Technical Discussion
Federal Dissolved Aquatic Life Ambient Water Quality Criteria
Compared to Montana Numeric Water Quality Standards
As Applied to Technical Impracticability Evaluations
Of Achieving Metals Standards at the Anaconda Smelter NPL Site

The surface water quality performance standards applied in the Anaconda Smelter Site Technical Impracticability (TI) waiver are for certain metals in surface water based on aquatic life. **Human health standards were not involved in this TI evaluation**. The metals of interest are generally insoluble in metallic form, but soluble in an oxidized state. They are referred to in this form as *divalent* metals. It is the divalent metals that can have toxic effects on aquatic life at elevated concentrations. Under the Clean Water Act, recommended criteria for divalent metals are prepared by the U.S. Environmental Protection Agency (EPA) and published as Section 304(a) of the Clean Water Act. These are the criteria that are proposed as the replacement standards in the proposed plan.

The 304(a) criteria are derived by a specific method in EPA's "*Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and their Uses*". This method uses toxicological testing results and statistical methodology to derive recommended criteria. EPA occasionally updates criteria using these guidelines when new toxicological test results become available. For example, the 1980 fresh water acute standard for cadmium was developed using 29 species while the 2016 revised standard used significantly more (101 species).

The toxicological data on which the criteria are based come from numerous sources including academia, industry, and government. When reviewing criteria, EPA evaluates the toxicological data for applicability and consistency using criteria in the guidelines. Most testing is conducted using established methodology such the "*Standard Guide for Conducting Acute Toxicity Tests on Test Materials with Fishes, Macroinvertebrates, and Amphibians*" (ASTM Designation E729-96). In this test, the metal is dissolved into specially-formulated water and the organisms are exposed to the water for specific periods of time under controlled conditions. Results are used to develop criteria by following the guidelines described above.

Toxicological effects to aquatic biota are thought to occur because divalent metals have the same ionic charge as calcium and the metals can interfere with biological processes involving calcium. Interferences can also occur with other divalent ions such as magnesium. The oxidized form of calcium, magnesium, and divalent metals occur in the dissolved state and the processes occur under aqueous conditions. This is considered to be the bioavailable form of the metals – those that are available for uptake by aquatic organisms. Exposure to metals via diet is not measured by these tests. This route uses a different test and is reported as a bioconcentration factor. Since the criteria are for contaminants in water, not in food sources, the recommended criteria focus on exposure to water.

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Early EPA-recommended criteria such as those contained in the *Red Book* (1976) and the *Gold Book* (1986) were published prior to the implementation of the guidelines and the ASTM standard. These were based on the unfiltered metals concentrations reported with the toxicological test results. **Toxicological research since that time has developed better models of exposure routes and toxic mechanisms generally determining the important toxicological effects occur as described above. As a result, EPA changed its recommended criteria in 1993 to use a dissolved metals concentration as being the bioavailable form.**

Montana retains the use of unfiltered metals concentrations for its standards. In a response to a comment on the dissolved standard in the 2016 triennial review of water quality standards under the Clean Water Act Section 303(c) by EPA, Montana responded:

