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To: Rick Humphreys, Mine Cleanup Coordinator
Groundwater Protection Section
Division of Water Quality

From: Joanna Crowe Curran, Ph.D.
Assistant Professor
Civil and Environmental Engineering
University of Virginia

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External Peer Review of the Water Quality Impacts of Suction Dredging for Gold Presented in the Draft Subsequent Environmental Impact Report of February, 2011

This review centers around the potential impacts of suction dredge mining on water quality and toxicology (Chapter 4.2 in the Suction Dredge Permitting Program: Draft Subsequent Environmental Impact Report), specifically the effects on turbidity/TSS, mercury, trace metal, and trace organic compounds mobilized into the river system as a result of suction dredging operations. Throughout this review Chapter 4.2 is referred to as the report. References are made to Attachment 2, which details the issues to be addressed by the peer reviewers.

The report summarizes a literature review, and makes statements regarding the significance of turbidity/TSS, mercury, trace metal, and trace organic compounds released as a consequence of suction dredging on water quality. Overall the report suffers from a lack of the quantitative data needed to judge the appropriateness of suction dredging for all of California. Many of the studies in the literature are specific case studies and applicable only under river and dredging conditions similar to those applied in the case studies. Extrapolation beyond case study conditions can only be done with caution, especially given the diverse physiographic conditions in California. Many of the sections in the report also fail to consider all of the potential impacts of each parameter to the watershed as a whole or the downstream portions of the river systems. This leaves the report lacking in completeness and the conclusions difficult to justify in some cases.

Each water quality parameter is addressed separately in this document. There is first a summary of the findings followed by detailed comments on specific lines of the report.

Turbidity/TSS

The report classified the effects of turbidity/TSS as 'less than significant.' The information presented in the literature has too many gaps to conclude that the impacts from suspension and mobilization of fine sediments are in fact less than significant. The report states that the plumes created by the dredges will elevate levels of turbidity and total suspended solids up to 300-340 mg/L. The values are presented as an upper limit but derive from a single case study conducted in an area with coarse substrate, a 4" nozzle and no other dredges operating in the immediate area. This scenario is not a worst case scenario as larger nozzles (up to 10") are known to be used in suction dredging, there are often multiple dredgers in the same watershed or on a single river reach. The cited study did not explore in depth the potential impacts of several dredges or larger nozzle sizes. Therefore the estimate of 340 mg/L cannot be used as the maximum value. Because there are no limitations on the number of dredgers allowed per watershed, the dredgers don't have to report where they are dredging, and there is limited monitoring of the watersheds, it is feasible that there could be several dredges in the same watershed. It is expected that if/when suction dredging is allowed there will be multiple dredgers operating along rivers within easy access points from campsites. It would be more reasonable for the literature summary to cite the 340 mg/L estimate and apply a multiplier determined by the expected number of dredgers in a single area.

The turbidity section is focused on the distance the visible turbidity plume travels from a single dredger. The report finds that the individual plumes would not cause long term degradation of water quality with regards to turbidity and TSS. However, the literature looking further downstream at the impacts of transported sediment on mercury accumulation with lake aggradation indicate that there is a greater amount of sediment mobilized and transported than what was measured by literature cited in the turbidity section. Admittedly there has been more quantitative research into the transport of mercury, but the studies showing downstream deposition of fine sediments are indicative of upstream releases of fine sediment into suspension. There is limited mention of reservoir infilling presented in the turbidity section and the case studies that discuss the potential to have the sediment transported downstream and accumulate in reservoirs behind dams are not emphasized. While this impact may be minimal for a single dredge, the combined impact of all of the dredges releasing sediment downstream would compound the negative effects. Over time the storage capacity of a reservoir would be reduced requiring an expensive dredging operation to remove excess sediment, and a safety hazard if the dam fails.

The cited studies acknowledge that the plumes could exceed turbidity objectives, but state that the plumes would not negatively affect aquatic organisms. In contrast, other studies that have shown that as the sediment settles out of the water column that it does have an impact on mussels in the downstream reach. The dredge tailings resulted in the death of a majority of each mussel species observed, and none of the organisms were able to escape from the tailings that deposited on them (e.g. Krueger, Chapman, Hallock, and Quinn, 2007). Again, the downstream impacts of the release of sediments into suspension need to be more fully considered.

