The valley surrounding Silverton was extensively mined for gold and silver from ~1880 to ~1930 and intermittent mining continued off and on well into the 20th century. This resulted in dozens of abandoned mines with no legacy companies to which ownership or responsibility can be traced. Consistent with the practice at the time, virtually all were abandoned with no reclamation or stabilization performed whatsoever. This left a huge mess with large piles of exposed waste rock and low grade tailings, open adits inviting amateur explorers into the mines, and continuous drainage of mildly acidic water into small alpine streams. One of the most obvious manifestations is that all streams in the valley have bed materials with a dark brown coating of manganese and iron oxides.

EPA, the Forest Service and other agencies have been struggling to achieve proper closure and remediation of these mines for decades. The problems are difficult because of the large number of small mines and exploration pits throughout the valley and beyond, the severe climate (the altitude of Silverton is 9,300 ft), access to many of the sites is difficult, and the very rough topography limits options for mine water treatment and tailings management.

Because of the climate and geology there's a lot of groundwater entering many of the mines and seeping from their entrances. Wikipedia, that great source of all that is true, describes a mine blowout in 1978 in which a mine filled up with water then let loose a flood that had sufficient momentum to knock over a 20 ton locomotive.

In my experience, the entrances to most of the mines have been blocked either intentionally to prevent folks from entering, or by rock falls and debris. This can allow the mine to fill with water and generate high heads if proper drainage isn't provided. According to reports of EPA's On Scene Coordinator (http://www.epaosc.org/site/site_profile.aspx?site_id=11082, a good source of information & some data) EPA was investigating the Gold King Mine, disturbed the debris blocking the mine entrance which then let loose spilling 3 Mgal into Cement Creek over the course of an hour or so. I have no personal knowledge of the spill but this seems to me to be an entirely reasonable explanation. Whether the high head of water in the mine could have been foreseen and precautions taken against a breach will almost certainly be the subject of future investigations and many lengthy and expensive lawsuits.

Considering all of the logistical complexities associated with the remote location EPA and environmental agencies in CO and NM sprang into action pretty quickly in my opinion. They started collecting samples of Cement Creek and the Animas River within a few hours and I saw the first analytical data on Sunday, 8/9/15, four days after the spill and three days after the last samples were collected. Anybody who's collected samples and had them analyzed knows that kind of response is amazing; usual sample turn around times are several weeks. I'm not defending EPA, but claims that they're not responsive aren't justified in my opinion.

The question facing downstream communities and water users is what are the consequences of the spill? The data from 8/5 and 8/6 show very high concentrations of several Safe Drinking Water Act (SDWA) metals including mg/L levels of As, Ba, Cr, Cu, Pb (179 mg/L in one creek sample), and Ag as well as very high concentrations (>100 mg/L) of Al, Ca, Fe, K, Mn, and Na. But what has not been reported in the press is that most of the SDWA metals are associated with solids, presumably iron solids which are the source of the bright yellow/orange color seen in the photos. Some of the highest metal concentrations were measured from a sample from Cement Creek at the 14th St Bridge in Silverton taken Wednesday at 4:00 p.m. The data for total recoverable and dissolved metals is shown in Table 1 which illustrates this point. Coagulation by iron and aluminum hydroxides is a very common method for removing solids and dissolved metals in drinking water treatment plants and is clearly serving the same function at this site.

Metal	Total Recoverable	Dissolved	Dissolved Fraction (%)
Aluminum	**945000**	**91900**	9.7
Antimony	**321**	< 5 U	0.0
Arsenic	**8230**	< 5 U	0.0
Barium	**9730**	< 50 U	0.0
Beryllium	**135**	**34.8**	25.8
Cadmium	**165**	**98.3**	59.6
Calcium	**454000**	**461000**	101.5
Chromium	**706**	< 10 U	0.0
Cobalt	**384**	**204**	53.1
Copper	**36700**	**10400**	28.3
Iron	**9930000**	**49500**	0.5
Lead	**179000**	**150**	0.1
Magnesium	**279000**	**36500**	13.1
Manganese	**78000**	**37100**	47.6
Molybdenum	**2010**	< 10 U	0.0
Nickel	**276**	**91.5**	33.2
Potassium	**212000**	**6630**	3.1
Selenium	< 500 U	< 10 U	0.0
Silver	**1110**	< 5 U	0.0
Sodium	**23400**	**4960**	21.2
Thallium	< 250 U	< 5 U	0.0
Vanadium	**5470**	< 20 U	0.0
Zinc	**44000**	**26800**	60.9

Table 1. Concentration of total recoverable and dissolved metals in water sample collected from Cement Creek at the 14th Street Bridge in Silverton, CO on 8/5/15 at 16:00.

The relatively small volume of the spill, the high dilution by the Animas River and downstream tributaries, and the rapid velocities of these high gradient streams has resulted in the dissolved phase contaminants washing through the system very rapidly. Data from EPA and the New Mexico Environment Department show that dissolved water quality all the way to the NM-AZ border is at or close to background levels. In my opinion, although this spill poses a challenge to public water systems along the rivers, it is manageable and presents little or no risk to consumers.

It seems to me the real environmental concerns relate to aquatic life and especially the benthic environment. Though Al, Cu, and Mn are toxic to coldwater fish, I know of no reports of fish kills and caged fish suspended in the water continue to survive. The available data is consistent with the hypothesis that the metals are effectively bound in the solids. Thus, we must ask what is the long term fate of those solids and associated contaminants? Research teams in NM, CO and elsewhere are feverishly writing proposals to address this question. This situation presents a great opportunity to better understand the fate and transport of contaminants from mining operations and to develop strategies for dealing with the next spill.

The second threat the spill poses is to irrigators. In an abundance of caution (an overworked phrase in my opinion), all diversions of river water were immediately stopped including flow to some big irrigation systems, especially the Navajo Irrigation Project (NIP). If irrigation water is cut off for more than a week or two and the monsoon rains don't re-appear, farmers are going to suffer severe losses. A secondary question may be what are the effects of contaminants on the soil, crops, and food chain? Will this cause further damage to the agricultural industry? The tension between the Navajo Nation and the U.S. government will introduce considerable complexity to these issues.

The Gold King Mine spill is not the first spill of hard rock mine water into a southwestern stream and almost certainly won't be the last. Its threat to human health and the environment is not trivial but has been greatly exaggerated. It certainly does not pose risks such as those of the 2014 Elk River spill of coal wash water in West Virginia or the 1979 failure of the Churchrock, NM uranium mill tailings dam. The professional community needs to deliberately and clearly identify the issues and challenges posed by this spill then develop management and remediation strategies to deal with them. It is my intent that this summary, which expresses only my personal perspective, will reduce the hysteria and hyperbole a bit and allow that conversation to begin.

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