

A Challenge to Remove Mercury from the California Environment

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The undersigned ad-hoc committee has been following the many research projects about mercury and other toxins in the environment. The scope of the research results have been a source of astonishment at their depth and admiration for the results that have been published.

Summary: The goal of the ad-hoc committee was to learn about the presence and effects of mercury(Hg) in the environment and to identify methods of removing such a health hazard from the environment. After following the published research and learning of advances in Hg removal technology, we have concluded that the possibility for realization of the stated goals is now in sight. Furthermore, the recent economic downturn, rather than decreasing the realization of Hg removal, may actually increase the possibilities of removal. The recent passage of economic stimulus legislation by Congress to provide employment opportunities should allow funding of Hg removal for reasons of providing employment with the added benefit of removal of a health hazard.

Background: The dispersal of Hg in the environment in earlier geologic times occurred only with earth movements such as volcanic eruptions. More recent industrial activities such as burning fossil fuels and mining, especially for use in gold extraction, and the process of gold extraction, have resulted in increased concentrations of HG (Sacramento River Watershed Program: www.sacrriver.org/issues/mercury), especially in California, to the extent that environmental Hg is a recognized health hazard. The recent report, presented as an executive summary at the December 2008 meeting of the Delta Tributary Mercury Council, "Mining's Toxic Legacy" (Carrie Monohan, PhD, Sierra Fund: www.sierrafund.org) traces the development of gold mining and its environmental consequences. The report states that 26 million pounds of mercury were brought to the California Gold Country of which about half were never recovered and escaped into the environment. This is the source of the estimated several hundred pounds of Hg that flow into San Francisco Bay annually. The report stated that the gold rush benefitted the entire United States and that the Federal and State governments should be involved in the mitigation of the problems.

The path of mercury into the food chain has been the subject of many studies. The results of these studies have led the Ad-Hoc Committee to conclude that removal of the metallic Hg, which is the source of Methyl-Hg, would result in the significant reduction (not easily quantifiable) of Hg from the food chain. The downstream progress of Hg-containing sediments has been severely reduced by the use of the natural outflow for agricultural, industrial, and urban activities, and, as a result, the flushing action of river transport to the ocean has been prolonged. For that reason, we believe that any removal of Hg from the sources will reduce the time for the concentrations to be lowered to where they are not dangerous to health.

Possible Solutions: The small-scale mining community using suction dredges and sluices in Washington State has provided a partial answer. In the May 2007 issue of the ICMJ Prospecting and Mining Journal, it was reported that the Washington Department of Ecology has received over 150 pounds of Hg from this source. The Hg was accumulated in the sluice boxes alongside the gold. Also, Carrie Monohan in the December 2008 presentation stated that metallic Hg was visible in a creek near her residence and that it was removed by simply using a common turkey baster. These reports have led the Ad-Hoc Committee to conclude that establishment of a state wide program of buying Hg that was removed from

the environment by miners or others, would result in a significant amount of Hg being intercepted before it causes any more damage. The USGS in publication "Fact Sheet 2005-3041 Version 1.1; C. N. Alpers, M. P. Hunerlach, J. T. May, R. L. Hothem (<http://pubs.usgs.gov/fs/2005/3014/>) states "Today, mercury is recovered as a by-product from small-scale gold dredging operations; also, mercury and gold are recovered as byproducts from some gravel mining operations, especially in areas affected by historical gold mining." These methods of Hg extraction from the environment if encouraged by financial incentives could, as stated previously, result in removal of significant amounts of Hg from the environment.

The Sierra watersheds are the sites of many reservoirs installed for irrigation and/or hydro power electric generation. Over the years, the silt that would otherwise be carried downstream has become trapped, and as a result, the holding capacity of the dams has diminished, thus necessitating removal of the silt. One such project at the Combie Reservoir on the Bear River has recognized this as an opportunity to also remove the Hg (private communication to I. Sturman). The project goals are listed as: renewed storage capacity, Hg removal from the sediment, commercial use of the dredged materials, improved recreation, and public education.