Fine sediment that creates turbidity will deposit on the surface of the stream bed, potentially infilling any open spaces in the sediments and burying any aquatic insects or mussels. As the sediment accumulates on the channel bed, it will smooth the bed surface and reduce surface complexities. If a number of dredgers operate in a single area, the amount of sediment released and deposited downstream could be enough to fill in any natural pools in the channel, which are often sites of important aquatic habitat. Most of these negative effects receive little mention in the literature review on water quality. They are discussed at greater length in the geomorphology section but deserve mention here as well because the added sediment deposition will affect overall stream health. While the turbidity studies have not detailed a significant negative direct effect on aquatic life, they have shown an effect on aquatic habitat.

The literature reviewed in the report is not sufficient to classify turbidity and TSS as either 'significant and unavoidable' or 'less than significant.' By the definition presented on page 4.2-24 significant impacts include "increase levels of any priority pollutant or other regulated water quality parameter in a water body such that the water body would be expected to exceed state or federal numeric or narrative water quality criteria… by frequency, magnitude and geographic extent and would result in adverse effects on one or more beneficial uses." While the increased turbidity and TSS may not result in bioaccumulation, there is not enough information about the impacts of dredge nozzle sizes larger than those presented in the literature, channel beds with significant fine sediment content, or multiple pieces of equipment operating in the same watershed to definitively rule out the potential to cause a significant impact. The data presented in the literature are from a sequence of individual case studies from streams with coarse substrate, using equipment that is smaller than specified by the regulations, and without any other dredging operations occurring nearby. If the regulation is to explicitly specify require that dredgers conform to these conditions, the impact may be 'less than significant,' but there is not enough information to consciously deem the impacts less then significant at this time.

In order to make a valid conclusion more information is needed in areas with silty substrate, using the maximum allowable equipment size, and with several dredges operating in the same watershed. These types of quantitative studies were not included in the literature considered in this report. The report makes note of these data gaps on page 4.2-21 line 43 "… the available data likely does not address every possible combination of variables in which turbidity/TSS discharges may occur." However, the language of the report minimizes these issues in the individual impact sections.

Specific Comments on IMPACT WQ-3: Effects of Turbidity/TSS Discharges

4.2-28 line 31: "resuspension of coarse and fine sediments into the water column by suction dredging activity is a function of several factors…" One of these factors is the number of dredgers operating in a watershed or river reach. Please specify the number of dredgers and their locations relative to each other.

4.2-29 line 14: the distance of the turbidity disturbance has been underestimated because the cited studies would not provide an accurate estimate. Harvey (1986) studied a site with a 100% gravel surface. The amount of fines that could have been suspended and created turbidity was negligible at best. Somer and Hassler (1992) conducted their studies under conditions that would minimize turbidity plumes. The dredging was conducted without any other nearby dredgers, using the small size 4" nozzle, and during high flows, which allowed for the fastest possible dispersal of suspended material.

4.2-29 line 16: “maximum reported TSS concentrations were up to 300- 340 milligrams per liter (mg/l) immediately downstream of the dredge, decreasing to background levels within 160 meters (Thomas 1985).” This finding derives from one case study from Montana. The stream bed in the case study was primarily gravels and cobbles, which would have minimal fine sediment available for suspension. Thus, this study is not a reliable source from which to estimate maximum TSS concentrations. It is from a state with a very different physiographic setting, from a stream with higher grain size distribution then is reasonable for a maximum scenario, and result from use of a 6.4 cm nozzle, which is much smaller than the regulatory maximum for recreational dredgers of approximately 18 cm in most areas.

4.2-29 line 23: “In one case, a turbidity plume was said to extend “well over a mile,” but turbidity levels from this plume were “within limits” (USFS, 1996). This study underestimates turbidity levels because the samples were taken below the mixing zone. If the samples were taken within the turbidity plume, the levels would have been much high and likely above acceptable limits.

4.2.29 line 24: “The extent of the turbidity plume is influenced by the composition of the streambed, dredging in streams with higher proportions of fine materials will generate a more extensive turbidity plume (Harvey 1982, Harvey 1986). Also, observations of large dredges and many dredges in a water course suggest that the turbidity increases can be large.” By these statements, the author communicates the limitations of his study and warns against broad extrapolation of the results. This kind of cautionary language needs to be included in the report. Showing data from a majority cobble stream or smaller dredging nozzles than the regulation stipulates is not giving an honest representation of the potential impacts of turbidity or TSS.

