

Comments on US EPA Proposed Sediment Quality Criteria Based on Acid Volatile Sulfide Normalization Heavy Metal Data¹

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In late December 1994, the US EPA announced that it planned to develop sediment quality criteria (SQC) for selected heavy metals based on acid volatile sulfide (AVS) normalization of heavy metal sediment concentration data. The Agency made a presentation to the Science Advisory Board (SAB) in early January 1995. In preparation for that presentation, the US EPA made available a paper, "Assessing Potential Bioavailability of Metals in Sediments: A Proposed Approach," authored by Ankley, et al. [Environmental Management, 18:331-337 (1994)] and a statement on how the Agency planned to use acid volatile sulfides in sediments in developing sediment quality criteria for selected heavy metals based on an equilibrium partitioning approach. Presented below is a discussion of the US EPA's proposed approach for developing SQC based on AVS normalization of sediment heavy metal data.

Overall Conclusions

The authors find that the US EPA's proposed development of sediment quality criteria for selected heavy metals based on AVS normalization is technically invalid. This approach is ill-conceived and will lead to regulatory chaos resulting in massive waste of public and private funds in the US EPA's "Aquafund" program that is being developed today. The justification for not supporting the Agency's proposed approach is presented below. Additional information on these issues is available from the authors upon request.

Background and Qualifications

Dr. G. Fred Lee has worked throughout his over 35-year professional career on sediment quality evaluation and management issues. Dr. A. Jones-Lee has worked on these topic areas since the mid-1970's. Extensive work has been done on heavy metal interactions with sulfides and other constituents in sediments. Further, they have been highly involved for about 20 years in developing sediment quality criteria and, most importantly, their use in a state and local regulatory framework in public policy formulation. A list of their professional papers and reports is appended to these comments, as well as other information on their qualifications.

Purpose of Sediment Quality Criteria

Sediment quality criteria should be directed toward developing regulatory tools that can be reliably used at the state and local levels for the purpose of determining when a particular sediment requires remediation as a result of excessive concentrations of toxic/available forms of chemical constituents in sediments that impair the designated beneficial uses of the waterbody in which the sediment is located. For the heavy metals that the US EPA proposes to develop AVS normalized sediment quality criteria, the concern is toxicity to aquatic life associated with

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sediments. While it has been known for over 30 years that various reduced sulfur species in sediments interact with heavy metals forming highly insoluble precipitates, it has also been known that there is a wide variety of other constituents in sediments which also interact with heavy metals to form non-toxic, non-available forms. For this reason, the measurement of heavy metals, or some fraction of the heavy metals based on chemical procedures, has been and will continue to be an unreliable approach for predicting sediment toxicity to aquatic life.

The Agency's proposed approach for selected heavy metal criteria represents an attempt to salvage a technically invalid approach that was initiated in the mid-1980s for developing sediment quality criteria based on chemical-specific measurements. As has been found by a number of individuals and professional organizations, such as the Water Environment Federation, the American Water Works Association, etc., equilibrium partitioning based approaches are inherently unreliable for developing sediment quality criteria that are to be used in a regulatory framework. As discussed by Lee and Jones (1992), those familiar with aquatic chemistry know that there is a wide variety of chemical constituents in aquatic sediments that detoxify heavy metals besides sulfides. The aqueous environmental chemistry of heavy metals in aquatic sediments is extremely complex and cannot be reduced to a few simple chemical reactions, as the Agency is now attempting to do with its AVS normalization of selected heavy metal chemical concentration data.

Since the purpose of the sediment quality criteria for heavy metals is protection against significant heavy metal toxicity, and since it has been well known for many years that chemical concentration measurements, including normalized measurement approaches in sediments, are poor predictors of heavy metal toxicity, it is more technically valid, cost-effective, and far more reliable to assess heavy metal toxicity based on direct measurement of toxicity in the sediments. Rather than wasting public and private funds making chemical measurements that are unreliable for predicting heavy metal toxicity, toxicity measurements should be made with a suite of sensitive organisms. If toxicity is found that is of significance to aquatic life and other resources of a waterbody, then studies can be initiated to determine the cause of the toxicity through a TIE approach, which would include for heavy metals, utilization of AVS information.