Other possibilities of interception could benefit from the model of the interception ponds installed on Cache Creek. Although not in the gold country, the Coast Range is the site of numerous Hg deposits that were mined for gold extraction use and thus Hg was introduced into the local mine environment.

The interception process in the Gold Country and the Coast Range could be the subject of many site specific research projects that would result in new methods of interception and Hg extraction.

The previously described procedures are specific for remediation of water-borne Hg. It is likely that there are many non-water related sites (Hg mines, industrial facilities, etc.). A 73 page summary of other methods of Hg removal was published by the U.S. Department of Energy in 2001 as "Mercury Contaminated Material Decontamination Methods: Investigation and Assessment" by M.A. Ebadian, PhD; Marshall Allen; Yong Cai, PhD; John F. McGahan (www.hcet.fiu.edu). An eight page article "Extractability and Bioavailability of Mercury from a Mercury Sulfide Contaminated Soil in Oak Ridge, Tennessee, USA" by F. X. Han, S. Shiyab, J. Chen, Y. Su, D. L. Monts, C. A. Waggoner, and F. B. Matta was published in Water Air Soil Pollution (2008) 194:67-75. Also, a detailed description (seven pages) of "...removing contaminants from contaminated soils...", "...using electrokinesis..." is available as a patent description "Process and Apparatus for recovering Heavy Metals from Contaminated Materials" (www.wipo.int).

The previously described methods for Hg removal will reduce the amount of Hg entering San Francisco Bay. However, the bay contains significant amounts of Hg owing to the water flow from both the Sierra Gold Country and the Coast Range deposits that have been mined. The Hg deposits from the Gold Country should be accompanied by deposits of gold (Au) as indicated in previous references (because of their similarity in density). This opens the possibility of locating higher concentrations (concentrated by natural forces, wind, wave, and tidal action), in bay sediments and selectively dredging them to remove the Hg (and Au) bearing layers using techniques such as air lift suction to minimally disturb the sediments. It may be that the concentration of Au in bay sediments is low, but recently developed technology (heap leaching) can extract Au from ores at less than one part per million by weight ("Gold from Panning to High-Tech Mining" Tom Farley, Invention and Technology, Summer 2008, Volume 23, Number 2). At this writing (June 2009) the price of Au is about \$900 per troy ounce. The price of Au has risen faster than the cost of extracting it. Any

recovery of Au would help mitigate the cost of Hg removal. The sediments from non-gold country sources, such as the Guadalupe River flowing into the south bay will require different methods for Hg extraction from the sediments, possibly centrifuge processing.

The previously mentioned economic stimulus plan was listed as a possible source of funds in "Cleanup of abandoned mines expected to continue", Joan Lowry (San Francisco Chronicle, February 16, 2009, page A11). "The final bill, approved by the House and Senate on Friday, contains more than \$1.5 billion for construction and maintenance projects in the Bureau of Land Management, the National Park Service and the Forest Service. This includes addressing pollution and safety hazards caused by abandoned mines on public lands." "... Senator Dianne Feinstein, D-Calif., (was) one of the lawmakers who sought the money." The article states that projects other than mine cleanups are also eligible for the funds. However, the economic stimulus bill is limited to Federal lands and thus cannot solve the entire problem of Hg contamination in California. But, there already are Superfund projects active in California, at Clear Lake, near Redding, and near Davis, Jane Kay (San Francisco Chronicle, April 16, 2009) so there are precedents.

The Challenge: The Federal, State, and Local Environmental and Water Quality Agencies, volunteer, non-profit environmental organizations local citizens organizations, mining companies, and small-scale miners are the vehicles by which the Hg contamination in California can finally be mitigated. These organizations are challenged to form an umbrella organization with the common goal of removing the Hg from the California environment. The task requires the application of a "Super Fund" clean up effort applied to the entire state, not just to a specific site. The results will not be instantaneous, but applying the methodology selectively to the most contaminated sites first, possibly one or a few at a time, will have the potential of reducing the San Francisco Bay and other California environment concentrations of Hg in tens of years rather than hundreds of years if nothing is done.

As quoted previously, the entire nation benefitted from the Gold Rush, thus it is appropriate that the cost for the clean up come from the federal government.

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