4.2-30 line 21: “affects and entire” - should be ‘an’ and not ‘and’

4.2-31 line 39: The impact of suspended solids on burial of non-mobile organisms is mentioned in the report, but no real solution considered or provided. Research from Washington State suggests dredge tailings have a significant impact on the lifespan of mussels in the streams. While there wasn’t a large impact on the organisms as they passed through the equipment, there was a very high mortality rate of those that were buried in the tailings.

Krueger, K., Chapman, P., Hallock, M. and T. Quinn. 2007. Some Effects of Suction Dredge Placer Mining on the Short Term Survival of Freshwater Mussels in Washington. *Northwest Science* **81**(4): 323-32.

4.2-31 line 36: “Thomas (1985) and Harvey (1986) indicate that in some streams where dredges operate at low density, suspended sediment is not a significant concern because effects are moderate, highly localized and readily avoided by mobile organisms.” Both of these studies underestimate suspended sediment as a result of the large grain sizes of the river substrate.

4.2-32 line 14: In addition to underestimating the TSS and turbidity values by presenting data from “average” scenarios and not worse case, no exploration is made into quantifying the impacts of having several dredges working together or in the same watershed. It is reasonable to expect that under those conditions the water would have increased suspended sediment and turbidity levels. The extent of an increase in turbidity is unknown, but could increase the likelihood of having an adverse impact on the fish and invertebrates.

4.2-32 line 23-26: The Program is supposed to include additional prohibitions that would avoid and limit potential disturbance of fine sediment, however no specifics are mentioned concerning moving dredging equipment in and out of rivers and the potential damage to the riparian area or channel bank.

Mercury

The report concludes that the effects of mercury discharged from suction dredging are 'significant and unavoidable.' This finding relies heavily on a case study comparing two dredging pits. The report is written with an emphasis on findings from Pit #2, leading the reader to believe that Pit #2 is a worst case scenario but without statistical evidence to prove show this. At the same time Pit #1 is presented as representative of the more common impact of dredging on contaminant transport. However, Pit #1 is a specific case from a channel where mining is unlikely to occur (see specific line comments below). Thus, the estimates of suspended sediment and contaminant concentrations in the water column as a result of conditions at Pit #1 are an underestimate of what should be expected. The impacts of suction dredging on mercury mobilization and transport are potentially more significant then what is presented in the report.

Because the report does not consider all potential impacts of mercury on the system, the conclusion that mercury's effects are 'significant and unavoidable' can be considered conservative. Upon study and analysis of the effects of larger dredging nozzles and mining at hot spots in the river system, the negative impacts of suction dredging on mercury mobilization can be anticipated to be greater. The addition of that information would serve to strengthen the conclusion already made based on a robust body of knowledge.

<u>Specific Comments on IMPACT WQ-4: Effects of Mercury Resuspension and Discharge</u>

4.2-36 line 13: "Humphreys (2005) describes a location where elemental Hg was present and whose sediment Hg concentration was 1,170 mg/kg." These results are from a lab test. The Hg concentration from tests performed on river waters is approximately 10 times higher than the lab test.

4.2-36 line 25: "some have noted that the equipment used in this study is no longer in production, and suggested that modern equipment may result in less flouring (McCracken, 2007)." There are no specifications in the rules that requiring operators to use flare end dredges, so it is not reasonable to assume they will. This was the mention of flare end dredges in the literature.

4.2-36 line 40: "This exercise was conducted for both the more typical background average Hg level sediment (Pit #1) and the worst-case hot spot sediment (Pit #2: BC)." The report defends the use of Pit #1 to represent background levels through literature citations that support the assumption (4.2-35) but an equally thorough case is not made for use of Pit #2:BC as the critical scenario in this analysis. Page 4.2-33 states "Levels from the bedrock contact layer of Pit #2:BC are assumed to be worst case from a mercury release standpoint because they are from a location know to be contaminated with historic gold mining Hg and because they are among the highest levels measured in California." There are no citations associated with these statements to lend credibility to these assumptions. Further, p.4.2-35 states "source assessment and sniping results suggested that this location is not a unique hotspot within the South Yuba River Watershed." If it is not a unique scenario, how can it be assumed that this is a true "worst case"?

4.2-36 line 45: specify that mercury discharge rates are from Pit #2:BC

4.2-37 line 10: The reported values cannot be extrapolated. The "worst case scenario" was based on a 6.4 cm nozzle in Montana while in California the dredges are typically 14 to 18 cm. In addition the cited literatures makes note that the results would be much larger if they used a larger dredge, smaller stream channel, or siltier substrate. The report should justify the numerical values picked and assumptions made when estimating values.

