



**Pangea Environmental, LLC**

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US Forest Service  
US Dept. of Agriculture

RE: Withdrawal of public land **Pactola Reservoir-Rapid Creek Watershed Withdrawal  
#NP-3479**

Pangea Environmental, LLC has conducted a preliminary review of the geology and hydrogeology of the area proposed for withdrawal, which consists of approximately 20,000 acres of public land. The review consisted of a literature search, review of USGS topographic maps and professional experience.

Our review supports the withdrawal, as a minimum, to protect the water supply of Rapid City and Ellsworth AFB. The groundwater does not always follow the surface water and this should be considered in potentially enlarging the area proposed for withdrawal. The extent of potential groundwater contamination that could extend beyond the proposed withdrawal should be considered.

The pre-Cambrian igneous and metamorphic rocks of the central Black Hills are fractured. These fractures in the rocks can conduct groundwater and in places the groundwater is sufficient to supply water to private wells (Miller et. al. 2004 and Redden, Dewitt 2008). Even where the permeability is not sufficient to produce enough water for a private well, the rocks can still transport contaminated groundwater to drinking water aquifers hydraulically downgradient. Groundwater flow in fractures is much faster than in porous rocks, such as sandstone.

In addition to the fractures, the alluvium of creek beds contains groundwater and is a migration pathway (Redden and Dewitt, 2008). This is complicated by the fact the creeks are both losing and gaining streams depending on the underlying hydrogeology. This can allow contaminated groundwater to either discharge to surface water or allow contaminated surface water to discharge to groundwater where it moves hydraulically downgradient and into aquifers used as a water supply out into the Plains (Redden and Dewitt, 2008).



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In addition to fractures that allow for groundwater movement, groundwater can move vertically through the soil and weathered bedrock and then along the contact with the unweathered bedrock.

Gold mining exposes sulfide minerals that can produce acidic runoff and groundwater. The heap leach method of gold extraction uses a cyanide solution to extract the gold from the broken rock. If this solution is released to the environment, there is potential for it to migrate downgradient and adversely impact aquifers further out into the Plains, as previously mentioned.

In summary, there is sufficient evidence to support the proposed withdrawal. Hopefully, the EIA or EIS will consider the complex hydrogeology and consider expanding the proposed acreage.

I have BS and MS degrees in Geology and post-graduate course work in hydrogeology. In my close to 45 years of professional experience, I have worked in both hydrogeology and mining. This includes work in the Black Hills for my MS thesis and professional work for the mining industry. I worked as a Senior Geologist for 11 years for the Michigan Department of Environmental Quality and retired from a community college after teaching geology for 13 years. In the private sector, I have worked in over a dozen States, western Canada and Colombia, SA. I have professional work experience with igneous, metamorphic and sedimentary rocks as well as unconsolidated glacial sediments.

I can be contacted for further information.

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References:

Miller, Silva and Tinant, 2004, Upper Rapid Creek Watershed Assessment, South Dakota Dept. of Environment and Natural Resources et.al..

Redden and Dewitt, 2008, Maps Showing Geology, Structure, and Geophysics of the Central Black Hills, USGS and SDSM&T.