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Characterization of mercury concentrations in suspended sediment loads in Guadalupe River and Coyote Creek, San Jose, California: Can TMDL targets be met?

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ABSTRACT

San Francisco Bay is listed on the Clean Water Act 303(d) list as a water body impaired by mercury. In response to the impairment listing, a mercury TMDL was developed by the Region 2 Regional Water Quality Control Board. The Bay TMDL contains specific recommendations for the Guadalupe River including the following: "Quantitatively demonstrate that the mercury concentration of suspended sediment that best represents sediment discharged from the watershed to San Francisco Bay is below the suspended sediment target". The question is: Can this target (0.2 mg/kg) be reasonably met? Presently the Guadalupe River suspended sediment load has a mercury concentration that is approximately 10x greater than the target during low to moderate rainfall years and possibly exceeds the target even more during very wet years. In contrast, pilot study data for Coyote Creek averaged approximately 0.2 mg/kg. Thus, presently Coyote Creek appears to meet the Bay TMDL sediment mercury target. The data support a hypothesis that other Bay Area watersheds dominated by urban and atmospheric sources can be managed to meet the target but it is presently difficult to predict if the Guadalupe River can be remediated and managed to meet the target.

METHODS:

Water samples were collected during flood flow in the Guadalupe River at USGS gauge 11169025 (**FIGURE 1**) during the wet seasons of water year 2003, 2004, and 2005. Samples were taken from a bridge at the San Jose International Airport (**FIGURE 2**) using clean hands protocols and a D-95 water quality sampler (**FIGURE 3**). In addition, bed load sediment samples were collected using a BL-84 sampler (**FIGURE 4**). Bed load samples were analyzed for total mercury on 8 grainsize fractions. Water samples were collected during flood flow in the Coyote Creek at USGS gauge 11172175 during the wet season of WY 2005 only (**FIGURE 5**). Coyote samples were collected by hand at wading stage by passing a trace metal cleaned Teflon bottle with a 2 inch neck into the water column to approximately mid depth.

RESULTS

A total of 114 samples were collected from Guadalupe River over the 3 sampling years and analyzed for total mercury. Total mercury concentration ranged between the limit of detection during base flow to 18,673 ng/L during flood flow (**FIGURE 6**). During water year 2003, when rainfall intensity was much greater, concentrations exceeded 2,000 ng/L during some storms. It is hypothesized that this was caused by the supply of mercury to tributary creeks from mining areas in the New Almaden Historic Mining District. We hope to sample another wet year in order to strengthen this hypothesis. During water year 2004 and 2005, total mercury concentrations were always <2,000 ng/L and formed a reasonable relationship with both discharge and suspended sediment concentration.

During water year 2005, total mercury in water was 97% particulate (flow-weighted mean) confirming the generally agreed upon notion that sediment is the main vector for the transport of mercury in river systems. During water year 2005, total methyl mercury ranged between the detection limit and 1.9 ng/L (**FIGURE 7**) and was also dominantly particulate (90%) (flow-weighted mean). Highest concentrations occurred during the first flush of the season. Dissolved methyl mercury did not form a strong relationship with discharge (**FIGURE 8**).

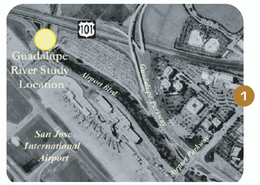
Just seven samples were gathered on Coyote Creek during water year 2005. Concentrations ranged between 11-59 ng/L and were greatest at greater discharge. Concentrations observed on Coyote Creek appear to be much lower than those observed in Guadalupe River, however on a relative basis, they were collected at lower flood discharge conditions. That said, when the total mercury concentrations were normalized to suspended sediment concentrations a pattern emerged (**FIGURE 9**). Normalization to suspended sediment concentrations was reasonable given mercury transport in Guadalupe is dominantly particulate. This is likely true also for Coyote Creek. Accepting this assumption, during water year 2005, particulate mercury concentrations in Guadalupe River averaged 2 mg/kg whereas particulate mercury concentrations averaged 0.2 mg/kg in Coyote Creek.

Concentrations in the bed load sediments of Guadalupe River ranged between 0.03-1.8 mg/kg (median of eight samples) (**FIGURE 10**). Mercury concentrations in the fine fraction of bed load sediments (<0.0625 mm) most closely matched mercury concentrations observed in suspended sediments. This is not surprising given that >90% of the suspended sediment in Guadalupe River during floods has a grainsize <0.0625 mm.

