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) and zinc (Zn) 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 approach uses a hardness-based (combination of calcium and magnesium) modeling approach to derive the applicable Cu and Zn 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 entitled the *biotic ligand model* (BLM), as described in *Aquatic Life Ambient Freshwater Quality Criteria- Copper* (EPA-822-R-07-001, February 2007),[2] for the development of water quality-based effluent limits for copper and zinc.

What are Alaska's Surface Water Quality Standards?

States adopt water quality standards (WQS) to protect public health or welfare, enhance the quality of state waters, and serve the purposes of the CWA. Alaska's WQS are established in regulations at 18 AAC 70. WQS generally consist of:

- The water quality goals or specific uses (i.e., classes and sub-classes) that will be protected in state waters,
- The criteria, both numeric and narrative, that will be used to determine whether such uses are being attained,
- An antidegradation provision to ensure existing water uses and the level of water quality necessary to protect existing uses are maintained and protected, and
- General provisions that affect implementation of WQS in state water pollution control programs (e.g., mixing zones, water quality standards variances).

Under the CWA, the term 'criteria' has two definitions. Under section 304(a), 'criteria' refers to specific numeric concentrations recommended by U.S. Environmental Protection Agency (EPA) that are considered to be protective of aquatic life and human health. Section 303(c) of the CWA defines 'criteria' as the numeric (or narrative) targets considered to be protective of the water quality goals (i.e. classes and subclasses). In each case, a criterion typically includes three components[3]:

[1] Alaska Department of Environmental Conservation (DEC). Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances (2008). Note 11.
[2] U.S. Environmental Protection Agency (EPA). 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] U.S. Environmental Protection Agency (EPA). 2017. *Water Quality Standards Handbook: Chapter 3: Water Quality Criteria.* EPA-823-B-17-001. EPA Office of Water, Office of Science and Technology, Washington, DC. Accessed June 2025. https://www.epa.gov/sites/production/files/2014-10/documents/handbook-chapter3.pdf

- Magnitude: Numeric or narrative value that represent the maximum allowable amount of a pollutant to be present in a waterbody while still considered to be protective of the associated use of that water.
- Duration: The time period used to calculate exposure (e.g., 1-hour or 96-hour average for toxic pollutants).
- Frequency: The allowable number of exceedances of the magnitude value that may occur within a specific time period. Frequency considers the amount to time required for a use to recover from the stress of exposure to a pollutant (e.g., no more than one exceedance every three years).

How are water quality standards revised?

WQS are revised periodically in accordance with state and federal administrative regulations. Revisions are made to incorporate new science, to meet new state or federal requirements, or to provide additional clarity to the regulated public. Per section 303(c) of the CWA and federal regulations at 40 CFR 131.21, WQS revisions must be submitted to the EPA for review and approval prior to use in state water pollution control programs (e.g., APDES permits, waterbody assessments).

States must submit the following documentation to EPA for consideration:

- State-adopted regulatory language,
- Methods used and analysis conducted in support of water quality standards revisions,
- Certification by state legal authority that the water quality standards were adopted pursuant to State law, and
- General information used to determine the adequacy of the scientific basis of the proposed standards and how the standard may be implemented in state water pollution control programs.

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 approach[4]:

> Hardness-dependent criteria may be calculated from the following equations for freshwater metals:
>
> Acute (*dissolved*) = exp $\{m_A[\ln(\text{hardness})] + b_A\}$ (CF^5)
>
> Chronic (*dissolved*) = exp$\{m_C[\ln(\text{hardness})] + b_C\}$ (CF)

Metal	m_A	b_A	m_C	b_C	Freshwater Conversion Factors	
					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 Cu. Input data for the BLM include: temperature, pH, dissolved organic carbon (DOC), major cations (Ca, Mg, Na, & K), major anions (SO_4 & Cl), alkalinity, and sulfide.[6] The collection and input of Cu 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.

[4] 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.
[5] "CF" is conversion factor
[6] https://www.epa.gov/wqs-tech/copper-biotic-ligand-model. Referenced January 10, 2024.

> 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 metals (i.e., copper) on a case-by-case basis expands on the relationship of water chemistry, Cu 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 generated using the BLM, the BLM-derived value becomes the site-specific copper criterion (see 40 CFR §131.36(b)(2) for an example).[7]

DEC has developed a performance-based approach (PBA)[8] 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* (2024). The PBA will be used by permittees seeking to develop site-specific criteria to be used in the calculation of permit-specific effluent limits and meeting the explicit requirements of the PBA. The PBA will serve as the foundation for developing water quality-based effluent limits, subject to APDES policies and procedures.

Per the EPA Technical Support Document for Water Quality Based Toxics Control (1991):[9]

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[7] 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).

[8] 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)

[9] 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

> 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 regulation[10]. (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 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 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 the 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 to satisfy EPA-requirements at 40 CFR 11(b)(1) as:

- The amendment references the applicable CWA Section 304(a) recommended criteria,
- The PBA includes site-specific statements of applicable duration and frequency,
- The PBA includes specific data collection, sampling, and QA/QC requirements,
- The PBA details how instantaneous water quality criteria (IWQC) derived by the BLM will be utilized to establish WQC; and

[10] 40 CFR 122.44(d)(1)(v)

- The PBA details how the Department will make 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.