



Water Quality Standards – Adoption of Biotic Ligand Model for Copper

Technical Support Document

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Executive Summary

State water quality standards (WQS) provide the basis for the development of effluent limits in Alaska Pollutant Discharge Elimination System (APDES) permits and water quality assessments per section 303(d) of the Clean Water Act (CWA). The Alaska Department of Environmental Conservation (DEC) adopted numeric criteria for copper (Cu) based on 304(a) aquatic life criterion issued in the *1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water* (EPA-820-B-96-001, September 1996).¹ The current criterion uses a hardness-based (combination of calcium and magnesium) equation to derive the applicable copper values in the water column.

The Alaska Department of Environmental Conservation (DEC) is proposing to adopt use of an alternative means of deriving water quality criteria for copper on a site-specific basis, entitled the *biotic ligand model* (BLM), as described in *Aquatic Life Ambient Freshwater Quality Criteria- Copper* (EPA-822-R-07-001, February 2007)².

Technical Support Document Application

This technical support document (TSD) is intended to describe DEC's technical and legal decision-making process and satisfy federal CWA requirements. It does not detail deliberations or specific implementation procedures that will be used by state water pollution control programs.

Alaska Water Quality Standards for Copper

18 AAC 70.020(b)(11) and 18 AAC 70.020(23) adopts by reference the *Alaska Water Quality Manual for Toxic and Other Deleterious Organic and Inorganic Substances* (Toxics manual) (2008). The Toxics manual adopts by reference EPA-recommended criteria for various metals including copper (freshwater) at Note 20:

This recommended criterion is based on a 304(a) aquatic life criterion that was issued in the 1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water, (EPA-820-B-96-001, September 1996).

DEC applies the 1995 criteria for copper using a formula-based approach³:

Hardness-dependent criteria may be calculated from the following for freshwater metals:

$$\text{Acute (dissolved)} = \exp \{m_A [\ln(\text{hardness})] + b_A\} \text{ (CF}^4\text{)}$$

$$\text{Chronic (dissolved)} = \exp \{m_C [\ln(\text{hardness})] + b_C\} \text{ (CF)}$$

Metal	m_A	b_A	m_C	b_C	Freshwater Conversion Factors
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¹ Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances (2008). Note 11.

² U.S. Environmental Protection Agency. 2007. Aquatic Life Ambient Freshwater Quality Criteria- Copper. EPA-822-R-07-001. Office of Water. Office of Science and Technology. Washington, D.C.

³ Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances (2008). Appendix A: Parameters for Calculating Freshwater Dissolved Metals That Are Hardness-Dependent.

⁴ "CF" means conversion factor

					Acute	Chronic
Copper	0.9422	-1.700	0.8545	-1.702	0.960	0.9422

U.S. Environmental Protection Agency Recommended Water Quality Criteria for Copper

In 2007 the U.S. Environmental Protection Agency (EPA) published nationally recommended ambient freshwater aquatic life criteria for copper (Cu) based on the application of the biotic ligand model (BLM). The BLM is a metal bioavailability model that uses water quality data to develop site-specific water quality criteria (WQC) for copper. Input data for the BLM include: temperature, pH, dissolved organic carbon (DOC), major cations (Ca, Mg, Na, & K), major anions (SO₄ & Cl), alkalinity, and sulfide.⁵ The collection and input of copper data is required use certain BLM tools. EPA also published freshwater BLM software to be used to generate aquatic life criteria to ensure consistency with the national recommendations.

As described by the EPA (2007), the BLM is a more robust means of accounting for site specific chemistry influences on copper's aquatic toxicity.

Per EPA (2007) p.10:

The BLM's ability to incorporate metal speciation reactions and organism interactions allows prediction of metal effect levels to a variety of organisms over a wide range of water quality conditions. Accordingly, the BLM is an attractive tool for deriving water quality criteria. Application of the BLM has the potential to substantially reduce the need for site-specific modifications, such as Water Effect Ratio, to account for site-specific chemistry influences on metal toxicity.

DEC currently uses the measurement of ambient water hardness described in in the 1995 *Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water*, (EPA-820-B-96-001, September 1996), and adopted by reference at Note 20 of the *Alaska Water Quality Manual for Toxic and Other Deleterious Organic and Inorganic Substances* (2022) to derive WQC applicable in state water pollution control programs. Application of the BLM for copper on a case-by-case basis expands on the relationship of water chemistry, copper bioavailability, and potential toxicity to aquatic life. Applying the BLM to derive water quality criteria in cases where the department determines that the quantity and quality of data meets the EPA (2007) recommendations will improve the accuracy of metal ecotoxicity predictions beyond those obtained with hardness alone.