4.2-38 line 1: Use of the term "estimated" in the table title implies the table provides values that have been extrapolated from 1 set of measurements taken from 2 sites. The actual studies from which these values were taken should be cited. It is not possible to assess the accuracy of the estimates without knowing how the measurements were made and if any replicate measurements were taken that could provide error bars for the estimates. The report needs to comment on the applicability of these estimates to the entire state of California.

4.2-38 line 11: The wording needs to make clear the length of the data record used to determine normal and dry flow years. As the report is currently written, it may be interpreted to say that a 4 year span to estimate normal and dry years. It would be useful to present a longer span of water data to be able to show how the observed flows compare to a long term data set and what discharge patterns constitute normal and dry.

4.2-42 line 2 -14: "More than the entire permitted population of suction dredgers … would need to be operating… to discharge 10% of the background Hg loading in a dry year using average size… dredges." Again, the wording when presenting information based on the results from Pit #1 is misleading when it implies that the results from one study under specific conditions can be extrapolated to broad conclusions about loading. The report states that these are unlikely conditions (4.2-41), and they should be treated as such throughout the report. Less text should be spent on Pit #1 and more text should be devoted to the conditions of Pit #2? The current report can be misinterpreted due to the limited discussion of Pit #2 to indicate that dredgers would only impact the river under only one specific situation when in reality it is the most plausible situation.

4.2-42 line 10: "assuming 50% of transported sediment is deposited in a reservoir between where suction dredging is occurring and downstream reaches where particle bound Hg may reach the Delta"- where is this 50% estimate coming from? Is it from the Alpers (in prep) data set? Why assume 50% when 4.2-41 states that "During water years 2001-2004, it is estimated that only 40% of total Hg inputs into Englebright Lake were deposited?" The Alpers (in prep) number may not accurately estimate the values transport downstream, as it relies on a single case study, but the report should expand upon the assumption to use 50% and therefore underestimate the values presented.

4.2-42 line 16: what about reservoir sediment accumulation and the impacts of Hg on this?

4.2-43: Figure 4.3-12 and comments derived from these results should reflect that these results are relative to an entire watershed. While the results alone show significant impact from the suction dredgers, the report should mention the likelihood that there could be several dredges in a watershed at the same time, perhaps after 4.2-42 line 2 "… of the background watershed loading."

4.2-46 line 36: "all taxa collected in 2007 had higher concentrations of MeHg than the same taxa from the same sites in 2008…. Overall, levels in 2008 were statistically significantly higher than levels in 2007." These statements appear contradictory.

4.2-51 line 15: "type sediment.." only need one period.

4.2-52 line 2: "2) estimates of watershed load" - is this water or sediment loadings, please specify.

4.2-52 line 36: Again, this is not where dredging is likely to occur, if the report includes this statement, it should add a statement about the unlikelihood of suction dredging taking place under non-ideal conditions. If the purpose is to show that background levels are not a substantial concern, please explicitly state that.

4.2-53 line 38- 4.2-54 line 16: How are these suggestions going to be implemented? As currently written, they are rather vague, for example not specifying an allowable nozzle size.

The Sierra Club, 2009 produced a document for Oregon that included an extensive list of suggested improvements to suction dredging regulations (i.e., improving and funding increased enforcement and education, identification and requirements of best practices and special rules for mercury). Any improvements to the regulations should consider limiting the number of dredgers per watershed, having the miners applying for the permits that specify machine type, horse power, nozzle size, and both watershed and specific river location where dredging will occur.

Riskedahl, Mark, and Lesley Adams. Letter to Beth Moore. 8 June 2010. Oregon Coastal Alliance. http://www.oregoncoastalliance.org/documents/NEDC%20re%20suction%20dred.pdf. Accessed online on 18 Apr. 2011.

4.2-54 line 11: who would monitor and enforce this?

Other Trace Metals

The release of trace metals is listed as a 'significant and unavoidable' effect of suction dredge mining. This contradicts the findings summarized for other trace metals in attachment 2 (page 3) which indicates that they are not expected to have a significant impact outside of hot spots, and that suction dredging would not "result in substantial, long term degradation that would cause substantial adverse effects to one or more beneficial uses of a water body." The difference may be due to an update but the language of the report could be misinterpreted.