Basically, rather than trying to estimate toxicity using chemically based, inherently unreliable methods, measure toxicity directly. This will reliably screen for potential heavy metal toxicity, as well as toxicity due to nonpolar organics and a large number of unregulated chemical constituents that can be present in aquatic sediments. Using toxicity tests to screen for potential toxicity is a common sense approach that should be adopted by the US EPA as a regulatory tool. It is one that is readily implementable at this time.

The Ankley, et al., 1994 paper discusses some of the problems with trying to use non-iron heavy metal concentrations as a reliable predictor of sediment toxicity. They have failed to mention, however, a number of other detoxification mechanisms that occur in aquatic sediments that are as important as AVS, such as in aerobic sediments, the interactions with hydrous metal oxides and carbonates. The transitory nature of AVS in some sediments could readily lead to the erroneous conclusion that in the absence of AVS the sediments are highly likely to be toxic. As discussed in the papers and report resulting from the over \$1 million research effort that the authors conducted for the Corps of Engineers in the 1970s, devoted to dredged sediment disposal

criteria, interactions with hydrous metal oxides and carbonates can represent highly significant detoxification mechanisms in sediments. Typically, when a sediment loses its AVS, hydrous metal oxides of iron are formed. Therefore, the absence of AVS should not be taken as a reliable indicator of heavy metal toxicity.

Importance of Not Creating Unreliable Sediment Quality Criteria

Since the early 1970s, we have repeatedly observed through our work as consultants to regulatory and public agencies, industry, and others that at the real-world operating level, where water quality and sediment quality criteria are used to formulate public policy, unreliable values often carry as much if not more weight in public policy formulation than technically defensible reliable approaches for evaluating water quality impacts of chemical constituents in the water column and sediments. While there are some who assert that unreliable equilibrium partitioning based sediment quality criteria can be used as screening tools for potential problems, the facts are that any approaches used for screening environmental impacts must be highly reliable to avoid their inappropriate use in assessing the water quality significance of constituents in the water column and/or sediments. At the state and local levels, any numeric value that is readily developed that carries an association with a regulatory approach will, independent of the number of caveats that the US EPA or state pollution control agency place on its use, become cleanup standards that can waste massive amounts of public and private funds in unnecessary cleanup, unnecessarily restrict NPDES permitted discharges of wastewaters and stormwaters, and direct regulatory attention away from the real issue that should be addressed of whether there is in fact toxicity in the sediments that is of significance to the designated beneficial uses of waterbodies.

The authors have recently experienced another example of how local entities develop decisions on sediment quality that are purported to be of concern because of heavy metal toxicity to aquatic life associated with the sediments. This situation is associated with the Santa Monica Bay Restoration Project, where the management of that project has recently approved a plan for bay restoration that includes the expenditure of \$42 million over the next five years to construct structural BMP's, such as detention basins, to reduce the heavy metal input to Santa Monica Bay from urban street runoff based on the fact that the heavy metals in the street runoff accumulate in Santa Monica Bay sediments, causing some of these sediments to have concentrations above Long & Morgan ER-M values. Such values have, according to some, been found to have co-occurrence with sediment toxicity. Those responsible for conducting the five-year Santa Monica Bay Project chose not to make toxicity measurements on the sediments to determine whether the co-occurrence based values had any technical validity in predicting toxicity in Santa Monica Bay sediments.

While most would agree that the approaches used in the Santa Monica Bay Restoration Project are technically invalid and should not have been followed, the facts are that this is the real world in which sediment quality criteria will be used. Basically it is one in which those responsible for projects of this type want some kind of a simple numeric value, such as a Long & Morgan ER-M value, with which to justify a pre-conceived notion that some kind of regulatory action is needed. It is our experience that they typically do not want to have to address technical issues, such as for AVS normalized sediment quality criteria, that there is need to do additional studies to determine whether the sediments contain other constituents that detoxify the heavy

metals. There is no doubt that the US EPA's proposed AVS heavy metals based sediment quality criteria will become cleanup standards and that as a result massive amounts of public and private funds will be inappropriately used in contaminated sediment remediation efforts.

