TO: Victor J. Izzo
Senior Engineering Geologist
Title 27 Permitting and Mining Unit

FROM: Jeff Huggins
Water Resources Control Engineer
Title 27 Permitting and Mining Unit

DATE: 9 September 2013

SUBJECT: REVIEW OF TREATMENT TECHNOLOGIES FOR THE CORONA AND TWIN PEAKS MINE REMEDIATION PROJECT, NAPA COUNTY

Purpose Statement:
The Corona Drain Tunnel at the Corona Mine and the Twin Peaks Adit at the Twin Peaks Mine are each point sources for mine drainage. Acid mine drainage (AMD) conditions are exhibited in the mine drainages, resulting in the discharge of metals to surface waters. Results from field investigations completed during 2003 and 2004 by the US Geological Survey, and EnviroGeo during 2007, documented that the Corona and Twin Peaks mines release iron, sulfate, nickel, and mercury to the James Creek watershed (USGS 2007, EnviroGeo 2007).

There are many strategies for treating acid mine drainage. Over the past 10 to 15 years, the emphasis for sulfate removal from wastewater streams has moved away from the traditional chemical treatment, or “active treatment”, to biological treatment[1]. This memorandum provides a review of innovative acid mine drainage treatment technologies that employ sulfate-reducing bacteria (SRB) to facilite the remediation of mine drainage point sources that could not practicably be treated with other technologies.

Bioremediation of Acid Mine Drainage Using Sulfate-Reducing Bacteria

- Passive and semi-passive treatment systems harness naturally-occurring processes to remediate contaminants. The potential advantages of passive treatment are lower costs, fewer site visits required, ability to work in remote areas, opportunities to use recycled or waste materials, and a more natural appearance. Potential drawbacks include vulnerability to high flows and high contaminant concentrations, seasonal variation in performance, the need for periodic maintenance or renovation, space requirements, and the relative lack of technical experience with these systems.[2]

[1] H.A. Greben, J.P. Maree and S. Mnqanqeni, “Comparison between Sucrose, Ethanol and Methanol as Carbon and Energy Sources for Biological Sulphate Reduction,” *Water Science and Technology* Vol 41 No. 12 (2000) pp 247-253.

[2] Doshi, Sheela M., “Bioremediation of Acid Mine Drainage Using Sulfate Reducing Bacteria, ”U.S. EPA (August 2006).

Passive Treatment of Acid Mine Drainage in Bioreactors Using Sulfate-Reducing Bacteria

- Sulfate-reducing passive bioreactors have received much attention lately as promising biotechnologies for AMD treatment. They offer advantages such as high metal removal at low pH, stable sludge, very low operation costs, and minimal energy consumption. Sulfide precipitation is the desired mechanism of contaminant removal; however, many mechanisms including adsorption and precipitation of metal carbonates and hydroxides occur in passive bioreactors. The efficiency of sulfate-reducing passive bioreactors is sometimes limited because they rely on the activity of an anaerobic microflora [including sulfate-reducing bacteria (SRB)] which is controlled primarily by the reactive mixture composition. The most important mixture component is the organic carbon source. The performance of field bioreactors can also be limited by AMD load and metal toxicity[3].

Bioremediation by Sulfate Reducing Bacteria of Acid Mine Drainage

- Mining activity produces metal sulfide wastes - particularly pyrite - which remain in the mine long after operations cease. When water percolates through a mine where oxygen is present, a series of chemical reactions occur which produce extremely low pH and high concentrations of toxic sulfate and metal ions. This toxic leachate can cause severe aquatic habitat degradation downstream of the mine. This study addresses this environmental problem by harnessing the metabolism of sulfate reducing bacteria, whose ability to reduce sulfate produces carbonate which neutralizes acids and sulfide, which chemically stabilizes toxic metal ions as solid metal sulfides. Batch reactors were set up with mine leachate, bacterial culture, a growth medium, and various sources of organic carbon. Results have shown that bacterial reactions caused copper and zinc reductions of 100%, pH increases of up to 2, and decreases in toxicity of 100%.[4]

Other Considerations:
Infiltration and land application solutions were examined for the Corona Drain Tunnel and the Twin Peaks Adit mine drainages, but these solutions were discarded because of lack of physical space and concerns involving runoff and potential saturation of existing unstable geologic features. Existing site conditions and potential costs make standard active treatment impractical. Physical plugging of the adits was also considered, but was ruled out as not being economical, and because it could potentially aggravate the problem.

For the reasons discussed above, the pilot-scale proposal holds promise and should be implemented. The potential threat to water quality is low, and pilot scale operations (60-90 days) would allow for the evaluation of the chemical dosing rates, design, and operation of the full-scale chemical delivery system.

The goal of the pilot study is not so much to precipitate metals, but to prevent metal mobilization via amending the subsurface chemical environment. Metal-bearing precipitates are anticipated to remain within the fractures and foliation through which groundwater currently migrates.

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[3] Neculita, C.M., Zagury, G.J., Bussiere, B., “Passive Treatment of Acid Mine Drainage in Bioreactors Using Sulfate-Reducing Bacteria: Critical Review and Research Needs,” *Journal of Environmental Quality* (Jan 2007) pp 1-16.

[4] Frank, Paul, “Bioremediation by Sulfate Reducing Bacteria of Acid Mine Drainage,” UC Berkeley (unknown date).

Substantial intermediate improvement of water quality could be attained through the pilot activities via armoring of some reactive sites within the source area for the drainage.