EPA has endorsed state efforts to implement the EPA (2007) recommendations in a strategic manner:

States choosing to use the BLM on a targeted basis may consider adding a paragraph to their water quality standards noting that site-specific criteria for copper may be developed on a case-by-case basis using the approach described in EPA's *Aquatic Life Ambient Freshwater Quality Criteria – Copper 2007 Revision* (EPA-822-R-07-001). Or, states may choose to include a footnote indicating that if a site-specific criterion is

⁵ <https://www.epa.gov/wqs-tech/copper-biotic-ligand-model>. Referenced January 10, 2024.

generated using the BLM, the BLM-derived value becomes the site-specific copper criterion (see 40 CFR §131.36(b)(2) for an example).⁶

DEC has developed a performance-based approach (PBA)⁷ titled *Implementation of the Biotic Ligand Model for Derivation of Freshwater Aquatic Life Criteria for Metals on a Site-specific Basis in State Water Quality Standards* (2025). The PBA will be used to develop site-specific criteria to be used in CWA applications. For example, once the PBA has gained EPA approval and site-specific criteria have been developed in compliance with the PBA, these criteria may be applied to the calculation of water-quality based effluent limits in discharge permits..

Per the EPA Technical Support Document for Water Quality Based Toxics Control (1991):⁸

If the permitting authority can demonstrate that control of specific chemicals is sufficient to control toxicity to the point of achieving compliance with the water quality criteria, then the permit limits alone will be sufficient to comply with the regulation⁹. (Section 3.1.1. Pg. 48).

DEC proposes to amend Note 20 of the *Alaska Water Quality Manual for Toxic and Other Deleterious Organic and Inorganic Substances* (2022) to explicitly authorize use of the EPA (2007) recommended approach for deriving freshwater quality criteria for copper via application of DEC-adopted PBA (2024).

DEC has demonstrated the ability to derive such control through application of the hardness-based approach in existing APDES permits. Application of the PBA to develop site-specific criteria is a natural extension of the program.

DEC-Proposed Water Quality Standards Action

DEC is proposing to amend the Toxics Manual (2008) at Endnote 20 to read:

²⁰ This recommended criterion is based on a 304(a) aquatic life criterion that was issued in the 1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water, (EPA-820-B-96-001, September 1996). This value was derived using the GLI Guidelines (60FR15393-15399, March 23, 1995; 40CFR132 Appendix A); the difference between the 1985 Guidelines and the GLI Guidelines are explained on page iv of the 1995 Updates. None of the decisions concerning the derivation of this criterion were affected by any considerations that are specific to the Great Lakes. **Alternatively, for the derivation of water quality criteria for copper**

⁶ EPA Training materials on Copper BLM: Implementation. Downloaded from <https://www.epa.gov/sites/default/files/2015-11/documents/copper-implementation-training.pdf> (accessed July 27, 2022).

⁷ When states and authorized tribes choose to adopt both the water chemistry-dependent criteria and an associated derivation methodology; this concept – combining criteria with associated derivation methodology – is referred to as a “performance-based approach.” EPA first formalized the concept of a performance-based approach for water quality standards in the preamble of the rule EPA Review and Approval of State and Tribal Water Quality Standards. (EPA Review and Approval of State and Tribal Water Quality Standards 65 Fed. Reg. 24641 (Apr. 27, 2000))

⁸ U.S. EPA. 1991. *Technical Support Document for Water Quality-based Toxics Control*. EPA-505-2-90-001. United States Environmental Protection Agency, Office of Water. Washington, DC

⁹ 40 CFR 122.44(d)(1)(v)

considered to be protective of aquatic life (freshwater), the methodology outlined in *Aquatic Life Ambient Freshwater Quality Criteria – Copper* (EPA-822-R-07-001, February 2007), which is hereby adopted by reference, may be used as an alternative to the method outlined in the 1995 updates on a site-specific basis. The department will implement the BLM-derived criteria via the procedure outlined in sections 4 through 10 of the *Implementation of the Biotic Ligand Model for Derivation of Freshwater Aquatic Life Criteria for Copper on a Site-specific Basis in State Water Quality Standards* (2025), which is hereby adopted by reference. This document is available through the department website.

DEC considers this amendment and subsequent adoption of the *Implementation of the Biotic Ligand Model for Derivation of Freshwater Aquatic Life Criteria for Copper on a Site-specific Basis in State Water Quality Standards* (2024) by reference satisfies EPA-requirements at 40 CFR 11(b)(1) when adopting a water quality standard as it:

- References the applicable CWA Section 304(a) recommended criteria;
- The PBA includes statements of applicable duration and frequency;
- The PBA includes specific data collection, sampling, and QA/QC requirements;
- The PBA includes a description of how IWQC data outputs will be utilized to establish a WQC; and
- The PBA includes a means of making decisions publicly available.

References

Alaska Department of Environmental Conservation. 2022. Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances. Juneau Alaska.

Stephen, Charles E., et al. 1985. Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses. EPA Office of Research and Development, Environmental Research Laboratories. PB85-227049, Duluth, MN.

U.S. Environmental Protection Agency. 2007. Aquatic Life Ambient Freshwater Quality Criteria – Copper. EPA-822-R-07-001. Office of Water. Office of Science and Technology. Washington D.C.