VERMONT

Implementation Procedure for the 2018 Aquatic Life Water Quality Criteria for Aluminum

In 2018, the US Environmental Protection Agency (EPA) issued the Final Aquatic Life Ambient Water Quality Criteria for Aluminum national recommendations to protect aquatic life from the toxic effects of aluminum. The criteria document provides two primary methods for deriving instantaneous site-specific acute and chronic concentration values for aluminum that would be considered protective of aquatic life, given the conditions of pH, total hardness, and dissolved organic carbon (DOC) at the site. Vermont utilizes these two methods to derive acute and chronic numeric criterion values:

1) When concurrent data are available, calculate the criteria values for each waterbody or waterbody segment by entering the pH, total hardness, and DOC values into EPA's Aluminum Criteria Calculator V2.0;
2) When concurrent data are unavailable, use the default values for the input variables of pH, total hardness, and DOC and the associated aluminum criteria value in the lookup tables provided in the 2018 Water Quality Criteria document.

The calculator was derived using a multiple linear regression (MLR) technique to model the interactive effects of three parameters on the bioavailability and toxicity of aluminum to aquatic life, and the lookup tables were created using results from the calculator. The term input parameters refer to site-specific concurrently measured values, or default values when concurrently measured data are unavailable, of pH, total hardness, and DOC used to derive numeric values of the criteria magnitude (outputs) that represent local conditions, using the aluminum criteria calculator or the lookup tables.

Criteria derived through use of the criteria calculator or lookup tables will be used to develop Water Quality Based Effluent Limitations (WQBELs), reasonable potential determinations, permit limits, 303(d) listings, and TMDL targets, each of which will then be separately subject to EPA review.

Input Parameters

Vermont requires sufficiently representative data for pH, total hardness, and DOC to ensure that worst case conditions in the waterbody are being adequately captured downstream from the point of discharge.

The U.S. Environmental Protection Agency's NPDES Permit Writers' Manual describes the importance of characterizing critical conditions for the effluent and the receiving water. Section 4.5.1 of the Technical Support Document for Water Quality-based Toxics Control explains that, where adequate data exist, dynamic modeling techniques may be used in lieu of steady-state modeling using critical conditions.

Regardless of the method used to derive site-specific criteria values, the input parameters for pH, total hardness, and DOC are needed at each site. These parameters affect the bioavailability of aluminum and its toxicity to aquatic life; however, the interactive effect of these three parameters—pH, total hardness, and DOC—is not linear.

Although pH and DOC are the main factors driving aluminum bioavailability and toxicity, total hardness also has an effect. By knowing the pH, total hardness, and DOC in a waterbody, one may derive the numeric criteria values for aluminum for the acute exposure (i.e., the criterion maximum concentration, CMC) and the chronic exposure (i.e., the criterion continuous concentration, CCC) that will be protective of aquatic life.

Number of Sampling Events and Spatial Variability

To ensure that criteria values derived will protect aquatic biota during critical conditions (i.e., when aluminum is most bioavailable), Vermont requires the concurrent collection of water chemistry data for pH, total hardness, and DOC upstream of the discharge and under a range of temporal and spatial conditions to account for the variability of those parameters in each waterbody or waterbody segment. Conditions of pH, total hardness, and DOC may vary within a waterbody throughout the year, thereby affecting the bioavailability of aluminum over time. To identify when critical conditions may occur in a waterbody, Vermont requires that sampling data representative of summer, fall, winter, and spring conditions be collected for the three input parameters. A minimum of three samples will be collected upstream of the discharge and representing seasonal conditions (12 samples total). Sampling methods will adhere to guidance provided in the WSMD Field Methods Manual and Ambient Biomonitoring Network Bioassessments of Flowing Waters in Vermont Quality Assurance Plan 2018 for rivers (lotic waters).

If there are fewer than twelve samples, conservative default values, which reflect the 10th percentile (or the 5th percentile for waters with threatened and endangered species) based on statewide DEC water quality monitoring data, will be used. The Watershed Management Division's water quality database currently has 14,358 water chemistry observations of pH (9,478), total hardness (3,678), and DOC (1,202) from 2,171 monitoring locations across Vermont's rivers and streams. Before summarizing the data, outlier data points that were greater or less than three times the interquartile range of each parameter were removed, resulting in the removal of 75 pH observations, 15 total hardness observations, and 37 DOC observations. To reduce the effects of sampling or spatial bias, for example the preponderance of monitoring data from acid impaired watersheds, the 5th and 10th percentiles of pH, total hardness, and DOC were calculated and then averaged for each HUC8-sized basin across the state (Table 1).

Table 1 Average 5th and 10th percentiles of pH, total hardness, and DOC of Vermont basins

Parameter	5th Percentile	10th Percentile
pH	6.5	6.7
Total hardness (mg/l)	24.7	30.3
DOC (mg/l)	2.6	2.9

The 10th percentile default values will be used unless rare, threatened, or endangered species are present, in which case the 5th percentile default values will apply. Based on the 10th percentile default values, the acute criteria (CMC) would be 790 µg/L and chronic criteria (CCC) would be 340 µg/L. Based on the 5th percentile default values, the acute criteria would be 530 µg/L and chronic criteria would be 250 µg/L. If partial site-specific data (fewer than the 12 samples) are lower than the default values, then the site-specific data will be considered as input parameters to ensure criteria will be protective. For NPDES discharges, it is likely that there will be receiving water pH and hardness data available. The current RPD procedure uses maximum effluent concentration, at maximum design flow, which would ensure criteria are protective, even under worst case conditions.

The Vermont DEC Watershed Management Division monitors the water quality of lakes, ponds, rivers, streams, and wetlands across Vermont. The total number of river/stream and lake monitoring stations exceed 1,650 and 650 respectively. The Vermont Integrated Watershed Information System (IWIS) is an online data portal for water quality information. Water quality parameters include nutrients, metals, chloride, cations, anions, total hardness, alkalinity, pH, dissolved oxygen, temperature and dissolved organic carbon (DOC). This monitoring data will help provide and identify the chemistry data needed to satisfy input values for implementation of the Aluminum criteria.

If monthly data are provided as inputs to the calculator, then corresponding instantaneous criteria values will be generated for each month data was provided. Vermont will analyze the range of monthly instantaneous criteria values to identify criteria values (e.g., lowest 10th percentile of model outputs) that will be protective under conditions when aluminum is most bioavailable and most toxic to aquatic biota. For receiving waters with federal or state listed threatened and endangered species the 5th percentile of model outputs will be used.

Depending on the amount and quality of the data, different time periods and conditions throughout the year are best protected by different criteria values. A single set of acute and chronic criteria values which are protective throughout the year may be chosen or two or more different sets of acute and chronic criteria values can be used, appropriate to the different time periods and conditions for permitting and assessment purposes (e.g., seasonal criteria).

References

EPA. 2018. Final Aquatic Life Ambient Water Quality Criteria for Aluminum 2018. EPA-822-R18-001. Washington, D. C.: U.S. Environmental Protection Agency, Office of Water.

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EPA. 2010. NPDES Permit Writers' Manual. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA-833-K-10-001. September 2010.

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