The Santa Monica Bay example is not an isolated case. We have found exactly the same kind of situation in San Diego Bay, where a copper ore concentrate spill occurred; the regulatory agencies were forced by environmental groups to ignore the fact that toxicity testing with nine different sensitive organisms showed no toxicity to any organism from sediments that had as much as 18,000 mg/kg copper. The Port of San Diego, however, had to spend an additional \$6 million to remediate the contaminated sediments for which there will be no improvement in the designated beneficial uses of San Diego Bay.

Area of Needed Research in Sediment Quality Criteria Development and Implementation

In our writings over the years, we have repeatedly urged the US EPA and others to initiate studies the results of which could be used to properly implement sediment quality criteria - state standards into public policy for those constituents of concern because of the potential toxicity to aquatic life, such as many of the heavy metals. It is well known that many waterbodies have sediments that are toxic to aquatic life due to natural and anthropogenically derived constituents, yet have very good to outstanding aquatic life resources. At this time, there is essentially no understanding of the significance of laboratory based toxicity measurements to a waterbody's designated beneficial uses.

The US EPA cannot expect its Aquafund program to eliminate all sediment toxicity in US waters. It therefore will be necessary to understand what a certain degree of toxicity measured with certain organisms means to the characteristics of the waterbody of concern to the public who ultimately must fund a sediment associated remediation program. Without a technically valid basis for translating laboratory based sediment toxicity measurements to water quality impairments of concern to the public, the US EPA and state regulatory programs formulated for the purpose of sediment quality enhancement and protection will be of limited technical reliability.

The SAB, through its Sediment Criteria Subcommittee, should recommend to the EPA that they shift some of the funding that the Agency is now proposing to devote to finding other ways to try to normalize heavy metal data in sediments to account for detoxification reactions to the greater, more important issue of the interpretation of sediment toxicity test results in a regulatory framework. This is the information that the state and local agencies need.

SAB Review of the EPA's Approach for Developing Heavy Metal Sediment Quality Criteria

We are concerned about the approach that is being followed by the SAB in conducting its review of the AVS normalized heavy metal based sediment quality criteria. While the program for the January 4-6 meeting allowed one hour for public comments, we have to question whether there is real interest in receiving public comments by the EPA or the SAB when the public, and especially professionals who have worked for many years on the topic area, are not notified about the meeting. It is very important that the SAB not be an agent of the US EPA to help

justify its ill-conceived programs in sediment quality criteria development. There is widespread concern in the technical community about the US EPA's ability to influence SAB reports based on what happened between the draft equilibrium partitioning based approach for developing sediment quality criteria for selective non-ionic organic chemicals for the SAB report and the final report released by the SAB.

Clearly a properly conducted SAB review of the heavy metals sediment quality criteria would have provided public notice to professionals of this meeting well in advance of the meeting. Further, certainly anyone like ourselves who have previously commented on SAB review of sediment quality criteria should have received from the SAB well in advance of the meeting notice of the meeting so that they could actively participate in the review process. As it stands now, the so-called "public comment" part of this review is perfunctory and does not represent a credible effort on the part of the SAB or the US EPA to involve the public.

Reference

Lee, G. F., and Jones, R. A., "Sediment Quality Criteria Development: Technical Difficulties with Current Approaches and Suggested Alternatives," Report of G. Fred Lee & Associates, El Macero, CA, January (1992). [Condensed version published as Lee, G. F., and Jones, R. A., "Sediment Quality Criteria Development: Technical Difficulties with Current Approaches (Condensed Version)," In: Proc. HMCRI R&D 92 Conference on the Control of Hazardous Materials, HMCRI, Greenbelt, MD, pp 204-211 (1992).]

More recent reports and publications of G. Fred Lee & Associates on these issues are available online at www.gfredlee.com in the Contaminated Sediment section:

http://www.gfredlee.com/Contaminated_Sediment.html

<http://www.gfredlee.com/psedqual2.html>

Summary biographical information about G. Fred Lee is available online at:

<http://www.gfredlee.com/gflinfo.html>