 to 300 gallons per minute and 100 to 200 gallons per minute, respectively. Following the installation of the last bulkhead, treatment of water discharged from the American Tunnel was discontinued.



Cross-Section of Gold King and Sunnyside Mines

This is comparable to a bathroom sink that has a drain and an overflow outlet. When the drain (i.e. American Tunnel) is open the water flows out the bottom of the sink. However, if you close the drain (i.e. with a bulkhead) the water will rise in the sink until it gets to the overflow outlet (i.e. Red and Bonita mine and Gold King 7th Level Adit).

Located at a high elevation, these mine sites are only accessible for a short period each year, generally from late June through early October. The

climate is characterized by long, cold winters and short cool summers. Annual precipitation averages 45 inches of which approximately 70% accumulates in a seasonal snowpack between November and April.

The EPA's work at the Red and Bonita mine site began in 2010, where the historical adit had been collapsed/covered for an unknown number of years. Acid mine drainage was leaking through this debris at a rate of 200 to 300 gallons per minute. The initial phase of this program involved drilling a hole into a void of the adit/tunnel behind the blocked portal to monitor the impounded water within the adit in order to determine if it was under hydraulic pressure from a possible mine pool within the mine workings. Once it was determined it was safe to proceed, the debris that was blocking the portal was removed and the water within the adit was pumped from the mine and treated prior to being released into Cement Creek. A new stable mine portal was installed in October 2011. This enabled workers to safely enter the mine to gather data required to determine the best way to stem the flow of acid mine water from this historic mine site. Results of this study indicated the most favorable place to locate a bulkhead is approximately 265 feet from the portal. Installation of the reinforced bulkhead with a valve that will provide hydraulic control was scheduled to occur during the summer of 2015.

During the 2015 field program at the Red and Bonita mine, the EPA also planned to remove the debris from the collapsed/covered Gold King 7th Level Adit in order to observe possible changes in the discharge resulting from the installation of the Red and Bonita mine bulkhead. However, unlike the program at the Red and Bonita mine, there is little documentation showing their work at the Gold King mine was as well planned or executed. Evidence suggests the EPA made no effort to determine how much water was impounded behind the debris that blocked the 7th Level Adit of the Gold King mine.

It appears they assumed that only five feet of water was behind the pile of debris in front of the mine. What evidence did they have to make this assumption? Did they follow the same procedure they used at the Red and Bonita mine? The EPA has provided no evidence to support their conclusion.

What was happening at the Gold King 7th Level Adit on August 5th, prior to commencing excavation of the debris that was blocking the adit? EPA records show they knew water had been accumulating within the Gold King mine workings for at least a decade. Was there any water seeping from the debris blocking the 7th Level Adit on August 5th prior to starting excavation? If so, what was its flow rate? If it was is seeping out at a normal rate, the chances of encountering significant amounts of water in the mine would be relatively low. However, if there was no seepage or only minor amount of water being released that would be indicative of a more serious problem.

Based on discussions with a retired mining engineer having experience with high elevation Colorado mines, it is highly unlikely unconsolidated debris blocking the Gold King 7th Level Adit would have been able to impound three million gallons of water within the mine. Such a loose debris blockage would

never have withstood the hydraulic head of that much water. A more likely scenario is the presence of an ice plug. That would account for the sudden release of the amount of water that was impounded within the mine workings.

Ice plugs are blockages that form by freezing water within an mine adit and/or saturated unconsolidated debris blocking an adit or tunnel. The ice completely blocks the adit and dams water behind it, filling the mine. Eventually the ice dam fails, suddenly releasing the water. Although common in northern Canada and Alaska, ice plugs have also been reported at high elevations in Colorado.

Blocked by loose, unconsolidated debris, the small, shallow inclined, 7th Level Adit at the Gold King mine was susceptible to the development of ice plugs. Although it is situated on a south-facing slope, its location near the bottom of a narrow, deep canyon limits its exposure to sunlight throughout much of the year. Its multiple levels on different elevations promotes natural flow of air through the mine as dense, colder air falls or warmer air rises. During the winter the falling cold air would promote freezing of pooled water within the Gold King mine.

If the EPA had made an effort to determine the level of water in the mine before they started digging around the entrance of the adit, they would have certainly learned there was considerably more water present than they assumed. Better preparation would have identified complicating factors that could have been dealt with in a responsible manner.

There is also evidence that this spill may have resulted from something as simple as miscommunication between the EPA staff. The on-scene coordinator for the EPA at the time of the spill was filling in for the long-term coordinator of the project, who was on vacation.

Removing the debris from the portal on the lowest level of the Gold King mine without first determining how much water was present in the mine workings should never have occurred. It is analogous to pulling the stopper from the drain in your bathtub. And the absence of a contingency plan if things went wrong only made things worse.

Not only did this endanger the lives of those working at the site that day, the release of three million gallons of polluted mine water into Cement Creek on August 5th unnecessarily disrupted lives, heightened health concerns and resulted in the loss of millions of dollars by those living downstream from this spill.

The EPA's cavalier behavior after the spill occurred is not acceptable. Not only did they wait nearly 24 hours to report the spill to local authorities, they continued to downplay the significance of the event after they took responsibility for the spill. Furthermore, the EPA continues to conceal information regarding many important issues related to the events of August 5th. Americans are entitled to nothing less than complete transparency with

regard to this matter. The EPA needs to be held to the same standard that applies to those it regulates.

It is important to understand the events that lead up to the Gold King mine spill on August 5th. An independent panel of experts should be appointed to investigate the cause of this spill, comment on actions that could have been taken to prevent this release, and make recommendations on actions that could be taken to ensure similar failures do not occur at other sites. During the course of this study, they should also identify: 1) any mechanism(s) for this spill; 2) any technical, management or other practices that may have enabled or contributed to this spill; and 3) any changes that could be considered to reduce the potential for future occurrences.

Good Samaritans like the Animas River Stakeholders Group, local and state agencies, environmentalists, mining companies and other responsible parties have an important role to play in cleaning up legacy sites, such as those found around Silverton, Colorado. However, until legislation is enacted to deal with potential liability issues that might result from these activities, there is little that can be done. I urge our elected representatives to find viable ways to help third-party volunteers reduce the amount of toxic pollutants released from abandoned mine sites throughout the west.

Disclaimer - David F. Briggs is a geologist, who has worked in the mining industry for more than 35 years.

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