> *On October 1, 1993, the U.S. Environmental Protection Agency (EPA), Office of Water recommended dissolved metals criteria to be adopted instead of total recoverable criteria as the State Water Quality Standard for metals to protect aquatic life. In the same memorandum, EPA maintained its position that the total recoverable fraction (TR) published under the 304(a) of the Clean Water Act is scientifically defensible and specified that it will approve individual state's risk management decisions to keep the total recoverable fraction as the water quality standard. The State of Montana adopted the total recoverable fraction as the water quality standard to protect aquatic life and human health, with the exception of aluminum which is expressed as the dissolved fraction (MT DEQ, 2012). In 2007, EPA issued a revised national recommendation for copper aquatic life criteria using the copper biotic ligand model (BLM) for those who wanted to use this approach (EPA 2007).*
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> *For the BLM, ten characteristics of the receiving water are necessary as inputs to the model (temperature, pH, dissolved organic carbon (DOC), major cations (Ca, Mg, Na, & K), major anions (SO4 & Cl), alkalinity, and sulfide). Whereas for the dissolved metal fraction, only two factors are necessary to implement the water quality standard: Factor one relates to the fact that the EPA's section 304(a) criteria for metals are expressed as total recoverable (TR) metal fraction, not as dissolved requiring a conversion factor (EPA 1996) to express the total recoverable fraction as a dissolved fraction; Factor two relates to Federal regulation 40CFR 122.45(c), which requires metal permit discharges to be expressed as total recoverable, not dissolved making, a translator factor necessary to determine the dissolved fraction of the total recoverable fraction in the fully mixed receiving water. This translator factor can be greatly influenced by temperature, pH, hardness, total suspended solids (TSS), particulate organic carbon (POC), dissolved organic carbon (DOC), acid volatile sulfides (AVS) as well as concentrations of other metals and organic compounds. A test of the parameters per site that influence the translation factor and development of the correspondent regressions to calculate the translator is the best approach. Other approaches have been used as interim measures in the absence of site specific information and conservative assumptions can be made. These approaches can be*

found in the EPA guidance document on how to develop a translator factor (EPA, 1996).

Although the dissolved fraction is more bioavailable to aquatic life, aquatic organisms are subjected to metals contamination from factors other than water. Dissolved fractions move with surface water and groundwater flows, interact with other compounds (ligands) to form complexes that reduce the apparent toxicity of the dissolved metal and adsorbed to sediment particles. Both the BLM and the dissolved fraction provide only estimates of water column toxicity. Ingestion of contaminated sediment is a pathway for aquatic organisms, therefore the use of sediment metals standards when using the BLM model or the dissolved metal fraction as water quality standard (WQS) is recommended (EPA, 1993). At present, there are not sediment standards, only guidance values. The total recoverable fraction is a more conservative approach but includes the particulates, which minimizes the need for a complementary sediment standard.

DEQ is currently in the process of evaluating data gaps, research needs, complexities and implications of the BLM and the dissolved fraction as a water quality standard. Stakeholder input will be incorporated to this process when the time arrives to present the findings. In the absence of these findings, the Board is not adopting use of the BLM in Montana and is not adopting the footnote suggested by the commenter. However, under Montana Code Annotated §75-5-310, a permit applicant, permittee, or person potentially liable under any state or federal environmental remediation statute may petition the Board of Environmental Review to adopt site-specific standards of water quality for acute and chronic life. The board's decision to adopt site-specific standards must be based on sound scientific, technical, and available site-specific evidence.

References

EPA. 2007. Aquatic Life Ambient Freshwater Water Quality Criteria – Copper – 2007 Revision. EPA 822-F- 007-001. U.S. Environmental Protection Agency, Office of Water. Washington, D.C.

EPA.1988. Ambient Water Quality Criteria for Aluminum. . EPA 440/5-88-008. U.S. Environmental Protection Agency, Office of Water. Washington, D.C.

EPA. 1996. The Metals Translator: Guidance for Calculating a Total Recoverable Permit Limit from a Dissolved Criterion. EPA 823-B-96-007. U.S. Environmental protection Agency, Office of Water. Washington, D.C.

EPA. 1993. Memorandum from Martha Prothro, Acting Assistant Administrator for Water. To: Water Management Division Directors. Subject: Office of Water Policy and technical Guidance on interpretation and Implementation of Aquatic Life Metals Criteria. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

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Based on the above response by the Montana Department of Environmental Quality, the state is attempting to be conservative by including the ingestion pathway as measured in the total recoverable (unfiltered) form of metals. The EPA guidelines for developing criteria specifically exclude toxicological tests where the organisms were fed. This limits the tests to include only those that evaluate the toxicological effects of the water column. **Since the ambient water quality criteria are applicable to water and not food sources to aquatic life, the criteria based on dissolved metals are appropriate for that purpose.**

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