DISCUSSION

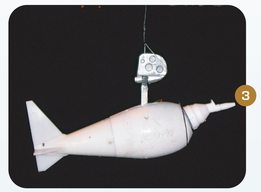
Observations of mercury concentrations are consistent with our understanding of sources of contamination in these two watershed systems. Mercury in Coyote Creek is mainly sourced from industrial and urban uses and atmospheric deposition with only minor influences from small mercury mines in the upper watershed. In addition to industrial and urban mercury uses and atmospheric deposition, Guadalupe River is contaminated with mining debris associated with the New Almaden Historic Mining District, the largest producer of mercury in North America. Sediment mercury concentrations in Guadalupe River are much greater than in Coyote Creek and reflect the mining influence.

The data collected so far provide evidence that Coyote Creek can be managed to meet the 0.2 mg/kg TMDL sediment target. In contrast, sediment concentrations in Guadalupe River are approximately 10x greater than the mercury TMDL sediment target. It will likely take many years and substantial management effort to reduce suspended sediment mercury concentrations in the Guadalupe River. It is presently difficult to predict if watersheds contaminated by mining wastes such as the Guadalupe River can be remediated and managed to meet the target. There are other indicators of progress towards the TMDL goals such as loads avoided (mercury mass removal from the system) and load reduction (a downward trend in river mercury load). It is possible that a mercury load trend may be the best indicator if the sediment target cannot be met over, for example, 20 years. In addition, bed load mercury concentrations and their relationship to suspended sediment mercury concentrations may also provide some insights into the way the system responds to channel maintenance activities and other management efforts that remove mercury mass. The determination of the right indicators for success should be a focus of further study.



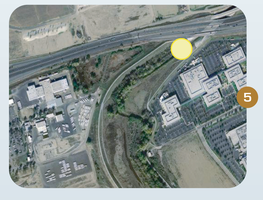
1 Sampling location on Guadalupe River, USGS gauge 11169025, San Jose International Airport rental car return bridge (Photo image curtsey of USGS)

2 Looking upstream from Hwy 101 on Guadalupe River at the sampling location. Our equipment is lowered off this bridge into the water using a 4-wheel boom truck and b-reel. Under flood conditions, the water can rise to about half way up the bridge pillar or even more.

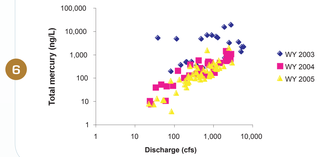


3 Teflon coated D-95 water quality sampler with trace metal clean Teflon components.

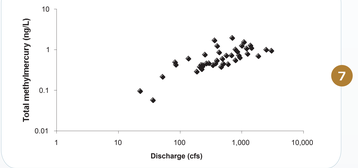
4 Sampling on the Guadalupe River for total mercury analysis in bed load using a BL-84 sampler.



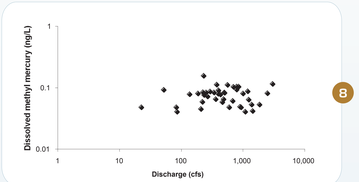
5 Sampling location on Coyote Creek, USGS gauge 11172175, Hwy 237, Milpitas (Photo image curtsey of USGS).



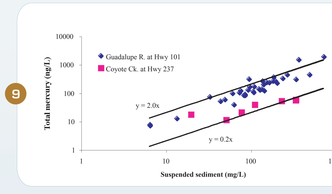
6 Total mercury concentrations on Guadalupe River during each water year.



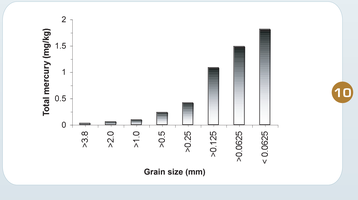
7 Total methyl mercury concentrations on Guadalupe River during water year 2005.



8 Dissolved methyl mercury concentrations on Guadalupe River during water year 2005.



9 Comparison of the relationship between suspended sediment concentration and total mercury in water in Guadalupe River and Coyote Creek during water year 2005.



10 Bed load total mercury concentrations in Guadalupe River during water year 2005.

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