The report indicates that "dissolved trace metals or that fraction of the total metal mobilized that is adsorbed to sediment particles <63 µm that stay suspended for long periods of time tend to be rapidly diluted…" (4.2-55 line 14). This statement can lead the reader to believe that once outside of the immediate proximity of the dredging operation there are few downstream impacts of the increased release of other trace metals. Instead, because these metals are transported with fine sediments, there is a strong possibility that these contaminants will deposit downstream and accumulate over several seasons. The report identifies suction dredging at river hot spots as having the potential to severely impact the river by releasing a large quantity of metal into the flow (4.2-58 line 7), but does not then detail the potential for accumulation of these metals although acknowledging that many 303(d) listed water bodies are lower elevation bays and estuaries, where the fine sediments transported downstream from suction dredging sites would be likely to accumulate. There is also no consideration given to the increased probability of trace metal impacts on the river system when multiple dredgers are operating in a single river reach.

Similar to the situation with the turbidity section, there is not a robust body of scientific literature from which to draw quantitative conclusions. However, there is enough information to indicate a possibility of adverse water quality effects from suction dredging. Releases of trace metals with suction dredging would be unavoidable because there are currently no means of tracking where suction dredging occurs or a database of hot spots in California Rivers. Without any record of where the dredging activity is going to take place, there exists the potential for dredging upstream of a habitat sensitive areas. The qualitative evidence of negative impacts from trace metals in hot spots makes dredging location an important factor in the classification of this parameter as 'significant and unavoidable,' and any summary of that section should clearly spell that out for the readers if attachment 2 is to be distributed to decision makers. Thus, in the case of trace metals, the conclusion that impacts are 'significant and unavoidable' derives more from qualitative assessment of the information than from quantitative analysis.

Specific Comments on IMPACT WQ-5: Effects of Resuspension and Discharge of Other Trace Metals

4.2-55 line 14: What about accumulation behind dams, or in pools and riffles? While this may be covered in the earlier report section on Geomorphology, it should be mentioned here as it can impact the overall stream health and quality.

4.2-56 line 20: Is this area a good representative? Does it represent a worst case scenario?

4.2-57 line 9: "particulate-derived metals should not affect downstream sediment concentrations significantly" What about what is bound to fine sediment traveling in suspension down to reservoirs as discussed in the mercury section? It may not explicitly be bioavailable, but it will still accumulate overtime.

4.2-57 line 25: these results are based on a single dredge operating. The report should make mention of the expected results when several dredgers are operating in the same watershed and if they are operating in series? (See USFS, 1996 for the likelihood of having several dredgers in a watershed).

4.2-57 line 26: What about impacts to buried eggs in the dredging areas? Are there any expected impacts to mussels (see Krueger et. al., 2007)?

Trace Organic Compounds

The finding for impacts due to trace organic compounds is 'less than significant.' The literature reviewed for this finding is both quantitative and qualitative. Trace organics are not known to have accumulated in large amounts in the upstream areas of California Rivers. Although there are not estimates of their actual amounts in California Rivers, the conclusions is supported by the cited literature. Organic compounds travel adsorbed to fine sediment and remain attached to the sediment upon its deposition. Because the compounds to not become bioavailable, even after mobilization and transport, they are unlikely to have any effect on overall water quality. Although the scientific literature on the subject is not extensive, it is complete and supports the finding of a 'less than significant' impact.

<u>Specific Comments on IMPACT WQ-6: Effects of Trace Organic Compounds Discharged</u>

4.2-59 line 19: "trace organic compounds have rarely been observed above public health thresholds in fish in upper elevation watersheds where suction dredging generally occurs."

4.2-59 line 44: "the vast majority of trace organic compounds mobilized by suction dredging would be adsorbed to sediments, most of which would rapidly re-settle to the stream bed within close proximity to the dredging site." A portion of the sediment may be transported far downstream (as stated in the mercury section). While the magnitudes on the individual scale may be small, the potential cumulative impact may be much more significant. The potential for future problems due to the effect of accumulated trace organics should be discussed.

4.2-60 line 18: What about several dredgers operating at the same time?

4.2-60 line 43: "would potential affect sediment…" should that be potentially?

Respectfully submitted,

Joanna Curran

Joanna Crowe Curran, Ph.D.
Assistant Professor
Civil and Environmental Engineering
University of Virginia